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HEATH'S

PRACTICAL ANATOMY

A

MANUAL OF DISSECTIONS

EIGHTH EDITION

EDITED BY

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WITH 329 ENGRAVINGS ON WOOD

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PREFACE TO THE EIGHTH EDITION.

THIS Edition has been subjected to an extensive revision in order to bring it to a level with current teaching and the present requirements of the Examination Boards. The more recent progress in Topographical Anatomy, involving as it has a greatly increased precision of description, especially in connexion with the Viscera, has necessitated an almost complete reconstruction of certain sections and the addition of new matter to the extent of 150 pages; but the original plan of the work has been carefully preserved.

The plates of Arteries prefixed to the last three Editions, and a certain number of text illustrations, chiefly histological, have been removed as superfluous; but these have been replaced by nearly a hundred new cuts, some original, and some borrowed from other works.

I desire to acknowledge the valuable assistance afforded by my friend and former pupil, Dr. W. S. Griffith, in passing the work through the press.

WILLIAM ANDERSON.

2, HARLEY STREET, W.
August, 1893.

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MANUAL OF PRACTICAL ANATOMY.

INTRODUCTION.

By Practical Anatomy is meant the study of Anatomy by dissection of the dead body, in contradistinction to Descriptive Anatomy, taught by lectures, diagrams, and preparations.

In dissecting, there are four principal objects to be constantly borne in mind by the student :—1st. The impression on the memory of the facts of general anatomy taught in the lectures. 2nd. The study of those parts of the body more especially concerned in surgical affections and operations. 3rd. The education of the sense of touch, and of the hand in the use of instruments ; and 4th, the education of the eye in the knowledge of the several structures of the body, in various positions, and under varying circumstances. It is to assist the student in these requirements that the following work is designed ; and every effort has been made to present the facts of Anatomy in such a manner that they may be most easily grasped by the mind and retained by the memory ; it will be found also, that as far as is compatible with a work of the kind, attention is drawn to those points which have especial interest in the practice of medicine or surgery, and directions are given for the performance of many operations which do not seriously interfere with or injure the dissection. The education of the eye is a gradual and tedious process, but one which is pretty certain to be satisfactorily accomplished if the student do but use his hands properly, and therefore a few words on the manual part of dissection may not be out of place.

First, as to the INSTRUMENTS requisite for dissection. A case containing six scalpels, two pairs of scissors, a pair of dissecting forceps, a set of chain-hooks, a blow-pipe, and a probe, will enable the student to make all requisite dissections, supposing that he is allowed the use of a saw and chisel in the dissecting-room.

SCALPELS for dissection are made of two principal shapes : in one the edge is bevelled to the point, the back being straight ; in the other both back and edge are bevelled to a point midway between the two. The latter form is preferable for most purposes. The blade should not be more than an inch and a half long, and never double-edged, but the material of which the handle is constructed is a matter of indifference. For all ordinary dissection it will be found most convenient to hold the scalpel like a pen ; but for cleaning the fascia off muscles, and following out small nerves, it is better to hold it reversed, so that the back of the knife may be against the tissue which is to be preserved. In making the first incision through the skin of a limb, or in any other position where a long incision is required, the knife may, with advantage, be held under the hand, by which the wrist has more play, and the student has the opportunity of practising a mode of holding the knife which he will find very useful when operating on a living body.

The FORCEPS should be broad at the extremities and coarsely serrated, so that it may retain a firm hold on small portions of tissue. It is very important that the forceps should not be too strong in the spring, for in that case its use becomes so fatiguing to the hand that it is impossible to continue it for any length of time. It is also important to ascertain that the points do not separate when the blades are pressed forcibly together. The forceps should be held lightly between the thumb and the first and second fingers of the left hand, which may be steadied by resting the little finger on a neighbouring part.

The CHAIN-HOOKS should be strong, and bent in the direction of the thickness and not of the breadth of the steel, as in the latter case they are liable to be unbent under any considerable strain. Care should be taken that the chains are firmly linked, and that the central ring is sufficiently stout to bear any force that may be applied to it.

The SCISSORS should be large and strong. A curved pair will be found very useful in preparing the ligaments.

SOUNDS and STAFFS for introduction into the bladder are found in most dissecting rooms, together with SAWS and other large tools requisite for dissection.

The student will do well to bear in mind that he will probably be called upon in after-life to operate on the living body, and that the only true preparation for the task is careful dissection ; he should, therefore, as far as possible, conduct all his dissections as methodically and with as much care as if operating on the living body, and by this means he will do much to fit himself for his duties as a practical surgeon.

The SKIN consists of two principal layers, the true skin or derma, and the scarf-skin or epidermis. In the dead body, if at all decomposed, the epidermis or cuticle is easily separated, but it should be carefully preserved during the dissection, as it prevents the subjacent parts from drying. In removing the skin, the first incisions should be made at once through its whole thickness, and a corner being held with the forceps, the knife is to be carried with a sweeping movement beneath it, the edge being towards the skin and the back to the fascia, which should be left smooth and uniform. The under surface of skin neatly reflected is white, and the tissue beneath it more or less yellow.

The SUPERFICIAL FASCIA consists of loose areolar tissue containing more or less fat. It contains the superficial blood-vessels, nerves, and lymphatics, and may in some situations be divided into two layers.

The DEEP FASCIA is a more or less dense fibrous structure, usually white and glistening in appearance, lying beneath the superficial fascia, closely investing the musculature of the limbs, and sending inwards deep intermuscular processes or septa, some of which are strongly attached to the bones. It forms sheaths for the muscles, and gives attachment to muscular fibres. In some parts it may be subdivided into superficial and deeper laminæ, as in the neck and thigh.

In cleaning MUSCLES, it is essential that the fibres should be made tense by moving the limb or applying the hooks. A muscle should invariably be cleaned along its fibres, the dissector beginning at one edge and advancing steadily to the other, and thus reflecting a complete layer of fascia; the knife being held with the back to the muscle, to avoid injury to it. The attachments of a muscle (origin and insertion) should always be most carefully followed out, and studied on the separate bones; but it is important also to clean the fascia from the whole length of the muscle, or it will soon look dirty. A muscle should be divided, when necessary, midway between its origin and insertion, so that these important points may be preserved for further reference.

The action of the various MUSCLES may be roughly but very usefully investigated in the course of dissection. As a rule, the effect of the contraction of a muscle, upon any articulation over which it passes, may be estimated by ascertaining what movements at that joint approximate the origin and insertion of the muscle; but where the connection of a muscle with a pulley or sesamoid bone leads

B 2

to an alteration in the course of its long axis, the calculation must be made from the point at which the line of action is so changed. Where a muscle passes over more than one joint, its effects upon each articulation must be tested separately, and it should be seen in what way those effects are modified by changes of position in the other joints concerned.

The muscles may act: (1) as joint motors causing various alterations in the position of the bones (flexion, extension, abduction, adduction, rotation inwards and outwards, &c.); (2) as dilators or constrictors of the various apertures of the body—mouth, anus, palpebral fissure, &c.; (3) as dilators or constrictors of the thoracic and abdomino-pelvic cavities; (4) as motors of soft parts—skin, mucous and synovial membranes, &c.; (5) as tensors of deep fasciæ, as in the thigh; thus probably aiding the circulation in the muscles.

The influence of gravitation upon muscular action is very considerable. In certain cases movements of flexion involve a predominant exertion of the extensor muscles, and *vice versâ.* Thus in bending forward the body at the hips while in the standing position, the movement having been initiated by the flexors, the extensors come into play to restrain and regulate it: *i.e.*, to lower the trunk to the degree and at the rate required.

The ARTERIES of a subject are usually injected, and it is impossible to follow out all the minute branches without this assistance; but an opportunity should be taken by the advanced student to repeat his dissection upon an uninjected subject, in which the appearance of the parts more closely resembles that of the living body.

The VEINS may be divided into superficial and deep, the former running in the superficial fascia, the latter accompanying the arteries. The two sets of vessels are united by communicating branches. Nearly all the arteries of the limbs are accompanied by paired veins (*venæ comites*), the exceptions to this rule being the common femoral and the upper part of the axillary arteries. In the head and neck the veins are usually single, and sometimes do not lie in close relation with the arteries.

The LYMPHATICS as a rule accompany the veins and like the latter form two groups, superficial and deep, which inter-communicate through apertures in the deep fascia.

The main trunks of the NERVES and their principal branches are readily followed out, but their minute ramifications require more time and labour for their dissection than a student can usually afford to bestow upon them.

The BONES should be frequently referred to in the course of the dissection, in order that their relation to the muscles, fasciæ, ligaments and other structures may be thoroughly understood.

The student should bear in mind that his manual labour is only a part of his duty, and will be thrown away unless he at the same time study the description of the part upon which he is engaged; he therefore should not carry the dissection of his part so far that he cannot learn its description on the same day, and *at the subject;* and he should if possible re-peruse the description in the evening, and always on the next morning, before carrying the dissection any further.

In order to preserve a part, it is essential that the dissector should himself secure the skin around it with a few stitches, and wrap it with damp or oiled cloths. These may be dipped in some preservative solution, or common salt may be grated finely over the part. This latter, however, destroys the colour and smooth appearance of the structures. A dissected part should be sponged over daily, when it is uncovered for fresh dissection.

PART I.

DISSECTION OF THE ARM.

[*The Student is requested to read the "Introduction" before commencing the Dissection, unless he has done so on a previous occasion.*]

Before beginning the dissection, the student should make himself fully acquainted with the external configuration of the part and the relations of surface-markings to deeper structures; and if he has already dissected this region, he should make the incisions necessary to expose the principal arteries, nerves, &c., in the positions in which they are usually subjected to operation, taking care not to disturb the tissues unnecessarily, and to stitch up the incisions without delay.

The curves of the *clavicle* are generally seen with ease; but the finger should be carried along the bone to note any irregularity denoting old fracture, and to trace its articulation with the acromion process of the scapula, where the outer end of the bone usually overrides the acromion and may form a marked prominence. The *acromio-clavicular joint fissure* runs in a sagittal direction, and lies vertically above the middle of the upper extremity of the humerus when the hand is supinated. The *sterno-clavicular joint* should also be examined, and if the arm is freely moved, the extensive range of motion in the articulation will be better appreciated. The prominence of the *acromion* is best felt posteriorly, and the subcutaneous surface of the *spine of the scapula* continuous with the corresponding surface of the acromion should be traced as far as the external angle of the basal triangle.

The development of the *mammary region* varies according to the sex and age of the subject. The advanced student should notice in a female subject the condition of the *nipple* and its surrounding *areola*, as indicating previous pregnancies or the contrary, and he may advantageously practise removal of the breast by two elliptical incisions, one above, the other below the nipple, taking great care to remove the whole of the breast, and not to leave any glandular tissue attached to the skin or the deeper structures. The position of the nipple varies considerably even in the male. It lies most commonly over the fourth intercostal space, but in the female is often at a lower level.

The roundness of the front of the SHOULDER will be found to depend upon the projection of the *head of the humerus* beyond the bony arch formed above it by the acromion and coraco-acromial ligament, and in a thin subject the head of the bone and the bicipital groove may be readily felt when the arm is rotated outwards. Close to the inner side of the head of the humerus and immediately below the clavicle, but projecting forwards and outwards to a plane anterior to it, is the *coracoid process*, and the relation of these bones to each other should be carefully observed. In a muscular subject, a long, triangular groove or dimple, the *infraclavicular fossa*, at this point marks the separation between the upper parts of the deltoid and the pectoralis major; and a linear furrow, extending obliquely from near the inner end of the clavicle, occasionally marks the division between the sternal and clavicular fibres of the latter muscle. By lifting the arm and drawing it from the body, the anterior and posterior boundaries of the *axilla* will be made prominent, and the fascia extending from one to the other will be put on the stretch so that the finger cannot be pushed into the armpit; whereas if the arm is brought to the side the fascia is relaxed, and the finger will readily feel the head and neck of the humerus, with the great vessels and nerves to their inner side, and internal to these again the wall of the thorax, with probably some lymphatic glands.

The *biceps* muscle forms a prominence on the front of the ARM, and the *brachial artery* and *median nerve* can be traced along its inner border to the bend of the elbow, and the shaft of the humerus can be readily felt. The position of the *coraco-brachialis* may be seen on the inner side of the arm in a muscular subject, and on the outer side a sulcus corresponding to the insertion of the *deltoid*, and below this the convexity of the subcutaneous portion of the brachialis anticus, between the biceps and triceps. The *supinator longus* is seen crossing the lower part of the brachialis anticus to reach the outer side of the front of the arm. In front of the elbow is a hollow, corresponding to a space between the supinator longus and pronator teres (see p. 36), and occasionally the *superficial veins* stand out prominently, in which case venesection should be practised. The prominent *internal condyle* of the humerus and its relation to the *olecranon process* of the ulna should be observed, and the *ulnar nerve* can be felt between the two points of bone. The rounded *external condyle*, with the ridge leading to it, is distinct in most subjects, and, immediately below it, the *head of the radius*, which should be rotated, in order that its relation to the condyle may be better appreciated. The rounded posterior surface of the arm is formed by the *triceps* muscle.

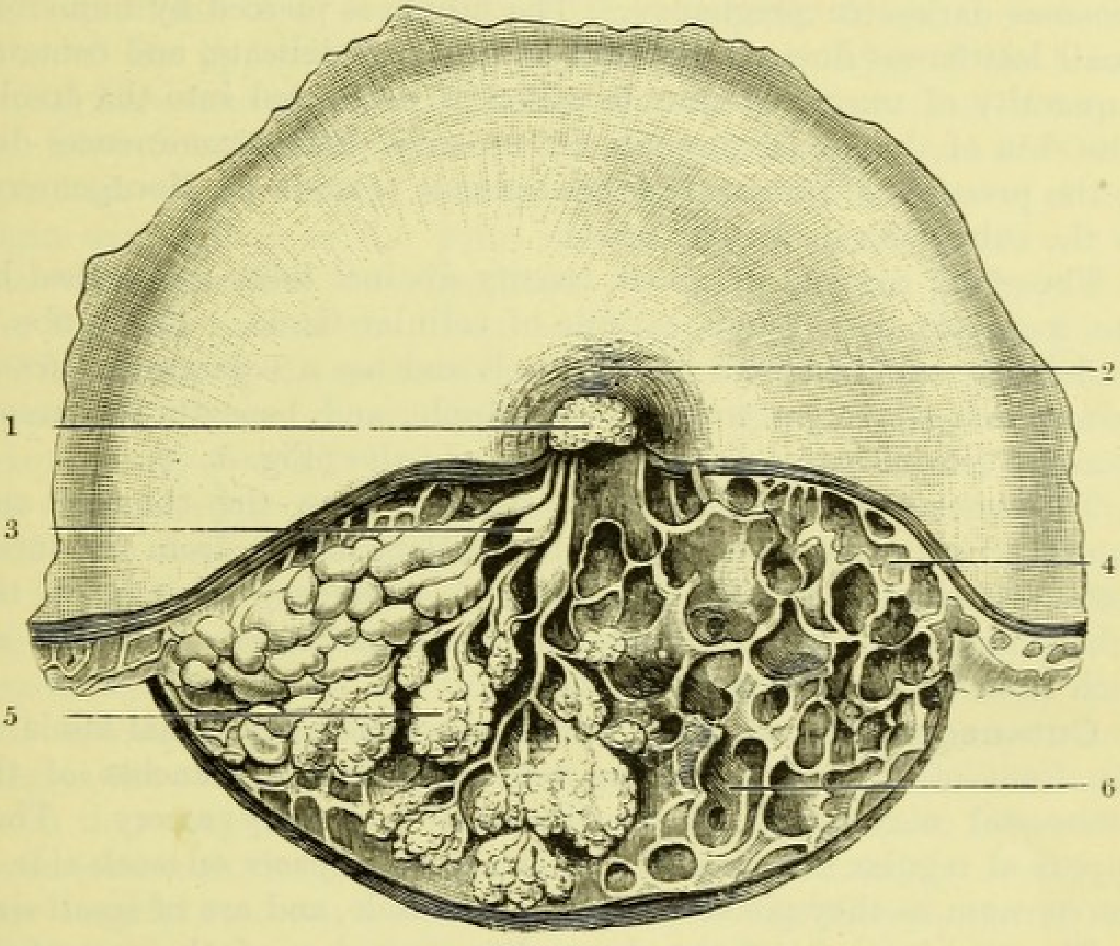
In the FORE-ARM the radius can be but little felt, except at its lower extremity; but the olecranon process and sharp posterior margin of the ulna are always to be recognised, even in very muscular subjects. The tendon of the biceps may be felt passing to its insertion. It should be observed that the ulna is the more prominent of the two bones at the wrist, whilst the end of the radius extends a little lower down than that of the ulna; and the styloid process of each can be readily distinguished. The tendons of the *flexor carpi radialis* and *flexor carpi ulnaris* are usually prominent, and serve as guides to the *radial* and *ulnar arteries*, which may be felt (if injected) to the outer, or radial, side of each tendon. In front, below the radio-carpal joint, may be felt the projection of the *pisiform bone* on the ulnar side, and, less distinctly, that of the tubercle of the scaphoid on the radial side. Behind and on the outer side may be traced the extensor tendons of the wrist, fingers, and thumb. In the HAND the *metacarpus* and the *phalanges* are to be examined, and the advanced student may advantageously amputate one or two fingers (middle or ring). It is to be borne in mind that the transverse markings, on either the palmar or dorsal aspect of the fingers, form no guide to the articulations. In the case of the metacarpo-phalangeal joints the line of articulation is about three-quarters of an inch on the proximal side of the web. When the finger is bent, the prominence at the articulation is due to the proximal bone, and the joint is distal to that point. The best rule, therefore, in amputating through the inter-phalangeal articulations, is to bend the phalanx which is to be removed to a right angle with the one above it, and to begin the incision on one side at a point midway in the thickness of the upper phalanx, and cut transversely to a corresponding point on the opposite side.

The limb should be carefully bandaged from the fingers to the middle of the upper arm, and only uncovered as far as may be necessary in the progress of the dissection.

[The arm being drawn away from the side, an incision is to be made half an inch to one side of the median line of the sternum in its whole length, and is to be joined at right angles by another running along the whole length of the clavicle to the acromion process, thence in a vertical direction half-way down the upper arm, and then across the inner aspect of the arm as far as the level of the posterior fold of the axilla. Another incision is to be made transversely from the ensiform cartilage, and must be carried beyond the posterior fold of the armpit. The large flap of skin thus marked out is to be reflected towards the arm, the dissector on the right side beginning at the lower end of the sternum, and on the left side at its upper extremity.]

Beneath the skin is the subcutaneous fascia, which is often very fatty. The mamma will also be exposed in the female, or its rudiment in the male subject, and an incision may be carried around the nipple so as to leave it attached to the gland in the

Fig. 1.



former. In a well-developed body the fibres of the platysma myoides may be seen arising from the fascia below the clavicle.

In the female the **Mamma**, or breast (Fig. 1), is a gland of very variable bulk lying upon the great pectoral muscle, from which it is

Fig. 1.—Dissection of mammary gland (after Luschka).

1. Mamilla, with orifices of lactiferous ducts.
2. Areola.
3. Ampulla of duct.
4. Subcutaneous fat loculi.
5. Acini of lacteal gland.
6. Gland loculi.

separated by a quantity of loose cellular tissue. Its base is tricuspid, and usually extends from the side of the sternum to the margin of the anterior wall of the axilla, reaching from the third to the sixth rib in the vertical direction. Two of the cusps or outlying processes run towards the axilla (one above, the other below), and the third extends towards the edge of the sternum, often reaching or overlapping it. From its pectoral surface minute lobules may penetrate the deep fascia and even become embedded in the fibres of the muscle. Immediately below the centre of its anterior surface, and usually between the fourth and fifth ribs, is the *mamilla* or nipple, around which is the *areola* of discoloured skin, the tint of which becomes darker in pregnancy. The nipple is pierced by numerous small lactiferous ducts. Its skin is thin and delicate, and contains a quantity of unstriped muscle which is prolonged into the areola. The skin of the areola presents a number of little prominences due to the presence of miniature lacteal glands (glands of Montgomery) in the subcutaneous areolar tissue.

The gland consists of about twenty distinct lobes ensheathed by the segments of a tough capsule of cellular tissue. Each lobe is abundantly supplied with blood-vessels and has a separate *lactiferous duct*, which converges towards the nipple, and beneath the areola becomes dilated into a *lacteal sinus* or *ampulla* (Fig. 1, 3).

The *arteries* of the breast are derived from the thoracic and external mammary branches of the axillary artery, from the intercostal arteries, and from the internal mammary branch of the subclavian, which runs behind the costal cartilages about half an inch from the border of the sternum.

Cutaneous Nerves and Vessels.—In the superficial fascia on the front of the chest are the *anterior cutaneous* branches of the intercostal nerves and of the internal mammary artery. They appear at regular intervals in the intercostal spaces on each side of the sternum as they pierce the pectoral muscle, and are of small size.

The terminations of the descending branches of the *superficial cervical plexus* may also be found beneath, or piercing, the platysma, and crossing the clavicle in the positions implied by their names, viz., *sternal*, *clavicular*, and *acromial*. Some twigs reach as low as the fourth rib.

[The pectoralis major is to be put on the stretch by drawing the arm from the side and supporting it at a convenient height, its fibres are then to be cleaned from below on the right, and from above on the left side. The strong axillary fascia is to be left untouched.]

The **Pectoralis Major** (Fig. 2, 2) consists of a sternal and a clavicular portion, separated at their origins by a cellular interval. The sternal portion *arises* from nearly the whole length of one side of the manubrium and body of the sternum, and by deep slips from the cartilages of all the true ribs except the seventh, and from the intercostal fascia, and is connected below with the aponeurosis of the external oblique muscle. The clavicular portion *arises* from the anterior surface of the inner or sternal half of the clavicle, and is separated from the deltoid muscle by another cellular interval, containing the cephalic vein and the humeral branch of the acromio-thoracic artery. The muscle is *inserted* into the anterior or outer edge of the bicipital groove of the humerus, by three superposed laminæ, the superficial layer consisting of the clavicular fibres, the middle layer of the upper sternal fibres, and the deep layer of the lower sternal fibres and those from the aponeurosis of the external oblique. The latter is continuous below with the middle layer, and its fibres cross each other in such a manner that those which are lowest at the origin are highest at the point of insertion, and *vice versâ*. It is more tendinous than the superficial layer, and sends a prolongation over the long head of the biceps to the capsule of the shoulder-joint.

The *action* of the pectoralis major is to flex, adduct, and rotate inwards the humerus, crossing it over the chest, and by its sternal fibres to draw forwards and inwards the whole scapular arch. If the arm were raised above the chest the muscle would depress it, or if the hand were fixed it would drag the trunk upwards, as in climbing. Its lower fibres may also act in extraordinary inspiration when the arm is fixed, as is seen in the case of asthmatic persons. It is *supplied* by the external and internal anterior thoracic nerves. In very well developed subjects, muscular slips are not unfrequently found lying at the side of the sternum and superficial to the pectoralis, with which they may have some connection; but they are more frequently continuous with the sterno-mastoid or rectus abdominis. A slip, of some surgical interest, is often found near the axillary border of the muscle connecting it with the biceps or the latissimus dorsi.

The Axilla.

[If the arm is well drawn from the side the boundaries of the axilla or armpit will be readily seen, and if the skin has not been already removed from the posterior boundary (latissimus dorsi), it should now be turned back. The strong deep fascia will be seen stretching from the pectoralis to the latissimus dorsi, forming the base of the conical space known as the axilla ; and the student should again notice that it is impossible to thrust the finger deeply into the space so long as the fascia is stretched by the extension of the arm, but that when the arm is drawn to the side the finger enters readily, and can feel the axillary artery (if injected), and the head of the humerus. The lateral cutaneous branches of the intercostal vessels and nerves are to be found behind the border of the pectoralis major, by carefully dividing the fascia parallel to the ribs.]

Lateral Cutaneous Nerves and Vessels.—The first intercostal nerve has no lateral branch, but six lateral branches from the upper nerves (from 2nd to 7th) will be found appearing at the side of the chest, between the digitations of the serratus magnus, and are

Fig. 2.

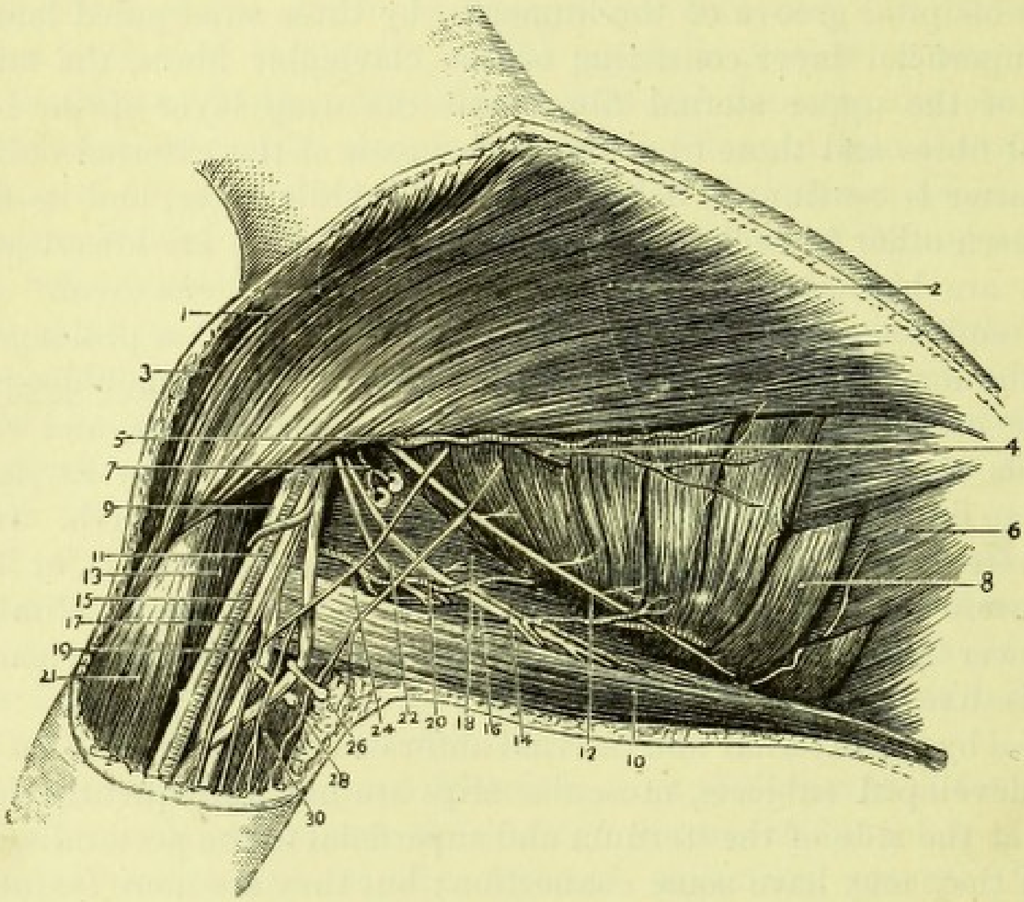


Fig. 2.—The axilla (drawn by J. T. Gray).

1. Cephalic vein.
2. Pectoralis major.
3. Deltoid.
4. Pectoralis minor.
5. Long thoracic artery.
6. Obliquus externus.
7. Alar thoracic artery.
8. Serratus magnus.
9. Median nerve.
10. Latissimus dorsi.
11. Axillary artery.
12. Posterior thoracic nerve.
13. Coraco-brachialis.
14. Long subscapular nerve.
15. Ulnar nerve.
16. Teres major.
17. Internal cutaneous nerve.
18. Subscapularis.
19. Nerve of Wrisberg.
20. Subscapular artery.
21. Biceps.
22. Middle subscapular nerve.
24. Intercosto-humeral nerve.
26. Basilic vein becoming axillary vein, held aside by hooks.
28. Musculo-spiral nerve.
30. Triceps.

accompanied by corresponding arterial twigs. Each lateral cutaneous nerve, except that of the second, divides into anterior and posterior branches, which turn forwards to the pectoral region, and backwards over the latissimus dorsi respectively.

The lateral cutaneous branch of the second nerve passes down the inner side of the arm to join the lesser internal cutaneous nerve, or nerve of Wrisberg, and is hence called the *intercosto-humeral nerve.* The corresponding branch from the third nerve usually accompanies and joins this. These last must be found at once and are to be carefully preserved (Fig. 2, 24).

[All the fat is to be removed from the axilla, and the muscles cleaned so far as they are exposed. Care must also be taken not to injure the following structures whilst cleaning them :—the axillary vessels (particularly the vein) and the large nerves, which are to the outer side of the space ; the posterior thoracic nerve, which runs vertically upon the serratus magnus, near the posterior wall of the axilla, giving off a branch to each digitation of the muscle ; the subscapular vessels at the outer border of the subscapularis ; the long thoracic artery, near the lower border of the pectoralis minor ; and the three subscapular nerves which cross the space, passing from above downwards and outwards. One or two of the numerous lymphatic glands should also be preserved.]

The **Axilla** (Figs. 2 and 3) is a conical space between the chest and upper arm, and has the following boundaries :—*In front*, the pectoralis major, the pectoralis minor, and the clavicle and subclavius ; *behind*, the subscapularis, latissimus dorsi, and teres major muscles, with the body of the scapula ; to the *inner side*, the serratus magnus, with the four upper ribs and intercostal spaces ; and to the *outer side*, the coracoid process, the upper part of the humerus and the coraco-brachialis and biceps muscles. The *base* of the cone has already been seen to be formed by the axillary fascia stretched between the anterior and posterior boundaries, and the *apex* is represented by a triangular interval between the clavicle, the upper border of the scapula, and the first rib. The great vessels and nerves, entering at the apex, lie along the outer boundary of the space, the artery being first on the outer side of the nerve cords, then between them, and the vein keeping to the inner side of the artery, whilst most of the branches of the artery take a general direction towards the thorax. Towards the inner side of the space, and imbedded in fat, are the glands, ten or twelve in number, which receive the lymphatics from (1) the front of the chest and the mamma, (2) the abdomen as low as the umbilicus, (3) from the arm and (4) from part of the back. The superficial glands lie along the edge of the pectoralis, and the deeper ones mostly in close proximity to the axillary vein, but others are found at the back of the axilla along the subscapular vessels. They are

Fig. 3.

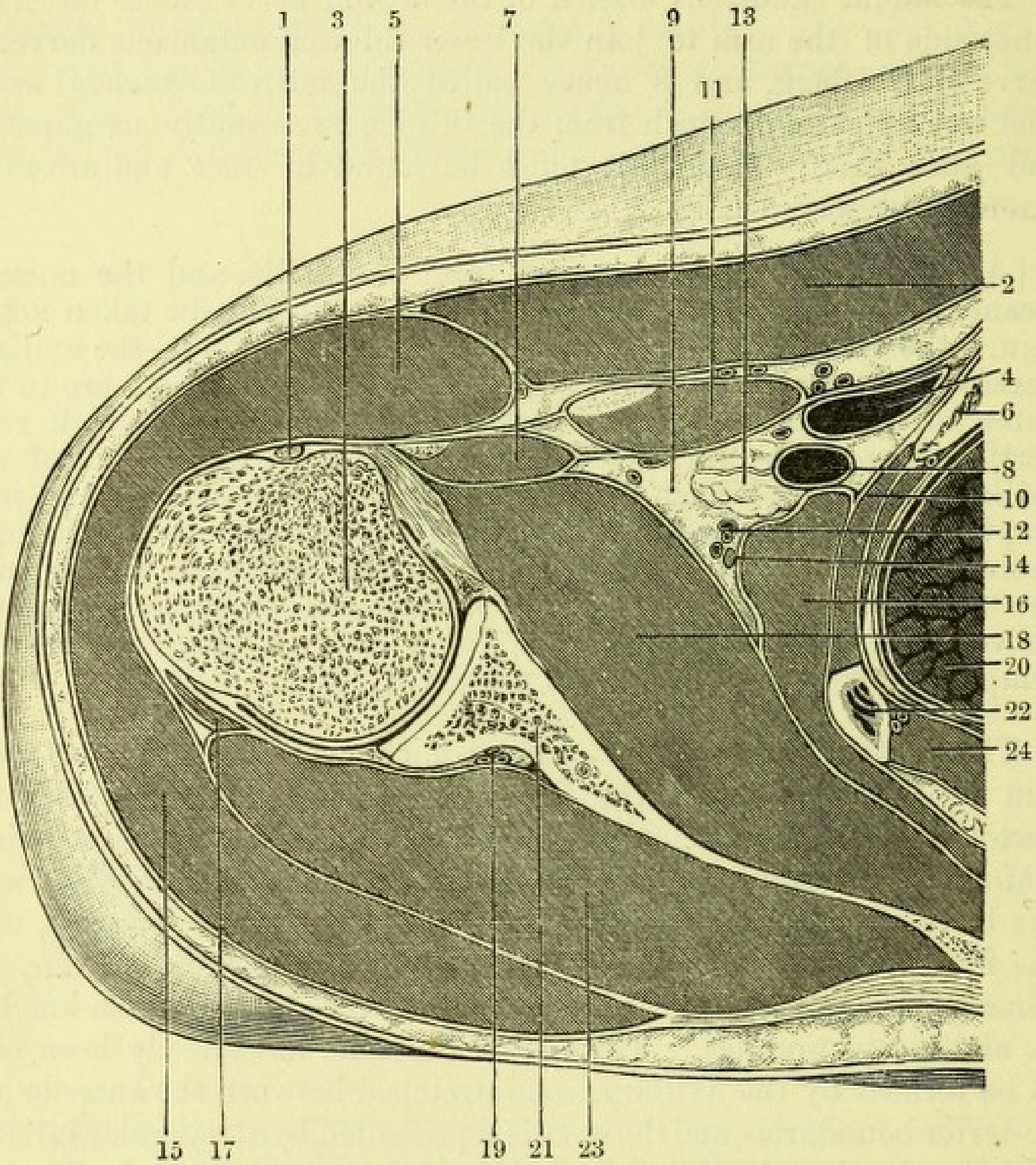


Fig. 3.—Horizontal section of left axilla (after Braune).

1. Long tendon of biceps.
2. Pectoralis major.
3. Head of humerus.
4. Axillary vein.
5. Deltoid.
6. First rib.
7. Coraco-brachialis and biceps.
8. Axillary artery.
9. Fat of axilla.
10. External intercostal.
11. Pectoralis minor.
12. Thoracic vessels.
13. Brachial nerves.
14. Nerve of Bell.
15. Deltoid.
16. Serratus magnus.
17. Teres minor.
18. Subscapularis.
19. Suprascapular vessels.
20. Lung.
21. Scapula.
22. Second rib.
23. Infra-spinatus.
24. Intercostal.

connected above with the deep cervical glands, which are hence liable to infection in the later stages of cancer of the breast.

Opportunity is to be taken, before any further dissection is made, to expose the lower part of the axillary artery thoroughly, as that is the portion of the vessel to which a ligature is most easily applied. It should be noted that a portion of the subclavian artery is exposed in the dissection of the axilla.

Surgery.—*To tie the axillary artery.* This operation is seldom required, but can be performed in two situations, above or below the pectoralis minor. *Above* the muscle the artery may be reached by a curved or straight incision below the clavicle, reaching from the sterno-clavicular joint to the coracoid process, and dividing the clavicular fibres of the pectoralis major. The fascia prolonged from the costo-coracoid membrane to the sheath of the vessels must then be incised, and the cephalic vein held aside, when a branch of the acromio-thoracic artery will be seen, and may be traced down to the axillary trunk, which has the vein to the inner and the brachial cords to the outer side.

Below the pectoralis minor the axillary artery may be reached by an incision parallel to the edge of the pectoralis major, and about midway in the axilla. The axillary vein first comes into view, and on drawing this inwards, the artery will be found surrounded by the cords of the brachial plexus, which must be displaced in order to expose it. The aneurism needle is to be passed from below (in this position), *i.e.*, between the vein and artery.

Both these operations are rather destructive of an important dissection, and should not usually be attempted.

When the axillary artery is tied the circulation in the limb will depend mainly upon the anastomoses between the branches of the artery above and below the ligature, *i.e.*, of the superior and acromio-thoracic with the subscapular and circumflex arteries. These last will also bring blood by their anastomoses with the supra-scapular and posterior scapular arteries from the thyroid axis, a branch of the subclavian, and the thoracic branches of the subscapular also communicate with the intercostal arteries.

[The clavicular portion of the pectoralis major is to be divided vertically about its middle and reflected, without injuring the cephalic vein, when branches of the acromio-thoracic artery and the external anterior thoracic nerve will be seen entering its under surface. After clearing away some loose cellular tissue, the coracoid process and the insertion of the pectoralis minor will be exposed, with the costo-coracoid membrane above the latter.]

The **Costo-coracoid Membrane** (Fig. 4, 2) is a strong fascia consisting of two layers, which embrace the subclavius muscle. It is attached above to the two lips of the subclavius groove on the under surface of the clavicle, internally to the first rib, and externally to the coracoid process. The two layers meet below, forming a distinct curved edge with the concavity downwards. A thin prolongation extends from it to the sheath of the axillary vessels and to the fascia of the pectoralis minor, and is perforated by the cephalic vein, the acromio-thoracic vessels, and the external anterior thoracic nerve.

The **Subclavius** (Fig. 4, 5) is a small muscle which *arises* by a tendon from the first rib at the junction of bone and cartilage, and is *inserted* into the groove on the under surface of the middle third of the clavicle. It is a depressor of the clavicle and shoulder girdle, and is *supplied* by a special branch of the fifth cervical nerve given off in the neck.

The *sheath* of the axillary vessels is derived from the deep cervical fascia, and is strengthened by a process of the costo-coracoid membrane. It may be traced into the arm, forearm, and hand.

[The costo-coracoid membrane and sheath of the vessels are to be carefully removed without injury to the superior and acromio-thoracic arteries, and the axillary artery and vein and brachial nerves in their upper part are to be cleaned. This dissection will admit light into the upper part of the axilla, and allow its boundaries and contents to be better studied. The remainder of the pectoralis major is then to be divided and reflected, to expose the pectoralis minor with the long thoracic artery at its lower border.]

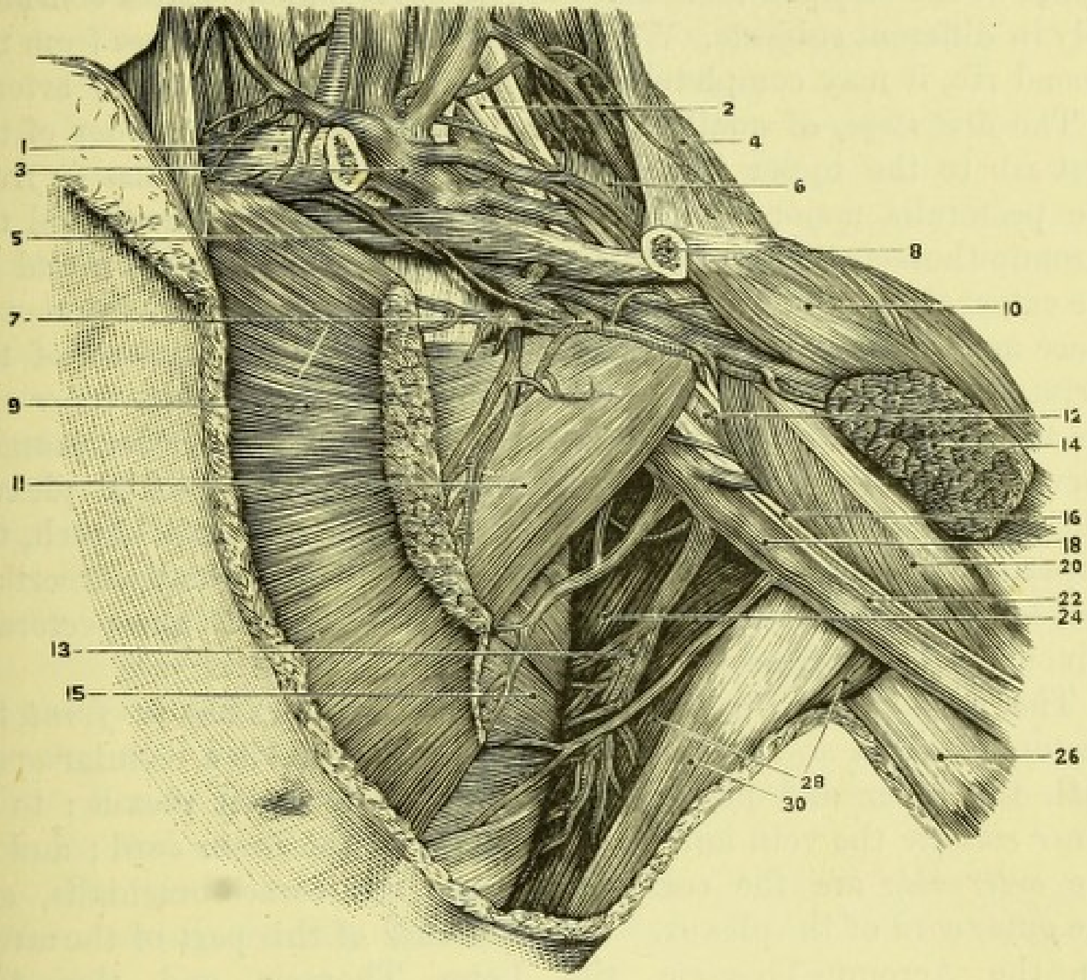
The **Pectoralis Minor** (Fig. 4, 11) lies beneath the pectoralis major, and is invested on both surfaces by a *fascia* which is attached above to the costo-coracoid membrane, and below to the axillary fascia, dividing the axillary space into two compartments. It *arises* from the anterior extremities of the bony portions of the third, fourth, and fifth ribs, sometimes also from the second, and from the intercostal fascia, and is *inserted* into the inner side and upper surface of the coracoid process of the scapula, and commonly also into an inter-muscular septum between it and the coraco-brachialis. It crosses the axillary vessels and nerves obliquely, and is said to divide the artery into three stages.

Action.—The muscle draws the coracoid process downwards, forwards, and inwards, and with it the whole scapular arch, increasing the range of motion of the upper extremity in these directions. It is also an extraordinary muscle of inspiration if the coracoid process be fixed.

It is *supplied* by the internal anterior thoracic nerve, which perforates it to reach the pectoralis major.

[The pectoralis minor is to be divided two inches from its insertion, when the axillary vessels and nerves will be fully exposed and must be cleaned. The small nerve emerging from between the artery and vein, and entering the pectoralis minor, is the internal anterior thoracic.]

Fig. 4.



The **Axillary Artery** (Figs. 4, 12, and 5, 4) is the continuation of the subclavian, and extends from the lower border of the first rib, opposite the middle of the clavicle, to the lower border of the inser

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Fig. 4.—Deep dissection of the axilla (from Bonamy and Beau).

1. Clavicle.
2. Brachial plexus.
3. Subclavian vein.
4. Trapezius.
5. Subclavius.
6. Serratus magnus (upper digitation).
7. Acromio-thoracic vessels.
8. Clavicle.
9. Pectoralis major.
10. Deltoid.
11. Pectoralis minor.
12. Axillary artery.
13. Subscapular vessels.
14. Pectoralis major.
15. Serratus magnus.
16. Median nerve (partially seen).
18. Axillary vein.
20. Biceps and coraco-brachialis.
22. Internal cutaneous nerve.
24. Subscapularis.
26. Triceps.
28. Teres major.
30. Latissimus dorsi.

tion of the teres major. In its upper part it is placed deeply in the axilla, but its lower portion is comparatively superficial. The artery is divided into three parts, the first, *above*; the second, *behind*; and the third, *below* the pectoralis minor; but it should be remembered that the position of the muscle shifts to some extent with the movements of the scapular arch, and that its development varies considerably in different subjects. When the pectoralis minor arises from the second rib, it may completely cover the upper portion of the artery.

The *first stage*, of small extent, runs from the lower border of the first rib to the upper border of pectoralis minor. It has *in front* the pectoralis major muscle, the costo-coracoid membrane and the acromio-thoracic artery, and is crossed by the cephalic vein and by the external anterior thoracic nerve; *behind*, it has the first intercostal space and second rib, with the first and second digitations of the serratus magnus and the posterior thoracic nerve; to its *inner side* are the axillary vein, lymphatics, and the internal anterior thoracic nerve, and to the *outer* are the large cords of the brachial plexus. This part of the artery generally gives off a single small branch, the Superior Thoracic. The acromio-thoracic, which is usually described as a branch of this stage, nearly always arises beneath the pectoralis minor and hence from the second stage.

The *second stage* (behind the pectoralis minor) has *in front* the pectoralis major and the pectoralis minor; *behind* is a cellular space with the inner and posterior cords of the brachial plexus; to its *inner side* are the vein and the lower part of the inner cord; and on the *outer side* are the coracoid process, the coraco-brachialis, and the outer cord of the plexus. The branches of this part of the artery are the Acromio-Thoracic, the Long Thoracic and the Alar Thoracic.

The *third stage* (from the lower border of the pectoralis minor to the lower border of the teres major) has *in front* the pectoralis major, the inner head of the median nerve, the large internal cutaneous nerve, and the outer brachial vena comes crossing at a variable point to join the inner: below the lower border of the pectoralis major the artery is subcutaneous; *behind*, it lies upon the lower part of the subscapularis, the tendon of the latissimus dorsi, and a small portion of the teres major muscle, with the musculo-spiral and the circumflex nerves; to its *inner side* is the axillary vein (formed by the junction of the basilic vein with the venæ comites), with the inner head of the median nerve (for a short distance), the ulnar, and the lesser internal cutaneous (Wrisberg) nerves; to the *outer side* is the coraco-brachialis muscle, with the outer head of the median at first, but lower down the entire nerve, and also the external cutaneous nerve until it pierces the coraco-brachialis. The branches of this portion are the Subscapular, Anterior Circumflex, and Posterior Circumflex, all of which usually arise near the lower border of the subscapularis.

Branches of the Axillary Artery (Fig. 5).

1. The *superior thoracic* (3) is a small branch supplying the side of the chest about the first and second ribs, and anastomosing with the internal mammary and intercostal arteries.

2. The *acromio-thoracic* (*thoracica-humeraria ; thoracic axis*) (1) is a large branch which arises from the artery behind the pectoralis minor, and after reaching the upper border of the muscle, pierces the costo-coracoid membrane and divides into four branches. One (*thoracic*) runs forward to supply the serratus magnus, intercostals, and pectoralis muscles ; a second (*acromial*) passes outwards to the acromion process and shoulder, anastomosing with the posterior circumflex and suprascapular ; a third (*humeral*) downwards in the groove between the pectoralis major and deltoid by the side of the cephalic vein; and a fourth (*clavicular*) upwards to the clavicle and subclavius.

3. The *long thoracic* (5) runs along the lower border of the pectoralis minor to the side of the chest, where it supplies the mamma, and is hence sometimes called the external mammary artery. It anastomoses with the internal mammary, intercostal, acromio-thoracic, and subscapular arteries. A separate *external mammary* artery often exists in females, parallel with but external to the long thoracic, and assists in supplying the breast.

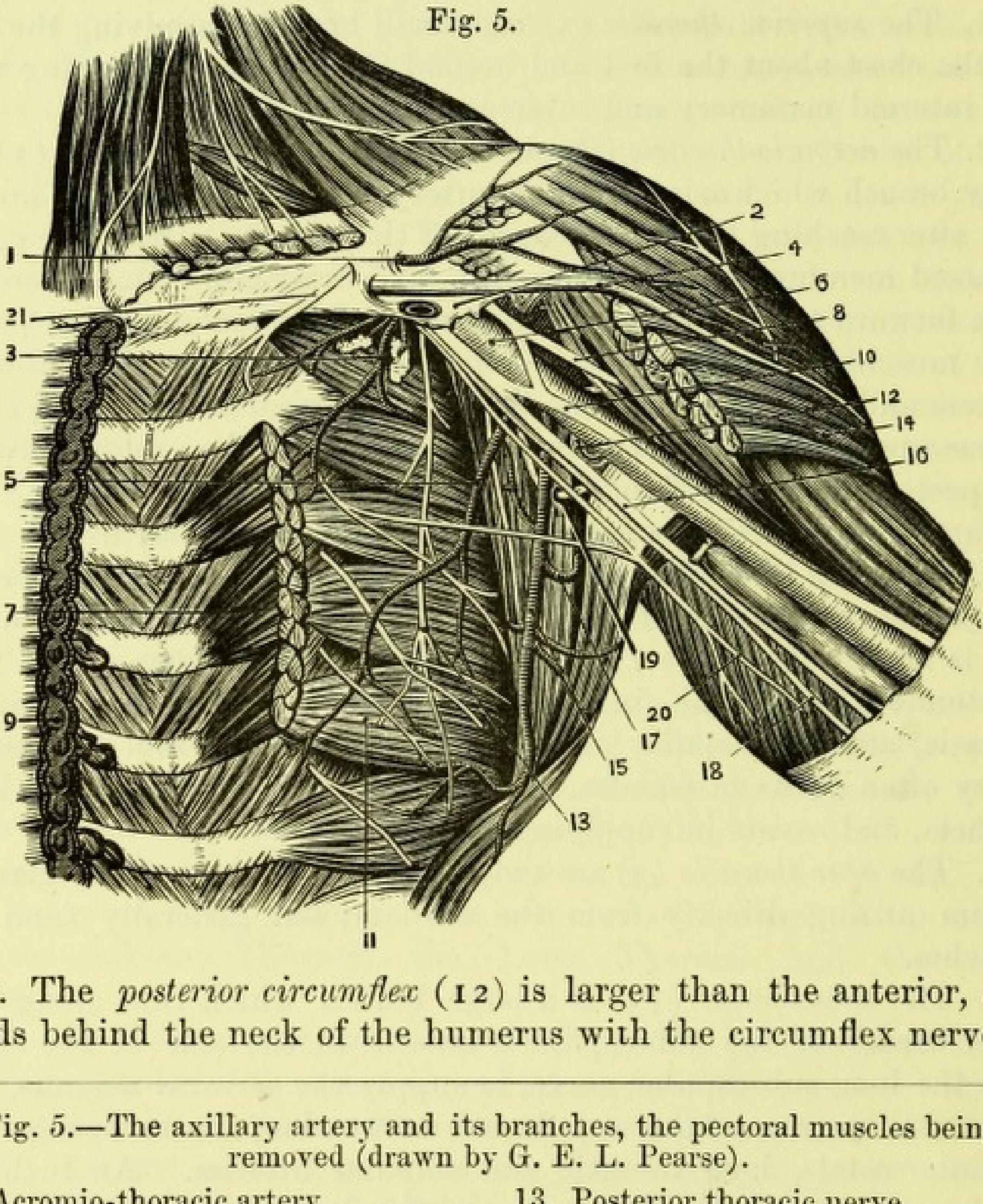
4. The *alar thoracic* (3) are twigs of supply to the axillary glands, seldom arising directly from the axillary, but generally from its branches.

5. The *subscapular* (15) is a large branch which runs along the lower border of the subscapularis muscle to the side of the chest with the long subscapular nerve, to supply the serratus magnus, the intercostal spaces, and the scapula and its muscles ; anastomosing with the intercostals, long thoracic and scapular arteries. An inch or less from its origin this artery gives off a large branch, the *dorsalis scapulæ* (17), which winds round the lower border of the subscapularis muscle, grooving the axillary border of the scapula, and, after giving a ventral branch, disappears through a triangular interval, bounded (as seen from the front) by the long head of the triceps, the teres major, and the subscapularis. The terminal branch of the subscapular runs to the angle of the bone and anastomoses with the termination of the posterior scapular.

6. The *anterior circumflex* is a small branch winding around the neck of the humerus beneath the coraco-brachialis and biceps, which

it supplies, giving also an ascending branch up the bicipital groove to the shoulder-joint, and a descending branch to anastomose with the superior radial collateral branch of the brachial. It terminates by communicating with the posterior circumflex.

Fig. 5.



7. The *posterior circumflex* (12) is larger than the anterior, and winds behind the neck of the humerus with the circumflex nerve to

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Fig. 5.—The axillary artery and its branches, the pectoral muscles being removed (drawn by G. E. L. Pearse).

1. Acromio-thoracic artery.
2. Costo-coracoid membrane with cut axillary vein.
3. Superior thoracic and alar thoracic arteries.
4. Cephalic vein.
5. Long thoracic artery.
6. Axillary artery.
7. Pectoralis minor (cut).
8. Musculo-cutaneous nerve.
9. Pectoralis major (cut).
10. Median nerve.
11. Serratus magnus.
12. Posterior circumflex artery.
13. Posterior thoracic nerve.
14. Pectoralis major.
15. Subscapular artery.
16. Ulnar nerve.
17. Dorsalis scapulæ artery.
18. Internal cutaneous nerve.
19. Circumflex nerve (drawn down).
20. Nerve of Wrisberg joined by intercosto-humeral nerve.
21. External anterior thoracic nerve. The internal anterior thoracic should be shown emerging between the axillary artery and vein.

supply the deltoid, passing through a quadrilateral space bounded (as seen in front) by the teres major, subscapularis, long head of the triceps, and the neck of the humerus. It also supplies branches to the shoulder-joint, the greater tuberosity of the humerus and the acromion. It anastomoses with the anterior circumflex, the suprascapular and the superior profunda.

The **Axillary Vein** (Fig. 4, 18) lies to the inner side of the artery. It is formed by the junction of the basilic vein with the *venæ comites* of the brachial artery, usually near the upper border of the teres major, and, having received tributaries corresponding to the branches of the axillary artery, and sometimes the cephalic vein immediately below the clavicle, it reaches the outer border of the first rib and becomes the subclavian. It is intimately related to the axillary lymphatics.

Brachial Nerves (Fig. 7).—The large cords of the brachial plexus are derived from the anterior branches of the 4th (communicating branch), 5th, 6th, 7th, 8th cervical and the greater part of the 1st dorsal nerves, which make their appearance in the posterior triangle of the neck (Part IV.). The nerves coalesce and divide again in a variable manner (see Posterior Triangle of the Neck), but the result is that they enter the axilla as three cords, lying to the outer side of the first part of the axillary artery. The posterior and internal cords then pass behind the second stage of the vessel, the latter continuing its course to reach the inner side, while the outer cord remains external ; and the several branches derived from these trunks, and now to be examined, more or less surround the artery in its third part. The plexus consists occasionally of only two cords, when it enters the axilla ; in which case a third cord is formed below the clavicle by the union of branches derived from these two cords.

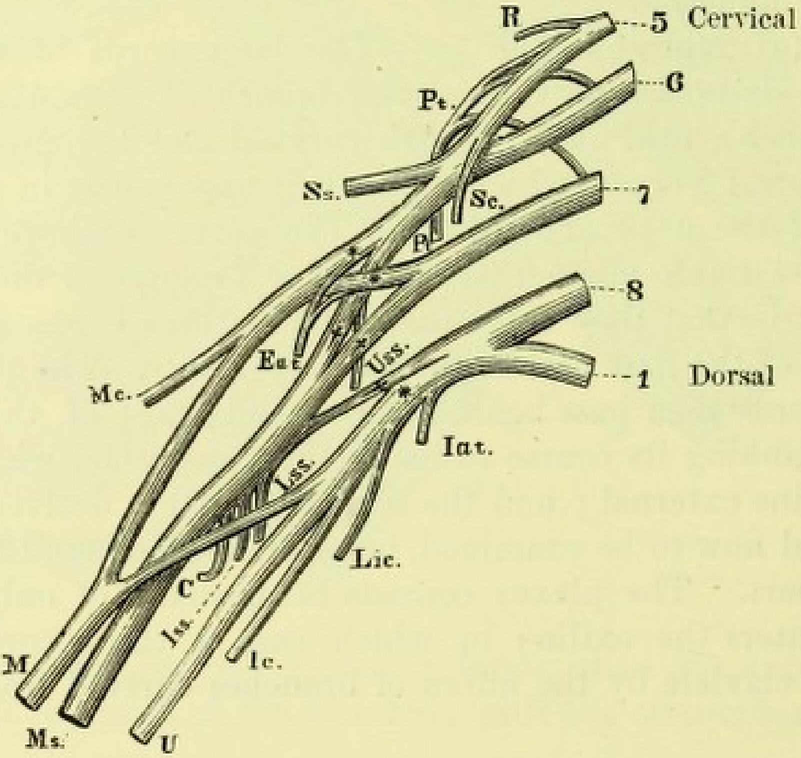
Brachial plexus formed by 5th, 6th, 7th, 8th cervical, and 1st dorsal nerves, with communicating branch above from 4th cervical . .	Outer cord . . . From 4th, 5th, 6th, and 7th cervical nerves.	External anterior thoracic. External cutaneous. Outer head of median.
	Inner cord . . . From 8th cervical and 1st dorsal nerves.	Internal anterior thoracic. Inner head of median. Ulnar. Internal cutaneous. Lesser internal cutaneous.
	Posterior cord . . From 5th, 6th, 7th, and 8th cervical nerves.	Three subscapular nerves (5th, 6th, 7th, and 8th c.). Musculo-spiral (6th, 7th, and 8th c. nerves, and 5th c. and 1st d.) Circumflex (5th and 6th c.).

The several branches are to be thoroughly identified, and their relations to the vessels ascertained (*vide* AXILLARY ARTERY); but the description of the majority of them is more conveniently taken at a later stage of the dissection.

The *External anterior thoracic nerve* (11) is a small branch derived from the outer cord, going to the under surface of the clavicular and upper sternal portion of the pectoralis major, which it supplies. It pierces the costo-coracoid membrane, and crosses the first stage of the axillary artery.

The *Internal anterior thoracic nerve* (10) is a small branch from the inner cord, which passes between the axillary artery and vein

Fig. 6.



to supply the pectoralis minor, and after communicating with the preceding nerve, sends a twig through the muscle to supply the lower part of the pectoralis major.

Fig. 6.—Diagram of the brachial plexus (Clement Lucas).

P. Nerve to rhomboid.
Pt. Posterior thoracic.
Ss. Supra-scapular.
Sc. Nerve to subclavius.
Mc. Musculo-cutaneous.
M. Median.
Eat. External anterior thoracic.
Uss. Superior subscapular.
Lss. Middle and inferior subscapular.
C. Circumflex.
Ms. Musculo-spiral.
U. Ulnar.
Ic. Internal cutaneous.
Lic. Lesser cutaneous.
Iat. Internal anterior thoracic.

The *Circumflex* (Fig. 5, 19) is a large nerve from the posterior cord, and lies behind the axillary artery for a short distance, leaving it then to accompany the posterior circumflex artery through the quadrilateral space already described, and winding round the humerus to supply the deltoid, teres minor, shoulder joint, and integument, to which it will be subsequently traced.

Three *Subscapular nerves* (Fig. 7, 27, 28, 29) are derived from the posterior cord. The long, or middle, subscapular nerve is seen at the lower border of the subscapularis muscle accompanying the subscapular artery, and ends in the latissimus dorsi. The two shorter subscapular nerves will be better dissected when the arm is removed ; the upper enters the subscapularis, the lower the subscapularis and teres major muscles.

The *Posterior* or *long thoracic nerve* (external respiratory of Bell) (16) lies upon the serratus magnus, giving off a twig to each serration. It is a supra-clavicular branch of the brachial plexus, derived from the fifth and sixth nerves, with an occasional branch from the seventh, and descends behind the brachial cords and axillary vessels to its distribution.

The **Serratus Magnus** (Fig. 7, 32) covers the side of the chest, *arising* by eight digitations from the outer surfaces of the eight upper ribs, and from the intercostal fascia, the first digitation being attached to the first and second ribs (joining on the latter the second digitation) and to a fibrous arch bridging the first intercostal space. The fibres have a general direction backwards to a special area upon the inner surface of the scapula bordering the vertebral margin, where they are *inserted*, the first two digitations uniting to form a thicker portion which is attached to the upper angle, while the last four or five, the lower three of which interdigitate with the external oblique muscle of the abdomen, form a still larger bundle, corresponding to the broader portion of the area adjoining the inferior angle of the scapula.

Action.—The muscle as a whole draws forward the scapula and with it the whole of the shoulder girdle, the centre of the movement being at the sterno-clavicular joint. The lower digitations acting alone draw forward the lower angle of the scapula and so rotate the glenoid cavity upwards and aid in the elevation of the arm, this motion occurring at the acromio-clavicular articulation. The muscle has no influence upon the respiratory movements. It is obvious from the direction of its serrations in relation to the axes of the bones to which they are severally attached, that were the scapula fixed the contraction of the muscle, except perhaps in the case of the last digitation, would tend to depress the ribs. It is not, however, a muscle of expiration, because this act is independent of

Fig. 7.

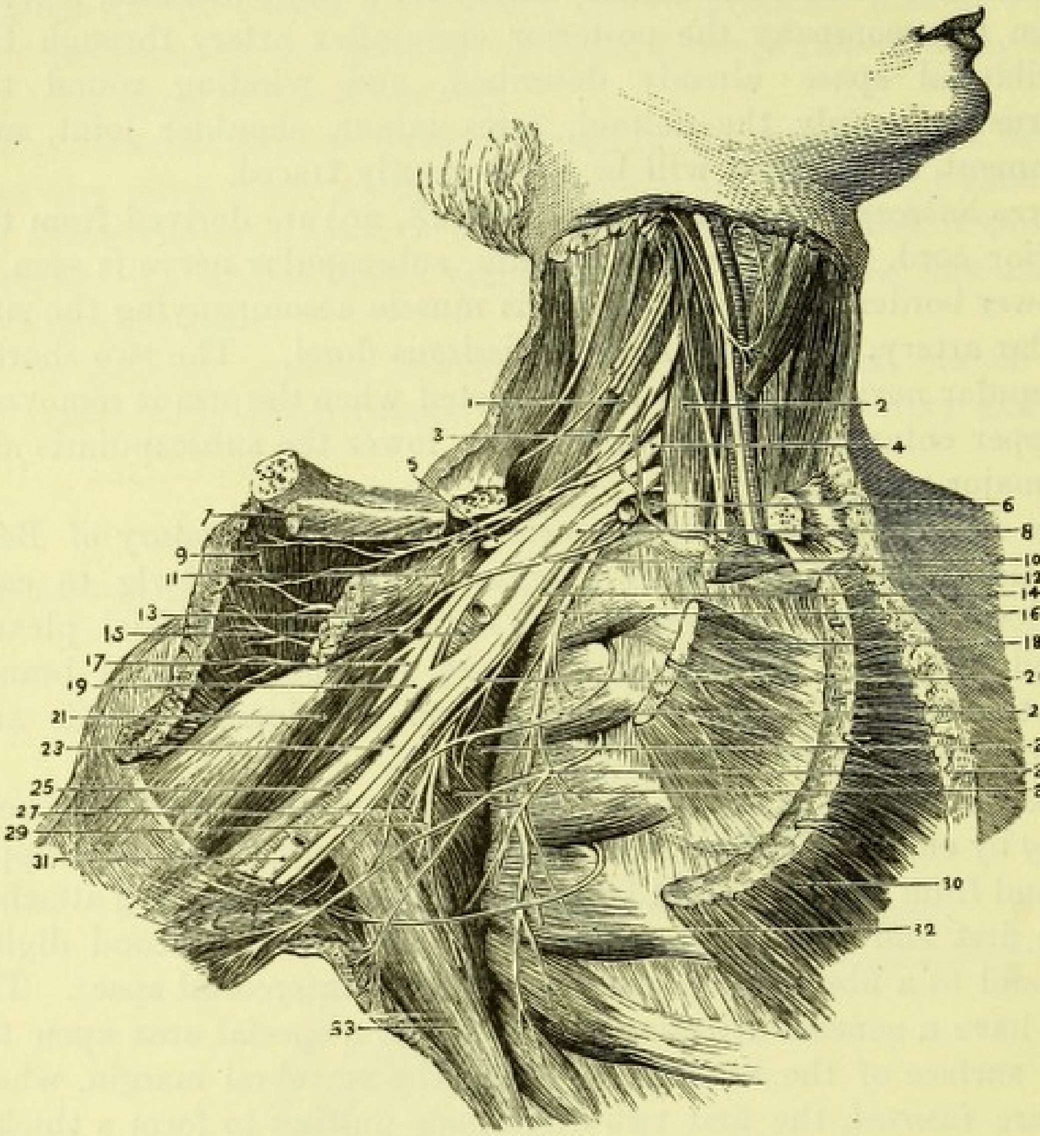


Fig. 7.—The nerves of the axilla (from Hirschfeld and Leveillé).

1. Scalenus medius.
2. Scalenus anticus.
3. Cord formed by 5th and 6th cervical nerves.
4. 7th cervical nerve.
5. Suprascapular nerve.
6. Subclavian artery (cut).
7. Insertion of subclavius.
8. Cord formed by 8th cervical and 1st dorsal nerves.
9. Pectoralis major (reflected).
10. Internal anterior thoracic nerve.
11. External anterior thoracic nerve.
12. Origin of subclavius.
13. Pectoralis minor (reflected).
14. Internal cutaneous nerve.
15. Axillary artery (cut).
16. Posterior thoracic nerve.
17. Musculo-cutaneous nerve.
18. Origin of pectoralis minor.
19. Median nerve.
20. Nerve of Wrisberg.
21. Coraco-brachialis.
22. Intercosto-humeral nerve.
23. Ulnar nerve.
24. Subscapularis.
25. Brachial artery.
26. Lateral cutaneous branch of 3rd intercostal nerve.
27. Middle subscapular nerve.
28. Short subscapular nerve.
29. Long subscapular nerve.
30. Pectoralis major (cut).
31. Basilic vein.
32. Serratus magnus.
33. Latissimus dorsi.

fixation of the scapula. Its essential uses are in reaching, pushing or striking in a forward direction, and in raising the arm. With the rhomboids, it keeps the vertebral border of the bone applied to the chest wall.

Insertions of the Latissimus Dorsi and Teres Major.—The upper part of the latissimus winds over the lower angle of the scapula, which it envelopes in a sort of fold, and ends in a broad, thin tendon, which passes in front of the teres major to be *inserted* into the bottom of the bicipital groove of the humerus. As in the case of the lower portion of the pectoralis major, the fibres of the muscle are twisted so that those which were highest at their origin are lowest at their insertion, and *vice versâ* ; it is the narrowest of the three tendons inserted into the bicipital groove.

The teres major passes behind the tendon of the latissimus dorsi, and is *inserted* into the inner or posterior edge of the bicipital groove, opposite the pectoralis major, and is separated by a bursa from the insertion of the latissimus.

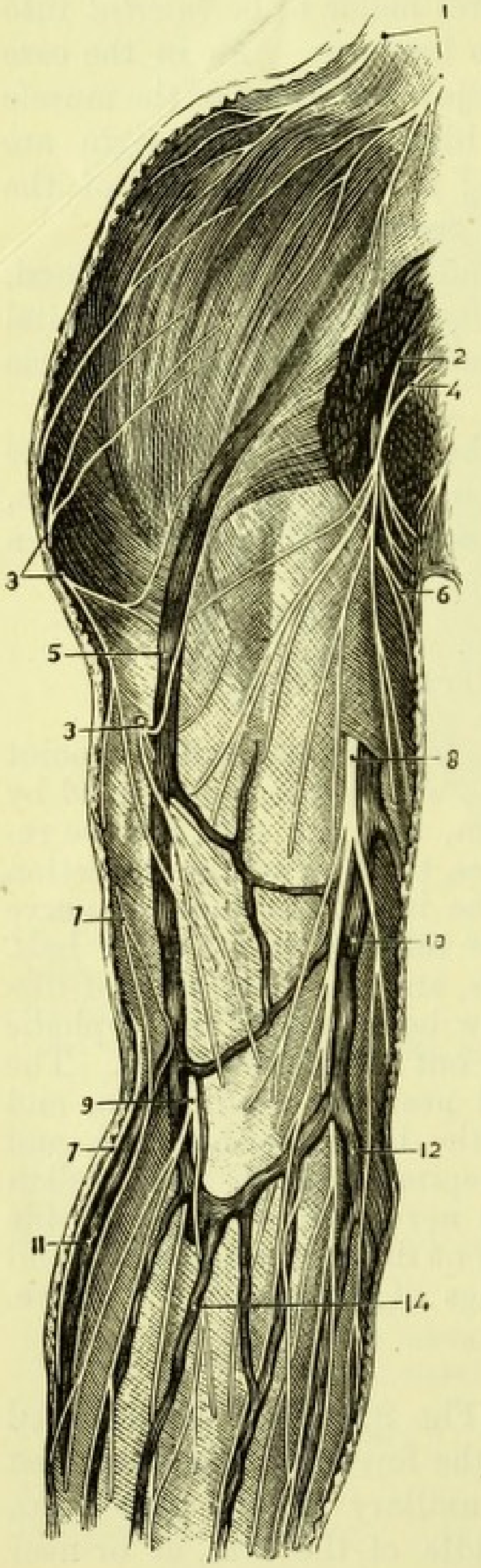
Opportunity should be taken, when the clavicle is divided by the dissector of the neck, to trace the axillary nerves to their origins, and to study the brachial plexus, the description of which is given with the "Posterior Triangle."

The Front of the Upper Arm.

[An incision is to be made down the front of the arm to a point three inches below the bend of the elbow, where it is to be joined by a transverse cut half round the fore-arm, and the skin is to be reflected on each side for a couple of inches, to allow of the dissection of the superficial nerves and veins. The intercosto-humeral nerve supplies the inner and posterior part of the arm in the upper half. The veins of the arm are very variable, and the best way of dissecting them, therefore, will be to follow both basilic and cephalic veins down to the elbow, and to trace out their tributaries. The internal cutaneous nerve will be found near the basilic vein, and internal to it the nerve of Wrisberg, the intercosto-humeral, and the internal cutaneous of the musculo-spiral. With the median cephalic vein is the external cutaneous nerve, above and outside this are two external cutaneous branches of the musculo-spiral ; and near the deltoid may be seen some twigs of the circumflex nerve. The deep fascia is not to be removed.]

The **Internal Cutaneous Nerve** (Fig. 8, 8) is to be followed out from the inner cord of the plexus to the fore-arm. It lies at first in front or to the inner side of the axillary artery, and then, piercing the deep fascia about the middle of the arm, at or near the point at which the basilic vein enters, it runs in front of the inner condyle and, subdividing, sends branches both over and under the median basilic vein to the inner side of the fore-arm. A posterior branch winds above the inner condyle to the back of the fore-arm.

Fig. 8.



The **Lesser Internal Cutaneous Nerve** (Nerve of Wrisberg) (Fig. 8, 2), after joining with the intercosto-humeral nerve, pierces the fascia at a variable point, and supplies the lower third of the inner side of the upper arm behind the internal cutaneous nerve. It is not always present.

The **Internal Cutaneous Branch of the Musculo-spiral Nerve** (Fig. 8, 6) appears on the inner side of the upper arm, below the teres major, and is distributed to the inner and back part of the arm.

The **Median Vein** (Fig. 8, 14), arising in a plexus above the wrist, runs up the centre of the fore-arm, and after receiving a deep vein (profunda) divides just below the elbow into two branches, the

Fig. 8.—Superficial dissection of the arm (from Hirschfeld and Leveillé).

1. Acromial nerves from superficial cervical plexus.
2. Nerve of Wrisberg.
3, 3. Circumflex nerve.
4. Intercosto-humeral nerve.
5. Cephalic vein.
6. Internal cutaneous branch of musculo-spiral nerve.
7, 7. External cutaneous branches of musculo-spiral nerve.
8. Internal cutaneous nerve.
9. External cutaneous nerve.
10. Basilic vein.
11. Radial vein.
12. Ulnar veins.
14. Median vein dividing into median-basilic and median-cephalic veins, and joined by the deep median.

median basilic and *median cephalic*, which pass obliquely inwards and outwards respectively, to assist in forming the basilic and cephalic veins. The *profunda* vein pierces the deep fascia near the bend of the elbow to join the median near its point of bifurcation, and forms a communication between the *venæ comites* of the arteries of the fore-arm and the superficial veins, the direction of the current of blood varying in different subjects.

The **Anterior** and **Posterior Ulnar Veins** (Fig. 8, 12), arising from the vena salvatella (see p. 48) and internal dorsal plexus end on the inner side of the fore-arm in a single trunk, which unites with the median basilic to form the basilic vein.

The **Basilic Vein** (Fig. 8, 10) runs up the inner side of the arm to about its middle, where it pierces the deep fascia and is continued up into the axillary vein, receiving, at a variable point, the venæ comites of the brachial artery. To the inner side of the basilic vein, and about an inch above the condyle, is a lymphatic gland of small size, which drains the inner part of the hand and fore-arm. Its efferent cords, with the rest of the fore-arm and hand lymphatics, end in the axillary glands.

The **Radial Vein** (Fig. 8, 11), arising from the radial dorsal plexus, ascends on the outer side to join the median cephalic and form the **Cephalic Vein** (5), which passes up the outer side of the biceps, and then between the pectoralis major and the deltoid; it has already been traced to its termination in the axillary or subclavian vein close to the outer border of the first rib.

The **Median Basilic Vein** has important relations, since it lies superficial to the brachial artery, and crosses over or under the internal cutaneous nerve. It is the vessel usually selected for venesection on account of its size. Some protection is afforded to the artery beneath by the interposition of the bicipital or semi-lunar fascia, a tendinous expansion from the biceps (Fig. 9, 22).

The **Median Cephalic Vein** is usually of smaller size and crosses the tendon of the biceps, close to the outer side of which, and beneath the vein, the **External Cutaneous Nerve** (Fig. 8, 9) pierces the fascia and divides into its anterior and posterior branches to the fore-arm. Above and to the outer side of the external cutaneous nerve are two *external cutaneous branches of the musculo-spiral nerve* (7), the upper and smaller one running along the cephalic vein to the upper and outer part of the front of the fore-arm: the lower passing to the back of the fore-arm; and the cutaneous branches of the *circumflex nerve* (3) emerge from below the deltoid to reach their distribution over the shoulder and arm.

The **Deep Fascia** of the arm is sufficiently seen in following the superficial vessels and nerves. It is continuous with the fascia of the axilla and fore-arm, and is attached to the supra-condylar ridges of the humerus, forming the external and internal intermuscular septa, which give attachment to muscular fibres. The *internal intermuscular septum* is the stronger, and is often pierced by the ulnar nerve and the inferior profunda and anastomotic arteries. The *external* is pierced by the musculo-spiral nerve and superior profunda artery.

[The muscles of the front of the arm are now to be cleaned together with the vessels and nerves, but the fascia on the upper part of the muscles of the fore-arm need not be disturbed, and care must be taken not to displace the vessels and nerves from their natural positions.]

The **Biceps** (Fig. 9, 9, 12) is the superficial muscle of the upper arm and arises by two heads, which generally unite in

Fig. 9.

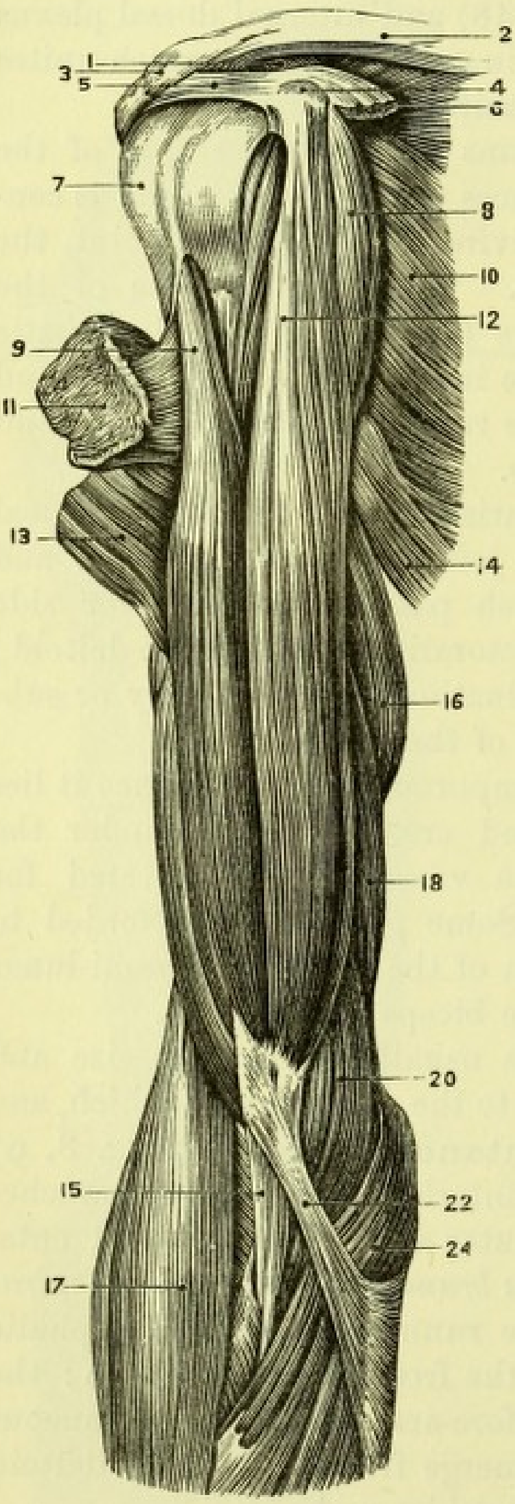
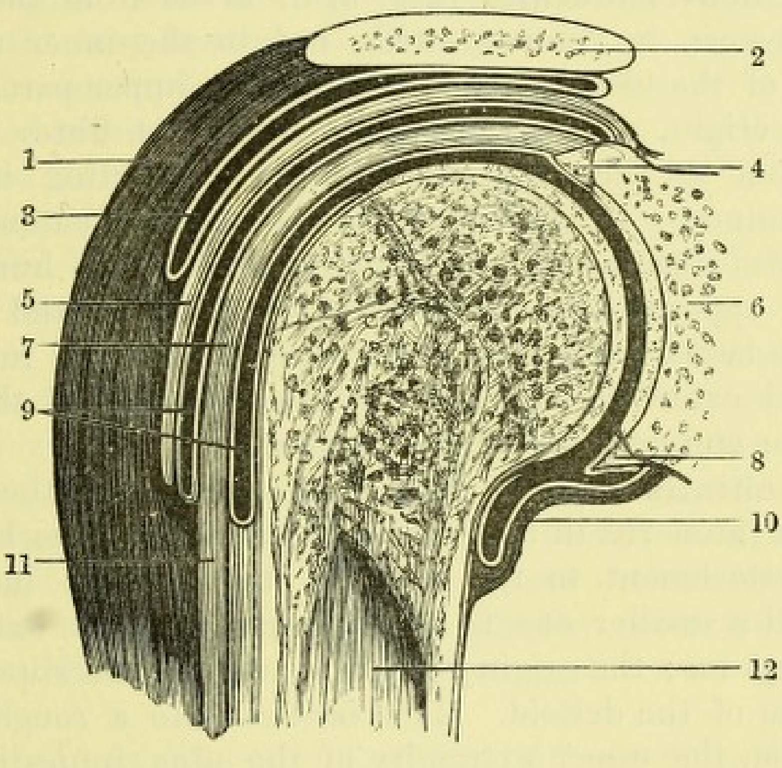


Fig. 9.—Muscles of the front of the upper arm (from Bonamy and Beau).

1. Coraco-clavicular ligament.
2. Clavicle.
3. Acromio-clavicular ligament.
4. Coracoid process.
5. Coraco-acromial ligament.
6. Pectoralis minor.
7. Head of humerus enclosed in capsule of shoulder-joint.
8. Coraco-brachialis.
9. Long head of biceps.
10. Subscapularis.
11. Pectoralis major (cut).
12. Short head of biceps.
13. Deltoid (cut).
14. Latissimus dorsi and teres major combined.
15. Tendon of biceps.
16. Long head of triceps.
17. Supinator longus.
18. Inner head of triceps.
20. Brachialis anticus.
22. Bicipital fascia.
24. Pronator radii teres.

the upper third of the arm, but occasionally remain distinct nearly to their insertion. The *long* or *outer* head, not to be fully traced at present, *arises* within the capsule of the shoulder-joint from the top of the glenoid cavity, and from the glenoid ligament. The tendon traversing the joint and enclosed in a tube of synovial membrane, enters the bicipital groove of the humerus, and is seen to emerge from the capsular ligament and lie upon the tendon of the latissimus dorsi, and between the insertions of the pectoralis major and teres major muscles. The *short* or *inner* head *arises* from the tip of the coracoid

Fig. 10.



process of the scapula, in common with, but to the outer side of, the coraco-brachialis, and the two heads unite to form a large fleshy belly. The fibres converge to a broad tendon, from which is given off, immediately above the elbow-joint, an expansion, the *bicipital* or *semilunar fascia*, receiving superficial fibres from both heads,

Fig. 10.—Diagrammatic section of shoulder through bicipital groove (W. A.).

1. Deltoid.
2. Acromion.
3. Subacromial bursa.
4. Glenoid ligament.
5. Capsule of shoulder joint.
6. Glenoid cavity.
7. Long tendon of biceps.
8. Glenoid ligament.
9. Synovial membrane lining capsule and ensheathing biceps tendon.
10. Inner fold of capsule and synovial membrane.
11. Extra-articular portion of biceps tendon.
12. Humerus.

and *inserted* into the fascia on the upper and inner part of the fore-arm (22). This would have to be divided in order to follow the tendon of the biceps (15), which passes deeply to be *inserted* into the posterior border of the bicipital tubercle of the radius, a bursa being placed between the tendon and the smooth anterior surface of the tubercle. It will be seen in a later dissection. The tendon becomes flattened near its insertion, and is twisted so that its *outer* edge becomes *anterior*. The chief action of the biceps is to supinate the fore-arm, and to flex it upon the upper arm, the radius then representing a lever of the third order. The long head slightly abducts and flexes, the short head adducts and flexes the humerus.

The **Coraco-brachialis** (Fig. 9, 8) *arises* from the tip of the coracoid process, in common with, but to the inner side of, the short head of the biceps, from the tendinous upper part of which it also takes origin, and some of its innermost fibres are usually derived from an intermuscular septum connecting it with the pectoralis minor. It is pierced by the external cutaneous nerve, and is *inserted* into the inner side of the shaft of the humerus about its middle, opposite the insertion of the deltoid, and into a process of deep fascia continuous below with the internal intermuscular septum, and extending upwards as far as the head of the humerus. It is a flexor and adductor of the humerus.

The **Brachialis anticus** (Fig. 12, 11) *arises* from the front of the shaft of the humerus in its lower half; and the fibres have also an extensive attachment to the front of the internal intermuscular septum, and a smaller one to the upper part of the external intermuscular septum; the origin is bifid above, the two slips embracing the insertion of the deltoid. It is *inserted* into a rough triangular impression on the upper extremity of the ulna, immediately below the coronoid process. It covers the front of the capsule of the elbow-joint, and is intimately connected with the anterior ligament. A considerable portion of the muscle appears superficially on the outer side of the arm between the biceps and triceps, but it is covered in front by the biceps, and is overlapped below by the supinator longus, extensor carpi radialis longior, and pronator radii teres. It is the direct flexor of the fore-arm upon the upper arm.

The biceps, coraco-brachialis, and brachialis anticus are *supplied* by the musculo-cutaneous nerve; and the brachialis anticus has an additional supply from the musculo-spiral nerve, which gets in front of it below and close to its outer border, under cover of the supinator longus.

The **Brachial Artery** (Fig. 12, 14) is the direct continuation of the axillary, and extends from the lower border of the teres major to its point of bifurcation into radial and ulnar arteries, about half an inch below the bend of the elbow. The artery is superficial, or at least crossed by no muscle, in the whole of its course, but may be overlapped by a well developed biceps ; and it gradually turns from the inner side of the arm to the middle of the bend of the elbow.

In front it has the skin and fascia, with the internal cutaneous nerve until this pierces the fascia, and about the middle of the arm it is generally crossed by the median nerve (but the nerve may pass beneath the vessel) ; at the bend of the elbow it is also crossed by the bicipital fascia and the median basilic vein. *Behind* it has first the musculo-spiral nerve and superior profunda vessels, which separate it from the long head of the triceps ; it then rests upon a small portion of the internal head of the triceps ; next, on the insertion of the coraco-brachialis ; and afterwards upon the brachialis anticus for the rest of its course. To the *outer* side is the median nerve, with the coraco-brachialis muscle for a short distance above, and afterwards the biceps muscle, which is the guide to the vessel in applying a ligature ; both these muscles overlap the artery in a muscular arm. To the *inner* side is the ulnar nerve, in close contact above, but soon leaving it to pass backwards to the hollow behind the internal condyle ; and afterwards, from a varying point, the median nerve, which continues in close relation to the vessel for the rest of its course. The basilic vein lies to the inner side of the artery throughout its course, but is in closer contact in the upper part than the lower, *i.e.*, after piercing the deep fascia. Venæ comites surround the artery in its whole length.

Surgery.—*To tie the brachial artery.* An incision, three inches long, is to be made close to and exposing the inner edge of the biceps in the middle third of the arm. A little dissection parallel to the muscle will expose the median nerve, and the artery will be found in close relation to it, and generally to its outer side in this position, but this will vary in different bodies. The needle is to be passed *from* the nerve, care being taken of the venæ comites.

When the brachial artery is tied, the circulation in the limb will be maintained by the anastomoses between the branches of the artery above and below the ligature, viz., of the superior profunda, and possibly of the inferior profunda above, with the anastomotic and with the recurrent branches of the radial, ulnar, and interosseous arteries below.

The **Branches** of the brachial artery (Fig. 11) are—

1. *Muscular*, arising at various points to supply the coraco-

brachialis, biceps, and brachialis anticus muscles. Some are of large size.

2. *Medullary* or *Nutrient*, which enters the foramen on the inner side of the humerus about the middle of the bone, and has a general direction *towards* the elbow.

3. *Superior radial collateral* of Henle. A small and inconstant

Fig. 11.

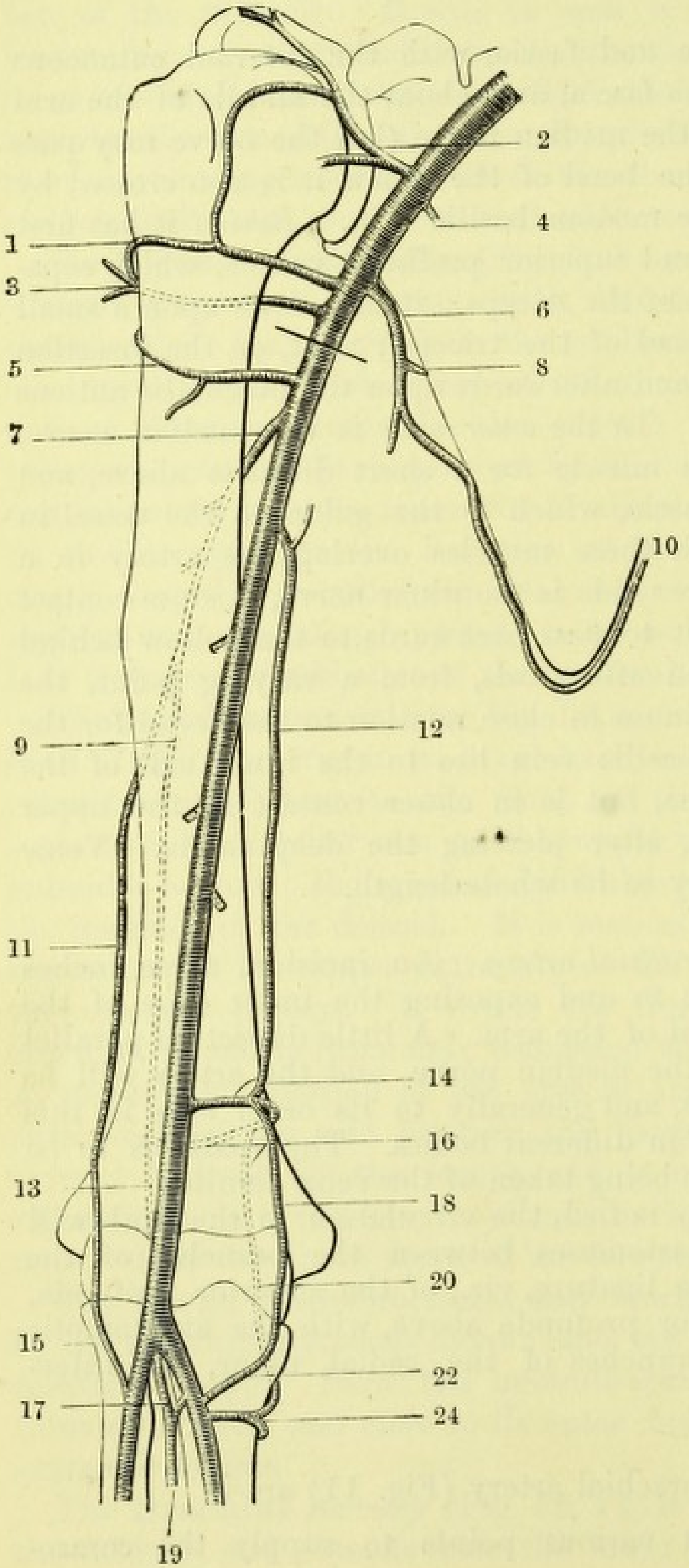


Fig. 11.—Diagram of the anastomoses of the brachial artery.

1. Anterior circumflex.
2. Acromio-thoracic.
3. Posterior circumflex.
4. Long thoracic.
5. Superior radial collateral (excessively large).
6. Subscapular.
7. Superior profunda.
8. Dorsalis scapulæ.
9. External posterior articular branch of superior profunda.
10. Posterior scapular.
11. External anterior articular branch of superior profunda.
12. Inferior profunda.
13. Posterior interosseous recurrent.
14. Anastomotica magna.
15. Radial recurrent.
16. Transverse branch of anastomotica magna.
17. Posterior interosseous recurrent.
18. Anastomosis of anterior ulnar recurrent with anastomotic.
19. Posterior interosseous from common interosseous of ulnar.
20. Anastomosis of posterior ulnar recurrent with anastomotic.
22. Anterior ulnar recurrent.
24. Posterior ulnar recurrent.

branch which runs transversely outwards a little above the middle of the arm, to the point of insertion of the deltoid. It supplies the muscle and anastomoses with the posterior circumflex.

4. The *Superior profunda* (Inferior radial collateral of Henle), which comes off from the inner side of the artery, just below the teres major, and immediately joining the musculo-spiral nerve, accompanies it between the outer and inner heads of the triceps and, under cover of the long head, round the humerus, to end by a small *anterior terminal* branch between the brachialis anticus and supinator longus in front of the elbow, where it anastomoses with the radial recurrent artery. It gives off a *posterior medullary* branch to the humerus, and muscular branches, principally to the triceps; also the *posterior terminal* or *descending articular*, larger than the anterior terminal artery, running behind the external intermuscular septum to the anconeus and back of the elbow, to anastomose with the posterior interosseous recurrent and anastomotic.

5. The *Inferior profunda*, which arises at a variable distance below the preceding or in common with it, and passes with the ulnar nerve behind the internal intermuscular septum. It runs with the nerve to the groove between the inner condyle and the olecranon, and there joins the posterior branch of the anastomotic and the posterior ulnar recurrent artery.

6. The *Anastomotic*, which arises an inch and a half above the elbow and runs directly inwards, sending an anterior descending branch downwards along the edge of the pronator radii teres to join the anterior ulnar recurrent; and then piercing the internal intermuscular septum gives off a *posterior descending* branch behind the internal condyle to anastomose with the inferior profunda and posterior ulnar recurrent arteries, and a large *transverse* branch to join the descending articular branch of the superior profunda and the posterior interosseous recurrent behind the outer condyle.

Irregularities of the Brachial Artery.—The point of bifurcation is occasionally much higher than the bend of the elbow, the abnormal branch being usually the radial, sometimes the ulnar, and more rarely the interosseous. Sometimes a *vas aberrans* leaves the brachial or axillary and, passing in front of the median nerve, joins either the radial or the ulnar, usually the former: or the brachial may consist of two trunks, which unite before the final subdivision into radial and ulnar. If any of these arrangements be present, two large vessels will be met with side by side in some part of the arm. The brachial artery is sometimes found passing with the median nerve through a fibrous canal beneath a process of bone above the inner condyle, the *supracondylar process*, to reach its normal position at the elbow. It is occasionally covered by a fleshy slip connected with the coraco-brachialis, biceps, brachialis anticus, or pronator teres ; and other less common peculiarities are sometimes met with. The two profunda arteries not uncommonly arise together, and occasionally there is an axis common to all the principal branches of the brachial.

Venæ Comites are in close relation with the brachial artery, and receive twigs corresponding to its branches : they unite with the basilic to form the axillary vein.

Nerves of the Arm.

The **Median Nerve** (Fig. 12, 6) is derived from the outer and inner cords of the brachial plexus by two roots, which embrace the axillary artery in the third part of its course. The nerve afterwards lies to the outer side of the axillary artery, and continues in the same relation to the brachial artery for about half its length ; then, crossing over (or occasionally under) that vessel, lies to its inner side, and continues in the same relation to the bend of the elbow. It gives off no branch in the upper arm until it reaches the level of the internal condyle, where a small twig is detached for the supply of the pronator radii teres. It occasionally communicates with the musculo-cutaneous nerve.

The **Musculo-cutaneous Nerve** (Fig. 12, 1) arises from the outer cord of the brachial plexus in common with the outer head of the median, and lies to the outer side of the median nerve and the axillary vessels for a short distance. It then pierces the coraco-brachialis obliquely (hence called *n. perforans Casserii*), and having given a branch to that muscle, it lies between the biceps and the brachialis anticus, both of which it supplies ; sending also a minute twig with the nutrient artery to the humerus. It finally becomes cutaneous at the outer side of the tendon of the biceps just above the bend of the elbow, where it has been already seen to lie beneath the median-cephalic vein.

The **Ulnar Nerve** (Fig. 12, 8) arises from the inner cord of the brachial plexus, and lies close to the inner side of the axillary vessels, and afterwards in a similar relation with the upper part of the brachial artery. It leaves that vessel about the middle of the arm, and then passes through the internal intermuscular septum, accompanied by the inferior profunda artery to the interval between the internal condyle and the olecranon process. The ulnar nerve gives no branch in the upper arm, but supplies a filament to the elbow joint.

The **Musculo-spiral Nerve** (Fig. 12, 13) is derived from the posterior cord of the brachial plexus, and lies at first behind the axillary artery, and upon the subscapularis muscle with the circumflex nerve. It then rests upon the latissimus dorsi and teres major, and, after giving off an *internal cutaneous* branch to the inner side of the arm, which usually arises in common with the branch to the inner head of the triceps, winds backwards around the humerus in the musculo-spiral groove, lying against the inner head of the triceps and afterwards between it and the outer head of that muscle, here giving off two *external cutaneous* branches. Branches to the triceps, anconeus and outer portion of the brachialis anticus will be seen in a subsequent dissection. Its lower portion is visible between the supinator longus and brachialis anticus, to both of which and to the extensor carpi radialis longior branches may

Fig. 12.

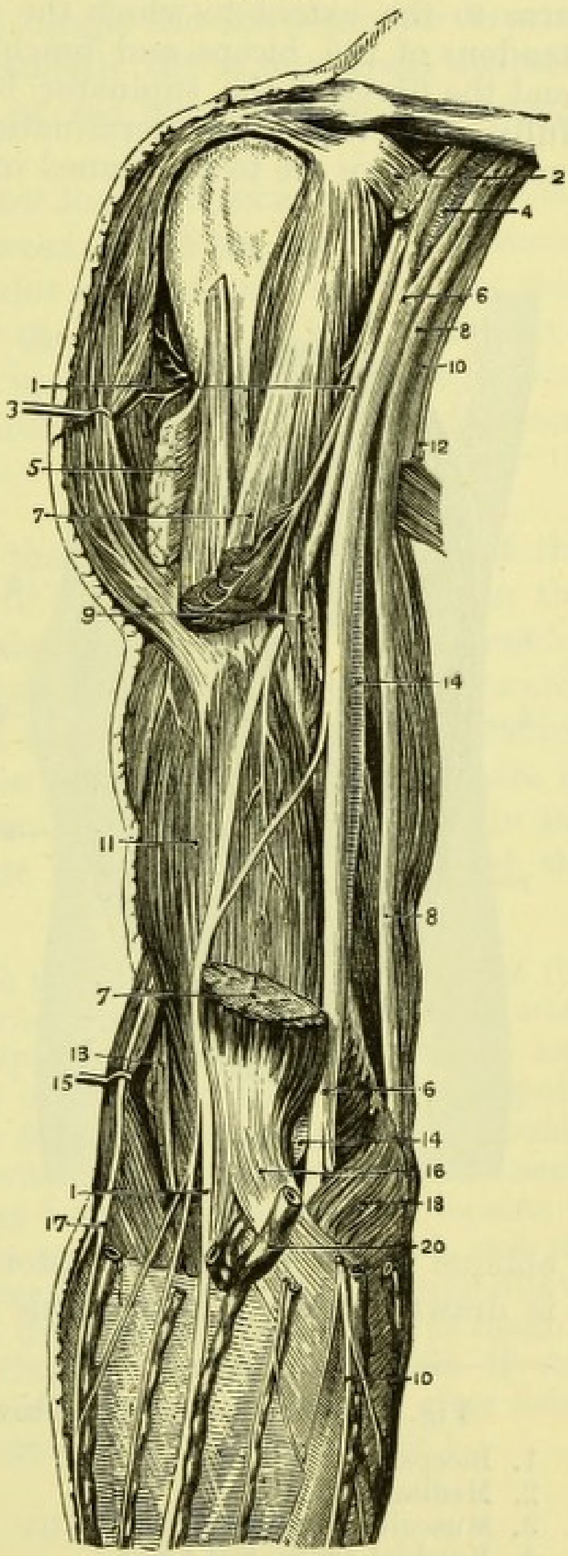


Fig. 12.—Deep dissection of the front of the upper arm (from Hirschfeld and Leveillé).

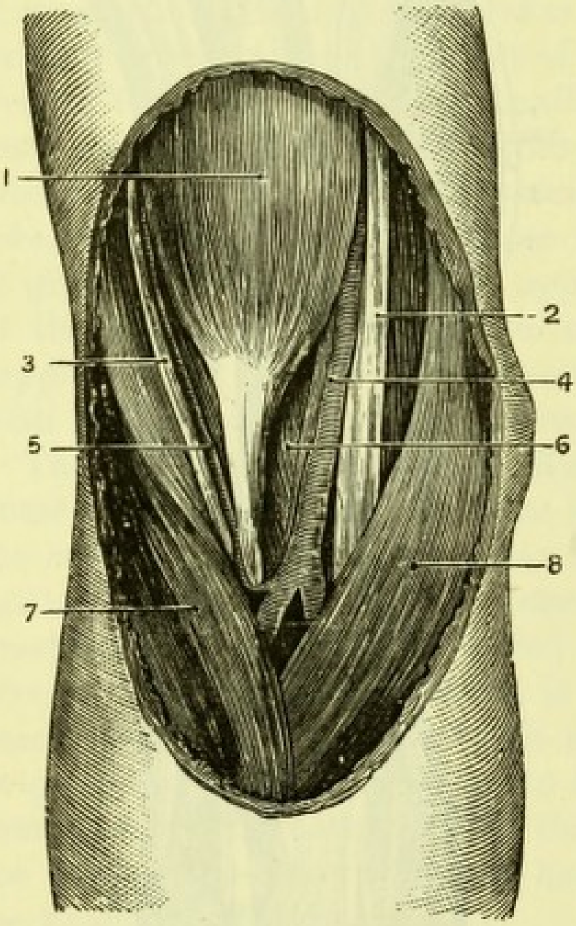
1, 1. Musculo-cutaneous nerve.
2. Pectoralis minor.
3. Deltoid.
4. Axillary artery.
5. Tendon of pectoralis major.
6, 6. Median nerve.
7, 7. Biceps.
8, 8. Ulnar nerve.
9. Coraco-brachialis.
10, 10. Internal cutaneous nerve.
11. Brachialis anticus.
12. Nerve of Wrisberg.
13. Musculo-spiral nerve.
14, 14. Brachial artery.
15. Supinator longus.
16. Bicipital fascia.
17. Inferior external cutaneous branch of musculo-spiral nerve.
18. Pronator radii teres.
20. Median basilic vein.

be traced ; and it ends by division into *radial* and *posterior interosseous* nerves in front of the external condyle.

The Bend of the Elbow.

[The boundaries of the space in front of the elbow are now to be exposed by removing the fascia from the muscles of the forearm to the extent to which the skin has been already reflected, the tendons of the biceps and brachialis are to be thoroughly cleaned, and the fibres of the supinator brevis in the floor of the space carefully dissected. The termination of the brachial artery and the median nerve are to be cleaned in the middle line ; and at the outer side are to be defined the bifurcation of the musculo-spiral nerve and an anastomosis between the superior profunda and the radial recurrent arteries, and at the inner side an anastomosis between the anterior branch of the anastomotic and the anterior ulnar recurrent, with some twigs from the inferior profunda.]

Fig. 13.



The **Triangle in front of the Elbow** (Fig. 13) is bounded *above* by an imaginary line drawn across the arm above the condyles, and *below* the apex is formed by the meeting of the pronator teres and supinator longus, two inches below the joint. The *external* boundary is the supinator longus, the *internal* the pronator teres ; whilst the *floor* is formed by the lower part of the brachialis anticus, and external to this may be seen the oblique fibres of the supinator brevis when the supinator longus is drawn aside. The relations of the superficial veins and nerves

Fig. 13.—The bend of the elbow (from University College Museum).

1. Biceps.
2. Median nerve.
3. Musculo-spiral nerve.
4. Brachial artery and veins.
5. Anastomosis of superior profunda with radial recurrent.
6. Brachialis anticus.
7. Supinator longus (turned back).
8. Pronator teres.

have been already examined (p. 26), and the *contents* of the space are now seen to be (1) the median nerve, (2) the brachial artery, and (3) the tendon of the biceps, which lie in that order from within outwards. The median nerve (2) runs almost vertically through the space, and disappears between the heads of the pronator teres : the brachial artery (4) usually bifurcates into radial and ulnar upon the insertion of the brachialis anticus, the radial resting against the tendon of the biceps and the supinator brevis, and the ulnar lying upon the brachialis till it disappears beneath the pronator teres. The twisting of the biceps tendon has already been referred to.

By slightly displacing the supinator longus outwards, the musculo-spiral nerve will be seen lying between it and the brachialis anticus, and dividing into radial and posterior interosseous nerves ; but this nerve is not, strictly speaking, in the triangle. The radial nerve may be traced for a short distance upon the supinator brevis, whilst the posterior interosseous to the inner side of the radial can be seen entering the fibres of the muscle.

It is supposed that by the time the dissection of the bend of the elbow is finished the subject will be turned, in which case the student of the arm should dissect the first two layers of the muscles of the back (*see* DISSECTION OF THE BACK), proceeding afterwards with the following dissections. If necessary, however, the dissection of the front of the fore-arm may be proceeded with first. Since in some dissecting-rooms the dissector of the arm has no part in the back, the following directions are given for the removal of the limb :—

[The two superficial layers of the muscles of the back comprise the trapezius, latissimus dorsi, rhomboidei, and levator anguli scapulæ. These having been divided, the suprascapular artery and nerve and omo-hyoid muscle are to be traced to the upper border of the scapula, and the posterior scapular artery followed beneath the rhomboids. If the clavicle has been already divided in the dissection of the neck, the scapula can now be drawn away from the ribs and will be seen to be attached solely by the serratus magnus, between which and the ribs is a quantity of loose large-meshed areolar tissue which allows the bone to glide smoothly upon the thorax. The serratus magnus having been divided, and the clavicle cut at its middle if still entire, the axillary vessels and nerves are to be severed after being tied together, and the entire limb removed from the trunk.]

PARTS ABOUT THE SCAPULA.

[The limb having been placed on the table, it is advisable to identify again the several insertions of muscles on the scapula, cutting each muscle about an inch from its attachment.]

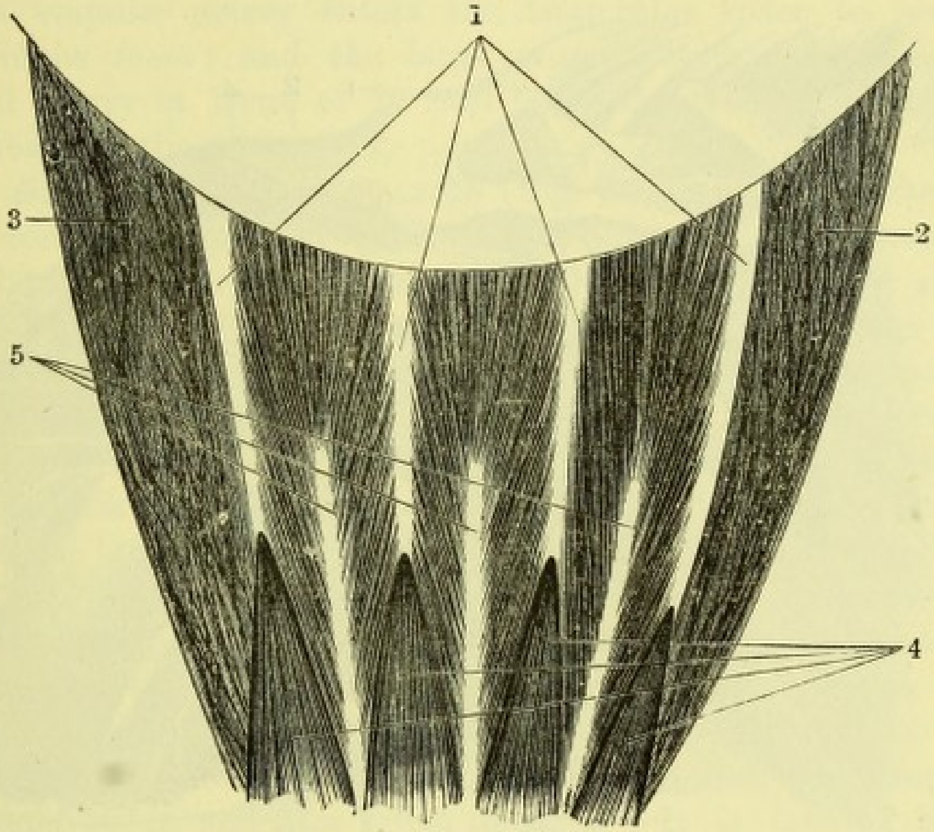
The insertion of the trapezius extends along the upper border of the spine of the scapula, the inner border of the acromion, and the outer third of the posterior border of the clavicle. The omohyoid arises from the upper margin of the scapula close to the notch and from the transverse ligament. The levator anguli scapulæ is inserted into that part of the vertebral border of the scapula which is above the basal triangle at the root of the spine, the rhomboideus minor into the part opposite the basal triangle, and the rhomboideus major into the rest of the border, by means of a tendinous arch to which the muscular fibres are attached. The serratus magnus is inserted into a special area running along the ventral surface of the scapula close to the vertebral border for its whole length, but the fibres are much thicker at the upper and lower angles than in the middle. The small insertion of the pectoralis minor is attached to the inner border and upper surface of the coracoid process, the tip of which process gives origin to the coraco-brachialis and the short head of the biceps.

[A small block is now to be placed beneath the lower border of the scapula so as to put the deltoid on the stretch, and the remainder of its fibres are then to be cleaned, notice being taken of one or two small branches of the circumflex nerve which turn round its posterior border, and of a few descending *acromial* twigs from the superficial branches of the cervical plexus (Fig. 8, 1) which supply the skin of the shoulder.]

The **Deltoid Muscle** (Fig. 15, 6) *arises* from the anterior border of the outer half of the clavicle and the adjacent portion of the superior surface as far as the curved deltoid ridge, and from the tip and outer edge of the acromion, and the lower lip of the spine of the scapula. Its strong coarse fibres converge to be *inserted* into a rough V-shaped surface on the outer side of the humerus above the middle of the shaft, and are embraced by the bifid origin of the brachialis anticus, and closely connected with the insertion of the pectoralis major. The muscle is coarsely fasciculated and intersected by tendinous bands, four of which above are attached to tubercles on the outer border of the acromion process, and three below to vertical ridges on the deltoid impression of the humerus. Fig. 14 will indicate the typical arrangement of the fibres, but many variations are met with. The *action* of the deltoid as a whole is to raise outwards the arm to the level of the shoulder, *i.e.*, to abduct the humerus; but the anterior fibres will assist in flexion and internal rotation, and the posterior in extension and external rotation of the shoulder-joint. It is *supplied* by the circumflex nerve.

[The deltoid is to be divided near its origin and turned down, the circumflex vessels and nerve being preserved. In doing this a large

Fig. 14.



bursa lying between the deltoid and the shoulder-joint should be noticed. The remains of the trapezius muscle are to be cut close to the spine of the scapula, and the thin fascia covering the muscles above and below it removed, the humerus being rotated inwards to put their fibres on the stretch.]

The **Sub-acromial Bursá** lines the interval between the upper part of the shoulder-joint and the under surface of the deltoid, acromion process, and coraco-acromial ligament. It thus forms an extensive sac, the enlargement of which may be confounded with disease of the joint. Physiologically it represents a synovial lining

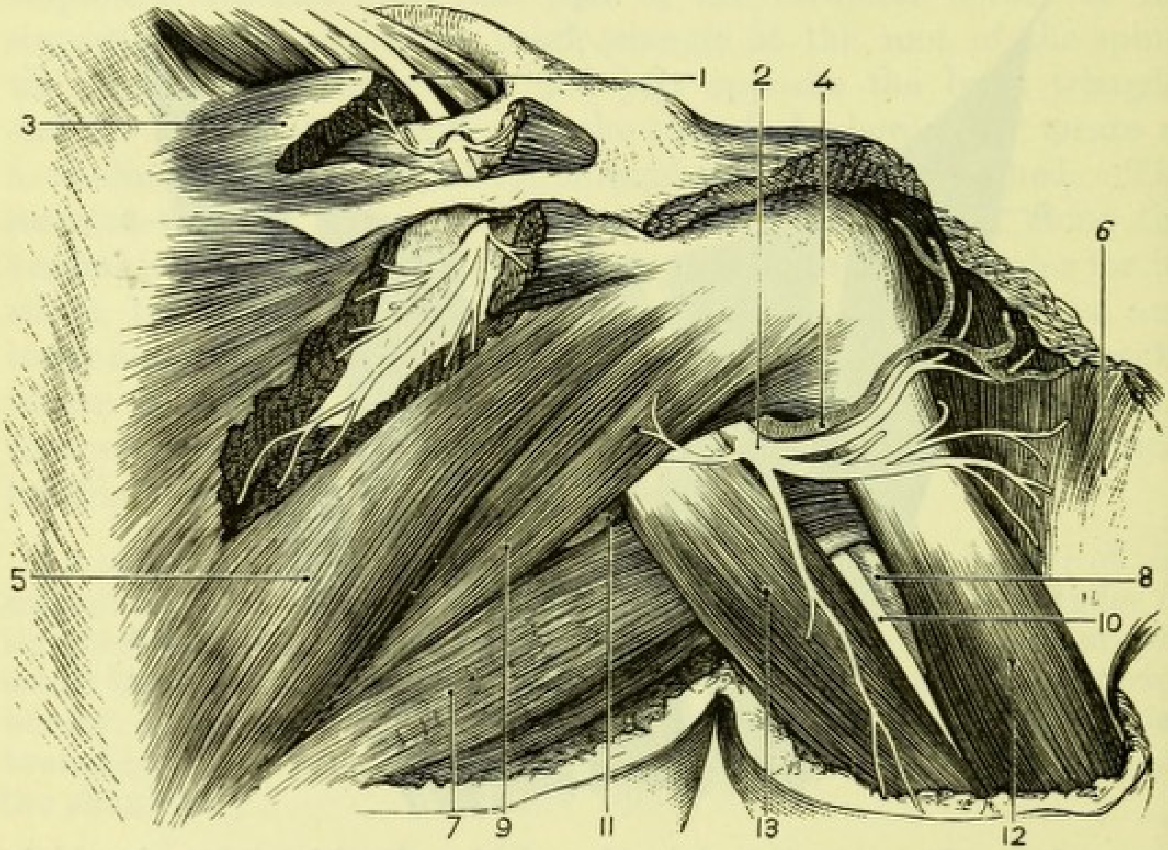
Fig. 14.—Plan of the deltoid (after Cunningham).

1. Upper tendinous intersections arising from acromion.
2. Clavicular fibres.
3. Spinous fibres.
4. Lower segments.
5. Lower tendinous intersections receiving three of the upper segments of the muscle and inserted into humerus.

to an accessory and extra-capsular shoulder-joint between the upper extremity of the humerus below and the hollow formed by the under surface of the acromion and coraco-acromial ligament above.

The **Parts beneath the Deltoid Muscle** (Fig. 15) are—the Coraco-acromial ligament, the Coracoid process with the muscles attached to it, the Sub-acromial bursa, the Infra-spinatus, the Teres

Fig. 15.



Minor and Major, the long head of the Triceps, the head and neck of the humerus, the coracoid process and the muscles attached to it, and the circumflex vessels and nerve. The tip of the coracoid process lies close to the interval between the pectoralis major and deltoid, but is usually overlapped by the latter.

The quadrilateral and triangular intermuscular spaces, referred to

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Fig. 15.—Scapular muscles, vessels, and nerves (from University College Museum).

1. Supra-scapular nerve.
2. Circumflex nerve.
3. Supra-spinatus.
4. Posterior circumflex artery.
5. Infra-spinatus.
6. Deltoid (reflected).
7. Teres major and latissimus.
8. Brachial artery.
9. Teres minor.
10. Musculo-spiral nerve.
11. Dorsalis scapulæ artery.
12. Triceps (outer head).
13. Triceps (long head).

in the dissection of the axilla (p. 19), can now be seen *from behind*, when the quadrilateral or outer space will be found to be bounded by the teres major, teres minor, humerus, and long head of triceps; the triangular or inner space, by the teres major, teres minor, and long head of triceps. (A triangular interval between the teres major and the long and external heads of the triceps must not be mistaken for this latter space.) The posterior circumflex vessels and circumflex nerve pass through the quadrilateral space; the dorsalis scapulæ artery enters the triangular space to reach the infraspinous fossa; and the large musculo-spiral nerve, with the brachial artery in front of it will be seen between the long and outer heads of the triceps.

The **Supra-spinatus Muscle** (Fig. 15, 3) occupies the supra-spinal fossa, *arising* from the inner two-thirds of the fossa itself, from the upper surface of the spine, and from the fascia covering the muscle. The tendon passes beneath the acromion to be *inserted* into the uppermost facet on the great tuberosity of the humerus, and slightly into the capsular ligament of the shoulder-joint. In order to follow the tendon thoroughly, the acromial end of the spine of the scapula is to be divided with the saw, when a part of the subacromial bursa, before mentioned, will be found between it and the muscle.

The **Infra-spinatus Muscle** (Fig. 15, 5) *arises* from the inner two-thirds of the infraspinal fossa (the part near the neck of the scapula being free from muscular attachments in all three fossæ), from the fascia covering the muscle, and from the intermuscular septa between it and the teres muscles. It is *inserted* into the middle facet on the great tuberosity of the humerus and into the capsule of the shoulder-joint, being blended there with the supra-spinatus and teres minor. It is occasionally separated from the capsule by a bursa. The supra- and infra-spinatus muscles are *supplied* by the suprascapular nerve.

The **Teres Minor Muscle** (Fig. 15, 9) is closely connected with the infra-spinatus. It *arises* from the upper part of the teres area upon the dorsal aspect of the scapula, from the fascia covering the muscle, and from the intermuscular septa between it and the infra-spinatus and teres major muscles; and is *inserted* into the lowest facet on the great tuberosity of the humerus and for nearly an inch below it, and also into the capsular ligament of the shoulder. It is *supplied* by a special branch of the circumflex nerve, which is remarkable for having an enlargement upon it depending upon a thickening of the perineural connective tissue.

The supra-spinatus is an *abductor* and *internal rotator*, and the infra-spinatus and teres minor muscles are *external rotators* and *adductors* of the humerus.

The **Teres Major Muscle** (Fig. 15, 7) *arises* from the lower portion of the triangular teres area, at the inferior angle of the scapula, and from the intermuscular septa between it and the teres minor and infra-spinatus muscles. Its close relation to the latissimus dorsi has been already noticed, but its *insertion* into the inner lip of the bicipital groove and the bursa between it and the tendon of the latissimus should be again clearly seen. It is *supplied* by the lower subscapular nerve, and is an *adductor* and *internal rotator* of the humerus.

The **Posterior Circumflex Artery** (Fig. 15, 4) with its veins, and the **Circumflex Nerve** (Fig. 15, 2), appear through the quadrilateral space (see pp. 21 and 40). The nerve is distributed to the deep surface of the deltoid muscle, and to the teres minor muscle (the branch presenting the above mentioned enlargement), and supplies also the shoulder-joint, and the skin over the lower part of the deltoid and back of the arm. The posterior circumflex artery not unfrequently arises from, or in common with, the superior profunda, in which case it is below instead of above the teres major. It supplies the same parts as the nerve.

The **Dorsalis Scapulæ Artery** (dorsal branch of subscapular) (Fig. 15, 11), does not pass through the triangular space as seen from behind, but winds beneath the teres minor in a groove on the axillary border of the scapula, to supply the infraspinal fossa and anastomose with the other scapular arteries. It gives off a ventral *infra-scapular* branch, which will be afterwards traced beneath the subscapularis, and a superficial branch, which runs between the teres major and minor and down to the angle of the scapula, to anastomose with the subscapular and posterior scapular arteries.

[The supra-spinatus and infra-spinatus are to be divided near their insertions, and the muscular fibres cleared out of the supra-spinal fossa in order to see the supra-scapular artery and nerve and the origin of the omo-hyoid muscle.]

The **Supra-scapular** or **Transversalis humeri Artery** (from the thyroid axis) passes over the transverse ligament of the scapula, and is distributed to the supraspinal fossa, and also to part of the infraspinal fossa by a branch which winds around the external border of the spine, and anastomoses with the dorsalis scapulæ and posterior scapular arteries. Before crossing the ligament, it sends a *supra-acromial* branch through the attachment of the trapezius, and a *subscapular* twig to the venter of the scapula.

The **Supra-scapular Nerve** (Fig. 15, 1) (from the anterior branches of the 5th and 6th cervical nerves) gives a branch to the shoulder-joint and passes through the supra-scapular notch and beneath the ligament, to be distributed to the supra- and infra-spinatus muscles.

The **Omo-hyoid Muscle** *arises* from about half an inch of the superior border of the scapula, immediately behind the supra-scapular notch, and from the transverse or posterior ligament over it. Its relations and insertion are seen in the dissection of the neck.

[The limb is to be turned over and the humerus rotated outwards to put the fibres of the subscapularis on the stretch ; they should then be cleaned, care being taken of the subscapular nerves entering the muscle. The axillary vessels and nerves should be tied to the coracoid process, so as to bring them as nearly as may be into their proper positions.]

The **Subscapularis Muscle** (Fig. 9, 10) is covered by a thin fascia, and has been already seen to form part of the posterior wall of the axilla. It *arises* from the whole of the venter scapulæ, except the part to which the serratus magnus is attached and the portion nearest the neck of the bone, and has several tendinous septa between its fibres, which are attached to the ridges on the surface of the bone, and bear some resemblance to those of the deltoid. It is *inserted* into the lesser tuberosity of the humerus and the bone below it for an inch, and into the capsular ligament of the shoulder-joint, a large bursa intervening between the muscle and the neck of the scapula, which almost always communicates with the cavity of the joint over the upper border of the tendon. The subscapularis is an *internal rotator* and *adductor* of the humerus, and is *supplied* by the short subscapular nerves.

An important action of the supra- and infra-spinati, teres minor, and subscapularis muscles is their combination to keep the head of the humerus in its proper relation to the glenoid cavity, and thus prevent dislocation. In the post-mortem relaxed condition of the parts, the head of the humerus can be drawn away from the glenoid cavity to the full extent of the loose capsular ligament.

The **Subscapular Nerves** (Fig. 7) are branches of the posterior cord of the brachial plexus, and are three in number. The long or middle subscapular nerve has been already seen in the axilla, and can still be traced to the latissimus dorsi; the short subscapular nerves (upper and lower) are now to be followed, the upper to the subscapularis muscle, the lower to the subscapularis and teres major.

The **Subscapular Artery** (p. 19) is still to be seen running along the axillary border of the scapula, and its branches should be thoroughly followed out. with Long Subscap. Nerve.

The **Infra-scapular Artery** is derived from the dorsal branch of the subscapular artery. It passes into the venter scapulæ, beneath the subscapularis muscle, which must be divided to expose it, and anastomoses with the neighbouring vessels.

The **Posterior Scapular Artery** is to be found between the serratus magnus and the rhomboidei, and its anastomoses upon the dorsal and ventral surfaces of the scapula should be defined.

By removing the muscular fibres from both surfaces of the scapula a very abundant network of vessels will be seen, formed by anastomosing branches from the arteries which have been already traced to the scapula; viz., the subscapular with its dorsal branch [axillary], the supra-scapular [thyroid axis], and the posterior scapular [thyroid axis or subclavian].

The Back of the Arm.

[The fore-arm and hand are to be doubled under the upper arm, which is to be placed on the table with the back upwards, and the scapula is to be drawn down with hooks so as to put the triceps on the stretch. When the skin has been removed from the back of the arm, two external cutaneous branches of the musculo-spiral nerve should be noticed.]

Cutaneous Nerves.—The *upper external cutaneous* branch of the *musculo-spiral* (Fig. 8, 7) appears about the middle of the outer side of the arm, and runs downwards and forwards along the cephalic vein to the upper part of the fore-arm; the *lower external*, of larger size (Fig. 16, 6), appears close above the external condyle, and will be afterwards traced down the back of the fore-arm to the wrist; and the third or *internal cutaneous* branch pierces the fascia near the tendon of the teres major and supplies an area on the inner side of the arm behind that of the intercosto-humeral nerve (Fig. 8, 6).

Branches from the *internal cutaneous* and *lesser internal cutaneous* nerves will be found on the inner side of the limb, and filaments of the *circumflex* nerve run downwards over the back of the arm, and upwards over the lower part of the deltoid (Fig. 16).

[When the strong deep fascia of the arm has been divided, the fibres of the triceps muscle should be cleaned, and a large bursa between the triangular posterior surface of the ulna and the skin should be noticed.]

The **Triceps Muscle** (Fig. 16) has of course three heads—the long or middle, the external, and the internal. The *long* (11) head *arises* from a somewhat triangular rough surface on the axillary border of the scapula immediately below the glenoid cavity. It has been already partly examined both from the front and from behind in relation with certain spaces (pp. 19, 40), and its fibres are now seen to be separated by another somewhat triangular interval from the back of the upper third of the humerus, until it joins the external head at the junction of the upper with the middle third of the bone. The *outer* head (4) *arises* from immediately below the insertion of the teres minor, and from the outer side of the posterior aspect of the bone, as far down as the musculo-spiral groove; also slightly from the external intermuscular septum which intervenes between it and the deltoid. It forms a tendinous arch over the musculo-spiral nerve. The *inner* head (13) *arises* from the whole of

Fig. 16.

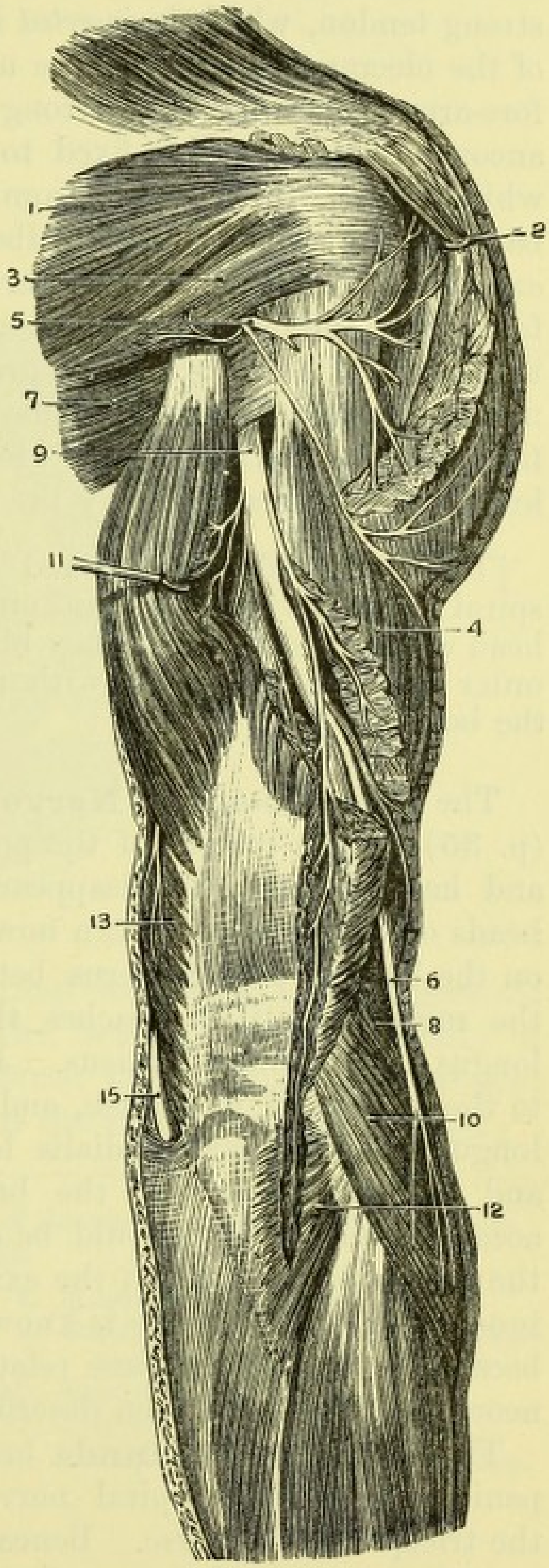


Fig. 16.—Dissection of back of upper arm (from Hirschfeld and Leveillé).

1. Infra-spinatus.
2. Deltoid.
3. Teres minor.
4. Outer head of triceps.
5. Circumflex nerve.
6. External cutaneous branch of musculo-spiral nerve.
7. Teres major.
8. Supinator longus.
9. Musculo-spiral nerve.
10. Extensor carpi radialis longior.
11. Middle head of triceps.
12. Anconeus.
13. Inner head of triceps.
15. Ulnar nerve.

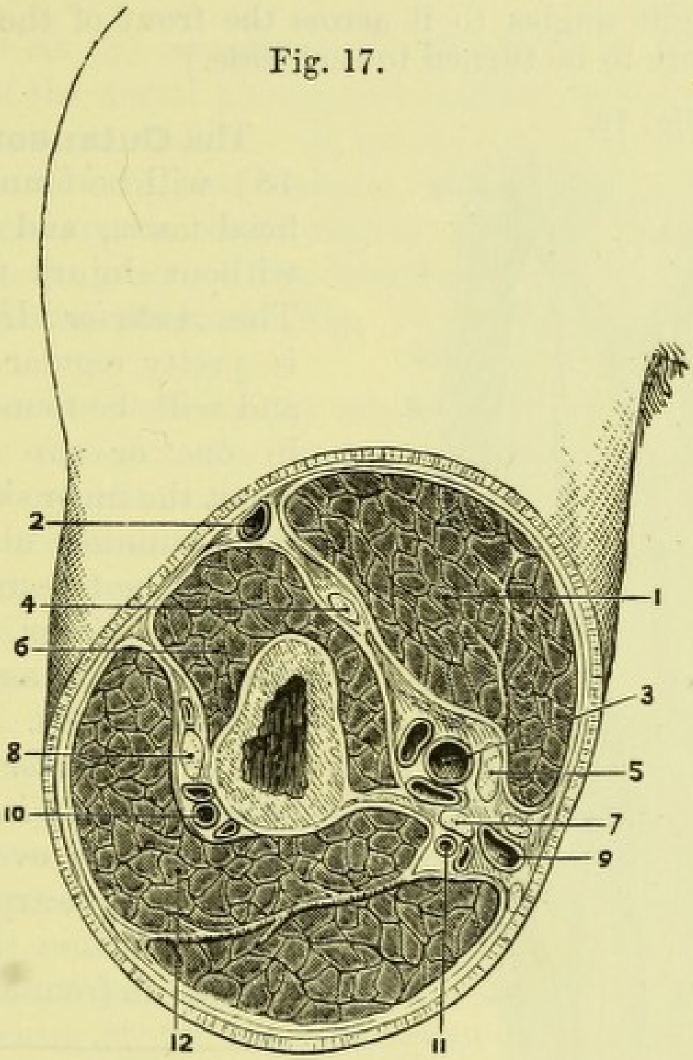
the posterior aspect of the humerus below the insertion of the teres major and the musculo-spiral groove, to within half an inch of the elbow-joint on the inner side, and extending to the back of the condyle on the outer side: fibres also arise from the external and internal intermuscular septa which intervene between it and muscles of the front of the arm. The whole of the fibres converge to a strong tendon, which is *inserted* into the posterior margin of the top of the olecranon process of the ulna, and into the deep fascia of the fore-arm by means of a strong prolongation, which lies over the anconeus muscle, and is fixed to the posterior border of the ulna; while a fasciculus detached from its deep surface is attached to the back of the capsule of the elbow-joint, and is known as the *sub-anconeus.* A small bursa intervenes between the tendon and the forepart of the olecranon process, which will be seen when the joint is opened. The triceps is the great *extensor* of the fore-arm upon the upper arm, and its action is that of a force applied to a lever of the first order. The long head also adducts and draws backwards the humerus. It is *supplied* by the musculo-spiral nerve.

[The long head being hooked to the inner side, and the musculo-spiral nerve having been put on the stretch, the fibres of the outer head are to be divided as they blend with those of the inner head in order to follow the nerve, with the superior profunda artery, round the bone.]

The **Musculo-spiral Nerve** (Fig. 16, 9) has been already shown (p. 35) to be a branch of the posterior cord of the brachial plexus, and has been seen to disappear between the internal and middle heads of the triceps; it can now be followed in the oblique groove on the back of the humerus between the inner and outer heads of the muscle, until it reaches the interval between the supinator longus and brachialis anticus. It gives off numerous large branches to the triceps in its course, and afterwards supplies the supinator longus, extensor carpi radialis longior, brachialis anticus (in part), and the anconeus; and the branch to the last muscle with an accompanying artery should be at once traced through the fibres of the triceps at the back of the external condyle. The branch to the inner head of the triceps is known as the *ulnar collateral* of Krause, because it descends in close relation to the ulnar nerve. The cutaneous branches have been described at p. 44.

The **Superior Profunda** branch of the brachial artery accompanies the musculo-spiral nerve around the bone, and supplies the triceps in its course. Beneath the muscle a branch ascends to anastomose with the posterior circumflex artery. At the inner edge of the triceps it gives off a rather large branch, the *descending articular*, which runs down to the back of the elbow beneath the triceps close to the external intermuscular septum to anastomose

Fig. 17.



with the posterior interosseous recurrent and with the anastomotic and inferior profunda arteries. The *terminal* branch, usually of small size, runs with the nerve between the supinator longus and brachialis anticus to anastomose with the radial recurrent artery.

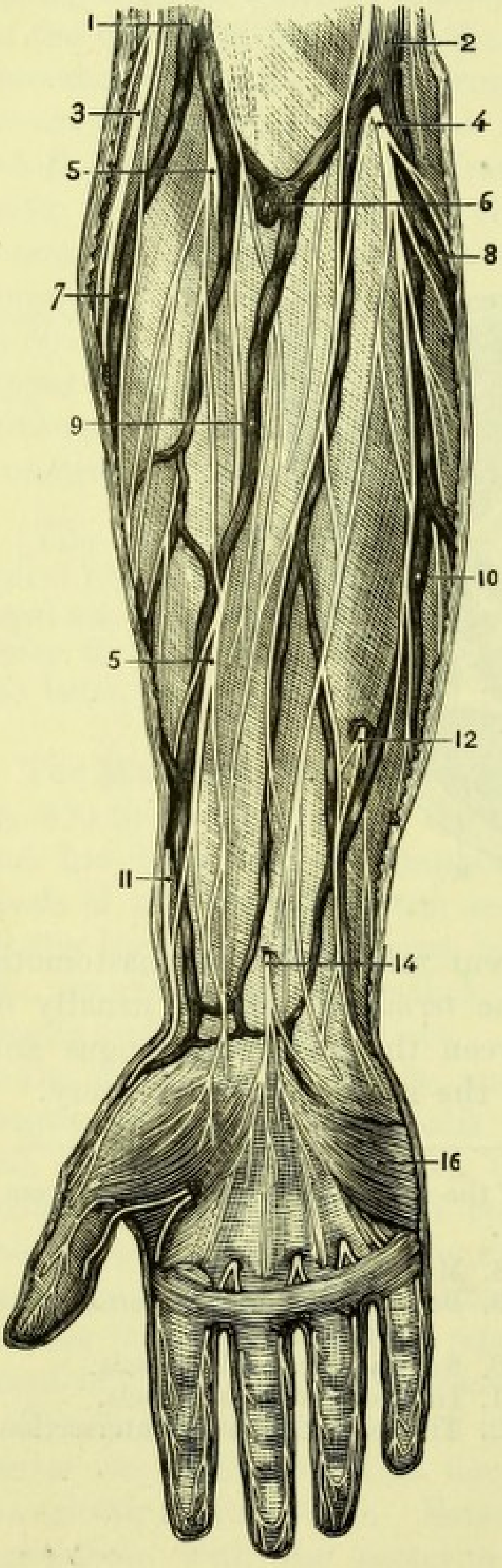
Fig. 17.—A section through the middle of the right upper arm (altered from Béraud).

1. Biceps.
2. Cephalic vein.
3. Brachial vessels.
4. Musculo-cutaneous nerve.
5. Median nerve.
6. Brachialis anticus.
7. Ulnar nerve.
8. Musculo-spiral nerve.
9. Basilic vein with internal cutaneous nerve.
10. Superior profunda vessels.
11. Inferior profunda vessels.
12. Triceps with fibrous intersection.

The Front of the Fore-arm.

[One incision is to be made down the middle of the fore-arm, and another at right angles to it across the front of the wrist, and the flaps of skin are to be turned to each side.]

Fig. 18.



The **Cutaneous Veins** (Fig. 18) will be found in the superficial fascia, and can be defined without injury to the nerves. The *Anterior Ulnar Vein* (10) is pretty regular in its course, and will be found to commence in one or two small branches about the inner side of the wrist; then running along the inner side of the fore-arm, it joins the *Posterior Ulnar Vein* (8) near the elbow, and assists in forming the basilic vein.

The *Posterior Ulnar Vein* arises from the inner side of the dorsal plexus over the 3rd, 4th, and 5th metacarpal bones.

The *Median Vein* (9) commences in front of the wrist near

Fig. 18.—Cutaneous dissection of the front of the fore-arm (from Hirschfeld and Leveillé).

1. Cephalic vein.
2. Basilic vein.
3. External cutaneous branch of musculo-spiral nerve.
4. Internal cutaneous nerve.
5, 5. External cutaneous nerve.
6. Deep vein joining the bifurcation of the median.
7. Radial vein.
8. Posterior ulnar vein.
9. Median vein, dividing into median-basilic and median-cephalic veins.
10. Anterior ulnar vein.
11. Radial nerve.
12. Cutaneous branch of ulnar nerve.
14. Palmar branch of median nerve.
16. Palmaris brevis muscle.

the root of the thumb, coursing obliquely to the centre of the limb near the bend of the elbow, where it is joined by the *profunda* vein and divides into median basilic and median cephalic branches (p. 27).

The *Radial Vein* (7) commences at the back of the hand from the outer side of the dorsal plexus, and appears on the radial side of the fore-arm about its middle. It has been seen to unite with the median cephalic to form the cephalic vein (p. 27). Besides these named veins there are numerous smaller branches which assist, and occasionally take the place of, the larger ones.

The **Cutaneous Nerves** (Fig. 18) are now to be followed out.

The *Internal cutaneous nerve* (4) can be traced to the whole of the inner side of the fore-arm, the branches winding round to the back of the limb. It sometimes forms a junction with the following—

The *palmar cutaneous branch of the Ulnar nerve* (12) may be found piercing the fascia about a hand's breadth above the wrist, close to the radial edge of the flexor carpi ulnaris tendon, and traced to the ulnar side of the palm.

The *External cutaneous* (musculo-cutaneous) *nerve* (5) is distributed to the radial side of the fore-arm by two branches:—the *anterior*, accompanying the radial vein, is distributed on the anterior aspect and ends on the ball of the thumb; the *posterior* reaches the back of the fore-arm, and, after joining the radial nerve, ends at the level of the wrist.

The *palmar cutaneous branch of the Median nerve* (14) pierces the fascia in the centre of the fore-arm about two inches above the wrist, and passes to the palm of the hand, communicating with the palmar cutaneous branch of the ulnar.

The **Deep fascia** is now to be cleaned, and will be found to be continuous with the deep fascia of the arm above, and with the annular ligament below. It gives off intermuscular septa which are attached deeply to ridges upon the radius and ulna, give origin to muscular fibres, and form sheaths for the muscles and tendons. In a thin subject these are seen as white lines, running more or less in the direction of the long axis of the limb.

[The muscles arising from the internal condyle are to be cleaned as far as possible without disturbing them; a small part only of the flexor sublimis will be thus exposed. The edge of the supinator longus is also to be cleaned. The radial artery must be shown throughout its course, and the ulnar artery near the wrist at the radial side of the tendon of the flexor carpi ulnaris. The median nerve will appear between the tendons of the flexor carpi radialis and flexor sublimis, and to the radial side of the latter.]

The **Muscles** (Fig. 19) arising from the inner condyle are five in number, four being *flexors* of the carpus and fingers, and one a *pronator* of the fore-arm. Beginning from the outer side, their relative positions are :—1, pronator teres ; 2, flexor carpi radialis ; 3, palmaris longus (which may be absent) ; 4, flexor sublimis digitorum ; 5, flexor carpi ulnaris. All these muscles have a common origin from (1) the internal condyle, (2) the fascia of the fore-arm, and (3) the intermuscular septa derived from it ; but three of them, viz., the pronator teres, flexor sublimis digitorum, and flexor carpi ulnaris, have extra bony attachments.

The **Pronator Radii Teres** (Fig. 19, 8) *arises* from the internal condyle above the other muscles, and from half an inch

Fig. 19.

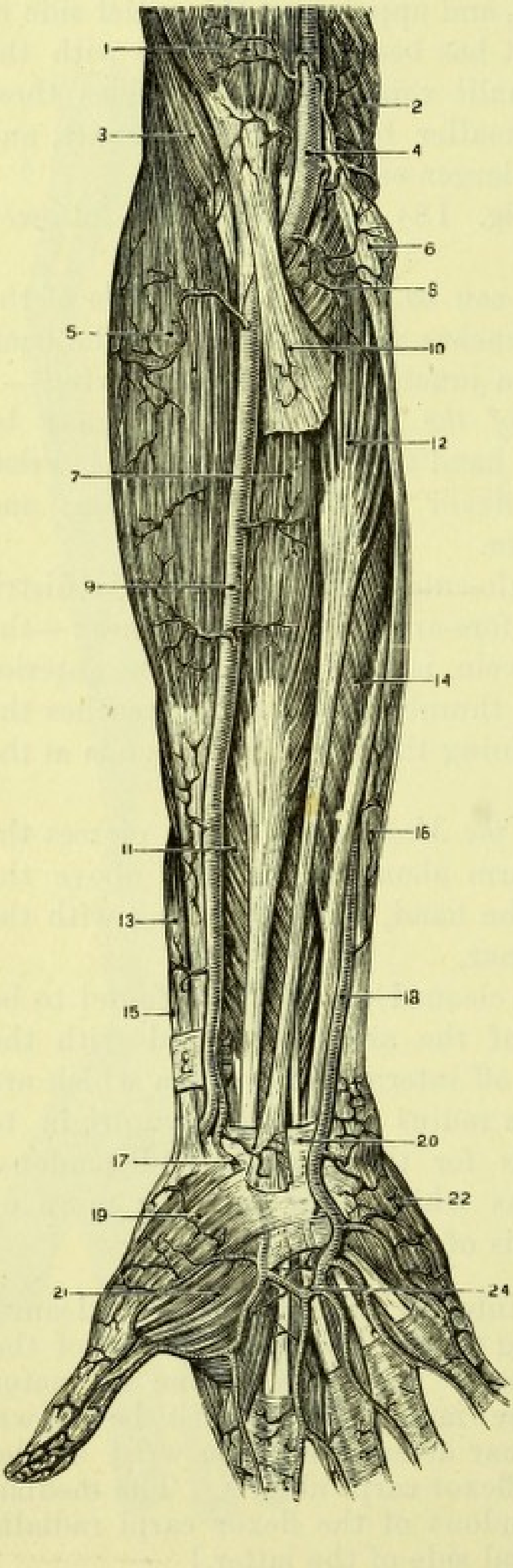


Fig. 19.—Superficial dissection of fore-arm and hand (from Bonamy and Beau).

1. Biceps.
2. Inner head of triceps.
3. Brachialis anticus.
4. Brachial artery.
5. Supinator longus.
6. Internal condyle.
7. Flexor carpi radialis.
8. Pronator radii teres.
9. Radial artery.
10. Bicipital fascia.
11. Flexor longus pollicis.
12. Palmaris longus.
13. Extensor ossis metacarpi pollicis.
14. Flexor sublimis digitorum.
15. Extensor primi internodii pollicis.
16. Flexor carpi ulnaris.
17. Superficial volar artery.
18. Ulnar artery.
19. Abductor pollicis.
20. Anterior annular ligament.
21. Flexor brevis pollicis.
22. Muscles of little finger.
24. Superficial palmar arch.

or an inch of the supra-condylar ridge ; from the fascia of the fore-arm over it ; and from the intermuscular septum between it and the flexor carpi radialis ; and by a second head from the ridge on the inner side of the coronoid process of the ulna below the ulnar origin of the flexor sublimis. The median nerve lies between the two heads, the ulnar artery beneath them. It is *inserted* by a broad tendon into the middle of the outer side of the radius, immediately below the supinator brevis. It pronates the hand by rolling the radius on the ulna, and flexes the elbow ; and is *supplied* by the highest branch of the median nerve.

The **Flexor Carpi Radialis** (Fig. 19, 7) *arises* from the internal condyle in common with the other muscles ; from the fascia of the fore-arm ; and from the intermuscular septa between it and the pronator teres on one side, and the palmaris longus and flexor sublimis on the other. It ends about the middle of the fore-arm in a broad tendon, which soon becomes rounded, and disappears at the root of the thumb, piercing the external attachment of the annular ligament and passing through the groove in the trapezium, to be *inserted* into the base of the second, and slightly into the base of the third metacarpal bone. It is a flexor, an abductor and a pronator of the hand, and a slight flexor of the elbow. As a flexor of the wrist it acts upon both the radio-carpal and intercarpal joints. It is *supplied* by the median nerve.

The **Palmaris Longus** (Fig. 19, 12) *arises* from the common attachment to the inner condyle ; from the fascia of the fore-arm ; and from the intermuscular septa on each side of and beneath it. Its long and narrow tendon passes superficially to be *inserted* into the annular ligament, and terminates by expanding into the radiating palmar fascia in the centre of the hand. It serves to make tense the palmar fascia and thus protect the deep structures in the palm. It slightly flexes the hand and elbow, and fixes the annular ligament during the action of the thumb and little finger. It is *supplied* by the median nerve.

The palmaris longus is subject to great variations ; it is frequently wanting, but is sometimes largely developed. Its muscular belly may be displaced downwards to the middle or lower part of the fore-arm, or may be double ; and there are many irregularities in its insertion.

The **Flexor Carpi Ulnaris** (Fig. 19, 16) *arises* from the common attachment to the internal condyle, from the fascia of the fore-arm, from the intermuscular septum between it and the adjacent muscles ; and by an additional aponeurotic origin from the inner side of the olecranon process and from the upper two-thirds of the posterior ridge of the ulna with the flexor profundus digitorum. The muscle is *inserted* by a flattened tendon (upon which the muscular fibres extend nearly to the wrist) into the annular ligament and into the pisiform bone, whence it is prolonged by ligamentous bands to the unciform process and base of the fifth metacarpal bone. The ulnar nerve enters the fore-arm between the two origins of this muscle; the dorsal cutaneous branch of the ulnar winds beneath it in the lower third of the fore-arm, and the ulnar

Fig. 20.

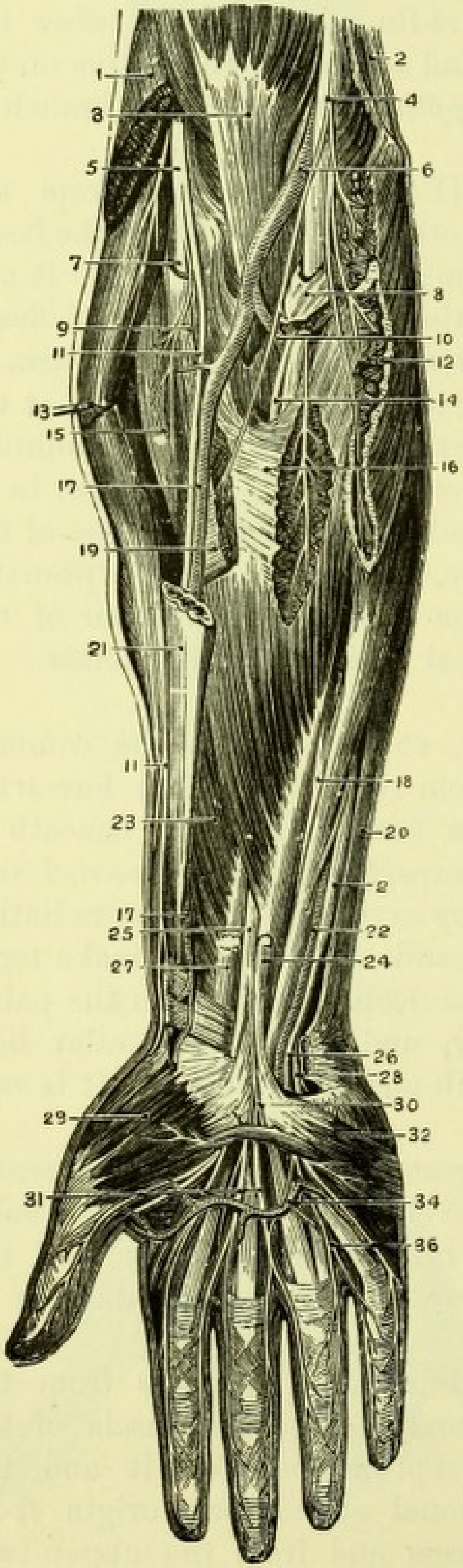


Fig. 20.—Superficial dissection of the front of the fore-arm (from Hirschfeld and Leveillé).

1. Supinator longus (cut).
2, 2. Ulnar nerve.
3. Biceps.
4. Median nerve.
5. Musculo-spiral nerve.
6. Brachial artery.
7. Posterior interosseous nerve.
8. Pronator teres.
9. Supinator brevis.
10. Ulnar artery.
11, 11. Radial nerve.
12. Flexor carpi radialis (cut).
13. Extensor carpi radialis longior.
14. Anterior interosseous nerve.
15. Extensor carpi radialis brevior.
16. Flexor sublimis digitorum.
17, 17. Radial artery.
18. Flexor profundus digitorum.
19. Tendon of pronator teres.
20. Tendon of flexor carpi ulnaris.
21. Tendon of supinator longus.
22. Ulnar artery.
23. Flexor longus pollicis.
24. Tendon of palmaris longus.
25. Median nerve, becoming superficial.
26. Superficial division of ulnar nerve.
27. Tendon of flexor carpi radialis.
28. Deep branch of ulnar nerve.
29. Abductor pollicis.
30. Cutaneous palmar branch of median nerve.
31. Digital branches of median nerve.
32. Palmaris brevis.
34. Superficial palmar arch.
36. Digital branches of ulnar nerve.

vessels and nerve lie beneath the process of insertion into the annular ligament close to the radial side of the tendon near the wrist. It is the only muscle inserted directly into one of the carpal bones, and is a flexor of the carpus and of the carpo-metacarpal joint of the little finger, an adductor of the hand, and fixes the pisiform bone and annular ligament during the actions of the muscles of the little finger. It is *supplied* by the ulnar nerve.

The **Radial Artery** (Fig. 19, 9), the smaller of the divisions of the brachial artery, extends in the fore-arm from the bifurcation at the bend of the elbow to the front of the styloid process of the radius. It is superficial in the whole of this course, except where it is more or less overlapped by the supinator longus muscle. It lies *between* the supinator longus and the pronator teres above, and in the lower half of the fore-arm between the tendons of the supinator longus and flexor carpi radialis, which latter tendon is here generally taken as the guide to the vessel. To its *outer* side is the radial nerve, which in the upper third of the arm is at some little distance, in the middle third sometimes touches the artery, and in the lower third quits the vessel altogether to pass beneath the supinator longus. *Beneath* the radial artery are (1) the tendon of the biceps (if the bifurcation takes place in the ordinary position) ; (2) the supinator brevis ; (3) the insertion of the pronator teres ; (4) the radial origin of the flexor sublimis ; (5) the flexor longus pollicis ; (6) the pronator quadratus ; and (7) the end of the radius. It has two venæ comites and gives off the following branches :—

Branches.—1. The *radial recurrent* (Fig. 21, 9) runs outwards beneath the supinator longus and gives ascending and descending branches, the former anastomosing with the termination of the superior profunda branch of the brachial artery.

2. *Muscular branches* are given off at various points to the adjacent muscles.

3. The *superficial volar* (21) arises near the root of the thumb and is of variable size. It runs forward, and generally beneath some of the fibres of the abductor pollicis, to complete the superficial palmar arch formed by the ulnar artery.

4. The *anterior carpal* is a small branch which runs across the wrist beneath the deep tendons, to join a corresponding branch of the ulnar artery at the level of the lower border of the pronator quadratus. It anastomoses with twigs of the anterior interosseous and deep palmar arch.

Surgery.—The radial artery is readily tied, about an inch above the wrist, by an incision one inch and a half long, placed midway between the tendons of the flexor carpi radialis and supinator longus, when the vessel will be found lying immediately beneath the deep fascia, with the venæ comites in close connection but with no nerve near it. The artery may be exposed in the upper part by an incision, two inches long, at any point in a line drawn from the centre of the bend of the elbow to the front of the styloid process of the radius, the knife going at once down to the supinator longus, which must then be carefully turned outwards. The position of the radial nerve to the outer side, in the middle third of the fore-arm, is to be borne in mind and the ligature passed from it.

When the radial artery is tied, the circulation is mainly carried on by the ulnar and its branches, the anastomoses through the palmar arches being very free.

[The pronator teres is to be divided about its middle, without injuring the median nerve or the ulnar origin of the muscle, which can now be thoroughly seen; and the flexor carpi radialis and palmaris longus are to be divided so as to expose thoroughly the flexor sublimis, which is to be cleaned. The skin of the front of one of the fingers is to be carefully removed without interfering with the palm, and the sheath of the tendons dissected out (Fig. 20). Branches of the median nerve will be seen to enter the pronator radii teres, the palmaris longus, the flexor sublimis and the flexor carpi radialis; the digital vessels and nerves on the side of the finger dissected must be preserved.]

The **Flexor Sublimis Digitorum** (perforatus) (Fig. 20, 16) is the only muscle of the fore-arm which has its origin from the three bones of the arm. It *arises* from the internal condyle of the humerus and slightly from the internal lateral ligament of the elbow; from the intermuscular septa between it and the more superficial muscles; from a tubercle on the inner side of the coronoid process of the ulna above the pronator teres origin; and from the whole of the oblique line on the front of the radius and part of the external border of this bone. Between the radial and ulnar origins passes the median nerve. The muscle ends in four tendons, the two to the second and third fingers lying in front of those to the first and fourth fingers, and all pass under the annular ligament and through the palm of the hand to the second phalanges of the four fingers. The tendon to the little finger is often of very small size.

To expose the insertion of the muscle the *sheath* of the finger tendons should be laid open along the centre. The sheath is formed by the bones and joints of the digit, and by a fibrous structure, the *ligamentum vaginale*, which is attached by thick and strong transverse bands to the lateral ridges on the first and second phalanges, and by thinner expansions to the ligaments of their articulations, some of its fibres decussating diagonally across the front of the two interphalangeal joints. The sheath is lined by a synovial membrane, which is reflected upon the tendons and forms certain little accessory structures called *vincula vasculosa.* These are of two kinds : (1) long thread-like bands passing downwards from the phalanges to the tendons of the flexor sublimis and flexor profundus, *ligamenta longa* ; and (2) short folds, one at the insertion of each tendon, *ligamenta brevia* (Marshall). The tendon of the flexor sublimis (perforatus) will be seen to divide on the first phalanx to give passage to the tendon of the flexor profundus (perforans), the two slips uniting beneath the latter and dividing again to be *inserted* into the ridges on the shaft of the second phalanx ; while the tendon of the flexor profundus runs on to the base of the third phalanx. The flexor sublimis is a flexor of the middle and proximal phalanges and of the carpus ; and is also a weak flexor of the elbow, but its chief action is upon the phalanx to which it is attached. It is *supplied* by the median nerve.

The position of the ulnar artery, between the tendon of the flexor carpi ulnaris and the innermost tendon of the flexor sublimis in the lower half of the fore-arm, is now to be noticed, and, by a slight separation of the tendons, the ulnar nerve can be seen lying close to the ulnar side of the artery. This is the point where the ulnar artery is usually tied.

[The flexor sublimis is now to be divided near its origin and turned down without injuring the median nerve, from which a branch may be traced to the deep surface of the muscle.]

The **Deep Muscles** (Fig. 21) of the fore-arm are the flexor longus pollicis on the radial side, the flexor profundus digitorum on the ulnar side, and the pronator quadratus, a small square muscle with transverse fibres, to be afterwards seen above the carpus by drawing aside the tendons. These are now to be cleaned, all vessels and nerves being carefully preserved.

The **Flexor Longus Pollicis** (Fig. 21, 15) *arises* from the whole of the anterior surface of the radius between the oblique line and the attachment of the pronator quadratus, and from the outer half of the interosseous membrane in nearly its whole length. It generally has a small additional origin, by a slip of variable size, from the inner side of the coronoid process of the ulna. The tendon, invested by its own bursal sheath, passes beneath the annular ligament, and through the palm of the hand between the two heads of the flexor brevis pollicis, to be *inserted* into the base of the terminal phalanx of the thumb. The *ligamentum vaginale* of this tendon is much weaker than those of the finger tendons, and its synovial lining is commonly continuous with the outer carpal bursa.

The **Flexor Profundus Digitorum** (perforans) (Fig. 21, 24) *arises* from the anterior surface of the ulna between the insertion of the brachialis anticus (which it embraces) and the origin of the pronator quadratus; from the adjacent half of the interosseous membrane; and from the upper two-thirds of the inner surface of the ulna, extending to the coronoid and olecranon processes, and to the posterior border of the bone. The muscle ends in four tendons (that to the index finger alone being quite separate in the fore-

Fig. 21.

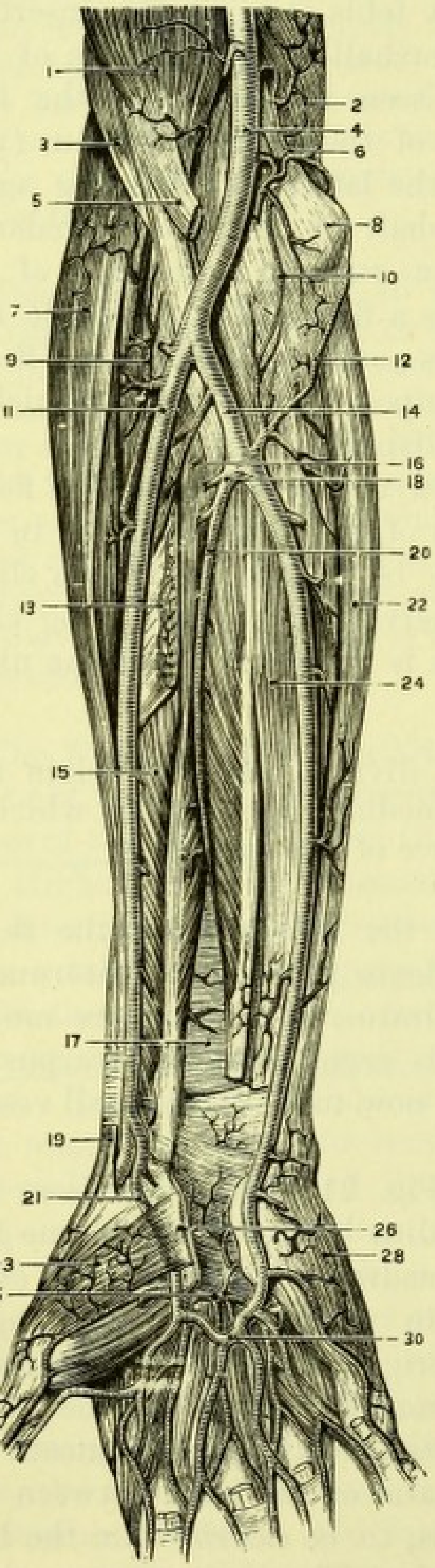


Fig. 21.—Deep dissection of fore-arm and hand (from Bonamy and Beau).

1. Biceps.
2. Inner head of triceps.
3. Brachialis anticus.
4. Brachial artery.
5. Bicipital fascia.
6. Anastomotic artery.
7. Supinator longus.
8. Internal condyle.
9. Radial recurrent artery.
10. Anterior ulnar recurrent artery.
11. Radial artery.
12. Posterior ulnar recurrent artery.
13. Insertion of pronator radii teres.
14. Ulnar artery.
15. Flexor longus pollicis.
16. Supinator brevis.
17. Pronator quadratus.
18. Interosseous artery.
19. Extensors of thumb.
20. Anterior interosseous artery.
21. Superficial volar artery.
22. Flexor carpi ulnaris.
23. Abductor pollicis.
24. Flexor profundus digitorum.
25. Deep palmar arch.
26. Anterior annular ligament.
28. Short muscles of little finger.
30. Superficial palmar arch.

arm), which pass beneath the annular ligament, and after giving origin to the lumbricales muscles in the palm, pierce the tendons of the flexor sublimis opposite the first phalanges, and are *inserted* into the bases of the third phalanges of the four fingers.

The two preceding muscles are direct flexors of the thumb and fingers, and of the carpus, acting chiefly upon the terminal phalanges. The flexor longus pollicis is *supplied* by the anterior interosseous branch of the median nerve ; the flexor profundus partly by the anterior interosseous branch of the median and partly by the ulnar nerve.

[By separating the flexor longus pollicis from the flexor profundus digitorum, the interosseous vessels and the anterior interosseous vessels and nerve, as well as the pronator quadratus muscle, will be displayed.]

The tendons of the sublimis and profundus are provided with *bursal sheaths* common to the two ; a *carpal* sheath lying beneath the anterior ligament and extending a little above and below it, and *digital* sheaths, one for each finger, lying within the theca, and extending more or less into the palm beyond the proximal side of the ligamentum vaginale, especially in the case of the little finger, the digital sheath of which often communicates with a distal extension of the carpal sheath. The bursal sheath of the thumb tendon commonly extends from above the annular ligament to the distal joint, but is occasionally divided into two parts by an interval opposite the metacarpal bone : in rare cases it communicates with the carpal sheaths of the finger tendons (Fig. 34).

The **Pronator Quadratus** (Fig. 21, 17) is the only muscle in the arm whose fibres are transverse. It *arises* from the lower oblique line on the front of the ulna, below the origin of the flexor profundus, and is *inserted* into the whole of the front of the radius below the attachment of the flexor longus pollicis. This muscle is a powerful pronator of the fore-arm, and is *supplied* by the anterior interosseous branch of the median nerve.

The **Ulnar Artery** (Fig. 21, 14) arises from the bifurcation of the brachial artery at the bend of the elbow, and at first takes an oblique course inwards *beneath* the median nerve (separated from it by the deep head of the pronator teres) and four of the muscles arising from the internal condyle (pronator teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum). It lies first *upon* the insertion of the brachialis anticus, then upon the flexor profundus digitorum, being there bound down by a process of deep fascia, and is joined in the middle of the fore-arm by the ulnar nerve, where it reaches the border of the flexor carpi ulnaris, which lies to its ulnar side for the rest of its course. In the lower third both artery and nerve lie comparatively superficially between the tendons of the flexor carpi ulnaris and the flexor sublimis, and they both rest on the flexor profundus digitorum until they pass forward to the hand between the annular ligament and a process from the tendon of the flexor carpi ulnaris. Two venæ comites are in close relation with the artery.

Surgery.—The ulnar artery is easily reached in its lower part by an incision two inches long upon the outer edge of the tendon of the flexor carpi ulnaris. The tendon being drawn a little inwards, it would only be necessary to divide the intermuscular layer of the deep fascia in order to expose the vessel with the nerve on its ulnar side. The operation for tying the artery in its upper part between the flexor muscles is impracticable on the living body, but the vessel may be reached on the subject by separating the flexor carpi ulnaris from the flexor sublimis digitorum until the ulnar nerve is exposed, when the artery will be found to its outer side.

When the ulnar artery is tied, the circulation is mainly carried on by the radial through the palmar arches, and also by the anterior and posterior interosseous arteries, which anastomose at the back of the fore-arm.

Branches.—1. The *Anterior ulnar recurrent* (Fig. 21, 10) will be found between the brachialis anticus and pronator teres, running up in front of the elbow joint to join the anterior branches of the anastomotic, and inferior profunda.

2. The *Posterior ulnar recurrent* (12) is to be followed beneath the flexor sublimis and flexor carpi ulnaris to the back of the internal condyle, where, after passing between the heads of the flexor carpi ulnaris, it runs in the groove occupied by the ulnar nerve, and anastomoses with the inferior profunda and anastomotic arteries.

3. The *Interosseous artery* (18) is a short trunk arising about one inch from the commencement of the artery. It is directed backwards to the interosseous space, where it subdivides into anterior and posterior interosseous branches.

The *posterior interosseous* passes between the radius and ulna in the interval between the oblique and interosseous ligaments to join the posterior interosseous nerve at the back of the fore-arm, where it will be dissected.

The *anterior interosseous* (20) is to be followed down the front of the interosseous membrane, where it will be found lying with a branch of the median nerve between the flexor longus pollicis and flexor profundus digitorum, until it disappears beneath the pronator quadratus to reach the wrist. It gives off numerous *muscular* branches; a *median* branch to accompany the median nerve (sometimes of large size); two *nutrient* arteries to the radius and ulna, which are directed *towards* the elbow; and a *communicating* branch to join the anterior carpal arch.

4. The anterior *Carpal artery* runs beneath the finger tendons near the lower border of the pronator quadratus, to supply the front and back of the carpus. It anastomoses with the anterior carpal from the radial, twigs from the anterior interosseous, and recurrent branches of the deep palmar arch. The *posterior carpal artery* passes to the back of the wrist, and will be seen later.

The **Median Nerve** (Figs. 20 and 22, see also p. 34) after passing between the heads of the pronator teres, and between the radial and ulnar origins of the flexor sublimis digitorum, crosses the ulnar artery to lie between the flexor sublimis and flexor profundus muscles. Near the wrist it is placed superficially between the tendon of the flexor carpi radialis and radial side of the flexor sublimis, and passes beneath the annular ligament into the hand.

Branches.—The median nerve supplies all the muscles of the front of the fore-arm except the flexor carpi ulnaris and half the flexor profundus. As soon as it enters the fore-arm it gives branches to the pronator teres, flexor carpi radialis, flexor sublimis digitorum, and palmaris longus, and, after crossing the ulnar artery, gives off the *anterior interosseous nerve* (Fig. 22, 25). This passes down the front of the interosseous membrane, giving branches to the flexor longus pollicis and the outer half of the flexor profundus digitorum, and the pronator quadratus, finally reaching the front of the wrist-joint, where it gives a branch to the articulation.

A *cutaneous palmar* branch of the median (Fig. 20, 30) arises a short distance above the annular ligament, over which it passes to be distributed to the skin of the palm.

Surgery.—The median nerve is often implicated in wounds above the wrist. It may be found there between the flexor carpi radialis and the flexor sublimis digitorum.

The **Ulnar Nerve** (Fig. 22, 2) enters the fore-arm behind the internal condyle, by passing between the heads of the flexor carpi ulnaris. It lies under cover of that muscle and upon the flexor profundus digitorum for the whole of its course in the fore-arm;

and about the middle third of the fore-arm comes into close relation with the ulnar artery, and, keeping to its ulnar side, accompanies it over the annular ligament into the palm.

Branches (Fig. 22).—The ulnar nerve gives small articular branches to the back of the elbow, and supplies one and a half of the muscles of the forearm, viz., the flexor carpi ulnaris and the inner half of the flexor profundus digitorum.

In the lower third of the fore-arm the nerve gives a *dorsal branch* (20), which turns back-

Fig. 22.

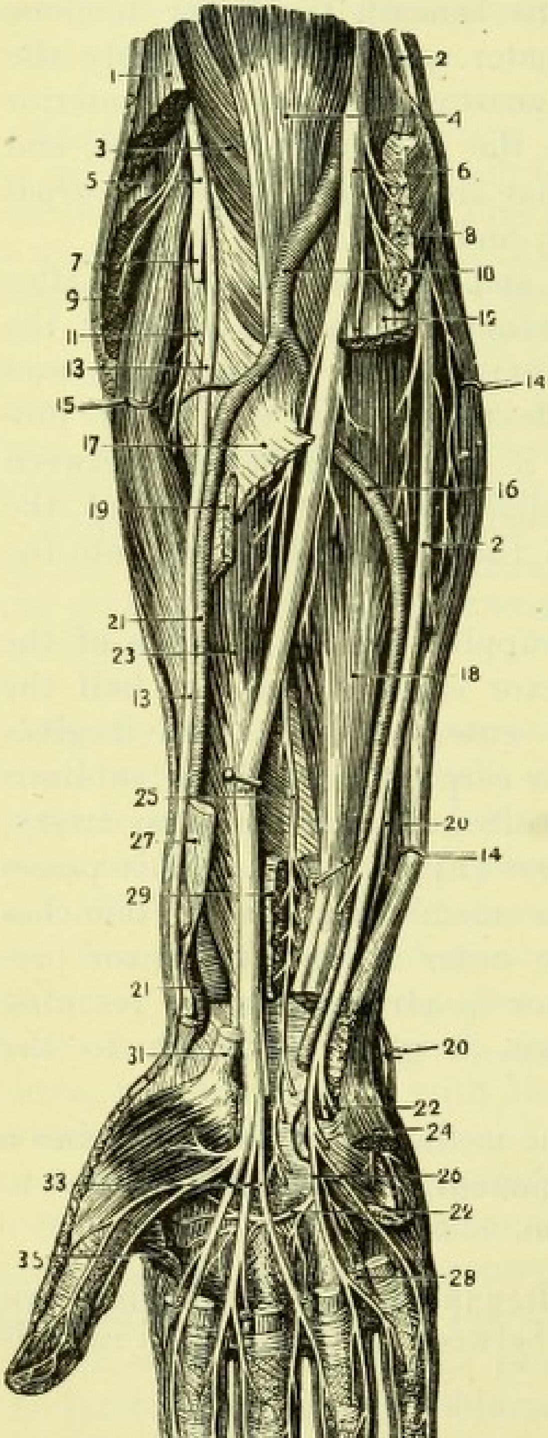


Fig. 22.—Deep dissection of the front of the fore-arm and hand (from Hirschfeld and Leveillé).

1. Supinator longus (cut).
2, 2. Ulnar nerve.
3. Brachialis anticus.
4. Biceps.
5. Musculo-spiral nerve
6. Median nerve.
7. Posterior interosseous nerve.
8. Pronator teres and flexor carpi radialis (cut).
9. Extensor carpi radialis longior (cut).
10. Brachial artery.
11. Supinator brevis.
12. Flexor sublimis digitorum (cut).
13, 13. Radial nerve.
14, 14. Flexor carpi ulnaris.
15. Extensor carpi radialis brevior.
16. Ulnar artery.
17. Radial origin of flexor sublimis digitorum (cut).
18. Flexor profundus digitorum.
19. Tendon of pronator teres.
20, 20. Dorsal branch of ulnar nerve.
21, 21. Radial artery.
22, 22. Deep branch of ulnar nerve.
23. Flexor longus pollicis.
24. Abductor minimi digiti.
25. Anterior interosseous nerve.
26. Digital branches of ulnar nerve.
27. Tendon of supinator longus.
28. One of the lumbricales.
29. Pronator quadratus.
31. Tendon of flexor carpi radialis.
33. Digital branches of median nerve.
35. Adductor transversus pollicis.

wards beneath the tendon of the flexor carpi ulnaris to be distributed to the back of the little and half the ring finger as far as the middle of their second phalanges, and sometimes replaces the adjoining branch of the radial.

A *cutaneous palmar* branch of small size arises below the middle of the fore-arm, and, after running down in front of the ulnar artery, becomes cutaneous close above the annular ligament, and is distributed to the skin of the palm on the ulnar side, communicating with the palmar cutaneous of the median.

Surgery.—The ulnar nerve is not unfrequently wounded or divided just above or at the wrist, and must be sought for entire, either between the tendons of the flexor carpi ulnaris and flexor digitorum sublimis, or in the fibrous canal formed between the anterior annular ligament and the process given to the latter by the flexor carpi ulnaris.

One of the most essential points in excision of the elbow-joint is to avoid injury to the ulnar nerve where it lies behind the internal condyle.

The **Radial Nerve** (Fig. 22, 13) is seen to arise from the musculo-spiral nerve opposite the elbow. It lies at first upon the supinator brevis, to the outer side of, and at some little distance from, the radial artery; but in the middle third of the fore-arm it is in close relation with the artery on the pronator teres, and occasionally touches it, leaving the vessel at the lower third to cross beneath the tendon of the supinator longus to the back of the fore-arm and hand.

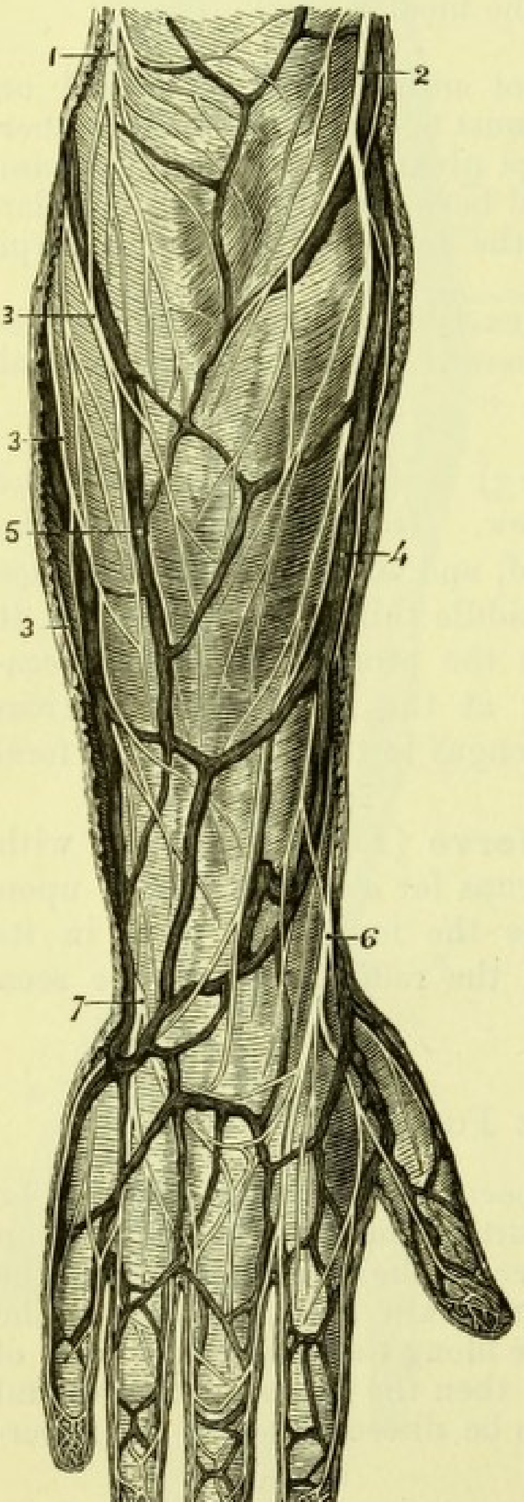
The **Posterior Interosseous Nerve** (Fig. 22, 7) arises with the radial and to its outer side. It runs for a short distance upon the supinator brevis, and then pierces the muscle to wind in its substance around the outer side of the radius. It will be seen again at the back of the fore-arm.

The Back of the Fore-arm.

[The front of the fore-arm having been dissected, the skin can be reflected from the back of it without further incisions, but an incision must be made along the inner border of the hand and across the knuckles, to permit the reflexion of the skin from the back of the hand. An incision is also to be made along the thumb and each of the fingers, and the skin reflected, and then the cutaneous nerves and vessels, but especially the veins, are to be dissected out of the superficial fascia.]

Cutaneous Nerves (Fig. 23).—The back of the fore-arm is supplied in the middle by the branches of the *musculo-spiral* nerve (2), which was seen above the condyles of the humerus in the dissection of the back of the arm (p. 44), and on the outer side of the limb by branches from the *musculo-cutaneous* nerve (4), and on the inner side by branches of the *internal cutaneous* nerve (3). At the wrist, on the outer side, the large *radial* nerve (6) pierces the deep fascia in the lower third of the fore-arm, and, after communicating with the musculo-cutaneous nerve, distributes digital branches to both sides of the thumb, fore-finger, and middle finger, and to the radial side of the ring finger; forming in addition a loop across the back of the hand with the *dorsal branch of the ulnar nerve* (7) which appears on the inner side of the wrist, at a point corresponding to the lower end of the ulna, and gives digital branches to both sides of the little finger and the ulnar side of the ring finger, joining the radial nerve across the back of the hand. The distribution of these dorsal digital nerves usually does not extend beyond the middle of the second phalanges, the distal portion of the dorsal integument receiving its supply from the palmar digital nerves.

Fig. 23.



The **Superficial Veins** (Fig. 23) across the back of the meta-

Fig. 23.—Superficial dissection of the back of the fore-arm (from Hirschfeld and Leveillé).

1. Posterior branch of internal cutaneous nerve.
2. External cutaneous branch of musculo-spiral nerve.
3, 3. Internal cutaneous nerve.
4. Radial vein and external cutaneous nerve
5. Posterior ulnar vein.
6. Radial nerve.
7. Dorsal branch of ulnar nerve.

carpus, originate in an irregular arch, from which arise the radial and posterior ulnar veins at its inner and outer extremities ; these wind round the fore-arm to join the radial and ulnar veins respectively, and one or two branches form communications between them and across the back of the fore-arm.

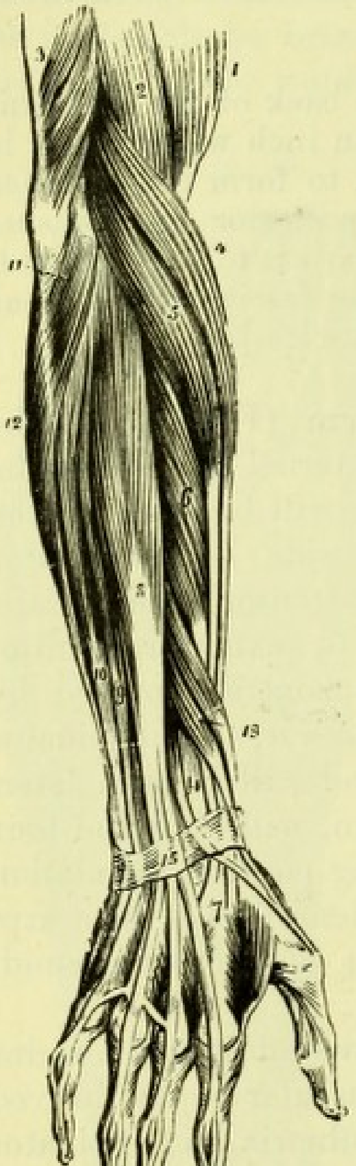
[The deep fascia is to be removed from the back of the fore-arm and hand, with the exception of a band about an inch wide, which is to be left opposite the lower end of the radius, to form the *posterior annular ligament* (Fig. 24, 15). The slender posterior interosseous artery to the outer side of the extensor carpi ulnaris is to be preserved. It will be found to be impossible to remove the fascia entirely near the elbow, where it is incorporated with the muscles.]

Muscles of the Back of the Fore-arm (Fig. 24).—The fore-arm muscles arising from and above the external condyle of the humerus are either *extensors* or *supinators*, and will be found in the following order, beginning from the radial side :—1, supinator longus ; 2, extensor carpi radialis longior ; 3, extensor carpi radialis brevior ; 4, extensor communis digitorum ; 5, extensor minimi digiti ; 6, extensor carpi ulnaris ; and 7, anconeus (covered by fascia prolonged from the triceps) ; another muscle, the supinator brevis, lies under cover of the long muscles and will be seen later. Arising deeply from the bones of the *fore*-arm, will be found four short extensor muscles, which hold the following position in relation to one another from the radial side :—1, extensor ossis metacarpi pollicis ; 2, extensor primi internodii pollicis ; 3, extensor secundi internodii pollicis ; 4, extensor indicis.

The muscles arising from the humerus have additional origins from the fascia of the arm or from intermuscular septa derived from it ; and two, viz., the extensor carpi ulnaris and supinator brevis, have additional origins from the ulna.

The **Supinator Radii Longus** (Fig. 24, 4) is a long muscle, and has been already seen in great part in previous dissections of the bend of the elbow and fore-arm. It *arises* from the upper two-thirds of the external supra-condylar ridge of the humerus, and from the external intermuscular septum of the arm, which separates it from the triceps ; and is *inserted* into the outer surface of the lower extremity of the radius at the bottom of the grooves for the extensores ossis metacarpi and primi internodii pollicis, reaching anteriorly a ridge-like tubercle about a third of an inch above the base of the styloid process of the radius. Its tendon is crossed by two short extensors of the thumb at the annular ligament, and the radial nerve passes beneath it to reach the back of the hand. It is *supplied* by a special branch of the musculo-spiral nerve. It is a powerful flexor of the fore-arm, and may also bring the radius into a position midway between pronation and supination.

Fig. 24.



The **Extensor Carpi Radialis Longior** (Fig. 24, 5, Fig. 25, 3) *arises* from the lower third of the external supra-condylar ridge and from the external intermuscular septum; its tendon passes beneath the extensors of the metacarpal bone and first phalanx of the thumb and through the second division of the annular ligament, and having then been crossed by the tendon of the third extensor of the thumb, is *inserted* into the base of the metacarpal bone of the fore-finger (2nd metacarpal bone). The muscle aids the supinator longus in flexion of the fore-arm, and is an extensor and abductor of the hand at the radio-carpal and intercarpal joints.

The **Extensor Carpi Radialis Brevior** (Fig. 24, 6), which is partly covered by the long extensor, *arises* from the outer condyle of the humerus; from the external lateral ligament; from the fascia of the fore-arm, and from the intermuscular septum between it and the extensor communis digitorum. Its tendon passes, with that of the long extensor, beneath the two extensors of the thumb and through the second division of the annular ligament; and lastly beneath the third extensor of the thumb, to be *inserted* into the styloid process on the base of the

Fig. 24.—Superficial muscles of the back of the fore-arm (from Wilson).

1. Biceps.
2. Brachialis anticus.
3. Lower part of the triceps, inserted into the olecranon.
4. Supinator longus.
5. Extensor carpi radialis longior.
6. Extensor carpi radialis brevior.
7. Tendons of insertion of these two muscles.
8. Extensor communis digitorum.
9. Extensor minimi digiti.
10. Extensor carpi ulnaris.
11. Anconeus.
12. Flexor carpi ulnaris.
13. Extensor ossis metacarpi and extensor primi internodii pollicis lying together.
14. Extensor secundi internodii pollicis.
15. Posterior annular ligament. The tendons of the common extensor are seen on the back of the hand, and the mode of insertion on the dorsum of the fingers.

metacarpal bone of the middle finger (3rd metacarpal bone). It is an extensor and a slight abductor of the hand.

The **Extensor Communis Digitorum** (Fig. 24, 8) *arises* from the external condyle with the preceding muscles; from the fascia of the fore-arm, and from the intermuscular septa on each side of it. It ends in three tendons, which pass through the fourth division of the annular ligament with the extensor indicis, and, the innermost having subdivided, the four tendons thus formed are *inserted* into the fingers in the following way:—Opposite the metacarpo-phalangeal joint each tendon receives slips on both sides from the interossei; it expands upon the phalanx, and is joined on the radial side by the tendon of the lumbricalis, finally its lateral portions are prolonged to the base of the third phalanx, whilst the middle portion is attached to that of the second phalanx. The division into three slips figured on diagrams is somewhat artificial, and must be made with the scalpel, since the three parts are, in the natural state, united. The tendon of the *extensor indicis* joins the ulnar side of the first or outermost tendon opposite the first phalanx; the tendon to the ring finger is joined by oblique tendinous slips to the tendons on each side; and the tendon to the little finger is joined by the two divisions of the extensor minimi digiti, both above and below the band uniting it with the tendon of the ring finger.

The *action* of this muscle is to extend the wrist and fingers, and in a very small degree the elbow. Its principal action, however, is upon the proximal phalanges (into which it is not directly inserted); the true extensors of the middle and ungual phalanges being the interossei and lumbricales.

The **Extensor Minimi Digiti** (Fig. 24, 9) might be taken as a part of the common extensor, but it is separated from it by an intermuscular septum. It *arises* from the external condyle; from the fascia and from the intermuscular septa on each side; and its tendon, after passing through the fifth division of the annular ligament in the groove between the radius and the ulna, and over the posterior inferior radio-ulnar ligament, is generally divided, both slips being *inserted* into the common expansion on the first phalanx of the little finger, but the innermost reaching further forward than its fellow (Fig. 27, 19). This muscle gives independent extension to the little finger, chiefly at the metacarpo-phalangeal joint, and aids the extensor communis in other respects.

The **Extensor Carpi Ulnaris** (Fig. 24, 10) *arises* from the back of the external condyle, from the fascia, and from the intermuscular septa on each side; and has an additional origin from an expansion attached to the outer side of the posterior border of the ulna, the fibres covering, but not being attached to, the inner part of the posterior surface of the bone. The tendon passes through the sixth division of the annular ligament, and in a groove behind the styloid process of the ulna, to be *inserted* into the base of the metacarpal bone of the little finger (5th metacarpal bone). It is an extensor and adductor of the hand, a feeble extensor of the fore-arm, and extends the carpo-metacarpal joint of the little finger.

It should be noted that all the flexors and extensors of the *carpus* are inserted, directly or indirectly, into the *metacarpus*, and act upon the radio-carpal, intercarpal, and carpo-metacarpal articulations. The *extensors of the fingers* act most powerfully on the proximal phalanges, the two other phalanges being principally extended by the lumbricales and interossei; the *radial extensors* are also abductors, and the *ulnar extensor* is an adductor of the radio-carpal articulation, and the *extensor carpi radialis longior* assists the supinator longus as a flexor of the fore-arm, the rest being feeble extensors of the elbow. The extensor carpi radialis longior is *supplied* by the musculo-spiral nerve; all the others by the posterior interosseous nerve, a branch of the musculo-spiral.

The **Anconeus** (Fig. 24, 11, Fig. 25, 4) is a small triangular muscle on the back of the elbow, which is apparently continuous with the triceps, but is separated from it by a narrow cellular interval. It is covered by an expansion from the tendon of the triceps, which must be removed to expose it. It *arises* from the back of the external condyle of the humerus by a separate origin, and spreads out to its fleshy *insertion* into the triangular surface upon the outer side of the olecranon and posterior surface of the ulna above the superior oblique line. It is an extensor of the fore-arm, and is *supplied* by a branch of the musculo-spiral nerve, which pierces its upper margin and is accompanied by a branch of the superior profunda artery. Its deep surface is in relation with the posterior interosseous recurrent vessels and with the capsule of the elbow and superior radio-ulnar joints (hence, when there is synovial effusion the muscle appears unduly prominent).

[The long extensors must be divided about the middle and turned aside in order to see the deep muscles thoroughly, but the supinator longus should be left uncut. The supinator brevis will require careful dissection beneath the origins of the other muscles, and the arm must be fully pronated in order to stretch the fibres whilst being cleaned. The posterior interosseous nerve piercing the muscle is to be carefully preserved, and its branches traced to the extensors.

The **Supinator Brevis** (Fig. 25, 9) is an oblique muscle, covered at the upper part by a tendinous expansion, from which some of its fibres take their origin. It *arises* from the external lateral ligament of the elbow, a few fibres perhaps reaching the external condyle ; from the back of the orbicular ligament of the radius ; from the triangular space below the lesser sigmoid cavity of the ulna, and from the adjacent part of the posterior surface of the bone for a short distance. Its fasciculi sweep spirally around the radius, and are *inserted* into the upper third of that bone, extending to the inner margin of the neck, the outer margin of the bicipital tuberosity, the oblique line, and the corresponding parts of the anterior, external, and posterior aspects of the bone. It is pierced by the posterior interosseous nerve (which *supplies* it), and the posterior interosseous artery passes between it and the extensor ossis metacarpi pollicis. It is a powerful supinator of the radius on the ulna.

The **Extensor Ossis Metacarpi Pollicis** (Fig. 25, 13) is the only one of the special extensors of the thumb which usually has an origin from both bones of the fore-arm. It *arises* from the middle of the posterior surface of the radius for about two inches, the origin reaching across the bone from the interosseous line to the attachments of the supinator brevis and pronator teres ; from a corresponding portion of the posterior surface of the interosseous membrane ; and from two inches of the middle of the outer side of the posterior surface of the ulna, between the attachments of the supinator brevis and anconeus above, and the extensor secundi internodii below. The muscle becomes superficial between the extensors of the carpus and fingers, and having crossed the extensor carpi radialis longior and brevior obliquely, and the insertion of the supinator longus, it passes on the outer side of the styloid process of the radius, through the first division of the annular ligament and over the radial artery, to be *inserted* into the base of the metacarpal bone of the thumb (1st metacarpal bone), sometimes sending a slip to the trapezium and the short muscles of the thumb.

The **Extensor Primi Internodii Pollicis** (Fig. 25, 15) *arises* from the back of the radius immediately below the extensor ossis metacarpi pollicis and close to the interosseous line, for a space two inches long and half an inch wide ; also from the radial half of the interosseous membrane for a corresponding distance. Its tendon lies to the ulnar side of the tendon of the extensor of the metacarpal bone in its whole course, passing through the same division of the annular ligament, and is prolonged to be *inserted* into the base of the first phalanx of the thumb.

The Extensor Secundi Internodii Pollicis (Fig. 25, 8) *arises* from the middle of the outer half of the posterior surface of the ulna between the origins of the extensor ossis metacarpi pollicis above, and the indicator below, and from the ulnar half of the corresponding portion of the interosseous membrane. Its tendon becomes superficial just above the annular ligament, through which it passes very obliquely in a separate division (the third); then crossing the tendons of the long and short radial extensors and the radial artery, it runs along the ulnar side of the extensor primi internodii to be *inserted* into the base of the terminal phalanx of the thumb. Its tendon receives fibrous processes (analogous to those given off to the finger extensors by the interossei) from the abductor pol-

Fig. 25.

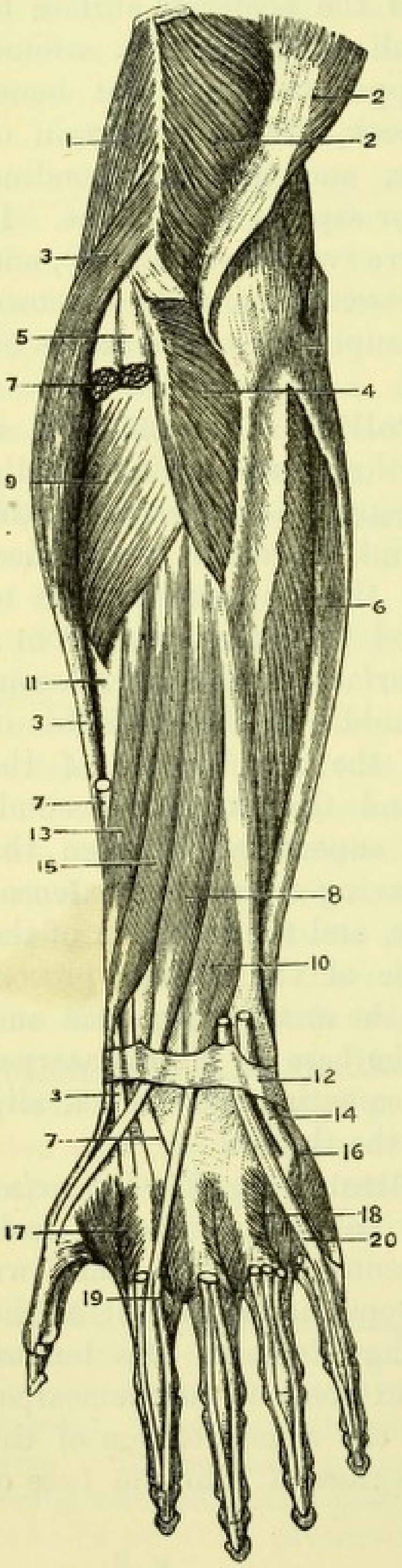


Fig. 25.—Deep muscles of the back of the fore-arm (from Sappey).

1. Supinator longus.
2, 2. Triceps.
3, 3, 3. Extensor carpi radialis longior.
4. Anconeus.
5. Common tendon of extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris.
6. Flexor carpi ulnaris, turned aside from flexor profundus digitorum.
7, 7, 7. Extensor carpi radialis brevior.
8. Extensor secundi internodii pollicis.
9 Supinator brevis.
10. Extensor indicis
11. Insertion of pronator radii teres.
12. Posterior annular ligament.
13. Extensor ossis metacarpi pollicis.
14. Insertion of extensor carpi ulnaris.
15. Extensor primi internodii pollicis.
16. Abductor minimi digiti.
17. Abductor indicis.
18. Dorsal interosseous of fourth interspace.
19. Expansion of extensor communis digitorum and tendon of extensor indicis.
20. Tendon of extensor minimi digiti about to blend with tendon of extensor communis digitorum.

licis on the outer side and the adductor obliquus on the inner side.

The **Extensor Indicis** (indicator) (Fig. 25, 10) *arises* from the posterior surface of the ulna below the preceding muscle, and slightly from the interosseous membrane. Its tendon is covered by those of the common extensor, and running through the fourth division of the annular ligament with them, joins the ulnar side of the tendon to the fore-finger.

Actions.—The *extensor ossis metacarpi pollicis* is not only an extensor and abductor of the metacarpal bone of the thumb, but it is also a *flexor* and abductor of the wrist, and by means of its ulnar fibres a slight supinator of the fore-arm. The *extensor primi internodii* has similar actions upon the wrist, and extends the thumb at the carpo-metacarpal and metacarpo-phalangeal joints. The *extensor secundi internodii* acts upon the carpo-metacarpal, metacarpo-phalangeal and interphalangeal joints (in the latter case being reinforced by the contraction of the two thenar muscles which send slips to its tendon), and aids also in supination of the radius.

It must be remembered that the planes of the angular movements of the thumb at the carpo-metacarpal joints are oblique in relation with those of the fingers.

The *extensor indicis* and *extensor minimi digiti* are accessory to the corresponding tendons of the extensor communis, and serve to give independent action to the two digits.

The **Posterior Interosseous Artery** (Fig. 27, 8) arising from the interosseous, a branch of the ulnar artery, reaches the back of the fore-arm by passing between the radius and ulna above the interosseous membrane, but below the oblique ligament (p. 58). It appears between the supinator brevis and extensor ossis metacarpi pollicis, giving *muscular* branches to the extensors and a *recurrent articular* branch to the elbow-joint; it is continued downwards close to the extensor carpi ulnaris, between the superficial and deep muscles, and terminates by joining the posterior carpal arteries and the terminal branch of the *anterior interosseous artery* (10), which will be found to reach the back of the fore-arm by piercing the interosseous membrane immediately above the lower end of the radius. The *recurrent* (6) branch runs beneath the anconeus to the outer and back part of the elbow, where it anastomoses with the descending articular branch of the superior profunda and the anastomotic artery.

The **Posterior Interosseous Nerve** (Fig. 26, 9) is one of the two terminal branches of the musculo-spiral, which has been already seen to divide on the outer side of the space in front of the elbow and beneath the supinator longus. It can now be traced running obliquely in the fibres of the supinator brevis around the outer side of the radius, and at its lower border breaking up into muscular branches and an articular branch to the wrist. The *muscular branches* supply the extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, the three special extensors of the thumb and the indicator; and the supinator brevis is supplied by a branch or two as the nerve passes through it. The *articular branch* to the wrist is a continuation of the nerve, and reaches the interosseous membrane between the extensors of the first and second phalanges of the thumb; passing beneath the latter muscle it runs to the back of the carpus, beneath

Fig. 26.

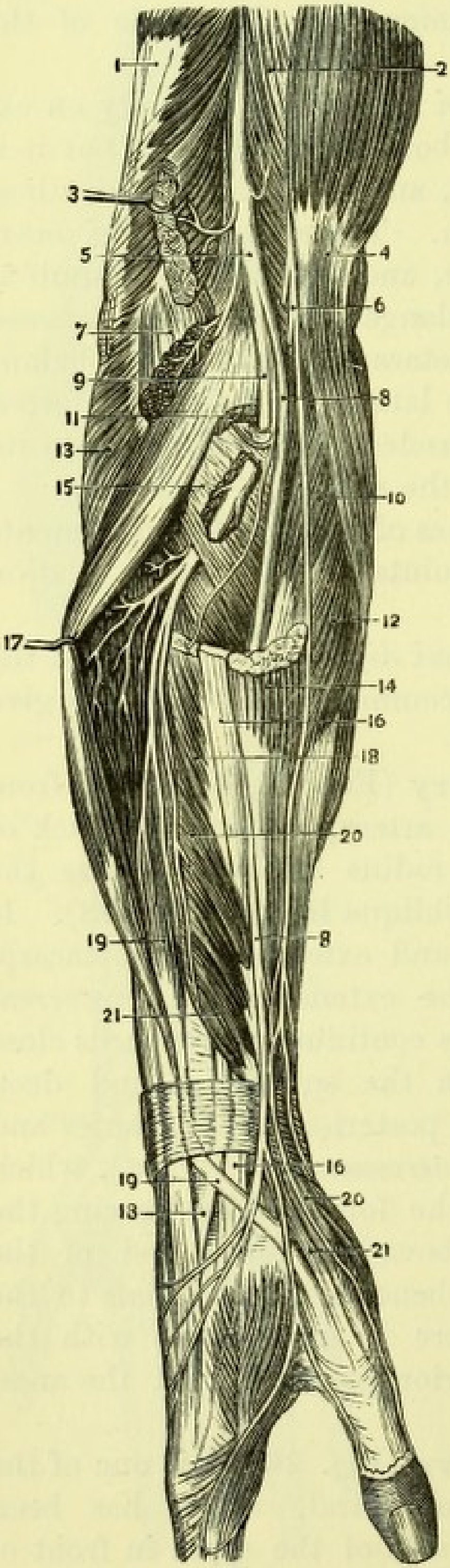
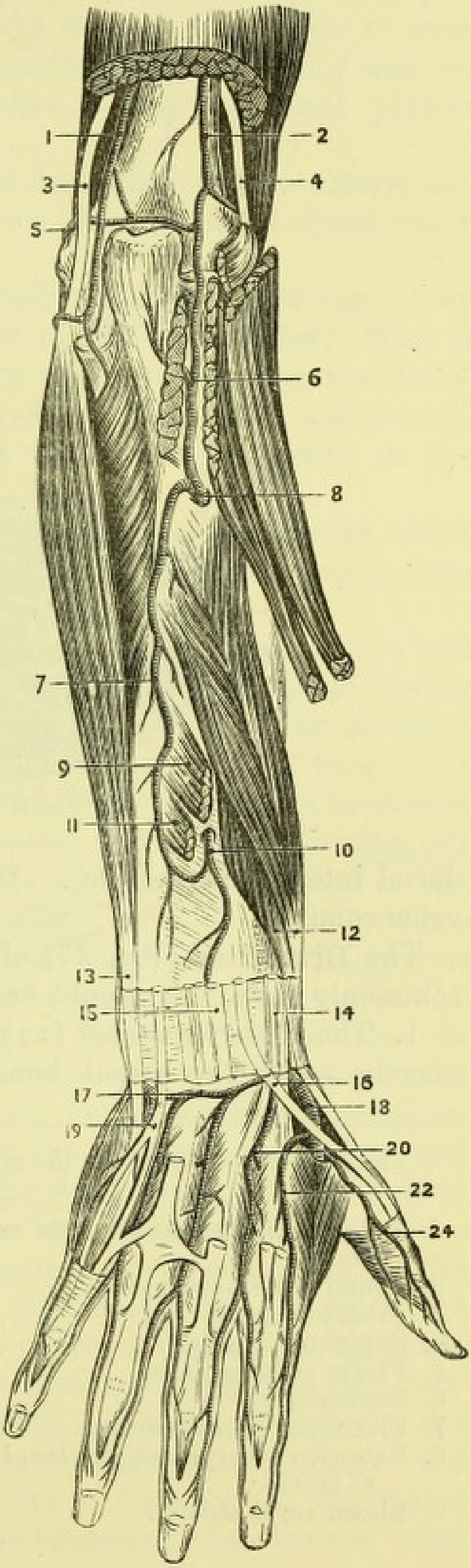


Fig. 26.—Dissection of the musculo-spiral nerve and its branches (from Hirschfeld and Leveillé).

1. Triceps.
2. Brachialis anticus.
3. Supinator longus.
4. Biceps.
5. Musculo-spiral nerve.
6. Musculo-cutaneous nerve.
7. Origin of extensor carpi radialis longior.
8, 8. Radial nerve.
9. Posterior interosseous nerve.
10. Pronator radii teres.
11. Origin of extensor carpi radialis brevior.
12. Flexor carpi radialis.
13. Anconeus.
14. Tendon of supinator longus.
15. Supinator brevis.
16, 16. Tendon of extensor carpi radialis longior.
17. Extensor communis digitorum.
18, 18. Tendon of extensor carpi radialis brevior.
19, 19. Extensor secundi internodii pollicis.
20, 20. Extensor ossis metacarpi pollicis.
21, 21. Extensor primi internodii pollicis.

the tendons of the extensor communis digitorum. Beneath the annular ligament a pseudo-ganglionic thickening of its connective tissue sheath may be found.

Fig. 27.



The **Radial Artery** at the wrist (Fig. 27, 18).—After leaving the front of the lower end of the radius (p. 53), the radial artery lies against the external lateral ligament of the wrist-joint, and beneath the extensors of the metacarpal bone and first phalanx of the thumb. It then winds over the back of the carpus, to the interval between the metacarpal bones of

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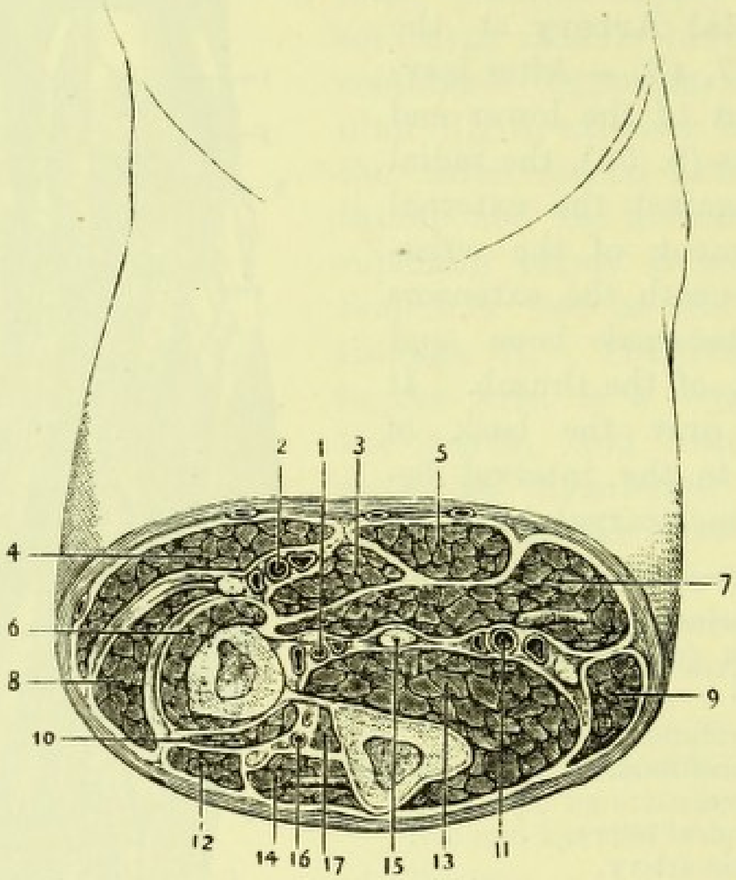
Fig. 27.—Arteries of the back of the fore-arm (drawn by G. E. L. Pearse).

1. Inferior profunda.
2. Superior profunda.
3. Ulnar nerve.
4. Musculo-spiral nerve.
5. Anastomotic artery.
6. Recurrent branch of posterior interosseous artery.
7. Descending branch of posterior interosseous artery.
8. Posterior interosseous artery.
9. Extensor secundi internodii pollicis.
10. Anterior interosseous artery.
11. Extensor indicis.
12. Extensor ossis metacarpi and primi internodii pollicis.
13. Extensor carpi ulnaris.
14. Extensor carpi radialis longior and extensor carpi radialis brevior.
15. Extensor communis digitorum and extensor indicis.
16. Extensor secundi internodii pollicis.
17. Posterior carpal artery.
18. Radial artery.
19. Extensor minimi digiti.
20. Metacarpal artery.
22. Art. dorsalis indicis.
24. Art. dorsalis pollicis.

the thumb and forefinger, where it is crossed by the extensor of the second phalanx of the thumb, and lastly passes into the palm of the hand between the two heads of the abductor indicis (first

Fig. 28.



dorsal interosseous muscle). It is accompanied here as elsewhere by venæ comites.

The **Branches** (Fig. 27) of the radial artery at the wrist very commonly vary, but should be five in number.

1. The *Posterior carpal* (17) is a small branch which runs transversely across the carpal bones, beneath the tendons, to join the

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Fig. 28.—A section above the middle of the right fore-arm (altered from Béraud).

1. Anterior interosseous vessels and nerve.
2. Radial vessels and nerve.
3. Pronator teres.
4. Supinator longus.
5. Flexor carpi radialis.
6. Supinator brevis.
7. Flexor sublimis digitorum.
8. Extensores carpi radialis longior et brevior.
9. Flexor carpi ulnaris.
10. Extensor ossis metacarpi pollicis.
11. Ulnar vessels and nerve.
12. Extensor communis digitorum.
13. Flexor profundus digitorum.
14. Extensor carpi ulnaris.
15. Median nerve.
16. Posterior interosseous vessels and nerve.
17. Extensor secundi internodii pollicis.

posterior carpal branch of the ulnar and form an arch. From this arise two *dorsal interosseous* arteries, which run on the third and fourth dorsal interosseous muscles, receive the corresponding perforating arteries, and bifurcate at the web of the fingers to form the *dorsal digital* arteries. They anastomose at the web and on the fingers with the digital branches of the superficial palmar arch.

2. The *Metacarpal* (20) is the first dorsal interosseous artery, and closely resembles the others. It runs on the second dorsal interosseous muscle.

3. The *Dorsalis indicis* (22) is a similar branch, which runs along the radial side of the metacarpal bone of the index finger. This is frequently replaced by a large artery which runs along the metacarpal bone and divides into branches to the fore-finger and thumb, being in fact the radialis indicis, a branch of the radial in the palm, arising earlier than usual.

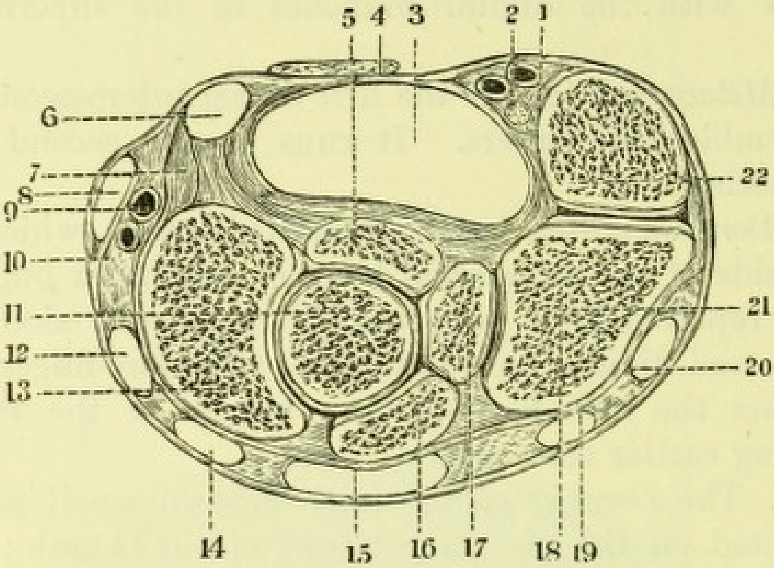
4 and 5. The *Dorsales pollicis* (24) are two small arteries which are distributed on the metacarpal bone of the thumb ; one is often wanting.

The *Posterior carpal branch of the* **Ulnar artery** (Fig. 27, 17) will be found appearing beneath the extensor carpi ulnaris, and having completed the arch formed by the posterior carpal of the radial, it ends in a branch to the ulnar side of the fifth metacarpal bone.

The **Posterior Annular Ligament** (Figs. 27, 29) is a thickened portion of the deep fascia of the fore-arm and hand : it is attached to the ridges on the radius externally and posteriorly, and to the cuneiform and pisiform bones internally. It has six subdivisions, which should be carefully examined and compared with the grooves on the bones. The *first* division corresponds to the groove on the outer side of the lower end of the radius, and transmits the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis : the *second* division corresponds to the outermost groove on the back of the bone, and transmits the tendons of the long and short radial extensors of the wrist : the *third* division corresponds to the narrow deep oblique groove on the back of the radius, and transmits the tendon of the extensor secundi internodii pollicis : the *fourth* division, corresponding to the innermost broad groove on the radius, transmits the tendons of the extensor communis digitorum and of the extensor indicis : the *fifth* division corresponds to a very slight groove on the edge of the radius (or is placed between the bones), and transmits the tendon of the extensor minimi digiti : the *sixth* division corresponds to the groove at the back of the styloid process of the ulna, and transmits the tendon of the extensor carpi ulnaris. Thus five divisions correspond to grooves on the radius and one to that on the ulna.

The **dorsal interosseous muscles**, four in number, can be

Fig. 29.



most conveniently dissected with those of the palm of the hand (page 89).

The Palm of the Hand.

Surface-Marking.—The delicacy of the skin of the palm will depend very much upon the previous occupation of the individual, but in every case it will be found to present no hairs and to be ribbed by the rows of papillæ, upon which the orifices of the sweat-ducts can be seen with a magnifying glass. If decomposition has

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Fig. 29.—Section of wrist through anterior and posterior annular ligaments and carpus (from Henle).

1. Ulnar vessels.
2. Ulnar nerve.
3. Canal for flexors sublimis and profundus digitorum and flexor longus pollicis, and median nerve.
4. Tendon of palmaris longus on anterior annular ligament.
5. Semilunar bone.
6. Sheath for flexor carpi radialis.
7. Radial origin of annular ligament.
8. Sheath for extensor ossis metacarpi and primi internodii pollicis.
9. Radial vessels.
10. Outer part of posterior annular ligament.
11. Os magnum.
12. Sheath of extensor secundi internodii pollicis.
13. Scaphoid.
14. Sheath of extensor carpi radialis, longior and brevior.
15. Sheath of extensor communis and indicator.
16. Semilunar.
17. Unciform.
18, 21. Cuneiform.
19. Sheath of extensor minimi digiti.
20. Sheath of extensor carpi ulnaris.
22. Pisiform.

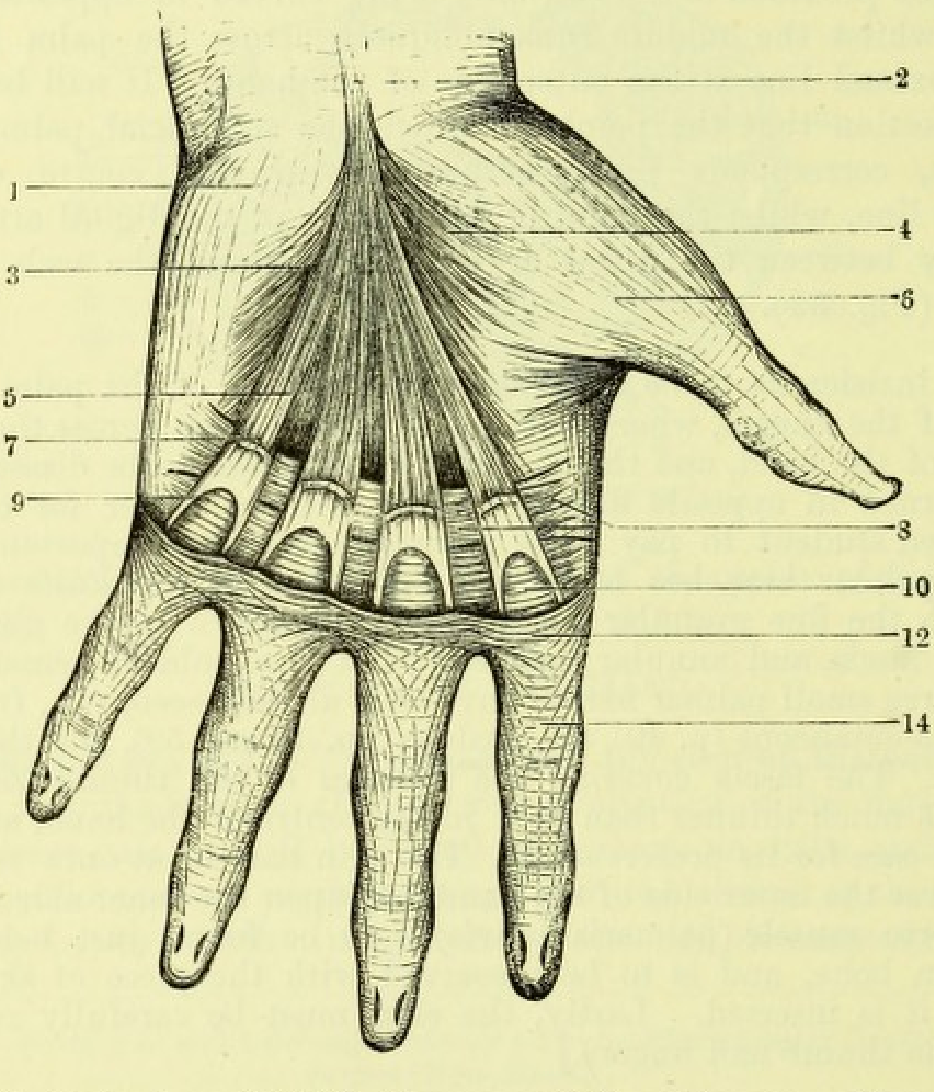
advanced rapidly, the cuticle will probably be detached in part, when upon examining its deep surface, depressions corresponding to the papillæ will be found. A fulness on each side of the palm corresponds to the special muscles of the thumb and little finger respectively, and the terms "thenar" and "hypothenar" eminences are sometimes applied to them. The palm presents three curved lines, the proximal and distal ones being curved in opposite directions, whilst the middle runs obliquely across the palm to join the proximal line at the outer side of the hand. It will be found on dissection that the point to which the superficial palmar arch reaches, corresponds pretty accurately with the centre of this middle line, whilst the point of bifurcation of the digital arteries is midway between the distal or anterior line and the web of the fingers (Fig. 32).

[An incision is to be made down the middle of the palm to the roots of the fingers, where another is to be drawn across the whole width of the hand, and the two flaps of skin are to be dissected up and turned in opposite directions. It will be better for the less advanced student to pay little attention to the unimportant cutaneous palmar branches of nerves, and to carry the knife at once through the fine granular fat of the palm down to the glistening palmar fascia and annular ligament; but it should be remembered that three small palmar nerves have been already seen, viz., from the musculo-cutaneous (p. 49), the median (pp. 49 and 59), and the ulnar (p. 49). The fascia covering the muscles of the thumb and little finger is much thinner than that in the centre of the hand, and will require care for its preservation. The skin may be at once reflected from over the outer side of the hand, but upon the inner side a small transverse muscle (palmaris brevis) is to be found just below the pisiform bone, and is to be preserved with the piece of skin into which it is inserted. Lastly, the skin must be carefully removed from the thumb and fingers.]

The **palmar fasciæ** are complex structures which may be analysed as follows (Fig. 30): 1, the *radiating palmar fascia* to which the term "palmar fascia" is usually limited; 2, the *muscular fasciæ* investing closely the muscles of the thumb and little finger and the interossei, the latter lying deeply beneath the tendons, vessels and nerves; 3, the *vaginal fascia*, a delicate transparent connective tissue sheath surrounding the vessels, nerves, tendons and lumbricales between the radiating and muscular fasciæ, to both of which it is closely adherent (Fig. 31); 4, the *fascia of Gerdy*, a superficial layer of rather loose fibres, continuous with the superficial digital fascia and with the dorsal fascia over the back of the hand. This terminates proximally on the palmar surface by a rather abrupt margin opposite the bases of the metacarpal phalanges. It is known also as the *superficial transverse ligament.*

The **Radiating Palmar Fascia** (Fig. 30) consists of three

Fig. 30.



portions, central or digital, thenar and hypothenar. The *central*, triangular in shape and attached to the annular ligament by its apex, is largely formed by the expansion of the tendon of the

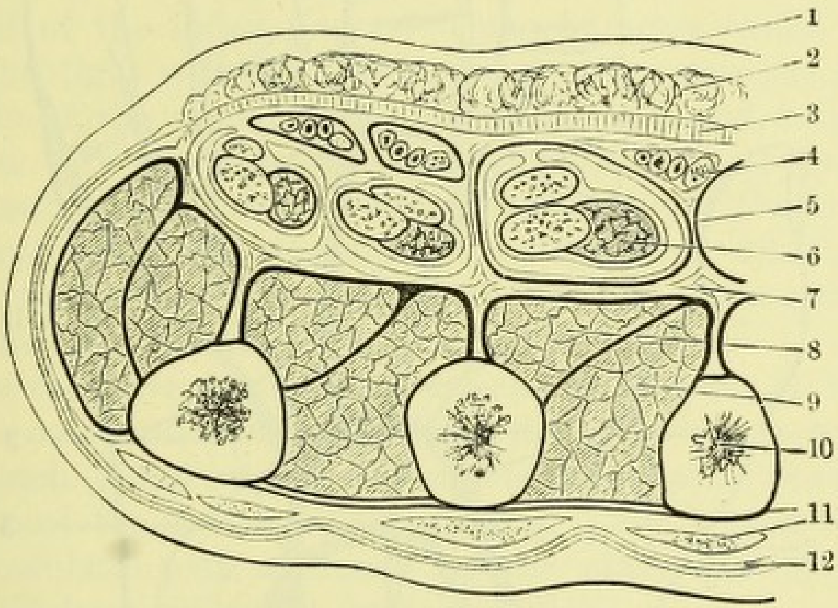
---

Fig. 30.—The palmar fasciæ (W. A.).

1. Hypothenar muscular fascia.
2. Palmaris longus.
3. Hypothenar segment of radiating fascia.
4. Thenar segment of radiating fascia.
5. Digital segment of radiating fascia.
6. Thenar muscular fascia.
7. Cutaneous process of radiating fascia.
8. Deep transverse palmar fascia.
9. Terminal slip of digital segment.
10. Vaginal fascia.
12. Fascia of Gerdy.
14. Digital fascia.

palmaris longus, but is still present when this muscle is wanting. Distally it expands towards the roots of the fingers, giving off in its course strong fibres from its anterior surface to the skin, chiefly at the palmar folds. Opposite the heads of the metacarpal bones it splits into four parts, one for each finger, connected together by deep transverse fibres. Each segment is prolonged over the sheath of the corresponding flexor tendon, and finally divides into two lateral bands, which pass one on either side to be attached to the shaft of the metacarpal phalanx, and may be prolonged on to the first inter-phalangeal joint and middle phalanx. The *lateral* thenar and hypothenar portions of the radiating fascia are much thinner than

Fig. 31.



the central portion, and merely blend with the fascia covering the muscles of the thumb and little finger.

The **Palmaris Brevis** (Fig. 18, 16) is a small muscle running transversely below the pisiform bone and immediately beneath the skin. *Arising* from the inner edge of the central fascia it crosses the ulnar artery and nerve, and is *inserted* into the skin on the inner side of the hand. It is *supplied* by the ulnar nerve. During its contraction it puckers the skin at its insertion, increases the

Fig. 31.—Transverse section of hand showing palmar fasciæ (W. A.).

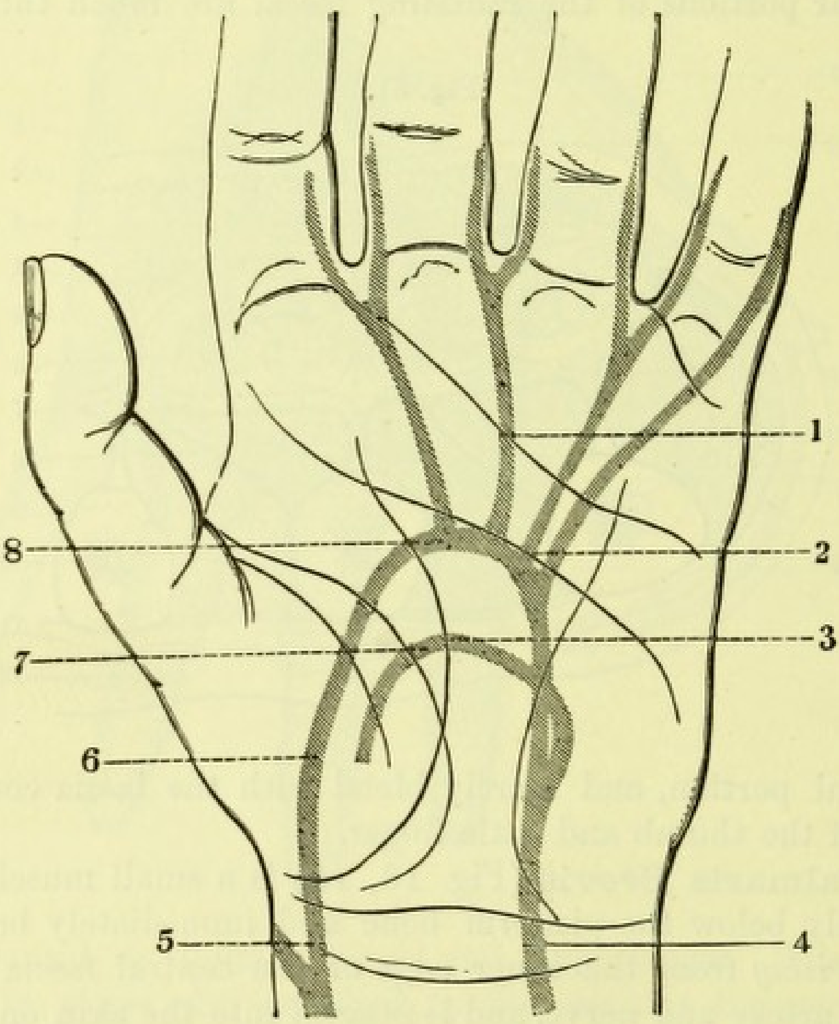
1. Palmar integument.
2. Fat.
3. Radiating fascia.
4. Vessels and nerve with vaginal fascia.
5. Septal process connecting fascia with deep radiating structures of palm.
6. Lumbricalis with flexor tendons.
7. Fascia of interossei.
8. Palmar interosseous.
9. Dorsal interosseous.
10. Metacarpal bone.
11. Extensor tendon.
12. Dorsal fascia.

prominence of the hypothenar eminence, and slightly deepens the hollow of the hand.

[The central portion of the palmar fascia is to be detached from the annular ligament and turned down, care being taken not to injure the vessels and nerves which are close beneath ; and these are then to be cleaned.]

The **Superficial Palmar Arch** (Fig. 19, 24) is the direct con-

Fig. 32.



tinuation of the ulnar artery, which reaches the palm by passing over the annular ligament on the radial side of the pisiform bone, and beneath a little fibrous slip from the flexor carpi ulnaris (p. 57) : it then lies between the radiating palmar fascia and the

Fig. 32.—Relation of palmar arches to flexure lines of hand.

1. Inferior fold.
2. Middle fold.
3. Superior fold.
4. Ulnar artery.
5. Radial artery.
6. Superficialis volæ.
7. Deep palmar arch.
8. Superficial palmar arch.

tendons and nerves. The vessel is subject to very great variations, but if regular, forms an arch with the convexity forwards, reaching to about midway between the annular ligament and the root of the middle finger, as far as the middle of the three palmar furrows (Fig. 32). The arch is completed on the radial side either by the superficial volar branch of the radial artery, which generally pierces a few of the fibres of the abductor pollicis, or more commonly by the radialis indicis (p. 88) or princeps pollicis: sometimes by all of these. From its convexity are given off four *digital arteries*, the first of which runs to the ulnar side of the little finger, whilst the three others bifurcate about half an inch from the web of the fingers to supply the radial side of the little finger, both sides of the ring, both sides of the middle, and the ulnar half of the index finger. These branches traced along the sides of the digits will be found to supply the cutaneous structures, the sheaths of the tendons and the joints, and send twigs back to anastomose with the dorsal arteries; finally they supply the pulp of the terminal phalanx and form a plexus beneath the nail. They are accompanied by the digital nerves; but their relative position differs in the palm and in the fingers,—in the former the arteries are superficial, in the latter the nerves.

Each of the three outer digital arteries at its point of bifurcation receives a communicating twig from the interosseous branches of the deep arch (radial artery), and an *intermetacarpal* branch from the bifurcation of the dorsal digital arteries. The branch to the forefinger inosculates with a branch on the other side of the finger also derived from the radial (radialis indicis).

The **Profunda Artery** is a small communicating branch arising from the ulnar artery as soon as it has crossed the annular ligament. It passes deeply, with the deep branch of the ulnar nerve, between the abductor and the flexor brevis minimi digiti, and along the ulnar side of the unciform process. It will be found to complete the deep palmar arch of the radial artery.

The median artery from the anterior interosseous (p. 59) is sometimes enlarged and joins the superficial palmar arch or supplies digital branches.

The **Ulnar Nerve** (Fig. 22, 26) accompanies the ulnar artery over the annular ligament, lying to its ulnar side, and immediately divides into a superficial and a deep portion. The *deep branch* (22) accompanies the profunda branch of the ulnar artery (*q. v.*) supplying the muscles of the little finger, and will be seen again in the deep dissection of the palm. The *superficial division* sends a small twig to the palmaris brevis and to the integument of the ulnar side of the palm, and subdivides into two digital branches which supply one and a half fingers, the inner one running on the ulnar side of the little finger, and the other bifurcating at the roots of the fingers into branches for the radial side of the little and ulnar side of the ring finger, the latter uniting with a branch of the median nerve. The digital nerves can be traced along the sides of the tendinous sheaths, lying superficially to the arteries and giving filaments to the pulp of the finger, dorsal twigs to the matrix of the nail, and others which unite with the dorsal digital nerves and supply almost entirely the skin over the backs of the second and third phalanges.*

The **Anterior Annular Ligament** (Fig. 36, 1) is the broad band of fascia binding down the flexor tendons at the wrist. It is attached on the outer side to the scaphoid bone and to both sides of the groove on the trapezium (binding down the flexor carpi radialis tendon), and on the inner side to the unciform process of the unciform bone, and slightly to the pisiform bone. It is crossed by the ulnar artery and nerve, the cutaneous palmar nerves, and the tendon of the palmaris longus, the deep fibres of which are inserted into it; and the tendon of the flexor carpi ulnaris sends an expansion to it over the ulnar artery and nerve. The outer attachment of the ligament gives passage to the tendon of the flexor carpi radialis, while beneath the ligament lie the median nerve, the tendons of the flexors of the thumb and fingers, and two **carpal bursal sheaths**, one for the tendon of the flexor longus pollicis, the other, larger and very complex, for the tendons of the superficial and deep finger flexors. These extend from just above the annular ligament to about the middle of the palm; the first generally, but not constantly, communicates with the digital bursal sheath of the thumb and the second with that of the little finger. This tissue occasionally becomes diseased, when fluid, often containing numerous rice-like bodies, is developed in it in considerable quantity, and forms a fluctuating tumour above and below the annular ligament (Fig. 34).

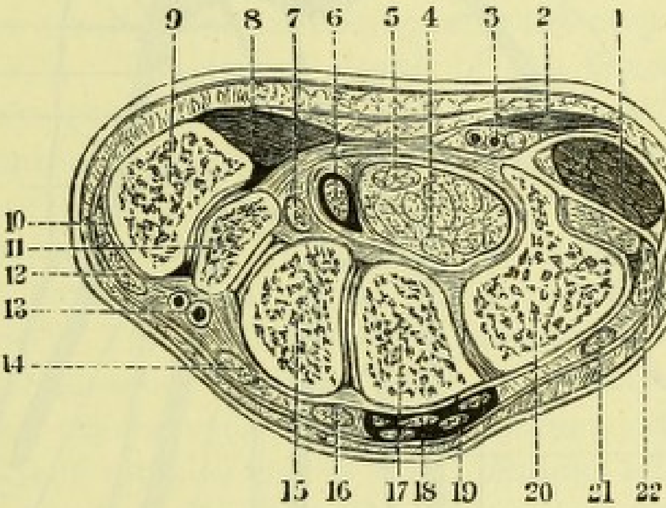
X The **Median Nerve** (Fig. 22, 33) is flattened as it passes beneath the annular ligament superficially to the tendons, and

* It will be observed that the number of fingers supplied by the ulnar artery is the complement of that supplied by the nerve, and that the same rule holds with respect to the radial artery and the median or radial nerves, thus:—

Ulnar artery	$3\frac{1}{2}$ fingers.
Ulnar nerve	$1\frac{1}{2}$ fingers.
Radial artery	$1\frac{1}{2}$ fingers.
Median or Radial nerve . .	$3\frac{1}{2}$ fingers.

divides into two trunks which subdivide into four *digital nerves*, to supply three and a half fingers. The first or outermost, after giving a small branch to supply the abductor, opponens, and outer head of the flexor brevis pollicis, bifurcates to supply the two sides of the palmar aspect of the thumb; the second digital nerve supplies the radial side of the index-finger, after giving a small twig to the first lumbricalis muscle; the third, after supplying the second lumbricalis, bifurcates near the roots of the fingers to supply the ulnar side of the index and the radial side of the middle fingers; the fourth bifurcates to supply the ulnar side of the middle finger

Fig. 33.



and the radial side of the ring finger, this last branch joining the branch from the ulnar nerve previously seen. The digital branches are distributed, like those of the ulnar nerve, to the pulp on the palmar side of the digits and to the distal half of the dorsal integument.

[The ulnar artery is to be divided beyond the origin of the profunda and the arch turned down as far as possible, but the nerve may be left uncut. The median nerve is to be divided at the wrist and

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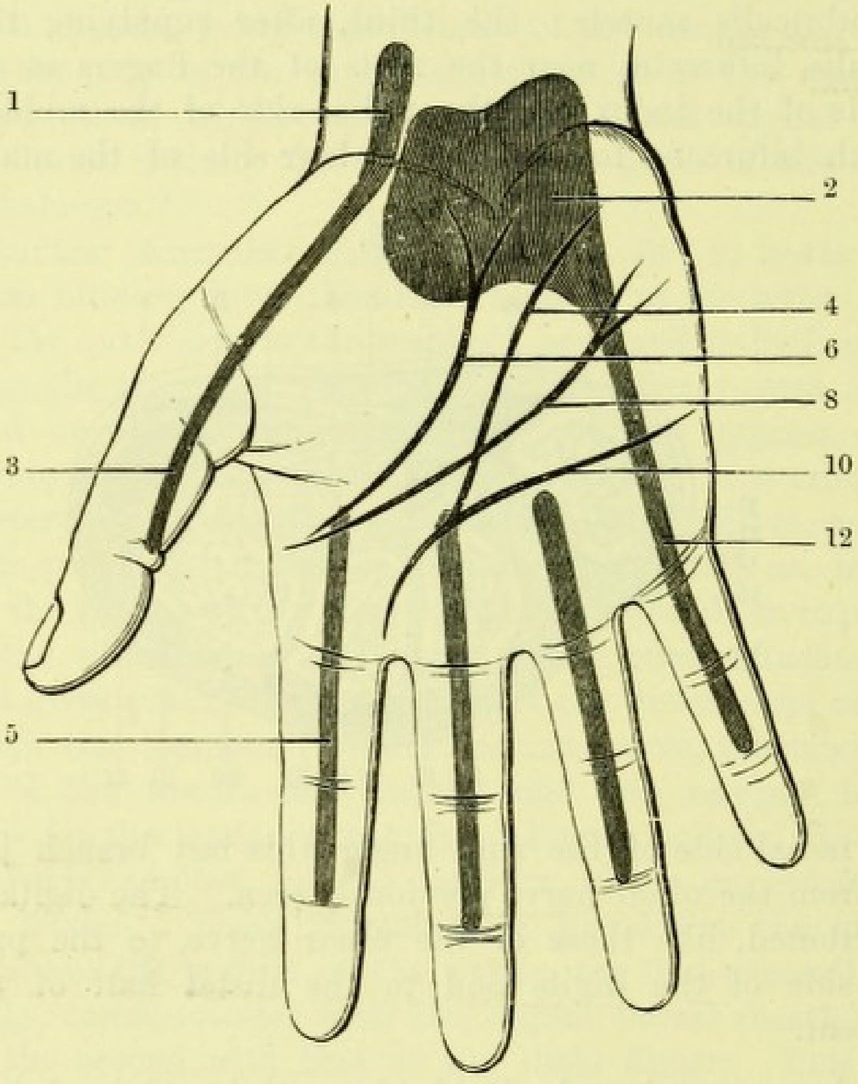
Fig. 33.—Section of hand through the carpal bones (after Henle).

1. Hypothenar muscles.
2. Palmaris brevis.
3. Ulnar vessels and nerve.
4. Flexor sublimis and profundus.
5. Median nerve.
6. Flexor longus pollicis.
7. Flexor carpi radialis.
8. Thenar muscles.
9. Base of first metacarpal bone.
10. Extensor primi internodii pollicis.
11. Trapezium.
12. Extensor secundi internodii pollicis.
13. Radial vessels.
14. Extensor carpi radialis longior.
15. Trapezoid.
16. Extensor carpi radialis brevior.
17. Os magnum.
18. Extensor indicis.
19. Extensor communis digitorum.
20. Unciform.
21. Extensor minimi digiti.
22. Extensor carpi ulnaris.

turned down, and the flexor tendons with the lumbricales muscles cleaned and traced to their insertions. The sheaths of the flexor tendons have been already described (p. 54), but at least one more should be laid open in order that the tendons may be well seen.]

Fig. 34.



The **Tendons of the Flexor Sublimis,** four in number, pass beneath the annular ligament and lie immediately beneath the branches of the median nerve in the palm. Each tendon becomes somewhat flattened, and on the first phalanx splits into two portions, which give passage to the tendon of the flexor profundus between

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Fig. 34.—Diagram of carpal and digital bursal sheaths of finger tendons.

1. Carpal sheath of flexor longus pollicis.
   Carpal sheath of flexors sublimis and profundus.
3. Digital sheath of flexor longus pollicis.
4. Linea hepatica.
5. Digital sheath of index finger.
6. Proximal flexion fold.
8. Middle flexion fold.
10. Distal flexion fold.
12. Digital sheath of little finger.

them, and, after uniting beneath the profundus, divide again to become inserted into the ridges bordering the palmar surface of the second phalanx. The tendons are united to the sheath and to each other by thread-like processes (*ligamenta longa*), and by shorter elastic bands (*ligamenta brevia*), the latter connecting each tendon with the front of the phalanx near its insertion.

The **Tendons of the Flexor Profundus** (Fig. 36, 7), also four in number, lie beneath the corresponding superficial tendons, which they perforate over the first phalanges; they then pass on to be *inserted* into the bases of the third phalanges.

Each pair of tendons is invested by a **digital bursal sheath**, which reaches about an inch above the cleft of the fingers; that of the little finger usually communicating with the carpal sheath already described (p. 57). The digital sheath of the flexor longus pollicis is nearly always continuous with the carpal sheath of the tendon beneath the annular ligament, and the carpal sheath occasionally communicates with that of the finger tendons (Fig. 34).

The **Lumbricales** (Fig. 36, 7) are four little muscles connected with the deep flexor tendons, and bear some resemblance to earth worms (lumbrici). The first lumbricalis, counting from the radial side (and sometimes the second), *arises* from the radial side of a single tendon, but the others *arise* from the adjacent sides of two deep tendons. The four muscles end in small tendons which wind to the radial sides of the four fingers, and, passing in front of the palmar transverse ligament of the metacarpus, are *inserted* into the expansions of the extensor tendons on the back of the first phalanges. The lumbricales act with the interossei as flexors of the first phalanges and extensors of the second and third phalanges. The first and second are *supplied* by branches of the median nerve; the third and fourth receive twigs from the deep branch of the ulnar nerve, which will be seen in the deeper dissection.

The **Tendon of the Flexor Longus Pollicis** (Fig. 36, 9) is on the same level as the tendons of the flexor profundus, and can be traced between the sesamoid bones and the two heads of the flexor brevis pollicis to the base of the terminal phalanx of the thumb. Its vaginal ligament is much less strongly developed than those of the fingers.

[The tendons of the flexor profundus are to be divided (but not the flexor longus pollicis) and turned down with the lumbricales; the muscles of the little finger and thumb are to be carefully dissected.]

Muscles of the Little Finger.

The **Abductor Minimi Digiti** (Fig. 36, 10) is the most superficial and the innermost of these. It *arises* from the pisiform bone and slightly from the tendon of the flexor carpi ulnaris, and is *inserted* into the ulnar side of the base of the first phalanx, giving a small fibrous expansion to the ulnar side of the extensor tendon, opposite to the similar expansion derived from the third palmar interosseous.

The **Flexor Brevis Minimi Digiti** (Fig. 36, 8) is often closely connected with the abductor; but the deep branches of the ulnar artery and nerve which pass between the two will serve as guides to the point of separation. It *arises* from the unciform process of the unciform bone and from the annular ligament, and is *inserted* with the abductor into the base of the first phalanx.

Actions.—The abductor and flexor brevis are flexors and abductors of the first phalanx, and the former by its slip to the extensor tendon aids in the extension of the second and third phalanges; both muscles act secondarily as flexors of the metacarpal bone.

The **Opponens** (flexor ossis metacarpi) **Minimi Digiti** is the deepest of the set, and *arises* from the unciform process close to the preceding muscle and from the annular ligament. It spreads into a triangular shape, and is *inserted* into the inner margin of the shaft of the fifth metacarpal bone, thus resembling the opponens pollicis as to insertion, but the power of "opposition" in the little finger is much more limited than in the thumb. The metacarpal bone of the little finger, however, has a range of from 10 to 15 degrees of movement in the antero-posterior direction, and by means of this power of flexion the transverse diameter of the hand can be diminished, and the hollow of the palm increased. It should be noticed that the base of the metacarpal phalanx of this digit is somewhat saddle-shaped.

Muscles of the Thumb.

The **Abductor Pollicis** (Fig. 36, 2) is a slender muscle, and is the most superficial of the series. It *arises* from the annular ligament, and usually from the ridge on the trapezium and from the tubercle of the scaphoid. It is *inserted* into the outer side of the base of the first phalanx of the thumb, with the outer half of the flexor brevis, and gives a fibrous expansion to join the side of the tendon of the extensor secundi internodii pollicis. The superficialis volæ artery commonly runs through its fibres to join the superficial palmar arch.

Its action is to abduct * and flex the metacarpal bone, to flex the first phalanx, and by virtue of its expansion to the extensor tendon, to extend the ungual phalanx. It must be divided to see the following :—

The **Opponens Pollicis** (flexor ossis metacarpi pollicis) (Fig. 36, 3) *arises* from the front of the trapezium and from the annular ligament, and is *inserted* into the outer border of the shaft of the metacarpal bone of the thumb. Its action is to flex and adduct the metacarpal and so help to "oppose" the thumb to the fingers, an action peculiar to man and monkeys.

The **Flexor Brevis Pollicis** (Fig. 36, 4) consists of two portions at

Fig. 35.

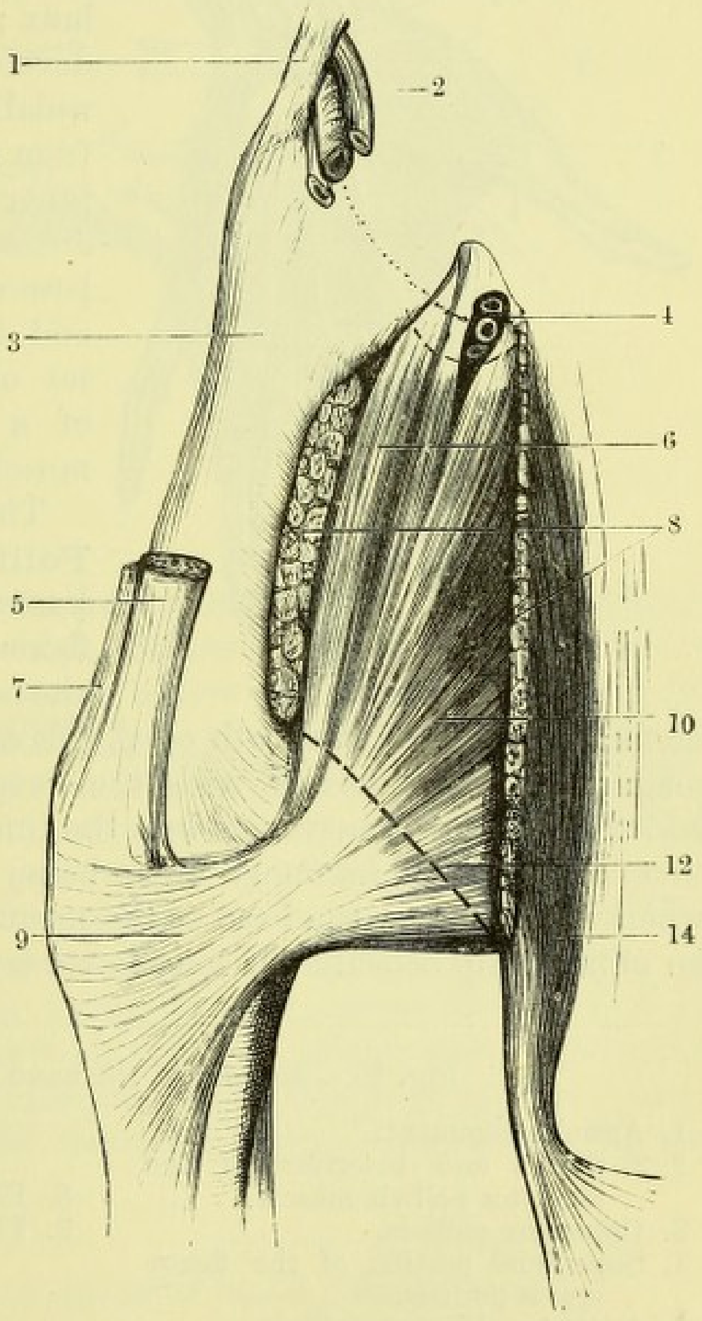


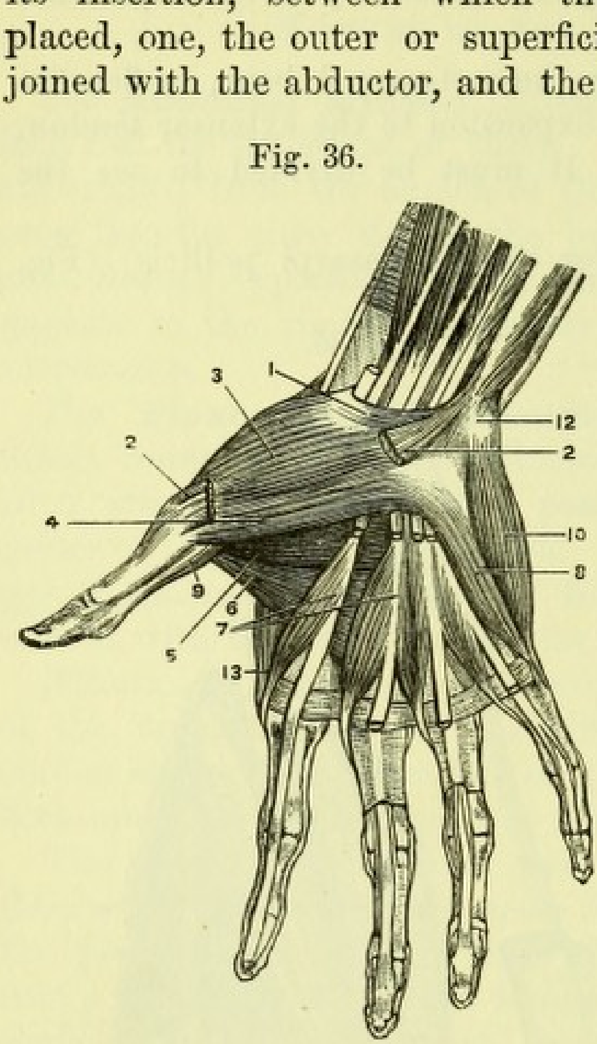
Fig. 35.—Muscles of thumb, from a dissection by F. G. Parsons (W. A.).

1. Extensor ossis metacarpi pollicis.
2. Radial vessels (cut).
3. First metacarpal bone.
4. Deep palmar arch.
5. Extensor secundi internodii.
6. Ulnar head of flexor brevis pollicis.
7. Extensor primi internodii.
8. First dorsal interosseous (partly removed).
9. Dorsal expansion of adductor.
10. Adductor obliquus.
12. Adductor transversus.
14. Second metacarpal bone.

* By the terms 'abduction' and 'adduction' are implied the movement of the thumb at the carpo-metacarpal joint from and towards the level of the palm. Flexion and extension are oblique movements at the same articulation in the plane of phalangeal flexion.

its insertion, between which the tendon of the long flexor is placed, one, the outer or superficial head, being more or less conjoined with the abductor, and the other deeply placed between the adductor obliquus and the abductor indicis. The outer *arises* from the lower part of the annular ligament, and is inserted with the abductor into the outer side of the base of the first phalanx; a sesamoid bone being developed in its tendon. It is usually joined by an oblique slip from the adductor obliquus. The inner head, of very small size, arises from the ulnar side of the base of the first metacarpal bone, and is inserted with the adductor obliquus. It has the aspect of a small palmar interosseous muscle (Fig. 35).

Fig. 36.



The **Adductor Obliquus Pollicis** (Fig. 36, 5), formerly known as the inner head of the flexor brevis pollicis, arises from the bases of the second and third metacarpal bones, the sheath of the flexor carpi radialis, and the os magnum. It is inserted with the deep head of the flexor brevis and the adductor transversus into the inner side of the base of the first phalanx, a sesamoid bone being developed in its tendon where it plays over the head of the metacarpal bone. It often gives an oblique slip beneath the long flexor tendon to join the outer head

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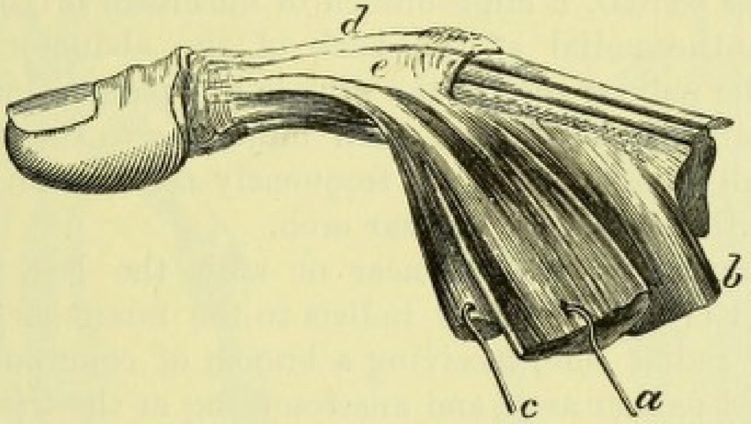
Fig. 36.—Muscles of the hand (from Wilson).

1. Annular ligament.
2, 2. Origin and insertion of the abductor pollicis muscle.
3. Opponens pollicis.
4. Superficial portion of the flexor brevis pollicis.
5. Adductor obliquus pollicis.
6. Adductor transversus pollicis.
7, 7. The lumbricales muscles, arising from the deep flexor tendons, upon which the figures are placed. The tendons of the flexor sublimis have been removed.
8. Flexor brevis minimi digiti.
9. The tendon of the flexor longus pollicis, passing between the two portions of the flexor brevis to the last phalanx.
10. Abductor minimi digiti.
12. Pisiform bone.
13. First dorsal interosseous muscle, the abductor indicis.

of the flexor brevis, and sends an expansion to the inner side of the extensor secundi internodii tendon (opposite to the similar expansion from the abductor pollicis). The deep palmar arch is buried in its fibres of origin, and emerges between it and the adjacent border of the adductor transversus (Fig. 35).

The **Adductor Transversus Pollicis** (Fig. 36, 6) *arises* from the narrow anterior surface of the lower two-thirds of the shaft of the middle metacarpal bone, and is *inserted* into the inner side of the base of the first phalanx of the thumb, and into the tendon

Fig. 37.



of the extensor secundi internodii; the muscle forming a triangle with its base to the ulnar side. It necessarily covers the muscles in the first and second interosseous spaces (which may be seen in part at its anterior border), and will have to be divided to expose them.

The **Deep Branch of the Ulnar Nerve** (Fig. 22, 22) is to be traced out, and will be found to arise from the ulnar trunk near the pisiform bone, and to pass with the profunda vessels around the ulnar side of the root of the unciform process and between the flexor brevis and the abductor minimi digiti, giving branches to these and to the opponens. It then forms an arch across the bases of the metacarpal bones, accompanying the deep palmar arch, and supplies the two innermost lumbricales, the seven interossei muscles (palmar and dorsal), the oblique and transverse adductors, and the deep head of the flexor brevis pollicis.

Fig. 37.—Insertion of muscles of thumb (from Duchenne).

a. Abductor pollicis.
b. Opponens pollicis.
c. Outer head of flexor brevis.
d. Tendon of extensor secundi internodii.
e. Tendinous extension from abductor and flexor brevis joining tendon of extensor secundi internodii.

The **Deep Palmar Arch,** the termination of the radial artery, commences in the first interosseous space immediately after passing through the interval between the two heads of the abductor indicis. It may be traced, with its venæ comites, running in the fibres of origin of the adductor obliquus pollicis to emerge between the adjacent borders of this muscle and the adductor transversus pollicis.

The deep arch has a slight convexity towards the fingers, and is placed at the junction of the bases with the shafts of the metacarpal bones. It is completed by anastomosis with the deep branch of the ulnar artery.

Its branches are as follows :—

1. *Princeps pollicis*, a large branch of uncertain origin, sometimes arising from the radial at the back of the abductor indicis, but usually on the palmar side of the muscle ; it passes along the metacarpal bone of the thumb, and then bifurcates to supply both sides of the thumb superficially. It frequently receives an anastomotic branch from the superficial palmar arch.

2. *Radialis indicis*, arising near or with the last, runs on the palmar aspect of the abductor indicis to the forefinger, of which it supplies the radial side, receiving a branch of communication from the superficial palmar arch, and anastomosing at the tip of the finger with the digital artery derived from the superficial arch.

3. Small *recurrent* branches to the carpus, anastomosing with branches of the anterior carpal arch beneath the flexor tendons and annular ligament.

4. Three *perforating* arteries to the dorsum, passing between the heads of the three inner dorsal interosseous muscles to join the dorsal digital arteries.

5. Three *interosseous arteries*, which run on the three palmar interosseous muscles to the roots of the fingers, and then anastomose with the digital branches of the superficial arch at their points of bifurcation. They supply the interossei.

The tendon of the *Flexor carpi radialis* can now be easily traced through the groove in the trapezium to its insertion into the base of the second and third metacarpal bones.

The **Palmar Transverse Metacarpal Ligament** passes in front of the heads of the metacarpal bones, and is closely connected with the sheaths of the flexor tendons and the glenoid plates of the metacarpo-phalangeal articulations. The lumbricales and the digital vessels and nerves pass in front of it to reach the fingers. It must be divided to follow out the interossei, which pass beneath it.

The **Dorsal Transverse Metacarpal Ligament** is a comparatively delicate band of fibres joining the heads of the metacarpal bones posteriorly. The tendons of the interossei of each space run through a kind of sheath formed by the two transverse ligaments and the metacarpal bones which they connect.

The **Interosseous Muscles** are seven in number, three palmar and four dorsal. Two of the palmar interossei are readily seen, but the adductor pollicis must be entirely detached from the middle metacarpal bone in order to expose the remaining one.

Fig. 38.

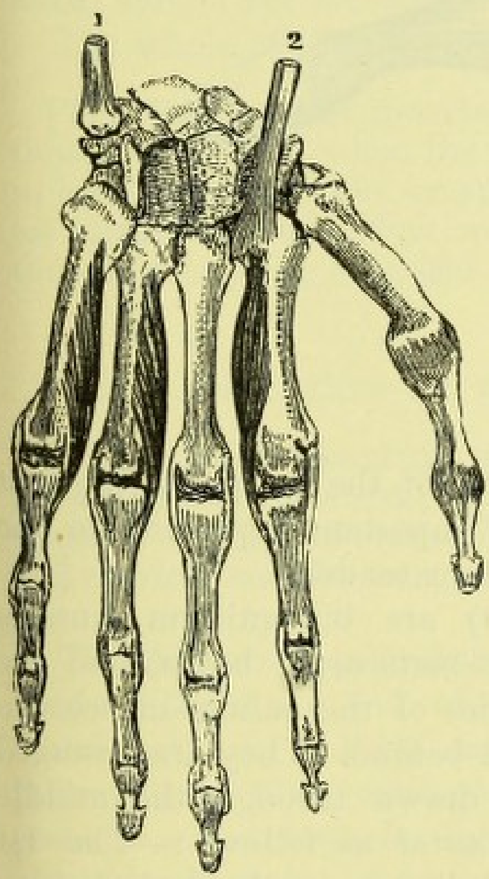
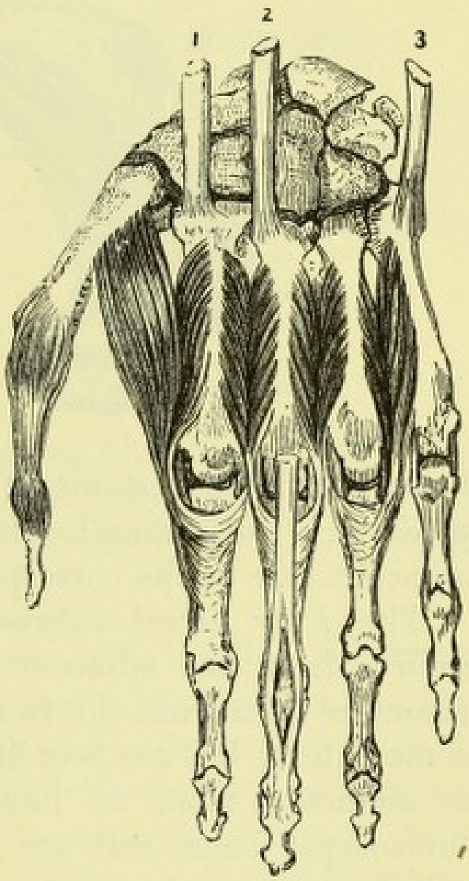


Fig. 39.



The *Three palmar interossei* (Fig. 38) are muscles placed in the three metacarpal spaces between the fingers, and are numbered 1st, 2nd, and 3rd from the radial side. They are arranged as *ad*ductors of the fingers to an imaginary line prolonged through the long or

Fig. 38.—The three palmar interosseous muscles of the hand (drawn by J. T. Gray).

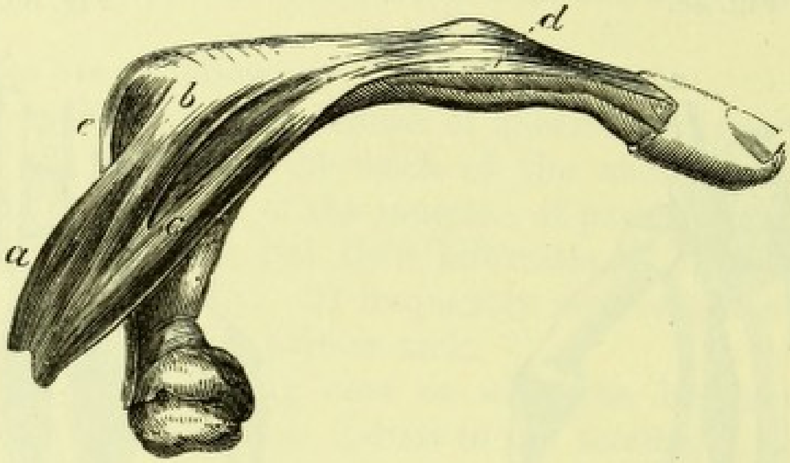
1. Tendon of flexor carpi ulnaris.
2. Tendon of flexor carpi radialis.

Fig. 39.—The four dorsal interosseous muscles of the hand (drawn by J. T. Gray).

1. Tendon of extensor carpi radialis longior.
2. Tendon of extensor carpi radialis brevior.
3. Tendon of extensor carpi ulnaris.

middle metacarpal bone, as follows :—The 1st palmar interosseous muscle *arises* from the ulnar side of the 2nd metacarpal bone, and is *inserted* into the ulnar side of the base of the corresponding first phalanx ; the 2nd *arises* from the radial side of the 4th metacarpal bone, and is *inserted* into the radial side of the corresponding first phalanx ; the 3rd *arises* from the radial side of the 5th metacarpal

Fig. 40.



bone, and is *inserted* into the radial side of the corresponding first phalanx. Each muscle also sends an important expansion to the adjacent side of the corresponding extensor tendon.

The *Four dorsal interossei* (Fig. 39) are bipenniform muscles *arising* from the adjacent sides of the metacarpal bones, and are therefore seen from the front by the sides of the palmar muscles to some extent, but are best dissected from behind. They are arranged as *ab*ductors from an imaginary line drawn through the middle metacarpal bone, and are therefore *inserted* as follows :—The 1st (abductor indicis) into the radial side of the base of the first phalanx of the fore-finger ; the 2nd into the radial side of the base of the first phalanx of the middle finger ; the 3rd into the ulnar side of the same phalanx ; the 4th into the ulnar side of the first phalanx of the ring-finger, each muscle, as in the case of the palmar interossei, giving a slip of insertion into the corresponding extensor tendon.*

Fig. 40.—Attachment of an interosseous muscle (from Duchenne).

a. Interosseous muscle.
b. Attachment to base of first phalanx.
c. Slip passing forward to (*d*) side of extensor tendon.
e. Central portion of extensor tendon.

* The long extensor tendon of each digit hence receives a fibrous slip on each side. The thumb tendon from the abductor and adductor pollicis, the index tendon from the first dorsal and first palmar interossei, the middle finger tendon

Action.—The insertions into the base of the first phalanx (Fig. 40) enable the interossei to act as flexors of that phalanx, and to give lateral movement to the fingers to which they are attached. The slip (*d*) sent forward to join the extensor tendon extends the second and third phalanges; and thus the action of the interossei includes adduction to and abduction from the median line of the hand, with flexion of the first and extension of the second and third phalanges. The lumbricales act in a similar manner, but have more power in initiating the flexion of the first phalanges, and they strengthen the radial side of the metacarpo-phalangeal joints.

The whole of the interossei are *supplied* by the ulnar nerve.

[The interosseous muscles of the hand should be compared with those of the foot, when the same arrangement will be found to exist in both cases, with the exception that, in the foot, the imaginary line for abduction and adduction is drawn through the long or *second* toe, the muscles being arranged in accordance.]

Ligaments of the Clavicle and Scapula.

[The muscles about the scapula are to be followed to their exact insertions and cut short; the deltoid and the remains of the trapezius must be carefully removed in order that the ligaments of the scapula and clavicle may be seen.]

The **Sterno-Clavicular Articulation** is a double ginglymus between the inner end of the clavicle and the sternum and first costal cartilage, and its cavity is subdivided into two parts by an interarticular fibro-cartilage. The *capsule* is formed by *anterior* and *posterior sterno-clavicular* ligaments, and is strengthened by an *inter-clavicular* ligament above, and a *costo-clavicular* or *rhomboid* ligament below. These structures are dissected with the head and neck (see Anterior Triangle).

The **Acromio-Clavicular Articulation** (Fig. 41) is a rotary arthrodial joint, with an inter-articular fibro-cartilage, usually imperfect, but occasionally complete and dividing the synovial cavity into two parts. The joint fissure runs straight from before backwards, and the articular surfaces of the bones are so bevelled as to favour upward displacement of the clavicle upon the acromion.

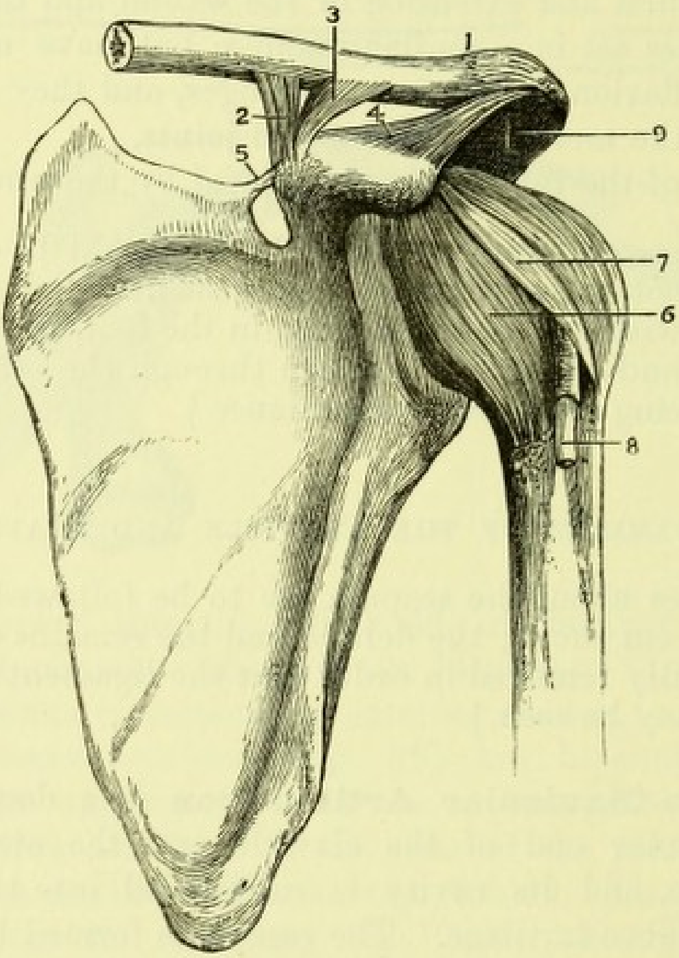
The *Superior acromio-clavicular ligament* (1) is a quadrilateral band of short strong fibres, more or less connected with the fibres

from the second and third dorsal interossei, the ring finger tendon from the second palmar and fourth dorsal interossei, and the little finger tendon from the third palmar interosseous and the abductor minimi digiti.

of the trapezius and deltoid. It is in reality continuous with the *inferior acromio-clavicular ligament*, which is similar in shape, but placed below the joint, the two forming a capsule.

The **Coraco-Clavicular Ligament** (Fig. 41, 2, 3) is really

Fig. 41.



but one ligament twisted upon itself so as to present two surfaces, to which the names Conoid and Trapezoid have been given. The two parts are separated by the insertion of the subclavius and by a bursa.

The *Conoid ligament* (3) is the posterior portion, and resembles

Fig. 41.—Ligaments of the scapula and shoulder-joint (from Wilson).

1. Superior acromio-clavicular ligament.
2. Coraco-clavicular ligament (trapezoid).
3. Coraco-clavicular ligament (conoid).
4. Coraco-acromial ligament.
5. Transverse ligament.
6. Capsular ligament.
7. Coraco-humeral ligament.
8. The long tendon of the biceps issuing from the capsular ligament and entering the bicipital groove.
9. Extra capsular portion of shoulder socket, formed by under surface of acromion and coraco-acromial ligament.

a cone with the base upwards. It is attached to the posterior and inner part of the base of the coracoid process *below*, and to the tubercle on the under surface of the clavicle and part of the adjacent bone *above*.

The *Trapezoid ligament* (2) might be more suitably called rhomboid from its shape. It is a quadrilateral band of fibres attached to the line on the posterior part of the upper surface of the coracoid process *below*, and to the line leading to the tubercle on the under surface of the clavicle *above*. It is anterior and external to the conoid ligament.

The **Coraco-Acromial Ligament** (Fig. 41, 4) is a triangular band attached to the outer side of the coracoid process, and by its smaller end to the tip of the acromion process, and often presents a cleft through which passes a vessel and occasionally a slip of the pectoralis minor. It arches above the shoulder-joint and prevents dislocation upwards. It is loosely stretched between its two attachments in order that it may adapt itself to the curve of the head of the humerus, for which it forms, together with the acromion, a supplementary socket.

The **Transverse Ligament** (Fig. 41, 5) is a short band converting the supra-scapular notch into a hole, and giving origin to part of the omo-hyoid muscle. It is often divided into two parts by the supra-scapular vein. The supra-scapular artery goes over the ligament, but the nerve beneath it.

Movements of Clavicular Joints.—The *sterno-clavicular joint* is the centre for the movements of the entire shoulder girdle. It admits of motion of the clavicle forwards and backwards around a vertical axis, and upwards and downwards around an antero posterior axis. The bone is *raised*, and with it the scapula and humerus, by the upper part of the trapezius, the clavicular head of the sterno-cleido-mastoid, the levator anguli scapulæ, and the rhomboids. It is *depressed* by the weight of the arm, assisted by the subclavius, the pectoralis minor, the lower fibres of the trapezius, and (indirectly) by the latissimus dorsi. It is drawn *forward* by the serratus magnus and the sternal fibres of the pectoralis major and *backward* by the rhomboidei and trapezius. The two clavicular joints thus share between them movements in all directions.

The movements of the *acromio-clavicular* joints are also very important. The scapula rotates around an axis passing through the clavicular facet in the direction of the long axis of the clavicle; and it is this movement which allows the forward movement of the arm to be carried above the level of the shoulder. The forward rotation causes the glenoid cavity to look upwards, carrying with it the humerus, and is effected by the lower digitations of the serratus magnus, aided by the upper fibres of the trapezius; the opposite movement is due to the rhomboideus major.

The Shoulder Joint.

[The muscles surrounding the shoulder are to be carefully removed, those which are inserted into the tubercles of the humerus being dissected as close to the capsular ligament as possible without injuring it, and then cut short.]

The shoulder is an *enarthrodial* or ball-and-socket joint, invested by a capsular ligament. It is surrounded and strengthened by the following muscles:—*above* by the supra-spinatus, *below* by the long head of the triceps, *in front* by the subscapularis, and *behind* by the infra-spinatus and teres minor.

Movements.—The shoulder-joint admits of flexion, extension, abduction, adduction, rotation, and circumduction. The humerus is *flexed* (in front of the trunk) by the pectoralis major and coraco-brachialis, the anterior fibres of the deltoid, and the biceps. It is *extended* (behind the trunk) by the latissimus dorsi, teres major and minor, and posterior fibres of the deltoid. It is *adducted* by the pectoralis major, latissimus dorsi, the two teres muscles, coraco-brachialis, long head of triceps, lower fibres of subscapularis, and slightly by the short head of the biceps; and *abducted* by the deltoid, supra-spinatus, and the long head of the biceps. *Rotation outwards* is produced by the infra-spinatus and teres minor; *inwards* by the supra-spinatus, subscapularis, teres major, latissimus dorsi, and pectoralis major muscles. The last two muscles are antagonistic in the fact that the pectoralis major draws the arm forward across the chest, after rotating it, whilst the latissimus dorsi draws it behind the back. The range of the movements of the humerus around the three axes—sagittal, frontal and ventral—is from only 90° to 100° for each. Abduction and flexion of the arm are hence effected only in part at the shoulder-joint, the rest of the movement taking place at the sterno and acromio-clavicular articulations.

The **Capsular Ligament** (Fig. 41, 6) is seen to be loose, allowing partial dislocation of the humerus now that all the muscles are divided, and there is almost always an opening on its inner side above the subscapularis tendon, by which the bursa of the subscapularis communicates with the articular cavity. The capsule is attached *above* to the outer margin of the glenoid cavity of the scapula, and *below* to the anatomical neck of the humerus, except on the inner side, where it is prolonged downwards as far as the surgical neck. It bridges across the bicipital groove, leaving an aperture for the long tendon of the biceps (Fig. 41, 8). It is thickened in front by an accessory band of fibres, the *Coraco-humeral ligament*, attached above to the lower part of the posterior border of the coracoid process, and below to the greater tuberosity of the humerus. This band is regarded by Mr. Bland Sutton as a degeneration of the pectoralis minor tendon, a slip from which occasionally reaches it by piercing the coraco-acromial ligament.

The *Gleno-humeral ligaments* are accessory bands springing from the anterior border of the glenoid cavity, seen on opening the capsule from behind. The *superior*, narrow and rounded, is attached above to the upper part of the anterior margin of the glenoid cavity in front of the origin of the long head of the biceps, and below to the upper part of the lesser tuberosity of the humerus.

Fig. 42.

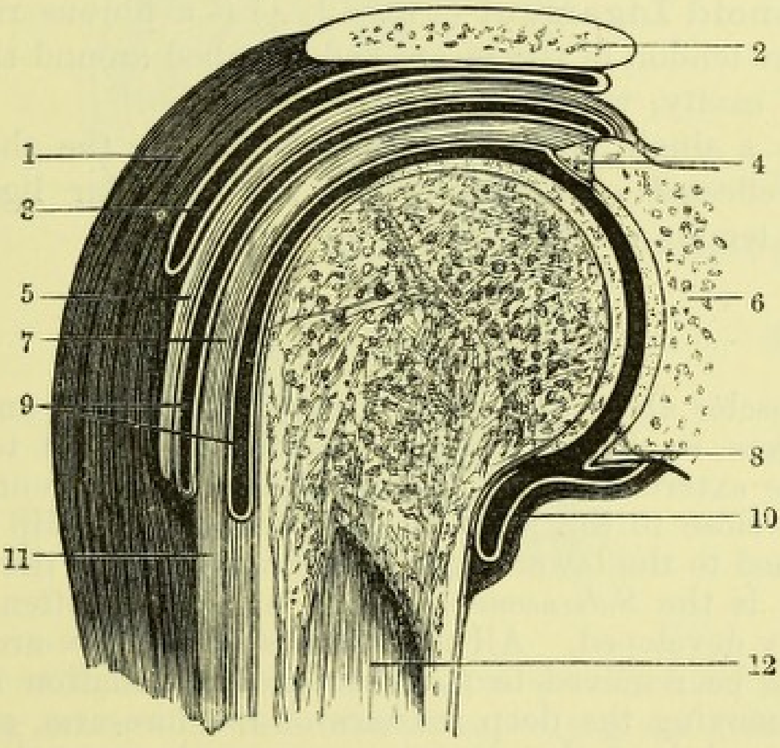


Fig. 42.—Diagrammatic section of shoulder through bicipital groove (W. A.).

1. Deltoid.
2. Acromion.
3. Subacromial bursa.
4. Glenoid ligament.
5. Capsule of shoulder joint.
6. Glenoid cavity.
7. Long tendon of biceps.
8. Glenoid ligament.
9. Synovial membrane lining capsule and ensheathing biceps tendon.
10. Inner fold of capsule and synovial membrane.
11. Extra-articular portion of biceps tendon.
12. Humerus.

It is supposed to represent the ligamentum teres of the lower extremity. The *inferior* gleno-humeral ligament, broad and strong, runs from the lower half of the anterior border of the glenoid cavity to the anterior and inner side of the neck of the humerus. A *middle* band is sometimes described between the two foregoing, arising with the superior and attached below to the inner side of the lesser tuberosity.

The tendon of the biceps is to be followed into the articulation by laying open the capsular ligament. It will be found invested by a tube of synovial membrane, and attached to the glenoid ligament and upper part of the glenoid cavity. Its synovial sheath can be demonstrated before the capsule is opened by making traction upon the tendon during flexion and abduction of the arm, when the lower portion of the tube emerges from the bicipital opening (Fig. 41). This should be remembered in amputation of the arm through the surgical neck of the humerus, when the tendon is divided, as otherwise the joint may be opened.

The **Glenoid Ligament** (Fig. 42, 4) is a fibrous ring continuous with the tendon of the biceps and attached around the border of the glenoid cavity, which it therefore deepens.

There is a single **Synovial Membrane** in the shoulder-joint, which is reflected over the glenoid and capsular ligaments and around the tendon of the biceps (Fig. 42).

The Elbow Joint.

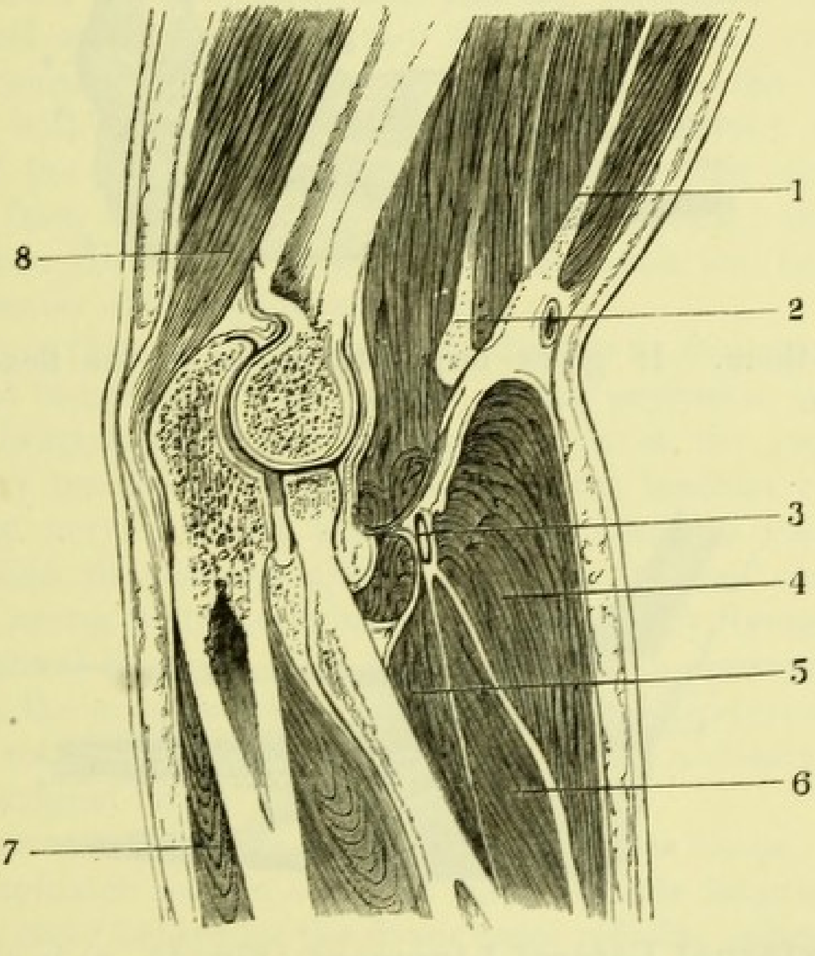
[The muscles about the elbow are to be removed, and great care must be taken, in detaching the supinator brevis, not to remove or damage the external lateral and the orbicular ligaments. Beneath the triceps close to the joint may be found a little slip of muscular fibre attached to the lower end of the humerus and the back of the joint; this is the *Subanconeus*, which is however often wanting or but slightly developed. All the muscles of the fore-arm and hand should now be removed to facilitate the examination of the wrist, &c. In removing the deep muscles of the fore-arm, care must be taken not to injure the interosseous membrane and the oblique ligament.]

The joint between the humerus and fore-arm bones, the elbow joint proper, is almost a pure *ginglymus* or hinge, and is provided with anterior, posterior and lateral ligaments. The superior radio-ulnar articulation which is continuous with the elbow joint is an example of *diarthrosis rotatorius*, the head rotating in a ring formed partly of bone, partly of ligament. All these ligaments unite to form one general capsule enclosing a single synovial cavity.

The **Anterior Ligament** (Fig. 44, 1) is a broad but thin membrane attached to the humerus immediately above the coronoid and radial fossæ, and below to the coronoid process of the ulna, a little below its edge, and to the front of the orbicular ligament.

The **Posterior Ligament** is thin and loose, and is attached to the humerus above the olecranon fossa and to the external and posterior borders of the olecranon process of the ulna, a short distance behind

Fig. 43.



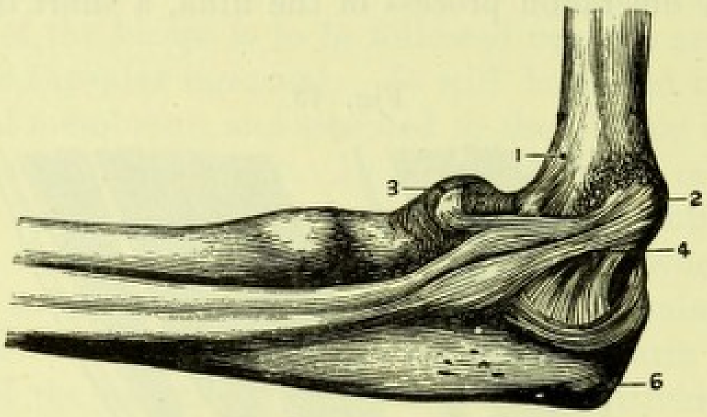
the articular surface. Its strongest fibres usually form a transverse band bridging across the olecranon fossa. It gives attachment by its posterior surface to a few fibres of the triceps (*sub-anconeus*) and anteriorly is connected with a *plica adiposa* which fills the olecranon fossa during flexion, but is drawn upwards by the sub-anconeus in extension.

Fig. 43.—Section of elbow (from Braune).

1. Biceps.
2. Brachialis anticus.
3. Musculo-spiral nerve.
4. Supinator longus.
5. Supinator brevis.
6. Extensor carpi radialis longior.
7. Extensor carpi ulnaris.
8. Triceps.

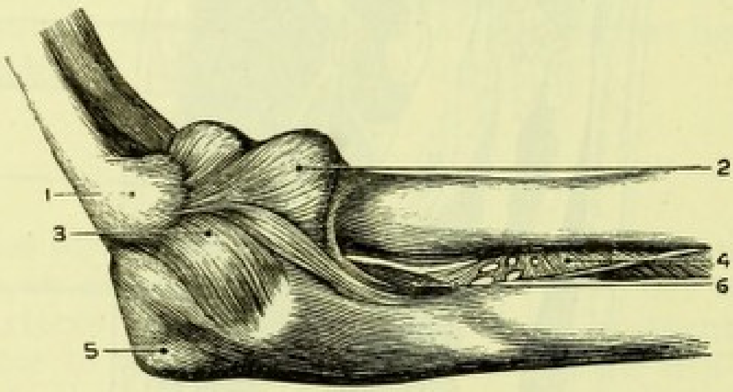
The **Internal Lateral Ligament** (Fig. 44, 4) is triangular, the apex being attached to the lower part of the prominent internal condyle, and the base reaching all along the inner margins of the coronoid and olecranon processes, and bridging across the notch

Fig. 44.



between them. It gives origin to fibres of the flexor sublimis digitorum.

Fig. 45.



The **External Lateral Ligament** (Fig. 45, 3) is a short thick band attached to the lower part of the outer condyle, and radiating to its attachment to the orbicular ligament of the radius, and

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Fig. 44.—Ligaments of the elbow from the inner side (from Sappey).

1. Anterior ligament.
2. Internal condyle.
3. Head of radius covered by orbicular ligament.
4. Internal lateral ligament.
6. Olecranon.

Fig. 45.—Ligaments of the elbow from the outer side (from Sappey).

1. External condyle of humerus.
2. Orbicular ligament covering head of radius.
3. External lateral ligament.
4. Interosseous membrane.
5. Olecranon.
6. Oblique ligament.

borders of the lesser sigmoid cavity of the ulna. It gives origin to fibres of the supinator brevis and extensor carpi radialis brevior.

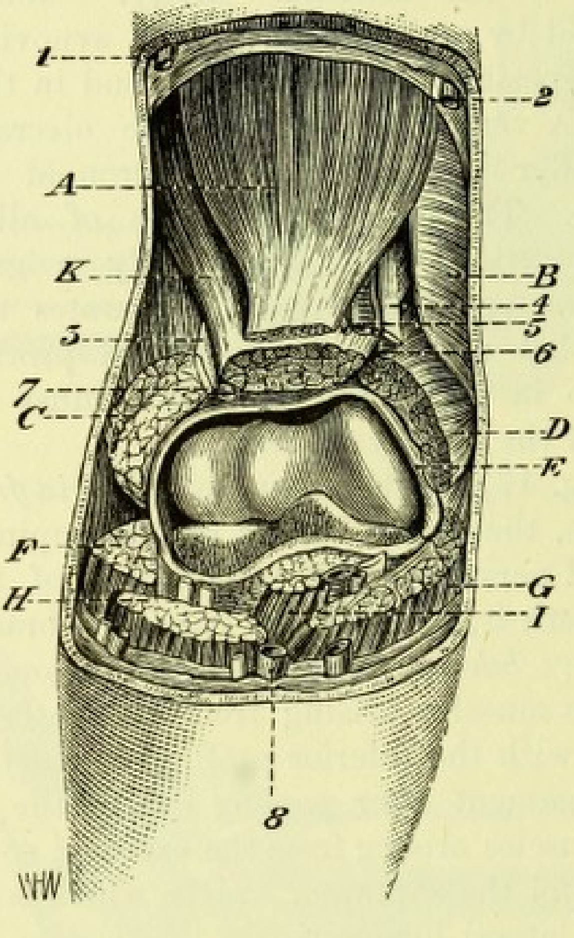
The **Synovial Membrane** common to the elbow and superior radio-ulnar joints will be seen by removing the anterior ligament, and will be found to be reflected upon the inner surface of the capsule, including the orbicular ligament, and upon the bones as far as the margin of the articular cavity. Well marked plicæ adiposæ are formed by an infolding of the synovial membrane and subsynovial fat opposite the joint furrows and in the position of the humeral fossæ. A very large one fills the olecranon fossa during flexion, and smaller ones occupy the coronoid and radial fossæ during extension. The articular surfaces of all the bones are encrusted with cartilage, but occasionally a groove across the bottom of the greater sigmoid cavity separates that covering the olecranon from that covering the coronoid process; this groove, which is seen also in the macerated bone, must not be mistaken for the remains of the epiphysial line.

RELATIONS (Fig. 47).—The elbow joint has *in front* the brachialis anticus and biceps, the inner border of the supinator longus with the musculo-spiral nerve and the termination of the superior profunda artery beneath it, the pronator teres, the brachial vessels, and the median nerve; *behind*, the triceps and anconeus muscles. To the *inner* side, the muscles arising from the internal condyle, and the ulnar nerve, with the inferior profunda artery, lying upon the internal lateral ligament after passing behind the internal condyle. *Externally*, the muscles arising from the external condyle and supracondyloid ridge, and the supinator brevis, which is closely connected with the external lateral ligament.

MOVEMENTS.—The fore-arm is *flexed* by the biceps, brachialis anticus, supinator longus, extensor carpi radialis longior, pronator radii teres, and (feebly) by the flexor carpi radialis, palmaris longus and flexor digitorum sublimis. It is *extended* by the triceps and anconeus, and slightly by the extensor carpi ulnaris, extensor digitorum communis and extensor minimi digiti. *Rotation of the radius* upon the ulna and humerus, and consequently a portion of the movements of pronation and supination of the hand, are produced as follows,—*Pronation* by the pronator quadratus, pronator teres and flexor carpi radialis, *supination* by the biceps, supinator brevis extensor ossis metacarpi pollicis (ulnar head) and extensor secundi internodii pollicis. The supinator longus has no influence of importance upon pronation and supination, but probably acts slightly in bringing the fore-arm into the position of semi-pronation when the elbow is flexed.

The rotation of the radius around the ulna in pronation and supination is associated during life with a kind of circumduction of the ulna, effected by movements of flexion, extension, abduction, and adduction that are almost imperceptible at the elbow joint, but are

Fig. 46.



easily seen at the wrist. They cannot, however, be demonstrated by passive rotation of the radius in the dead subject.

It must be recollected that the entire movement of hand rotation is equal to 280°, and that not more than 120° of this is effected at the radio-ulnar articulations. The rest is accomplished chiefly at

Fig. 46.—The elbow joint exposed from the front.

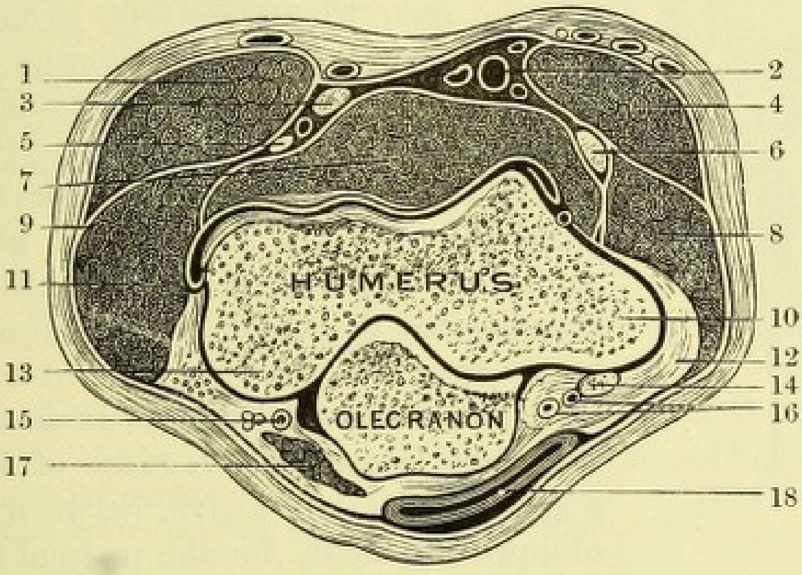
1. Cephalic vein.
2. Basilic vein and internal cutaneous nerve.
3. Musculo-spiral nerve.
4. Median nerve.
5. Brachial artery and venæ comites.
6. Anastomotica magna.
7. Radial recurrent.
8. Median vein.

A. Biceps.
B. Triceps.
C. Supinator longus and extensor carpi radialis longior (the division between them is not evident enough).
D. Origins of flexors and pronators.
E. Capsule of joint.
F. Extensor carpi radialis longior.
G. Pronotor teres.
H. Supinator longus.
I. Tendon of biceps (beneath which are the brachialis anticus and the capsule).

the shoulder joint (about 100°), the carpal joints, and, in exaggerated action, even by the movement of the scapular arch and spinal column. During full extension of the elbow only the anterior border of the upper surface of the radius rests against the capitellum of the humerus.

The movements of flexion and extension of the elbow take place around an axis passing through the lower end of the humerus from condyle to condyle, but with a slight inclination downwards at its inner extremity. As a result of this obliquity, the hand lies in a plane internal to that of the head of the humerus when the fore-arm

Fig. 47.



is fully flexed upon the upper arm, and during complete extension the arm and fore-arm join at a very obtuse angle, the opening of which is directed outwards. The total range of flexion and extension is about 150°.

Radio-Ulnar Articulations.

Superior (Fig. 45, 2).—This is a part of the elbow joint. Its only ligament is the *Orbicular* (Fig. 48, 3), a strong flat band of

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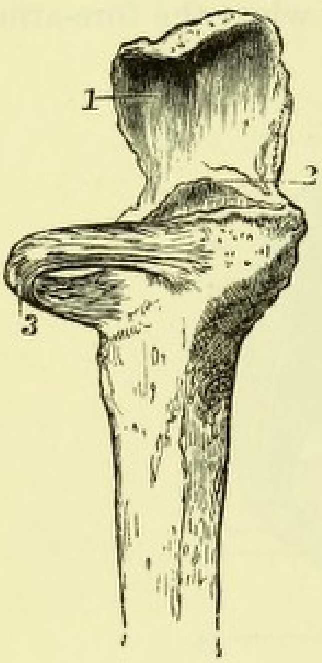
Fig. 47.—Transverse section through humerus and olecranon.

1. Supinator longus.
2. Brachial artery with venæ comites.
3. Tendon of biceps.
4. Pronator teres.
5. Musculo-spiral nerve with superior profunda artery.
6. Median nerve.
7. Brachialis anticus.
8. Origin of flexors.
10. Inner condyle.
11. Origin of extensors.
12. Internal lateral ligament.
13. Outer condyle.
14. Ulnar nerve.
15. Posterior interosseous recurrent vessels.
16. Posterior ulnar recurrent vessels.
17. Anconeus.
18. Olecranon bursa.

fibres encircling the head and neck of radius, and attached to the extremities of the lesser sigmoid cavity and slightly into the neck of the radius. It blends with the external lateral ligament of the elbow, and gives origin to fibres of the supinator brevis; the joint cavity is continuous with that of the elbow.

Inferior (Fig. 49, 3).—The bones are connected below by *anterior* and *posterior* ligaments, short fibrous bands passing between the borders of the sigmoid cavity of the radius and the head of the ulna internal to the articular surface; and by an *inter-articular fibro-cartilage* which will be seen when the joint is opened (Fig. 51, 3). The synovial membrane (*membrana sacciformis*) is very loose and contains a good deal of fluid.

Fig. 48.



The *Interosseous ligament* or membrane (Fig. 45, 4) is the great bond between the shafts of the bones of the fore-arm, its fibres running for the most part obliquely downwards from the radius to the ulna, but some in the opposite direction. It is attached to the sharp interosseous borders of both bones, a space being left above, between it and the oblique ligament, for the passage of the posterior interosseous vessels. The membrane is pierced below by the anterior interosseous artery, and one or two of its branches (Fig. 49, 4).

The *Oblique ligament* (Fig. 45, 6) is an inconstant band, running from the outer side of the tuberosity of the ulna to the radius below the bicipital tubercle. Its direction is therefore the reverse of that of the principal fibres of the interosseous membrane.

The Wrist Joint.

The term "wrist joint" is somewhat loosely applied by anatomists, and may be taken to signify either the radio-carpal joint, or the whole of the articulations into the formation of which the carpal bones enter.

The **Radio-Carpal Joint** is a modified ginglymus admitting of

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Fig. 48.—Upper part of ulna with orbicular ligament (from Wilson).
1. Olecranon. 2. Tip of coronoid process. 3. Orbicular ligament

Fig. 49.

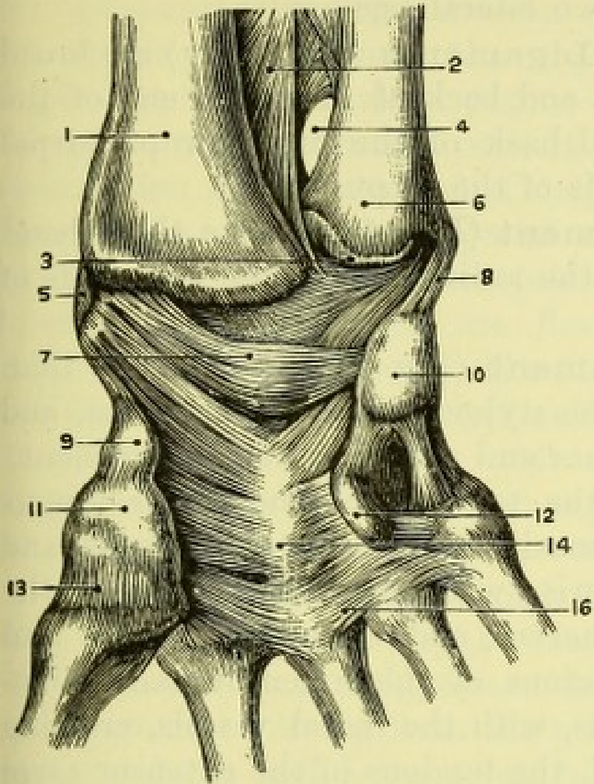


Fig. 50.

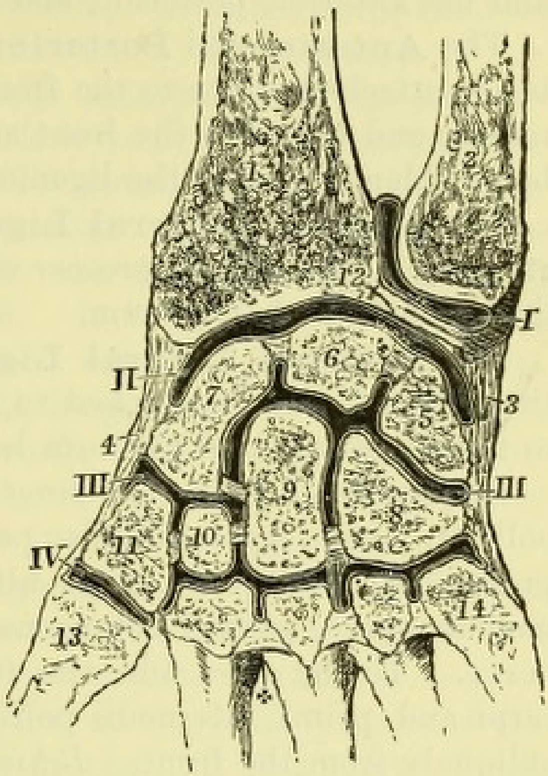


Fig. 49.—Ligaments of the anterior aspect of the wrist and hand (from Sappey).

1. Radius.
2. Interosseous membrane.
3. Articulation between lower end of ulna and triangular fibro-cartilage opened.
4. Space for anterior interosseous artery.
5. External lateral ligament of wrist.
6. Lower end of ulna.
7. Anterior ligament of wrist.
8. Internal lateral ligament of wrist.
9. Tubercle of scaphoid.
10. Pisiform bone.
11. Trapezium.
12. Hook of unciform.
13. Articulation between trapezium and first metacarpal.
14. Anterior ligament of carpus.
16. Ligaments uniting metacarpals with one another and with carpus.

Fig. 50.—Section showing the disposition of the chief synovial membranes of the wrist-joint (from Wilson).

(The reflection of the membranes over the articular cartilages is erroneous. It should cover only the ligamentous structures.)

I. Sacciform membrane.
II. Second synovial membrane.
III. Third or large synovial membrane.
IV. Synovial membrane between the trapezium and metacarpal bone of thumb. That of the pisiform bone is not visible in this view.
V. Synovial membrane between unciform and two inner metacarpals.

1. Radius. 2. Ulna.
3. Internal lateral ligament.
4. External lateral ligament.
5. Cuneiform bone.
6. Semilunar. 7. Scaphoid.
8. Unciform. 9. Os magnum.
10. Trapezoid. 11. Trapezium.
12. Interarticular fibro-cartilage.
13. Metacarpal bone of thumb.
14. Metacarpal bone of little finger.

×. Interosseous metacarpal ligaments. Interosseous ligaments are also seen connecting the bones of each row of the carpus.

flexion and extension with some lateral and rotatory movements, and has anterior, posterior, and two lateral ligaments.

The **Anterior** and **Posterior Ligaments** (Fig. 49, 7) are broad bands attached above to the front and back of the lower end of the radius, and below to the front and back of the first row of carpal bones, blending with the ligaments of the carpus.

The **External Lateral Ligament** (Fig. 49, 5) is a thick band attached to the styloid process of the radius, and to the outer side of the scaphoid and trapezium.

The **Internal Lateral Ligament** (Fig. 49, 8) is longer than the external, and is attached to the styloid process of the ulna, and to the cuneiform and pisiform bones and anterior annular ligament.

Relations.—It has *in front* the tendons of the flexor longus pollicis, flexor carpi radialis, palmaris longus, flexor sublimis and profundus, and flexor carpi ulnaris, with the radial vessels, the median nerve, palmar cutaneous nerves, and the ulnar vessels and nerve. To the *outer* side, the tendons of the extensor ossis metacarpi and primi internodii pollicis, with the radial vessels, crossing obliquely from the front. *Behind*, the tendons of the extensor carpi radialis longior and the brevior, extensor secundi internodii pollicis, extensor communis digitorum, extensor indicis, extensor minimi digiti, and extensor carpi ulnaris, with the radial nerve, the dorsal branch of the ulnar nerve and the terminal branch of the posterior interosseous nerve, as well as some small vessels (Fig. 33).

The **ligaments connecting together the carpal bones** are very numerous and scarcely repay a special dissection. They may be classified as follows:—

1. Ligaments of the upper row:
   Dorsal, Palmar, and Interosseous, running between semilunar and bones on either side; Capsular, between pisiform and cuneiform; Transverse, between scaphoid and cuneiform, passing across back of head of os magnum.
2. Ligaments of lower row:
   Dorsal, Palmar, and Interosseous, connecting each bone with its neighbours.
3. Ligaments connecting the two rows with each other:
   Dorsal and Palmar.
   External Lateral between scaphoid and trapezium.
   Internal Lateral between cuneiform and unciform.

The **Medio-carpal Joint** between the two rows of carpal bones is one of great importance, as the movements of flexion and extension of the hand are shared almost equally between this and the radio-carpal articulations.

MOVEMENTS OF HAND AT WRIST.—The hand is *flexed* (90°) at the radio-carpal and medio-carpal joints by the flexor carpi radialis, the flexor carpi ulnaris, the superficial and deep flexors of the fingers and thumb, the extensor ossis metacarpi pollicis and the extensor primi internodii pollicis. It is *extended* (60°) at the same articulation by the two radial carpal extensors, the extensor carpi ulnaris, the common and special extensors of the fingers, and the extensor secundi internodii pollicis; the range of motion being greatest when the fingers are flexed. It is *abducted* (25°) at the radio-carpal joint only by the thumb extensors, the flexor carpi radialis, and the extensor carpi radialis longior; and is *adducted* (55°) by the flexor and extensor carpi ulnaris. The *rotatory* movements associated with pronation and supination are effected by those of the pronators and supinators that are attached to the hand.

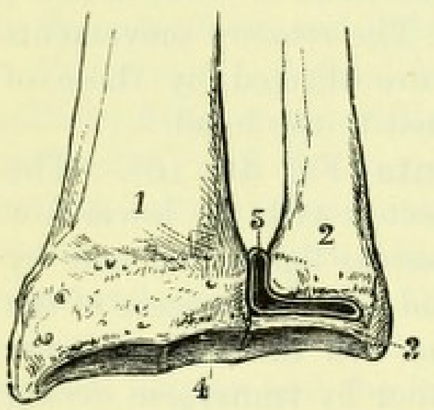
The **Superior Metacarpal Ligaments** (Fig. 49, 16).—The 2nd, 3rd and 4th metacarpal bones are conected with the lower row of the carpus by *dorsal*, *palmar* and *interosseous* ligaments, and by two ligaments running from the pisiform and annular process of the *unciform* (*piso-* and *hamo-metacarpal*) to the 5th metacarpal bone. The same metacarpal bones are joined together by transverse *dorsal*, *palmar*, and *interosseous* ligaments. The first metacarpal bone has a separate *capsular* ligament connecting it with the trapezium, this joint allowing double angular movement with slight rotation. The joint between the fifth metacarpal bone and the unciform permits similar angular movements, but much more limited in range (Fig. 50, 13). The remaining carpo-metacarpal joints are capable only of a slight gliding or *arthrodial* movement.

[The synovial membranes of the wrist are to be opened by the following incisions on the dorsal aspect of the hand: one between the lower ends of the radius and ulna (care being taken not to divide the fibro-cartilage), and three transverse incisions carried between the lower end of the radius and the carpus, the two rows of carpal bones, and the carpus and metacarpus respectively. The articulations of the pisiform bone and of the first metacarpal bone are also to be opened.]

The **Synovial Cavities of the wrist** (Fig. 50) are five in number. (1) between the radius and the under surface of the triangular fibro-cartilage above, and the three outer bones of the first row of the carpus below; (2) between the first and second rows of carpal bones, passing between the several bones as well, also between the second and third metacarpal bones, and the opposed carpal bones. It is sometimes sub-divided into two by an interosseous ligament at the articulation between the scaphoid and trapezoid; (3) between the cuneiform and pisiform bones; (4) between the trapezium and the metacarpal bone of the thumb; (5) between the unciform and two inner metacarpal bones, occasionally continuous with the 2nd. The synovial cavity between the lower ends of the radius and ulna lies above the wrist, and hence should not be included in the enumeration.

The **Triangular Fibro-cartilage** (Fig. 51, 3) is best seen after removing the carpus altogether. It is a powerful ligamentous structure, occasionally perforate, and is attached by its base to the margin of the radius, between the ulnar and carpal surfaces, and by its apex to a depression close to the root of the styloid process of the ulna. It is in relation below with the cuneiform and a portion of the semilunar bones.

Fig. 51.



The **Inferior Metacarpal Ligaments.**—The distal ends of the four inner metacarpal bones are joined together by palmar and dorsal transverse ligaments. The *palmar transverse* ligament is of great strength and blends with the metacarpo-phalangeal ligaments. The *dorsal transverse* ligament is much weaker, and is separated from the former by a space which transmits the tendons of the interossei.

The **Metacarpus** and **Phalanges** are connected mainly by two lateral ligaments, but anterior and posterior ligaments are sometimes recognised.

The *Anterior ligament* is represented by strong fibro-cartilaginous *glenoid plates* passing from the anterior border of the base of the phalanx, to be loosely attached to the metacarpal bone just above the head, and closely connected with the palmar transverse metacarpal ligament and lateral ligaments; it assists in forming the sheath of the tendons.

The *Posterior ligament* consists merely of a few delicate fibres strengthening the synovial membrane beneath the expansion of the extensor tendons.

Fig. 51.—Lower end of radius and ulna with triangular fibro-cartilage (from Wilson).

1. Radius.
2. Ulna.
3. Interarticular fibro-cartilage.
4. Articular surface of radius.
5. Membrana sacciformis.

The *Lateral ligaments* are strong bands which are attached above to the sides of the heads of the metacarpal bones, and spreading out in a fan-like manner, pass obliquely to the anterior and lateral margins of the phalanges, decussating with each other in front of the joint, and blending with the glenoid plate. The strength of the radial ligament is greater than that of the ulnar, and is reinforced by the lumbricalis.

Each joint is provided with a *synovial membrane* which forms a circular fold (plica adiposa) between the two bones at the level of the articular fissure. The articulation is enarthrodial, and its movements are flexion, extension, abduction, adduction, and slight rotation. The latter motion occurs only during circumduction.

The **Phalangeal Articulations** are similar to those between the metacarpus and phalanges, but their movements are limited to flexion and extension, and the joints are hence ginglymoid.

MOVEMENTS.—The METACARPO-PHALANGEAL JOINTS (exclusive of that of the thumb) are *flexed* by the interossei and lumbricales, and secondarily by the flexor sublimis and flexor profundus; they are *extended* by the common and special extensors, and *lateralised* by the interossei and lumbricales (*q. v.*). The PHALANGEAL JOINTS are *flexed* by the flexor sublimis and flexor profundus, and *extended* by the interossei aud lumbricales, and secondarily by the common and special extensors. In the case of the LITTLE FINGER the muscles named are aided by the special abductor, flexor brevis and flexor ossis metacarpi minimi digiti. It must be remembered, too, that there is a motion of about 15° in the direction of flexion and extension at the carpo-metacarpal joint of the finger, and it is probable that the ulnar carpal tendons attached to the base of the metacarpal bone assist the long and short muscles of the digit in acting upon the articulation. The CARPO-METACARPAL JOINT OF THE THUMB is *flexed* by the abductor flexor brevis, adductors and opponens and by the long flexor, *extended* by the three extensors, *abducted* by the abductor outer head of the flexor brevis and opponens, *adducted* by the extensor ossis metacarpi, adductors, inner head of flexor brevis and first dorsal interosseous. The METACARPO-PHALANGEAL JOINT OF THE THUMB is acted upon by the same muscles, except, of course, those which do not reach the phalanx. The *phalangeal joint* is flexed by the long flexor, and extended by the long extensor.

TABLE I.—MUSCLES OF UPPER EXTREMITY.

Muscle.	Origin.	Insertion.	Nerve.
Pectoralis major ..	Sternum, costal cartilages, 1—6 .... Clavicle, inner half .... Aponeurosis of external oblique	Humerus, outer bicipital ridge........	External and internal anterior thoracic.
Pectoralis minor	Ribs, 3, 4, 5, intercostal fascia	Scapula, coracoid process	Internal anterior thoracic.
Subclavius	Costal cartilage, 1	Clavicle, middle third of under surface.	Special from brachial plexus.
Serratus magnus......	Ribs, 1—8, intercostal fascia	Scapula, venter near vertebral border ..	Posterior thoracic. "Bell".
Biceps	Scapula { Glenoid cavity .... Coracoid process .... }	Radius, tubercle. Fascia	Musculo-cutaneous.
Coraco-brachialis	Scapula, coracoid process, tendon of biceps	Humerus, middle of inner surface	Musculo-cutaneous.
Brachialis anticus	Humerus, lower ½. Intermuscular septa	Ulna, tubercle below coronoid process..	Musculo-cutaneous. Musculo-spiral.
Deltoid	Clavicle, outer ⅓. Scapula, acromion and spine	Humerus, middle of outer surface	Circumflex.
Supra-spinatus	Scapula, supraspinal fossa and spine	Humerus, great tuberosity	Supra-scapular.
Infra-spinatus........	Scapula, infraspinal fossa. Fascia............	Humerus, great tuberosity	Supra-scapular.
Teres minor	Scapula, upper teres area	Humerus, great tuberosity	Circumflex.
Teres major	Scapula, lower teres area near inferior angle ..	Humerus, inner bicipital ridge........	Subscapular.
Latissimus dorsi	Iliac crest, ½, 5 lumbar, 6 dorsal spines, 4 ribs ..	Humerus, bottom of bicipital groove ..	Long subscapular.
Subscapularis	Scapula, venter	Humerus, lesser tuberosity	Subscapular.
Triceps	Scapula, below glenoid cavity .... Humerus, below teres minor................ Humerus, below teres major................	Ulna, olecranon process..............	Musculo-spiral.
Sup. Pronator radii teres . 3.	Humerus, inner condyle and supra-condylar ridge. Fascia .... Ulna, coronoid process	Radius, middle of outer surface	Median.
Sup. Flexor carpi radialis ..	Humerus, inner condyle. Fascia	Metacarpal bones, 2 & 3	Median.
" Palmaris longus	Humerus, inner condyle. Fascia	Palmar fascia and annular ligament ..	Median.
" Flexor carpi ulnaris . 2.	Humerus, inner condyle. Fascia .... Ulna, olecranon and posterior edge	Pisiform. Metacarpal, 5. Annular ligament	Ulnar.
Sup. Flexor sublimis digitorum .... 3.	Humerus, inner condyle. Fascia .... Ulna, coronoid process .... Internal lateral ligament of elbow .... Radius, oblique line and outer border........	Four fingers, 2nd phalanges (perforatus)	Median.
Flexor longus pollicis 2.	Radius, anterior surface. Interosseous m. ½.. Ulna, coronoid process (occasionally)	Thumb, terminal phalanx............	Anterior interosseous (median).
[illegible]	Ulna, anterior and inner. [illegible]	[illegible]	[illegible]

	Pronator quadratus ..	Ulna, anterior lower ¼	Radius, anterior lower ¼	ous (median).
Sub.	Supinator radii longus	Humerus, ...	...	
,,	Extensor carpi radialis longior......	Humerus, supracondyloid ridge ⅓. Septum....	Metacarpal bone, 2nd................	Musculo-spiral.
Deep	Extensor carpi radialis brevior......	Humerus, external condyle. Fascia	Metacarpal bone, 3rd	Posterior interosseous (musculo-spiral).
Sup.	Extensor communis digitorum	Humerus, external condyle. Fascia	Four fingers, 2nd & 3rd phalanges	Posterior interosseous.
,, .	Extensor minimi digiti	Humerus, external condyle. Fascia	Little finger, 2nd & 3rd phalanges	Posterior interosseous.
,, .	Extensor carpi ulnaris.	Humerus, external condyle. Fascia	Metacarpal bone, 5th	Posterior interosseous.
,, .	Anconeus	Humerus, external condyle. Fascia	Ulna, upper ⅓ of outer surface	Musculo-spiral.
Deep.	Supinator brevis....	Ulna below lesser sigmoid. Ext. lat. ligt. of elbow. Orbicular ligament. Humerus, external condyle occasionally	Radius, anterior and outer surfaces above oblique lines	Posterior interosseous (musculo-spiral).
,, .	Extensor ossis metacarpi pollicis	Radius, middle posterior. Ulna, middle posterior. Interosseous membrane	Thumb, metacarpal..................	Posterior interosseous.
,, .	Extensor primi internodii pollicis	Radius, posterior. Interosseous membrane ½ ..	Thumb, 1st phalanx	Posterior interosseous.
,, .	Extensor secundi internodii pollicis..	Ulna, posterior. Interosseous membrane ½	Thumb, 2nd phalanx	Posterior interosseous.
,, .	Extensor indicis	Ulna, posterior. Interosseous membrane	Fore finger, common extensor tendon..	Posterior interosseous.
.	Palmaris brevis	Palmar fascia	Skin of palm	Ulnar.
	Lumbricales (4)	Tendons of flexor profundus digitorum	Expansion of extensors	Median. Ulnar (deep). 2 inner.
	Abductor minimi digiti	Pisiform. Flexor carpi ulnaris tendon	Little finger, 1st phalanx, extensor tendon	Ulnar.
	Flexor brevis minimi digiti	Unciform. Annular ligament	Little finger, 1st phalanx	Ulnar.
	Opponens minimi digiti	Unciform. Annular ligament	Little finger, metacarpal bone	Ulnar.
	Abductor pollicis......	Trapezium. Annular ligament	Thumb, 1st phalanx, extensor tendon..	Median.
	Opponens pollicis	Trapezium. Annular ligament	Thumb, metacarpal..................	Median.
	Flexor brevis pollicis..	Annular ligament. Metacarpal base............	Thumb, 1st phalanx (sesamoids)	Median. Inner = Ulnar
	Adductor obliquus pollicis	Metacarpals, 2nd & 3rd bases. Os magnum. Sheath of flexor carpi radialis	Thumb, 1st phalanx, extensor tendon..	Ulnar (deep).
	Adductor transversus pollicis	Middle metacarpal	Thumb, 1st phalanx, with last........	Ulnar (deep).
	Palmar interossei (3)..	Metacarpals, 2nd, 4th, 5th..................	Corresponding 1st phalanges, extensor tendon	Ulnar (deep). All 7
	Dorsal interossei (4) ..	Adjacent sides of metacarpals	1st, 2nd, & 3rd fingers, 1st phalanges, extensor tendons	Ulnar (deep). Interossei.

TABLE II.—ARTERIES OF UPPER EXTREMITY.

Axillary Artery. From outer border of 1st rib to lower border of teres major.

1st Stage
- 1. Sup. thoracic.

2nd Stage
- 2. Acromio-thoracic. Clavicular, acromial, thoracic and humeral branches.
- 3. Long thoracic.
- 4. Alar thoracic to glands. Irregular in origin.

3rd Stage
- 5. Subscapular. Subscapular, dorsal-scapular, and infra-scapular branches.
- 6. Anterior circumflex. Muscular, articular and anastomotic branches.
- 7. Posterior circumflex. Muscular, articular, acromial, and anastomotic. Extra branch in female, external mammary.

Brachial Artery. From lower border of teres major to bend of elbow.
- 1. Superior profunda. Muscular, post. external articular, and anterior external articular branches.
- 2. Inferior profunda. Muscular and internal anastomotic branches.
- 3. Nutrient to humerus.
- 4. Anastomotica magna. Anterior and posterior internal articular and post. transverse branches.
- 5. Muscular to coraco-brachialis, biceps, and brachialis anticus.

Radial Artery. From bend of elbow to palm.

Forearm ..
- 1. External anterior recurrent.
- 2. Muscular.
- 3. Superficial volar.
- 4. Anterior carpal.

Wrist ....
- 5. Posterior carpal.
- 6. Metacarpal and 1st dorsal interosseous.
- 7. Dorsalis pollicis.
- 8. Dorsalis indicis.

Hand .... (Deep palmar arch.)
- 9. Princeps pollicis ......
- 10. Radialis indicis ......
- 11. Recurrent carpal......
- 12. Perforating ....
- 13. Interosseous..........

Ulnar Artery. From bend of elbow to palm.

Forearm ..
- 1. Anterior internal recurrent.
- 2. Posterior internal recurrent.
- 3. Common interosseous .. Anterior—Median, muscular, and nutrient branches. Posterior—Posterior external recurrent and muscular branches.
- 4. Muscular.

Wrist ....
- 5. Anterior carpal.
- 6. Posterior carpal. Metacarpal and anastomotic branches.

Outer Cord

- *External anterior thoracic.* Muscular to pectoralis major, communicating by internal anterior thoracic.
- *Musculo-cutaneous*
  - *Muscular* to coraco-brachialis, biceps, and brachialis anticus.
  - *Cutaneous* to outer side of forearm.
  - *Articular* to carpus.
- *Outer head of median*, joining inner head on outer side or in front of artery.

Posterior Cord

- *Superior subscapular* to subscapularis.
- *Middle or long subscapular* to latissimus dorsi.
- *Inferior subscapular* to subscapularis and teres major.
- *Circumflex*
  - (1) *Muscular* to deltoid and teres minor.
  - *Cutaneous* to skin over lower part of deltoid and back of arm.
  - *Articular* to shoulder-joint.
- *Musculo-spiral*
  - *Internal cutaneous* to arm.
  - *Muscular* to triceps, anconeus, brachialis anticus, supinator longus, and extensor carpi radialis longior.
  - *External cutaneous* (2) to arm and back of forearm.
  - *Posterior interosseous*
    - Muscular to supinator brevis and extensors of wrist, thumb, and fingers.
    - Articular to elbow and wrist.
  - *Radial* to skin of radial half of back of hand.

Inner Cord

- *Internal anterior thoracic* muscular to pectoralis minor and major.
- *Internal cutaneous* to inner side of forearm.
- *Lesser internal cutaneous* to inner side of upper arm.
- *Ulnar:*
  - *Forearm* .
    - *Articular* to elbow.
    - *Muscular* to flexor carpi ulnaris, ulnar half of flexor profundus.
    - *Palmar cutaneous.*
    - *Dorsal cutaneous* of hand.
  - *Hand* ....
    - *Superficial palmar* .
      - Muscular to palmaris brevis.
      - Cutaneous to little and half of ring finger.
      - Communicating to median.
    - *Deep palmar*
      - Muscular to muscles of little finger, all interossei, two thumb adductors, inner head of short flexor, and two inner lumbricales.
- *Inner head of median:*
  - *Branches of median:*
    - *In forearm*
      - *Muscular* to pronator teres, flexor radialis, palmaris longus, flexor sublimis.
      - *Anterior interosseous* to half of flexor profundus, flexor longus pollicis and pronator quadratus.
      - *Palmar cutaneous.*
    - *In hand* ..
      - *Muscular* to abductor, opponens, outer head of flexor brevis pollicis, and two outer lumbricals.
      - *Cutaneous* to thumb, index, middle, and half of ring fingers.

PART II.

DISSECTION OF THE LEG.

[*The Student is requested to read the 'Introduction' before commencing the dissection, unless he has done so on a previous occasion.*]

BEFORE beginning the actual dissection, the student should make himself fully acquainted with the external configuration of the part, and the relations which superficial appearances bear to deeper structures. If he has already dissected this region, he should also make the incisions necessary to expose the several arteries in the positions in which they are usually tied, according to the directions which accompany the description of each vessel, taking care not to disturb the tissues unnecessarily, and to stitch up the incisions without delay.

External appearances.—The fold of the groin separates the abdomen from the thigh; and the finger, if carried along it, will recognise *Poupart's ligament*, stretched tightly across when the limb is fully extended. In the same position also the front of the thigh will be convex owing to the large extensor muscles, but if the knee be slightly bent and the thigh abducted, a shallow depression will be seen immediately below the groin corresponding to *Scarpa's triangle*, and Poupart's ligament will be felt to become relaxed. *Lymphatic glands* of variable size can be felt along, or a little above the line of Poupart's ligament; whilst below it, and more or less in a vertical direction, will be found others which belong strictly to the thigh. In the centre of the hollow on the front of the thigh can be felt the *femoral artery*, which may be followed for about a third of the length of the thigh in a thin subject. At the fold of the groin it lies about a third of an inch internal to the middle of Poupart's ligament. The *saphenous vein* is occasionally to be seen, when enlarged, on the inner side of the limb, and the course of others joining it is sometimes visible. If the body should be the subject of femoral hernia, probably the hernial tumor will be found occupying the upper part of the hollow in the front of the thigh, and reaching more or less above the inner portion of Poupart's ligament. In such a case, if the hernial protrusion be returned, the finger can be readily passed into the enlarged *saphenous opening* and up into the crural ring behind Poupart's ligament.

The crest and the anterior and posterior superior spines of the *ilium* will be readily seen and felt; the spine and crest of the pubes can also be distinguished. The tuberosity of the *ischium* is obscured by the gluteus maximus if the hip is extended, but it may be felt distinctly during flexion, the muscle then lying above it. The *great trochanter* is easily recognised from three to four inches below the

Fig. 52.

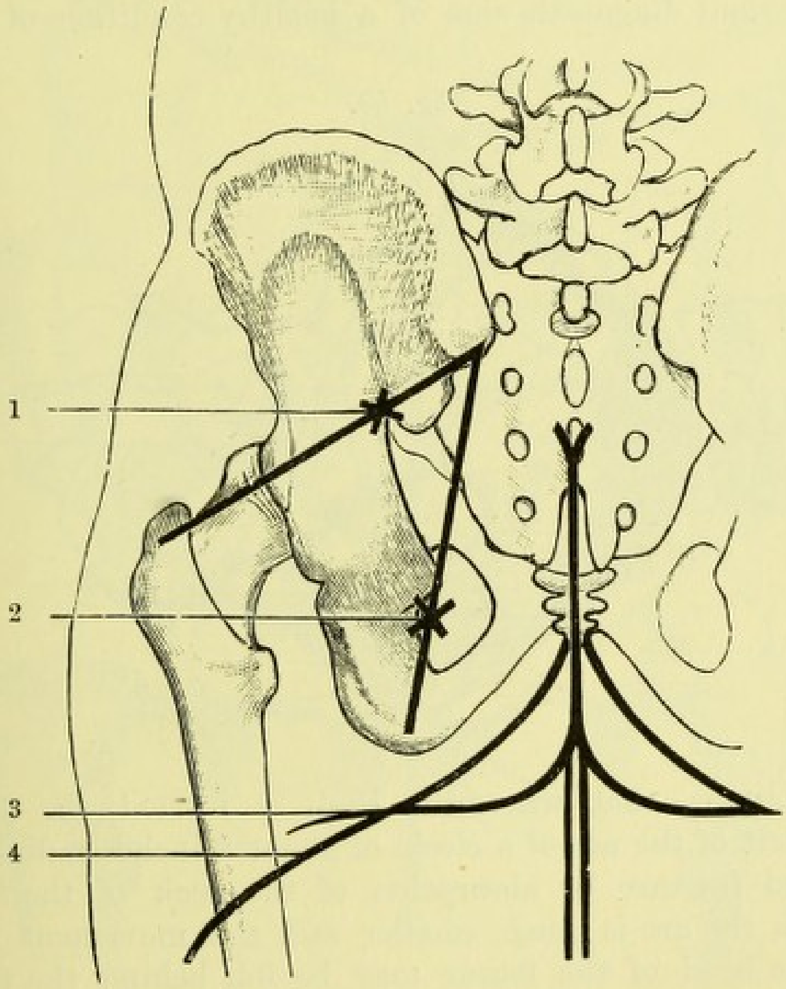


Fig. 52.—Diagram showing landmarks for gluteal and sciatic arteries at their point of exit from the pelvis (W. A.)

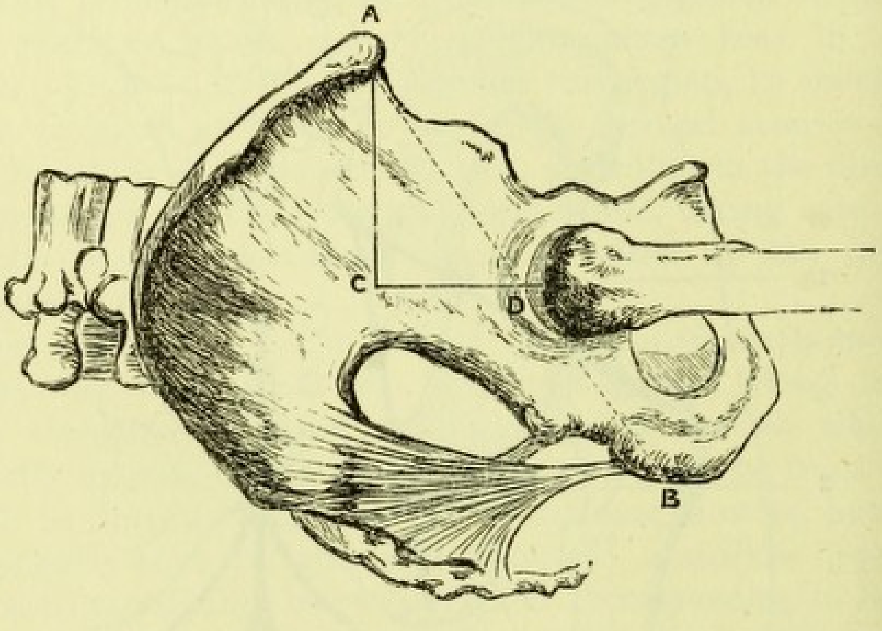
Gluteal artery (at junction of upper and middle thirds of line from posterior superior iliac spine to great trochanter.
Sciatic artery (at junction of middle and lower thirds of line from posterior iliac spine to tuber ischii.
3. Fold of nates.
4. Lower border of gluteus maximus.

crest of the ilium, and should be thoroughly manipulated so that its relation to the upper border of the pelvis and surrounding parts may be clearly appreciated during the movements of the limb ; and the two sides of the body should be compared if any morbid change about the hip is suspected.

The positions of the *gluteal* and *sciatic vessels* where they escape from the pelvis may be found by drawing two lines from the posterior superior iliac spine to the top of the posterior border of the great trochanter and to the tuber ischii respectively. The gluteal artery will be found at the junction of the upper and middle thirds of the first, and the sciatic artery at the junction of the middle and lower thirds of the second (Fig. 52).

An important diagnostic sign of a healthy condition of the neck

Fig. 53.



of the femur is, that when the limb is rotated the trochanter describes part of the arc of a circle of about 2 inches radius. When an impacted fracture or absorption of the neck of the femur has taken place, the arc is much smaller and the movement less complete. The head of the femur may be felt behind the trochanter when the limb is rotated inwards, and in a very thin subject it may be detected in front when the finger is thrust deeply into Scarpa's triangle. The great sciatic nerve lies midway between the great trochanter and the ischial tuberosity, and to the inner side of the acetabular margin.

Fig. 53.—A B, Nélaton's test line ; A C D, Bryant's ilio-femoral triangle.

Nélaton's test line for dislocation of the head of the femur upwards or backwards is one drawn from the anterior superior iliac spine to the tuberosity of the ischium (Fig. 53, A B), which in health touches the top of the great trochanter. *Byrant's test line* for fracture of the neck of the femur is one taken vertically from the anterior superior iliac spine when the body is recumbent (Fig. 53, A C), from which the distance (C D) to the top of the great trochanter can be accurately measured.

The position of the *hip joint* may be defined by drawing a line

Fig. 54.

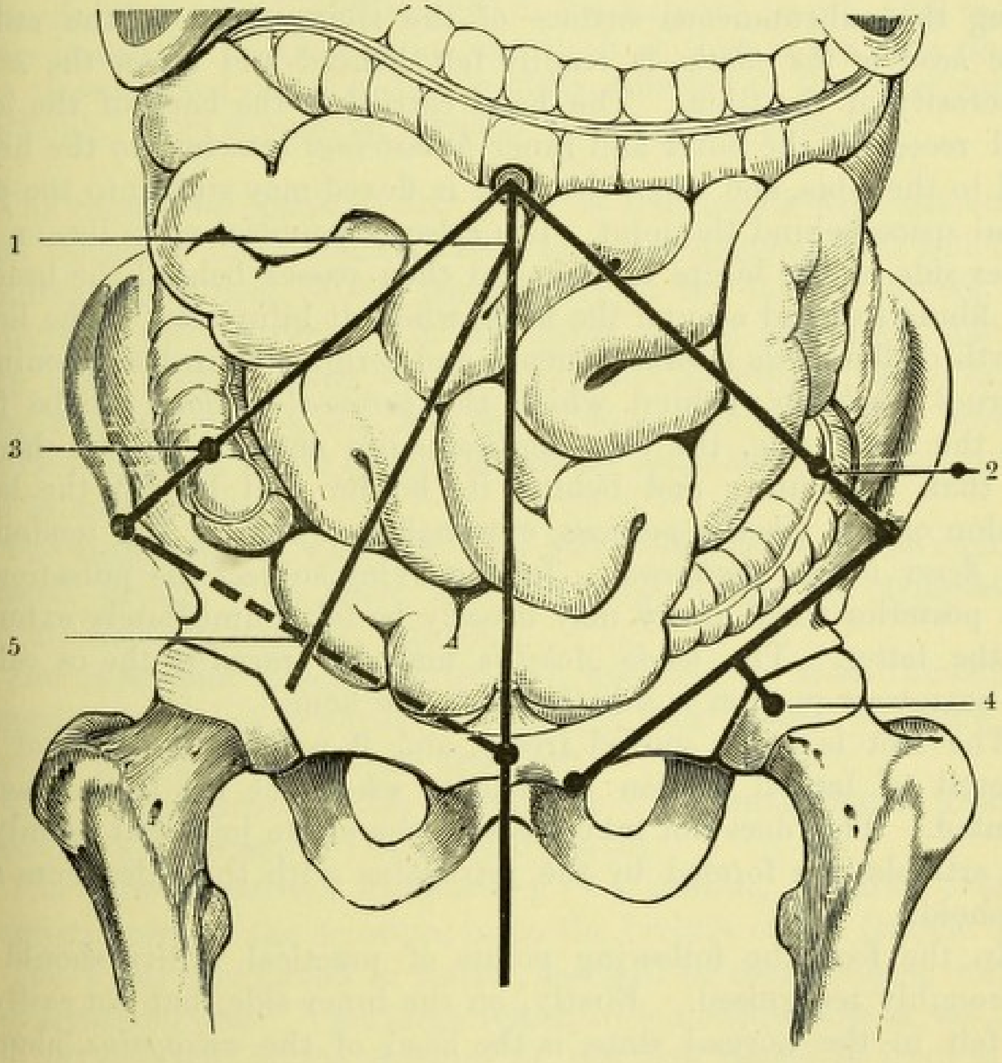


Fig. 54.—Diagram illustrating position of cæcum, sigmoid flexure, iliac vessels, and hip joint (W. A.).

1. Point of bifurcation of aorta.
2. Position of sigmoid flexure in line from umbilicus to anterior superior iliac spine.
3. Position of cæcum.
4. Position of hip joint at a distance of an inch in a line at right angles to middle of Poupart's ligament.
5. Line of external and common iliac arteries crossing middle of dotted line.

an inch long at right angles to the middle of Poupart's ligament. The free extremity of this line corresponds to the head of the femur immediately below the middle of the border of the acetabulum (Fig. 54).

The *condyles of the femur*, the *adductor tubercle* above the inner tuberosity, and the *patella* are to be examined, and it should be noticed how large a part of the articular end of the femur is uncovered by the patella when the knee is flexed, while during extension two-thirds of the articular surface of the patella is above the femoral trochlea. The *ligamentum patellæ* and its attachment to the tibia are to be noticed, and the finger should be carried along the subcutaneous surface of the tibia, down to the ankle. The *head of the fibula* is readily felt behind and below the outer tuberosity of the tibia. The hand carried to the back of the joint will recognise the outer and inner *hamstrings* attached to the fibula and to the tibia, and when the knee is flexed may sink into the popliteal space behind the joint. The *external popliteal nerve* lies on the inner side of the biceps tendon and then passes behind the head of the fibula to wind around the neck, where it bifurcates. The lower fourth of the *fibula* is subcutaneous and terminates in the prominent *external malleolus*, behind which the *peroneal tendons* can be felt. On the inner side, the *inner malleolus* lies anterior to and higher up than the outer; and behind its border will be felt the large tendon of the *tibialis posticus*, external to which is the tendon of the *flexor longus digitorum*. In the living subject the pulsation of the posterior tibial artery may usually be felt immediately external to the latter. The *tendo Achillis* may be traced to the os calcis. Its narrowest portion is a little above the bone.

The foot is to be moved freely, and it will be found that the amount of lateral motion is greatest when the toe is thoroughly pointed. This does not take place at the ankle joint but mainly in the articulations formed by the astragalus with the calcaneum and scaphoid.

In the foot, the following points of practical utility should be thoroughly recognised. Firstly, on the inner side, but not easily to be felt in the normal state, is the head of the *astragalus*, about a finger's breadth below the anterior border of the malleolus; in front of this is the prominence of the tuberosity of the *scaphoid* bone, to which the tendon of the tibialis posticus may be traced, and which is the guide in Chopart's amputation of the foot; and more anteriorly lies the slighter prominence of the *internal cuneiform* bone, with the base of the *first metatarsal* bone in front of it, and the tendon of the tibialis anticus attached to both bones. Secondly, on the outer side, the tendons of the peronei crossing the calcaneum, and farther forwards the prominent base of the *fifth metatarsal bone*, which with the base of the first metatarsal bone indicates the line of Hey's operation. The toes are commonly much distorted owing to the long pressure of ill-fitting shoes, and the metatarso-phalangeal articulation of the great toe frequently projects inwards and is covered by an enlarged bursa (bunion).

The Front of the Thigh.

[An incision is to be made along Poupart's ligament, and carried down the inner border of the thigh for half its length, and this is to be joined by another across the limb at that point; the flap of skin thus marked out is to be carefully reflected to the outer side of the thigh. The superficial fascia is to be first examined.]

The *Superficial fascia* of the thigh is continuous with the superficial fascia of the abdomen over Poupart's ligament, and generally contains a good deal of fat, particularly in the female subject. It is divisible into two layers in the upper part of the thigh, and the deep layer will be seen by reflecting the superficial layer in the same way as the skin, but not so far down, the separation between the two layers of fascia being marked by some small vessels, glands, and minute nerves.

The **Superficial Vessels** (Fig. 55) are branches of the common femoral artery, with their accompanying veins and lymphatics, and are three in number, viz. :—

The *Superficial epigastric artery* (*e*), which arises from the femoral immediately below Poupart's ligament, and passes upwards and inwards over the front of the abdomen.

The *Superficial circumflex iliac artery* (*d*), a small branch running outwards a little below Poupart's ligament.

The *Superior external pudic artery* (*f*), running inwards over the spermatic cord to the scrotum, or to the labium in the female.

The *Veins* correspond in course, and will be seen to open into the *long saphenous vein.* This large vessel, which commences at the inner side of an arch on the dorsum of the foot, passes in front of the inner malleolus and up into the thigh along the back of the inner side of the knee. After receiving branches from the front and back of the limb as well as those just referred to, it goes through the saphenous opening, and pierces the sheath of the vessels to open into the common femoral vein.

The *Superficial lymphatic glands* will also be found between the layers of superficial fascia, and are arranged in two rows, one extending obliquely along the groin, and receiving the lymphatics of the penis, scrotum, perinæum, anal region, nates, and abdominal

Fig. 55.

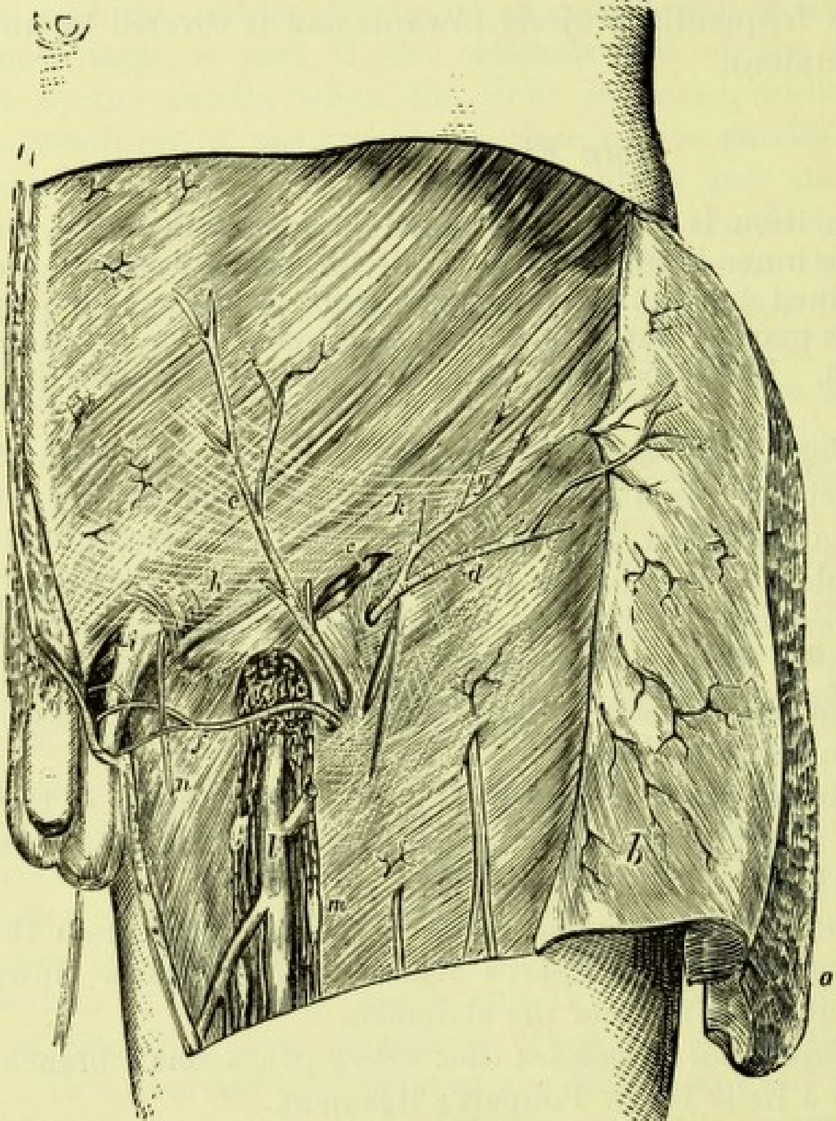


Fig. 55.—Superficial dissection of the inguinal and femoral regions (from Wood).

a. Superficial layer of fascia (reflected).
b. Deeper layer of fascia (reflected), the superficial vessels being left attached to the external oblique.
c. Inguinal lymphatic glands.
d. Superficial circumflex iliac artery. The genito-crural nerve is seen beneath it.
e. Superficial epigastric artery.
f. Superior external pudic artery.
g. Poupart's ligament.
h. Inter-columnar fascia.
i. External abdominal ring.
k. Arciform or inter-columnar fibres of external oblique.
l. Internal saphenous vein.
m. Femoral lymphatic glands.
n. Ilio-inguinal nerve.
o. Saphenous opening.

wall below the umbilicus; and another running down vertically below the groin and draining the superficial lymphatics of the limb. The relation of the lymphatics to these glands is to be borne in mind, since the position of a bubo will vary according to the part primarily affected.

A few *Deeper lymphatic glands* will be afterwards met with surrounding the femoral vessels. These drain the deep structures of the lower extremity.

The *Superficial Nerves* are the terminations of the *ilio-inguinal*, *crural branch* of the *genito-crural*, and *external cutaneous*, from the lumbar plexus; and the *middle* and *internal cutaneous* branches of the anterior crural. Their distribution will be given later.

The *Deep layer of superficial fascia* is more membranous than the superficial layer, and will be best seen by raising it from the deep fascia beneath, beginning about four inches below the groin and reflecting it on to Poupart's ligament. This layer of superficial fascia will be found to be bound down to the fascia lata below Poupart's ligament, and around the margin of the opening through which the saphenous vein disappears, called the *Saphenous opening.* Unlike the superficial layer, it does not pass over Poupart's ligament, and therefore has some influence in directing a large femoral hernia along the groin. It receives the name of *Cribriform fascia* at the part where it crosses the saphenous opening, because it is perforated by numerous small apertures for the passage of vessels and lymphatics. Great care must be taken not to destroy the saphenous opening in removing the deep layer of the superficial fascia.

The *Deep fascia of the thigh* (fascia lata) is now exposed, and is to be cleaned as far as is necessary for the study of the parts concerned in femoral hernia, the several nerves piercing it being left for subsequent examination.

Femoral Hernia.

[The saphenous vein is seen to disappear through an opening in the fascia lata about an inch and a half below Poupart's ligament. This is the saphenous opening, which is obscured by the attachment of a portion of the superficial fascia, called from the numerous perforations in it *cribriform.* If the cribriform fascia have been carefully removed together with the small veins, the artificially produced saphenous opening will be clearly seen.]

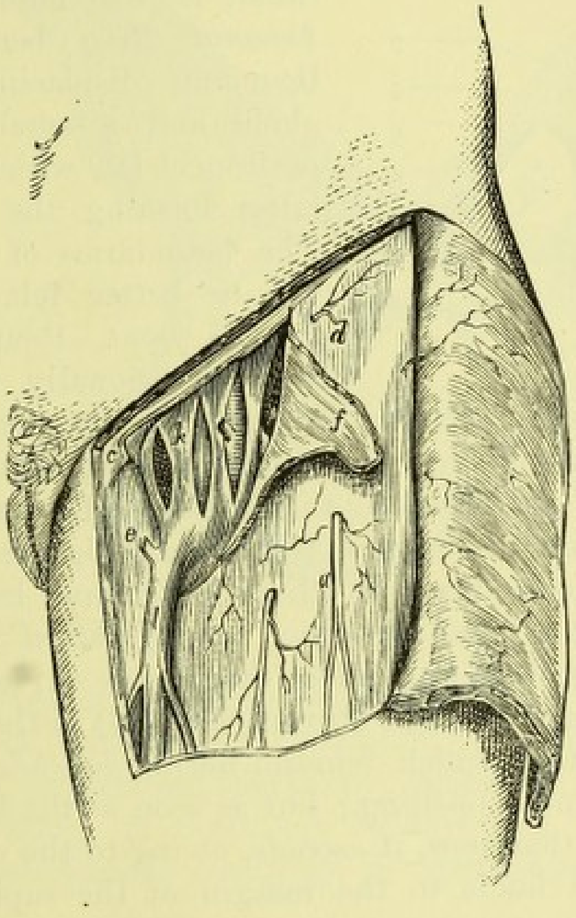
The **Saphenous opening** (Fig. 55, *o*) varies considerably in different subjects, and is generally best seen in the female. It is an oval cleft nearly half an inch wide, without any distinct limitation internally, but sharply bounded on the outer side and below by the semicircular border (*falciform margin*) of a process of fascia (*process of Burns*), which passes from the fascia lata of the front of the thigh to become attached to the whole length of Poupart's ligament. The falciform margin which partly encircles the long saphenous vein has a well defined curve like that of a French horn. It crosses in front of the femoral sheath to join the inner part of Poupart's ligament at a variable point, while internally and below it passes imperceptibly into the pubic portion of the fascia lata which covers the pectineus muscle. The pectineal fascia passes behind the femoral sheath to be attached to the ilio-pectineal line above, and to become continuous with the ilio-psoas fascia externally. The saphenous opening is the external aperture through which a femoral hernia passes, and might therefore well be called the external femoral ring, although strictly speaking there is in the undissected condition no definite ring, but merely a weak point in the fascia through which the hernia protrudes, pushing before it the cribriform fascia. The edges of the saphenous opening will be found to be relaxed when the thigh is flexed and adducted, the position in which the limb is placed when the "taxis" is applied for the reduction of a hernia.

[An incision is to be made from the lower end of the saphenous opening transversely outwards for two inches, and a corresponding one immediately below Poupart's ligament, and the piece of fascia thus marked out and including the falciform process is to be reflected to the outer side.]

Gimbernat's ligament (Fig. 58, 11) consists of a strong band of fibres passing from the innermost portion of Poupart's ligament to the inner extremity of the ilio-pectineal line. It fills the angle between Poupart's ligament and the pubic bone, and presents a free edge turned outwards towards the femoral sheath. Behind it lies the conjoined tendon, the fascia transversalis, a small anastomotic arch between the pubic branches of the deep epigastric and obturator vessels, and more deeply the subperitoneal tissue and peritoneum. The name *Ligament of Cooper* is given to a fibrous band which runs along the ilio-pectineal line from the ilio-pectineal eminence to the pubic spine.

The **Sheath of the Common Femoral Vessels** (Fig. 56, *k*) lies between the process of fascia lata (process of Burns) passing to Poupart's ligament in front, and the pectineal and iliac fasciæ behind. This sheath appears as a tube, broader above than below, and composed of a delicate connective tissue, containing more or less fat. It invests the femoral artery, vein, and a portion of the deep lymphatics, and may be traced beneath Poupart's ligament upon the external iliac vessels, where it is continuous with the subperitoneal fascia which ensheaths the latter, while below it may be followed as a vascular sheath throughout the limb. It is usually stated to be formed by the union of the fascia transversalis and fascia iliaca around the vessels, but it is essentially a prolongation

Fig. 56.



of the subperitoneal tissue sheath of the iliac vessels, reinforced by some fibres from the fascia transversalis in front, and is separated from the iliac fascia behind by loose connective tissue. Three vertical incisions, one in the centre and one at each side of the tubular sheath, will enable the dissector to see that it is divided by two slender septa into three compartments, the femoral artery

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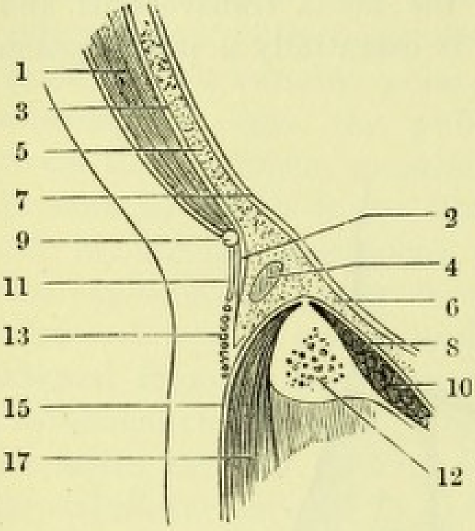
Fig. 56.—Crural sheath laid open (from Wood).

a. Middle cutaneous nerve.
c. Placed to inner side of Gimbernat's ligament.
d. Iliac portion of fascia lata.
e. Pubic portion of fascia lata.
f. Margin of saphenous opening (turned back).
k. Femoral sheath opened by three incisions.
l. Saphenous vein.

occupying the outermost, the femoral vein the middle, and sub-peritoneal fat and a lymphatic gland the innermost or smallest one.* This last division of the femoral sheath is the *femoral* or *crural canal.*

Fig. 57.



The **Femoral** or **Crural Ring** (Fig. 58, 12).—If the finger be passed upwards along the crural canal, it will enter the *Crural* or *Femoral Ring* beneath Poupart's ligament, displacing a lymphatic gland and a small piece of sub-peritoneal fat, which occupy it, the latter forming the *septum crurale.* The boundaries of the crural ring can be better felt than seen, and are, *in front*, Poupart's ligament, with occasionally a distinct band of fascia transversalis beneath it, called the *deep crural arch; behind*, the body of the pubes, with the pectineus muscle and pubic portion of the fascia lata; *externally*, the femoral vein; and *internally*, the sharp margin of Gimbernat's ligament. The crural ring is the aperture through which a femoral hernia leaves the abdomen, and the point at which strangulation most commonly occurs; the finger should therefore thoroughly explore it.

The **Crural** or **Femoral Canal** (Fig. 56) is the canal, half an inch in length, along which femoral hernia *descends* from the crural ring to the saphenous opening; but as soon as the hernia has forced its way through that spot, it *ascends*, owing to the close attachment of the superficial fascia to the margin of the saphenous opening,

Fig. 57.—Diagrammatic section of crural canal (W. A.). (Section internal to that in Fig. 58.)

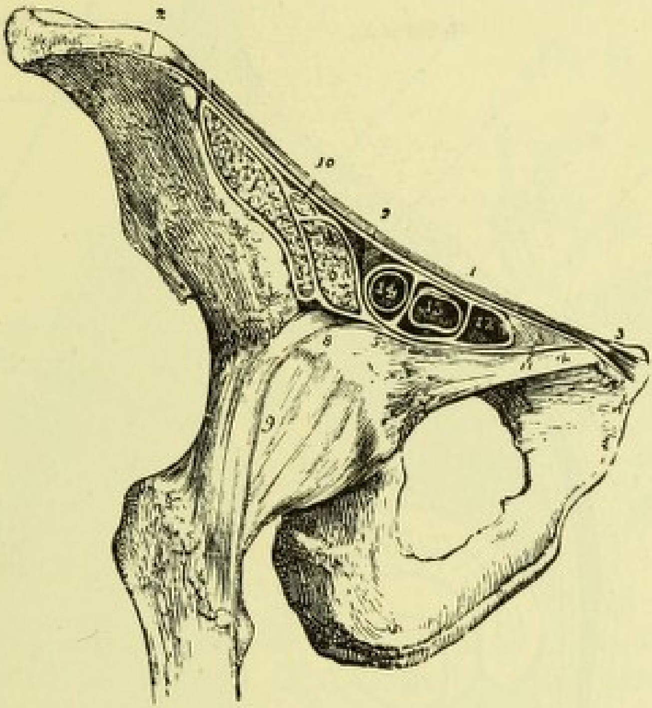
1. Abdominal muscles.
2. Process of fascia transversalis strengthening front of femoral sheath.
3. Fascia transversalis.
4. Lymphatic gland.
5, 6. Subperitoneal tissue.
7. Peritoneum.
8. Obturator fascia.
9. Poupart's ligament.
10. Obturator internus.
11. Falciform process of Burns.
12. Pubic bone.
13. Cribriform fascia.
15. Pubic portion of fascia lata.
17. Pectineus.

* A precisely similar arrangement is found in connection with the iliac vessels above Poupart's ligament (see "Journal of Anatomy and Physiology," 1891).

and lies along Poupart's ligament, or if of large size, may stretch the fascia sufficiently to mount over the ligament and simulate an inguinal hernia.

The **Coverings of a Femoral Hernia** (Fig. 57) will be readily

Fig. 58.



learned if the course it takes has been thoroughly understood. In its descent the intestine pushes before it (1) peritoneal sac, (2) sub-peritoneal fat, (3) femoral sheath, (4) cribriform fascia, (5) superficial fascia and skin. It must not be supposed that the surgeon will recognise these various coverings in operating upon a strangu-

Fig. 58.—Section of the structures which pass beneath the femoral arch (from Wilson).

1. Poupart's ligament.
2, 2. Iliac portion of the fascia lata, attached along the margin of the crest of the ilium, and, by means of the process of Burns, along Poupart's ligament as far as the spine of the pubes (3).
4. Pubic portion of the fascia lata, continuous at 3 with the iliac portion, and passing behind the sheath of the femoral vessels to its outer border at 5, where it divides into two layers; one is continuous with the sheath of the psoas (6) and iliacus (7); the other (8) is lost upon the capsule of the hip-joint (9). It is attached above to the ilio-pectineal line.
10. The anterior crural nerve.
11. Gimbernat's ligament.
12. The femoral ring, within the femoral sheath.
13. Femoral vein.
14. Femoral artery; the two vessels and the ring are surrounded by the femoral sheath.

lated femoral hernia, but it is necessary that he should identify the sac or peritoneum, which is usually to be recognised by its thin bluish

Fig. 59.

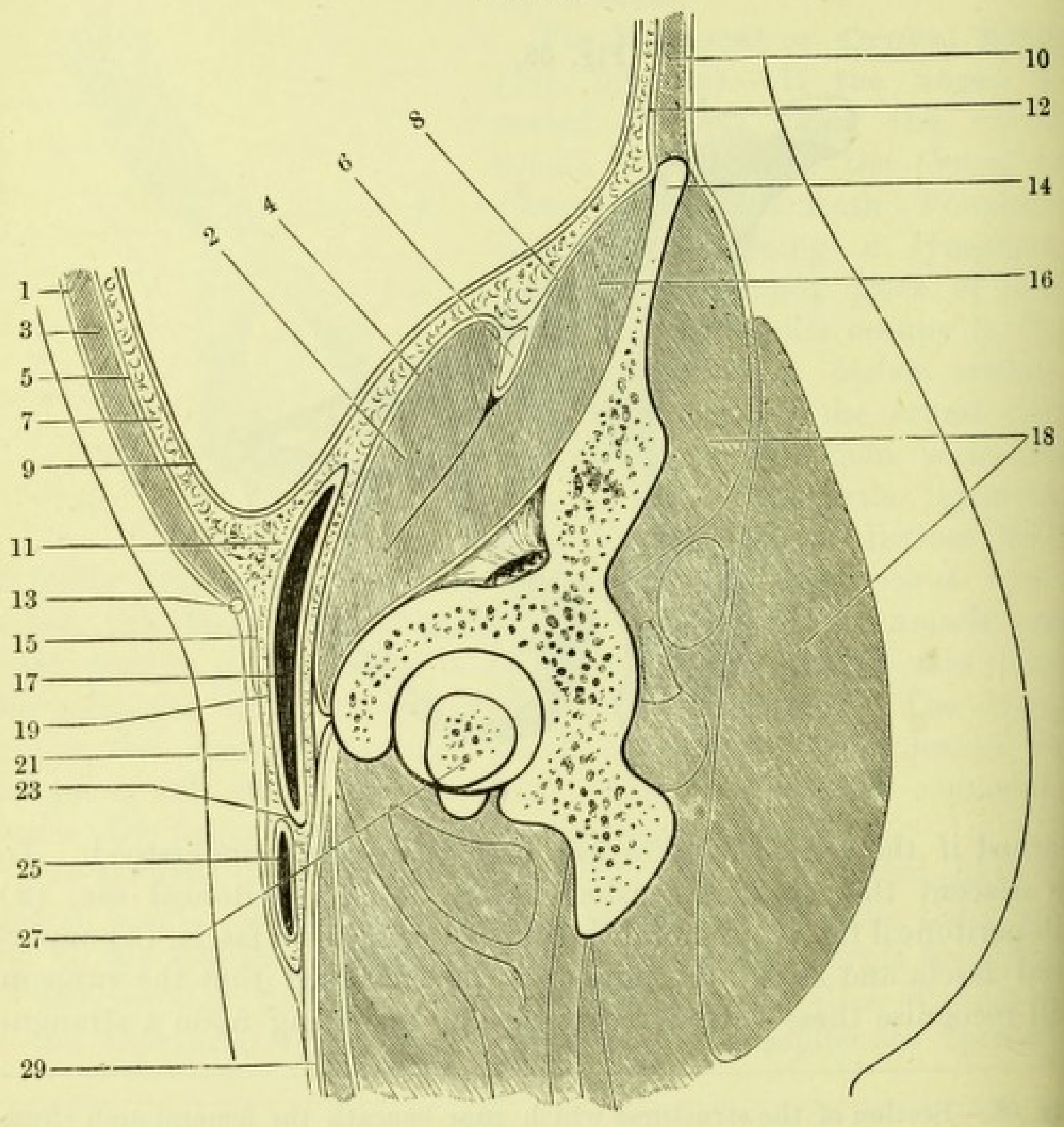


Fig. 59.—Diagrammatic section through femoral and iliac sheaths (W. A.).

1. External abdominal fascia.
2. Psoas.
3. Abdominal muscles.
4. Psoas fascia.
5, 12. Fascia transversalis.
6. Anterior crural nerve.
7, 11. Subperitoneal tissue.
8. Iliac fascia.
9. Peritoneum.
10. Muscles of post-abdominal wall.
13. Poupart's ligament.
14. Crest of ilium.
15. Process of fascia transversalis strengthening front of femoral sheath.
16. Iliacus.
17. Femoral artery.
18. Muscles of gluteal region.
19. Anterior wall of femoral sheath.
21. Deep layer of superficial fascia.
23. Septum of femoral sheath.
25. Femoral vein.
27. Neck of femur.
29. Fascia lata.

appearance, and by the fluid generally to be seen through its slightly transparent wall.*

Surgery.—*Operation for strangulated femoral hernia.* The point of stricture is very rarely at the saphenous opening, since it becomes so much enlarged in an old hernia as to offer no resistance. The skin and superficial structures having been divided (usually by a vertical incision), the forefinger can therefore be readily passed along the

Fig. 60.

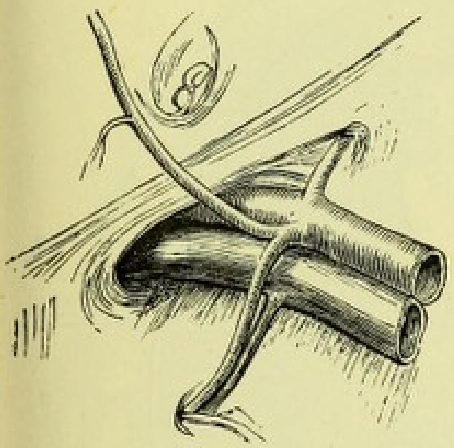
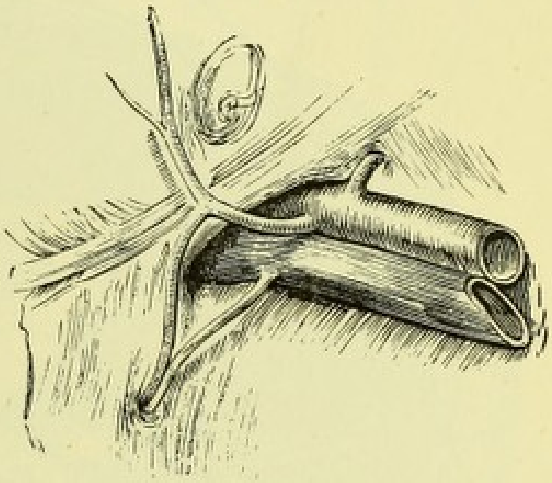


Fig. 61.



crural canal on the inner side of the hernia to the crural ring, where the stricture will be found. This may be most satisfactorily and safely relieved by cutting cautiously inwards with a hernia-knife, so as to notch or divide Gimbernat's ligament; but if this should not prove sufficient, the sac must be carefully opened and the stricture divided from within it.

The only possible danger which can be met with in the deep incision is an abnormal distribution of the obturator artery (Figs. 60 and 61), which, if it arise from the epigastric artery and wind close to the *inner* side of the neck of the sac, might be divided and give rise to troublesome hæmorrhage. Fortunately this vessel, if it exists, is seldom damaged by a cautious use of the knife, and, as it is impossible to ascertain its presence beforehand, its existence may be ignored in practice.

[The cutaneous nerves of the upper part of the front of the thigh are to be examined with the fascia lata, before it is removed to expose Scarpa's triangle.]

Fig. 60.—Irregular origin of obturator artery from epigastric. 1st variety (1 in 4) external to crural ring (from Wood).

Fig. 61.—Irregular origin of obturator artery from epigastric. 2nd variety (1 in 80) internal to crural ring (from Wood).

* The student is particularly warned against the common error of supposing the sac of a hernia to be smooth and glistening on its *exterior*.

Fascia lata of thigh.—If the process of Burns passing to Poupart's ligament in front of the femoral sheath and anterior crural nerve be dissected away, the true arrangement of the deep fascia of the upper part of the thigh will be much more clearly understood. It will then

Fig. 62.

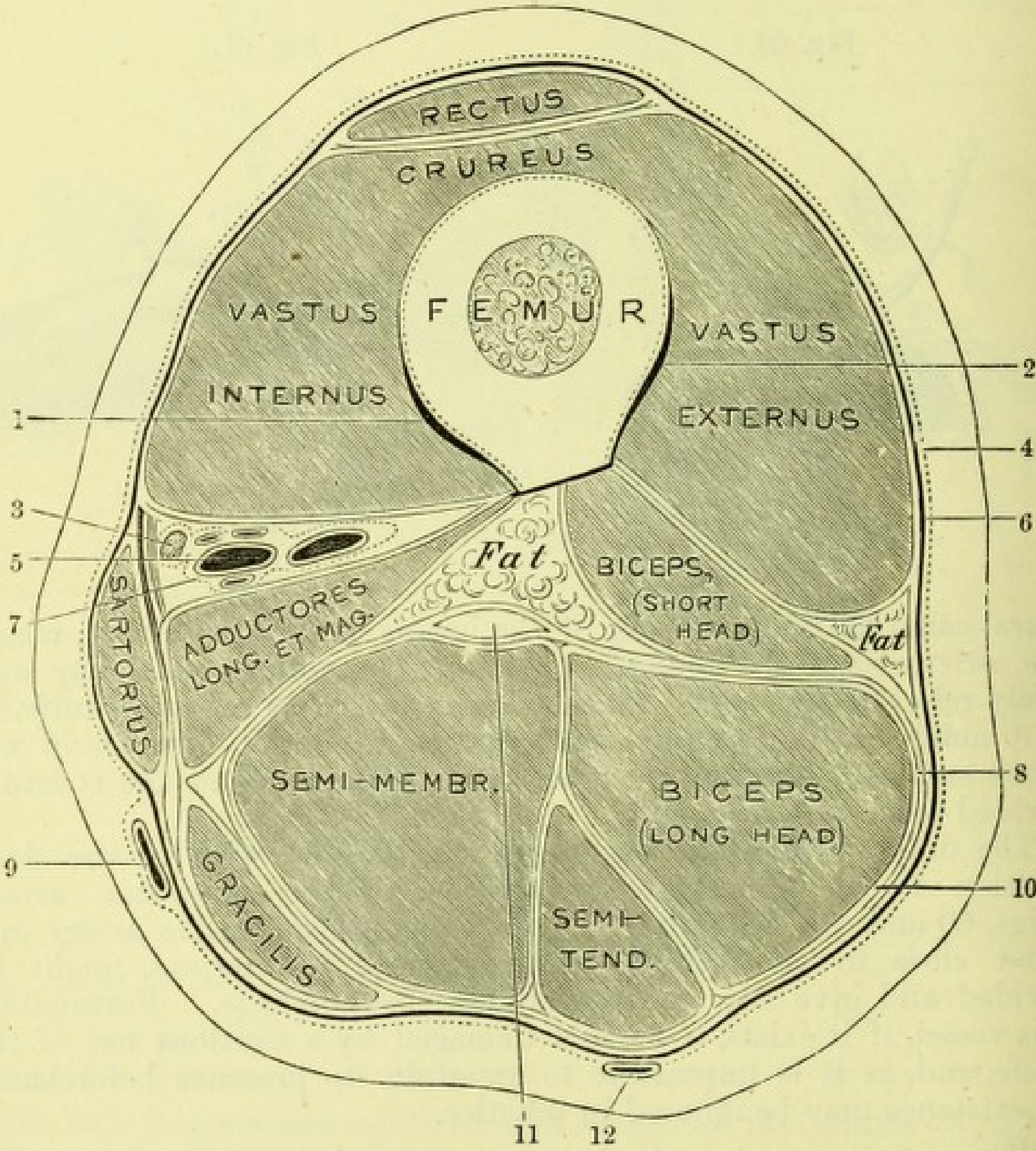


Fig. 62.—Section of thigh through upper part of Hunter's canal (W. A.).

1, 2. Lymph spaces.
3. Long saphenous nerve.
4. Superficial fascia.
5. Femoral artery, with small venæ comites (femoral vein deeper).
6. Deep fascia continued over back of thigh as superficial layer of deep fascia.
7. Sheath of vessels.
8. Middle layer of deep fascia.
9. Long saphenous vein.
10. Deep layer of deep fascia (muscular aponeurosis).
11. Great sciatic nerve.
12. Vein

be seen as a strong fibrous investment of the muscles, attached above all around the margins of the pelvis, from the anterior superior spine externally and in front, along the outer lip of the iliac crest (giving a deep process, however, on the inner surface of the tensor vaginæ femoris and gluteus maximus), to the posterior superior and inferior iliac spines and the intervening notch, to the greater sacro-

Fig. 63.

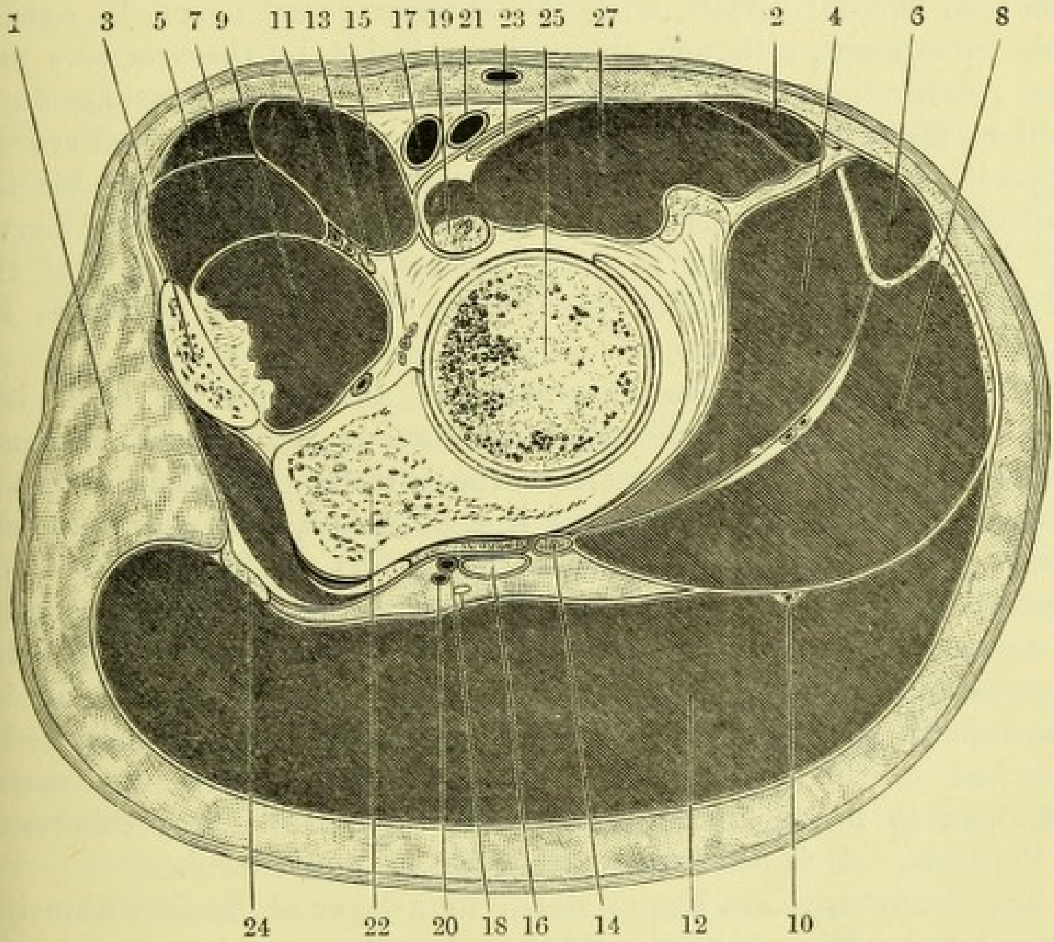


Fig. 63.—Horizontal section of thigh at level of hip (after Braune).

1. Fat.
2. Sartorius.
3. Ischial ramus.
4. Gluteus minimus.
5. Adductor brevis.
6. Tensor vaginæ femoris.
7. Adductor longus.
8. Gluteus medius.
9. Obturator externus.
10. Artery to gluteus.
11. Pectineus.
12. Gluteus maximus.
13. Obturator.
14. Pyriformis tendon.
15. Articular vessels.
16. Great sciatic nerve.
17. Femoral vein.
18, 20. Sciatic vessels.
19. Psoas.
21. Femoral artery.
22. Ischium with obturator internus winding around it.
23. Anterior crural nerve.
24. Great sacro-sciatic ligament.
25. Head of femur.
27. Iliacus (tendon of rectus between it and acetabulum).

sciatic ligament, the outer lip of the tuber ischii, the outer border of the ischio-pubic rami, the margin of the symphysis, the pubic angle, crest and spine, and over the pectineus to the ilio-pectineal line. At the ilio-pectineal eminence it becomes directly continuous with the ilio-psoas fascia, which may be followed up over the psoas and iliacus to the lumbar vertebræ and inner lip of the iliac crest. The fascia covers the whole of the limb, sending septal processes between the muscles and to the bony ridges from which they arise. The common femoral vessels, with the anterior crural nerve, lie outside this investment, although they are concealed by the accessory process passing from it to Poupart's ligament; and two large apertures will be found in the fascial sheath, one for the deep femoral vessels, opposite the lower border of the pectineus, and another for the superficial femoral vessels and a portion of the anterior crural nerve, at the point where the sartorius crosses the outer border of the adductor longus. Besides these there are smaller apertures for other vessels and nerves.

In the middle and lower portion of the thigh the fascia lata sends inwards two strong *intermuscular septa,* an external dividing the vastus externus from the hamstrings and an internal, between the vastus internus and the adductors, both giving attachment extensively to muscular fibres (Fig. 62). The portion of the fascia lata on the outer side of the thigh is of remarkable strength; it receives above the insertions of the tensor vaginæ femoris and gluteus maximus, both of which it encloses before reaching its attachment to the os innominatum, and runs downwards to be attached to the outer border of the patella below the vastus externus, to the ligamentum patellæ and to the outer tuberosity of the tibia. It is sometimes called the *ilio-tibial band.*

The hamstrings are bound down by a layer of fascia within the fascia lata, and in addition a third and still deeper investment can be demonstrated as a sheath for each of the muscles (semimembranosus, semitendinosus and biceps) (Fig. 62).

Cutaneous nerves (Fig. 64).—The *Ilio-inguinal nerve,* which emerges from the external abdominal ring, in its course to the scrotum or labium gives one or two small branches to the thigh.

The *Crural branch of the Genito-crural nerve* pierces the fascia half an inch below Poupart's ligament and just outside the femoral artery, and joins the middle cutaneous nerve. It is very seldom satisfactorily seen unless traced from the lumbar plexus.

The *External cutaneous nerve* (3) is to be found amongst some fat in a fold of fascia lata close to the anterior superior spine of the ilium, and pierces the fascia at a variable point, to be distributed by an anterior and a posterior branch to the outer side of the thigh and part of the buttock.

The *Middle Cutaneous nerve* (5) (from the anterior crural), pierces the fascia in the upper third of the thigh, usually in two places, and will be afterwards traced as far as the knee. This nerve, or its outer branch, usually pierces the sartorius, which muscle it generally supplies.

The *Internal cutaneous* and *Long Saphenous nerves* are not seen at present.

SCARPA'S TRIANGLE.

[The fascia is to be removed from the hollow below Poupart's ligament, and from the front of the thigh as far as the skin has been reflected, and the muscles, vessels, and nerves thus exposed are to be as thoroughly cleaned as is possible without disturbing their relations. The cutaneous nerves are also to remain untouched.]

Scarpa's triangle is a superficial space in the upper third of the front of the thigh, containing the femoral vessels and anterior crural nerve. The *base* of the triangle is formed by Poupart's ligament; the *outer border* by the inner edge of the sartorius muscle; the *inner border* by the outer margin of the adductor longus; and the *apex* by the meeting of these muscles. The space is covered in by the skin and superficial fascia and Burns's process of the fascia lata, and its *floor* will now be seen to be formed by the psoas and iliacus on the outer side; the pectineus and, in some subjects, a small portion of the adductor brevis on the inner side: these muscles all being covered by their fasciæ.

Scarpa's triangle *contains* the common femoral artery giving off some small branches and bifurcating into the superficial and deep divisions; the femoral vein with its tributaries and some deep lymphatic glands: and the anterior crural nerve with some of its branches. The saphenous vein is not one of the contents of the space, until it has pierced the fascia lata to end in the common femoral vein.

The **Femoral Artery in Scarpa's Triangle** (Fig. 64, 4).—The femoral artery (under which term is included the common femoral trunk and its superficial femoral branch) is the continuation of the external iliac artery, and extends from Poupart's ligament to the opening in the adductor magnus, through which it passes to the popliteal space. The part now exposed is that above the point crossed by the sartorius, and is usually over a third of the whole length of the vessel. When the thigh is slightly flexed and abducted, the artery runs from a point midway between the symphysis pubis and the anterior superior iliac spine (or about a third of an inch to the inner side of the centre of Poupart's ligament), through the middle of the triangle in a line with the prominent adductor tubercle on the inner condyle of the femur; but when the thigh is fully extended it will be seen to wind slightly to the inner side of the limb. This portion of the artery lying within its sheath is *covered* by the superficial fascia and the fascia of Burns, and one or two branches of the internal cutaneous nerve cross the vessel at variable points. *Behind* the artery from above downwards are, the psoas; the nerve to the pectineus; the pectineus itself, separated from the femoral artery by the profunda artery and vein and the femoral vein; and occasionally between the pectineus and the adductor longus, a small portion of the adductor brevis. To the *outer* side throughout is the anterior crural nerve, usually separated at the upper part by a small interspace; and the long saphenous branch and the nerve to the vastus internus are in close

Fig. 64.

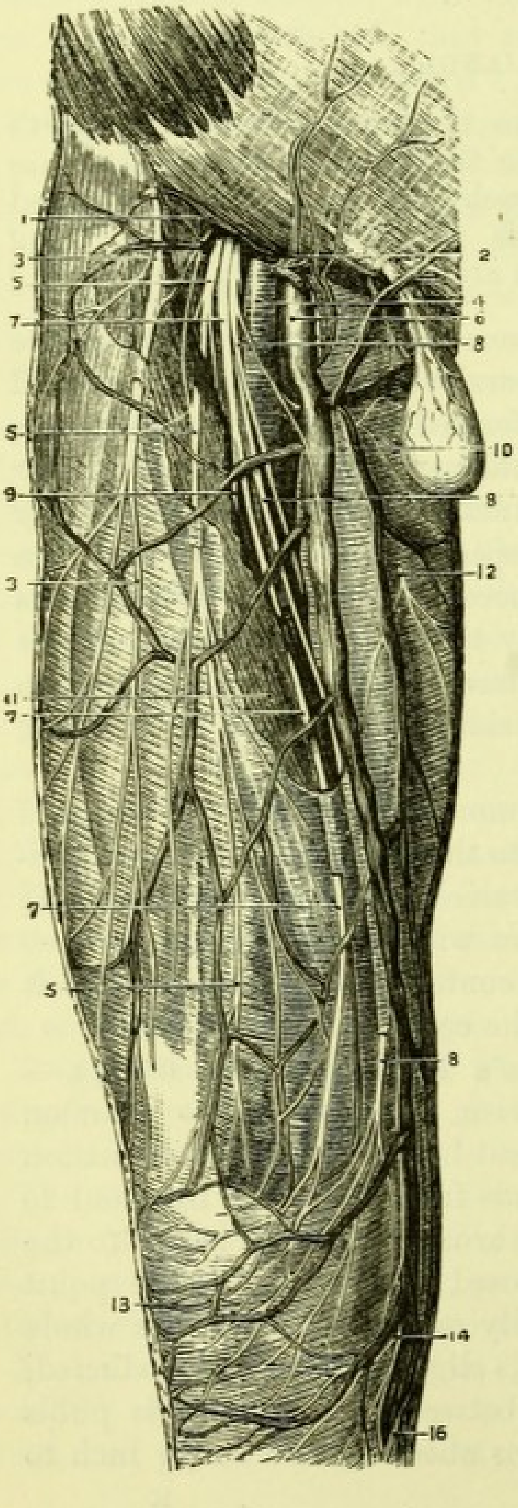


Fig. 64.—Superficial dissection of the front of the thigh (from Hirschfeld and Leveillé).

1. Poupart's ligament.
2. Superficial branches of femoral artery.
3. External cutaneous nerve.
4. Femoral artery.
5, 5, 5. Middle cutaneous nerve.
6. Femoral vein.
7, 7, 7. Anterior division of internal cutaneous nerve.
8, 8, 8. Posterior division of internal cutaneous nerve.
9. Branch to sartorius from middle cutaneous.
10. Saphenous vein.
11. Sartorius.
12. Cutaneous branch of obturator nerve.
13. Plexus patellæ.
14. Patellar branch of long saphenous nerve.
16. Long or internal saphenous nerve.

relation with it at the lower part of the space (Fig. 69, 19), the latter external to the former. The femoral vein is to the *inner* side near Poupart's ligament, but lower down passes *behind* the artery, and forms one of its posterior relations at the apex of the triangle.

Surgery.—From its superficial position the femoral artery can be readily felt during life, and compression may be effected in any part of the triangle, but most satisfactorily against the margin of the pubic bone. The artery has been tied above the origin of the profunda, through an incision parallel to Poupart's ligament and half an inch below it, but the vessel is more commonly tied just below the point at which it is crossed by the inner edge of the sartorius. The latter operation is readily performed through an incision, from three to four inches long, beginning two inches below Poupart's ligament and running in the middle of the lower part of the space, and in the axis of the abducted limb. The incision should be carried at once through the fascia so as to expose the fibres of the sartorius, which are recognisable by their oblique direction. The muscle being turned a little outwards, the fibrous sheath of the vessels will be seen, and must be carefully opened with the scalpel, when the artery can be isolated and secured. The needle may be passed from either side, great care being taken not to pierce or include the vein, which is behind and in very close contact, or the long saphenous nerve which is to the outer side of the vessel.

When the femoral artery is tied above the profunda, the circulation is carried on by the obturator, gluteal, and sciatic arteries, which anastomose with the circumflex and perforating branches of the profunda, and thus indirectly with the articular branches of the popliteal. The operation is not a desirable one on account of the small interval often existing between the origins of the deep circumflex iliac and epigastric vessels and that of the profunda.

When the artery is tied below the profunda the circulation is carried on directly through the communication of the terminal branch of the profunda with the *anastomotica magna* and the branches of the popliteal, in addition to those anastomoses given above.

Branches in Scarpa's Triangle (Fig. 64).—The small (1) *superficial epigastric;* (2) *superficial circumflex iliac;* and (3) *superficial external pudic*, have been already examined. A larger branch (4) the *inferior external pudic*, arises from the upper part of the artery and passes beneath the fascia lata to the scrotum or labium and perinæum.

In many subjects the *deep epigastric* and *deep circumflex iliac* branches are seen to arise below Poupart's ligament from the common femoral, instead of from the external iliac.

The largest branch, (5) the *profunda* artery, arises from one to two inches or more below Poupart's ligament and is now seen lying first to the outer side of, and then behind, the femoral artery and vein, and resting upon the iliacus and pectineus. Should, however, the external circumflex arise from the common femoral instead of from the profunda, the commencement of the latter vessel lies behind or even to the inner side of the superficial femoral. The profunda is the great artery to the muscles of the thigh, and will be afterwards dissected.

The **Femoral Vein** at the lower part of Scarpa's triangle lies behind and sometimes a little to the outer side of the artery. It then crosses obliquely behind it, and after being joined by the profunda vein, reaches the inner side of the common femoral artery at the upper part of the space; and there it receives the saphenous vein, which has previously been joined by the veins corresponding to the small branches of the artery (superficial epigastric, circumflex iliac and external pudic). At the apex of the triangle it is very closely connected with the artery.

The **Anterior Crural Nerve** (Fig. 69, 5) is derived from the 2nd, 3rd, and 4th nerves of the lumbar plexus, and enters Scarpa's triangle beneath Poupart's ligament, resting upon the adjacent borders of the psoas and iliacus muscles. It breaks up into superficial and deep divisions, which are separated by the external circumflex vessels, the *superficial* giving off the middle and internal cutaneous nerves and supplying the sartorius; the *deep* supplying muscular branches to the pectineus, rectus femoris, crureus, vastus internus and vastus externus, and the long or internal saphenous nerve, which becomes cutaneous at the inner side of the knee. The nerve to the pectineus passes beneath the femoral sheath to reach the muscle.

[The limb being extended, the line of incision on the inner side of the thigh is to be prolonged to three inches below the knee, and then carried across the limb, when the skin thus marked out is to be reflected to the outer side, and the superficial fascia to the same extent, all the cutaneous nerves being carefully left at their points of emergence from the fascia lata and traced to their terminations.]

The *Bursæ* in front of the patella may be three in number, (1) a *bursa subcutanea*, large and particularly prone to inflammation in persons whose occupation involves much kneeling; (2) a *bursa subfascialis* beneath the bands of deep fascia passing in front of the patella; (3) a *bursa subtendinosa*, small and inconstant, beneath the prolongation of the rectus tendon over the bone. The cavities of 1 and 2 occasionally intercommunicate.

Piercing the fascia at several points are the cutaneous nerves of the thigh, some of which have been already seen, but the following are now to be traced to their distributions and then to their origins, the fascia being removed as may be necessary for the latter purpose.

The *Internal cutaneous nerve* (Fig. 64, 7, 8) is a branch of the anterior crural, it gives two or three small twigs to the upper and inner parts of the thigh, and crosses the femoral artery in Scarpa's triangle. Either before or after doing so it divides into two branches, *anterior* and *posterior*. The *anterior* branch becomes cutaneous in the lower third of the thigh, the filaments reaching as far as the patellar plexus; the *posterior* branch appears close to the saphenous vein a little above the knee, and its branches unite with those of the other branch, with the internal saphenous nerve, and occasionally with a superficial branch of the obturator, and are distributed over and a little below the inner side of the knee.

The *Long* or *Internal Saphenous nerve* (Fig. 64, 16) (the course of which will be afterwards seen) becomes cutaneous at the inner side of the knee-joint, where it lies at first in front of the saphenous vein. Before becoming cutaneous it sends a large branch forward to the skin of the patella (*ramus cutaneus patellæ*) (14) which pierces the sartorius, and unites with branches of the internal and middle cutaneous and external popliteal nerves to form what has been called the *plexus patellæ*.

The *Superficial Veins* of the thigh are very variable, but they either open into the saphenous vein separately, or form one or more separate branches which join the main trunk at or near the saphenous opening.

Muscles of the Front of the Thigh.

[The remains of the fascia lata are to be removed and the cutaneous nerves turned aside. By flexing the knee, the muscles of the front of the thigh will be made tense, except the sartorius, which must be stretched with hooks in order to clean it. All the loose fascia is to be removed, and each muscle cleaned in the direction of its fibres, special care being taken to expose clearly, as far as possible, the origin and insertion of each.]

Connected with the fascia lata on the outer side of the thigh is the **Tensor Fasciæ** or **Vaginæ Femoris** (Fig. 65, 4), which is to be exposed by removing the fascia below the crest of the ilium. The muscle *arises* from the outside of the anterior superior spine of the ilium and from part of the notch between the two anterior iliac spines, from a small portion of the crest, and from its fascial sheath; and the fibres pass downwards and backwards to be *inserted* into the fascia lata below the great trochanter, the fascia being split at this point to receive the muscular fibres. The muscle as its name implies, is a tensor of the fascia of the thigh, and thereby supports and assists the other muscles of the limb, especially the gluteus maximus, by fixing their fascial attachments ; it is also an abductor and internal rotator of the femur and acts upon the trunk when the thigh is fixed. It is *supplied* by a branch of the superior gluteal nerve, which may be seen entering the deep surface of the muscle when it is reflected.

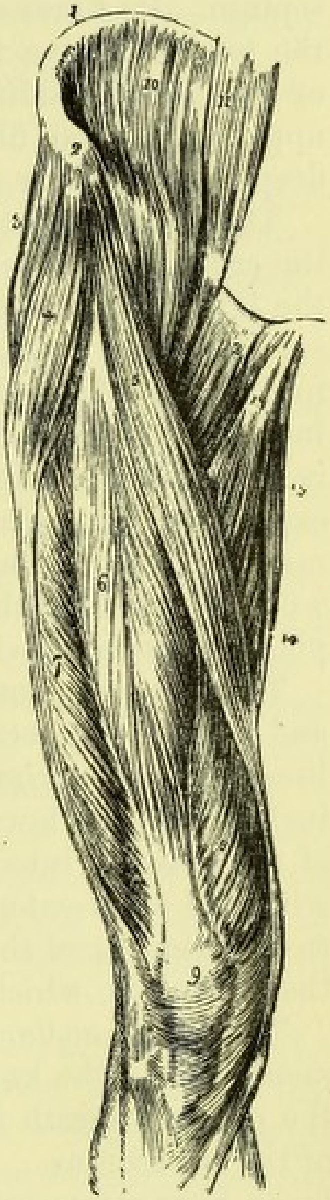
The **Sartorius** (Fig. 65, 5) is the longest muscle of the body, and when dissected lies loosely upon the subjacent muscles. It *arises* from the anterior superior spine of the ilium, from the notch below it, and from the outermost portion of Poupart's ligament; and crossing obliquely over the thigh, winds behind the inner tuberosity of the femur and, turning forwards below the inner tuberosity of the tibia, is *inserted* into the subcutaneous surface below the junction of the head of the bone with the shaft, by a broad tendinous expansion, which is incorporated with the fascia of the limb and overlaps the insertions of the gracilis and semitendinosus muscles, a bursa intervening between them ; it may also send a slip beneath the other tendons. It is a flexor of the leg upon the thigh, and a flexor, rotator outwards, and slight abductor of the thigh upon the pelvis, thus helping to place the leg in the position assumed by the tailor ; whence the name (tailor-muscle). It is *supplied* by the middle cutaneous branch of the anterior crural nerve, and pierced by the middle and internal cutaneous nerves and by the cutaneous patellæ of the long saphenous.

The **Quadriceps Extensor** is the fleshy mass on the front of the thigh, consisting of the rectus femoris superficially, with the crureus beneath it, and the vastus externus and internus on either side.

The **Rectus Femoris** (Fig. 65, 6) has no attachment to the femur, but stretches over it from the pelvis to the patella. It *arises* by two tendons, one from the anterior inferior spine of the ilium, the other from a rough impression above the acetabulum. The outer or reflected tendon may be easily exposed by separating the tensor vaginæ femoris and rectus, and clearing away the fat and connective tissue from the deep interspace with the handle of the scalpel. The two heads unite to form a bi-penniform muscle, which is tendinous on its upper surface above and on its under surface at the lower part, and passes to be attached to the upper border and anterior surface of the patella in conjunction with the other extensor muscles, the strong fibres which pass in front of the patella forming the superficial portion of the ligamentum patellæ and reaching the tubercle of the tibia, the true insertion of the quadriceps. The crureus joins the back of the tendon above the patella, and the vasti are attached to its borders.

It will be noticed that the straight head is in the axial line of the muscle during extension of the thigh, the reflected head during right angle flexion.

Fig. 65.



Surgery.—The most direct and eligible incision to reach the hip joint extends along the interspace between the tensor vaginæ and sartorius, and more deeply between the rectus and iliacus.

Beneath the rectus will be seen the *External circumflex* branch of the profunda artery (Fig. 66, 11). This arises from the outer side of the vessel near its origin, and runs transversely between the branches of the anterior crural nerve, upon the vastus externus and beneath the sartorius and rectus femoris, to the outer side of the thigh, where it divides into ascending, transverse, and descending sets of branches. The *ascending* branches pass beneath the tensor fasciæ to anastomose with the gluteal and the deep circumflex iliac arteries; the *transverse* set supply the vastus externus, and, turning round the limb, anastomose with the perforating branches of the profunda; whilst the *descending* branch passes into the vastus externus with the nerve to that muscle and ends at the knee joint, where it anastomoses with the superior external articular branch of the popliteal.

The **Vastus Externus** (Fig. 65, 7) is the largest of the three muscles in front of the femur. It *arises* from the anterior border of the great trochanter as far as the base of the superior tubercle of the neck, from the lower border

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Fig 65.—Muscles of the anterior femoral region (from Wilson).

1. Crest of the ilium.
2. Its anterior superior spinous process.
3. Gluteus medius.
4. Tensor vaginæ femoris; its insertion into the fascia lata is shown inferiorly.
5. Sartorius.
6. Rectus femoris.
7. Vastus externus.
8. Vastus internus.
9. Patella.
10. Iliacus internus.
11. Psoas magnus.
12. Pectineus.
13. Adductor longus.
14. Part of the adductor magnus.
15. Gracilis.

of the trochanter, the outer part of the gluteal ridge, the outer border of the linea aspera, the upper half of the external supracondylar ridge, and extensively from the external intermuscular septum. Its fibres end in a broad aponeurosis, which is *inserted* into the tendon of the rectus and the upper third of the outer border of the patella, aiding in the formation of the knee capsule. Its upper superficial fibres are commonly detached from the rest by a deep intermuscular space.

The **Vastus Internus** (Fig. 65, 8) is more or less united with the crureus. It *arises* from the lower half of the spiral line, from the inner side of the linea aspera, from the upper part of the internal supracondylar ridge, from the tendons of the adductor longus and magnus, and from the internal intermuscular septum. It is *inserted* into the upper half of the inner side of the patella, and into the rectus tendon. Like the vastus externus it helps to form the capsule of the knee joint. The origin of the lower part of the muscle cannot be seen quite distinctly at present, since it is united with the tendon of the adductors longus and magnus, by a sub-sartorial plane of fascia which covers in the femoral vessels in Hunter's canal.

The **Crureus** covers the front of the femur between the two vasti, and beneath the rectus. It *arises* from the upper part of the spiral line and the anterior and outer surfaces of the femur, to about four inches from the lower end of the bone, as well as from the lower part of the external intermuscular septum, and is *inserted* into the patella with the other extensor muscles. Its surface is tendinous, to allow free movement of the rectus upon it. Its lowest fibres of origin form the *subcrureus*, which will be best dissected with the knee joint.

The *supra-patellar pouch* is a prolongation upwards of the synovial membrane of the knee joint for two inches or more above the top of the patella beneath the crureus and vasti, and receives the insertion of the subcrureus. It is often separated from the true joint cavity by an hour-glass constriction, and occasionally by a complete septum. *Bursæ* in connection with the quadriceps will be found in front of the patella, and between the ligamentum patellæ and the upper part of the tubercle of the tibia (Fig. 101).

Action.—The quadriceps extensor is the great extensor of the leg upon the thigh, and is therefore in constant requisition in walking, but it will be observed that in standing upright the vasti are relaxed and the patella can be moved freely from side to side. The rectus, in addition, flexes the thigh upon the pelvis; and, when the leg is fixed, flexes the pelvis upon the femur.* It is *supplied* by the anterior crural nerve.

* It should be observed that its long axis inclines in such a direction towards the patella that it tends to displace the bone outwards, but this is corrected by

Surgery.—These powerful muscles occasionally fracture the patella transversely by their violent and sudden action, the bone being snapped across the condyles of the femur, and the upper fragment afterwards drawn up by the contraction of the muscles. In order to relax the muscles and bring the fragment down, it is advised to 'extend the leg upon the thigh and flex the thigh upon the pelvis.'

The **Femoral Artery in Hunter's Canal** (Fig. 66, 19).—Hunter's canal is an intermuscular space beneath the sartorius in the middle third of the thigh, and is continuous with the apex of Scarpa's triangle above, and with the popliteal space below. It contains the femoral vessels, the long saphenous nerve, and the nerve to the vastus internus. It is bounded *behind* by the adductors longus and magnus, *externally* by the vastus internus, and *in front* by a fascial aponeurosis stretching over the vessels from the external to the posterior wall, and by the sartorius. It ends at the opening in the adductor magnus, where the artery enters the popliteal space. On laying open the canal, the femoral artery will be found with its vein behind and external to it, and a second smaller vena comes is often seen on the opposite side of the vessel. Some deep lymphatic cords accompany the veins, and the whole of the vessels are invested by a delicate connective tissue-sheath. With these, but outside the sheath, are the long saphenous nerve and, external to this, the nerve to the vastus internus giving filaments to its muscle. The saphenous nerve lies at first to the outer side of the artery, but crosses it below to wind around the tendon of the sartorius and become cutaneous on the inner side of the knee.

The *Opening in the Adductor Magnus*, as it is commonly called, is in reality an opening between the round tendon of the adductor magnus on the inner side, and the fibres of the vastus internus and the femur on the outer side. The only structures passing through it are the femoral vessels with some deep lymphatics.

Branches of the Femoral Artery.—Except some large unnamed *muscular* branches, the *Anastomotica magna* is the only vessel arising from the femoral artery in Hunter's canal. The anastomotica has a superficial and a deep branch : the superficial accompanying the saphenous nerve to the skin, the deep branch entering the vastus internus, through which it descends to the knee to anastomose with the internal articular branches of the popliteal artery, and sending a branch across the femur above the patella to join deep branches of the external circumflex and the superior external articular.

the predominance of the patellar fibres of the vastus internus over those of the vastus externus.

Surgery.—Deligation of the femoral artery in Hunter's canal is not frequently performed in the present day, but the vessel is readily reached by an incision to the inner side of the vastus internus in the middle third of the thigh, at the outer edge of the sartorius. The sartorius is turned inwards, and the sub-sartorial fascia is brought into view; this being divided the artery will be exposed. It is most convenient to pass the aneurism-needle from without inwards, the vein lying to the outer side, and great care must be exercised to avoid piercing the closely adherent veins.

The **Anterior Crural Nerve** (Fig 69, 5) supplies branches to all the muscles of the front of the thigh except the tensor fasciæ femoris, and also gives a branch to the pectineus on the inner side of the limb. The branch to the sartorius has been already seen to arise from the middle cutaneous nerve, and the remaining branches can now be traced from the deep division. The nerve to the vastus internus (19) and that to the vastus externus both supply small twigs to the knee joint. The nerve to the pectineus, which is often double, (10) crosses transversely beneath the femoral vessels to the surface of the pectineus muscle. From several of the upper muscular branches twigs are given to the hip joint.

The **Internal Saphenous Nerve** (Fig. 69, 22) is the longest branch of the deep division of the anterior crural nerve. It lies close to the outer side of the femoral artery, and enters Hunter's canal with it; then crossing the artery near the lower end of the canal it pierces the sheath, appearing beneath the sartorius at the inner side of the knee. In the thigh it gives a *communicating* branch to a subsartorial plexus formed by the internal cutaneous and obturator nerves, and at the knee its *internal patellar* branch pierces the sartorius and ends in the patellar plexus. The nerve becomes cutaneous between the sartorius and gracilis, and runs down the inner side of the leg and foot.

Inner Side of the Thigh.

[The superficial muscle of the inner side of the thigh (adductor longus) is already partially seen; to expose the rest of the region, an incision is to be made along the rami of the pubes and ischium, and the skin is to be reflected, when the gracilis will be brought into view. The femoral vessels must either be cut and turned down, or pulled forcibly outwards.]

A few cutaneous branches of nerve to the skin of the inner side of the thigh will be found appearing below the adductor longus. They are derived from the obturator.

The **Adductor Longus** (Fig 65, 13) *arises* by a round tendon from the front of the os pubis immediately below the crest, and expands to be *inserted* into the inner border of the linea aspera, in the middle third of the bone and into the internal intermuscular septum, blending with the insertions of the adductors brevis and magnus. It is *supplied* by the superficial division of the obturator nerve. In the middle third of the thigh it separates the superficial from the deep femoral vessels, the latter disappearing from Scarpa's triangle between the adjacent borders of this muscle and the pectineus.

The **Gracilis** (Fig. 66, 20) is the most internal of the muscles of the thigh, and *arises* from the rami of the os pubis and ischium by a broad thin tendon about three inches wide. It is *inserted* into the inner surface of the tibia under cover of the sartorius and above the semi-tendinosus, a bursa intervening between it and these muscles. It is *supplied* by the superficial division of the obturator nerve.

[The adductor longus is to be divided near its origin and turned down, in order to expose the adductor brevis and the insertions of the pectineus, psoas, and iliacus. The branch of the obturator nerve to the muscle is to be preserved, and the profunda vessels are to be cleaned as far as exposed.]

The **Pectineus** (Fig. 66, 4) has been already seen in relation with the femoral artery and forming part of the floor of Scarpa's triangle. It *arises* from the inner part of the ilio-pectineal line and from the triangular surface immediately in front of it, between the pubic spine and the ilio-pubic eminence; and winds to the back of the femur to be *inserted* into the upper part of the pectineal line leading from behind the trochanter minor to the linea aspera, a bursa intervening. It is *supplied* by the anterior crural nerve and sometimes also by the obturator or accessory obturator. In front of it lie the femoral and profunda vessels and part of the anterior crural nerve, the internal circumflex vessels wind over its upper border, the profunda vessels disappear from Scarpa's triangle at its lower border, and its deep surface is in relation with the obturator externus, the adductor brevis, the superficial division of the obturator nerve, and the inner part of the capsule of the hip joint.

[The pectineus should be divided and turned aside, in order to bring the deeper parts into view, *viz.*, the obturator externus and the obturator nerve, with the accessory obturator nerve, if present; a part of the hip-joint, and more of the internal circumflex artery than has yet been seen.]

Insertion of the Psoas and Iliacus.—The two muscles are conjoined as they enter the thigh; the psoas is inserted by tendon into the small trochanter, the iliacus by fleshy fibres into the tendon of the psoas, and into a triangular mark on the femur below the small trochanter and in front of the pectineus insertion.

The **Adductor Brevis** (Fig. 66, 18) has the superficial division of the obturator nerve lying upon it, and the deep division of the same nerve between it and the adductor magnus. It *arises* from the front of the pubic ramus, below the adductor longus and between the gracilis and obturator externus, and is *inserted* into the whole of the line leading from the lesser trochanter to the linea aspera, behind the pectineus and upper part of the adductor longus and

Fig. 66.

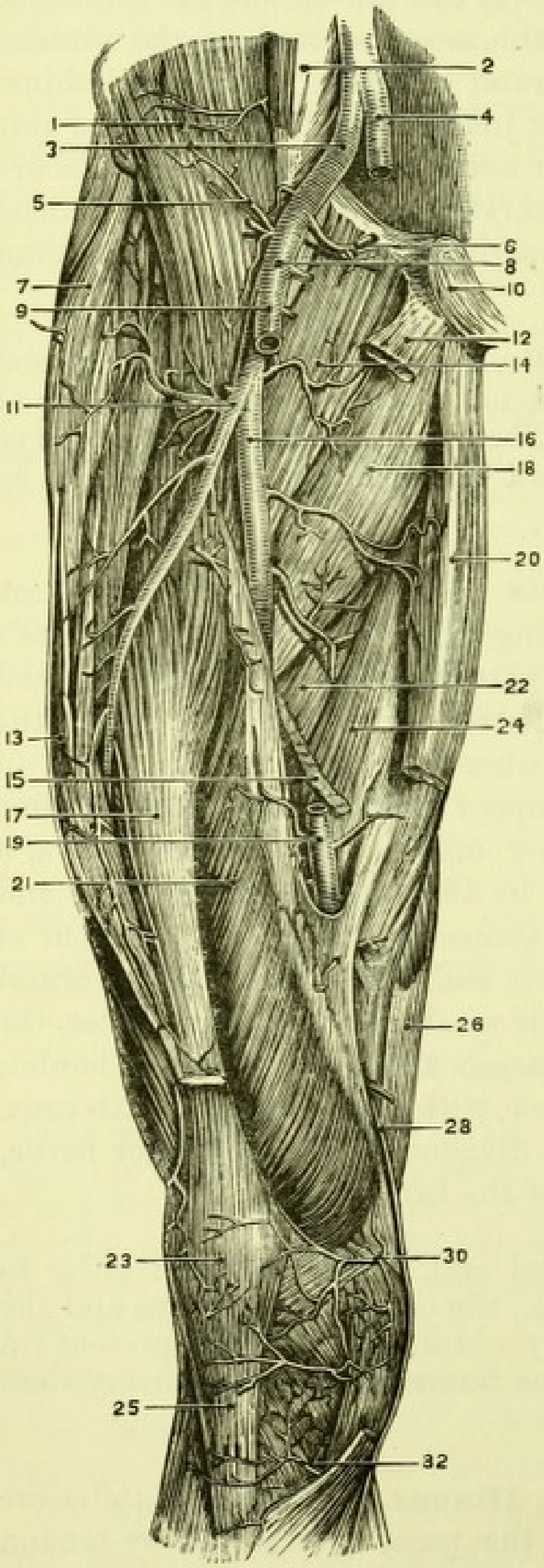


Fig. 66. — Profunda artery and its branches (Bonamy and Beau).

1. Iliacus.
2. Psoas.
3. External iliac artery.
4. Internal iliac artery.
5. Deep circumflex iliac.
6. Deep epigastric.
7. Tensor vaginæ femoris.
8. Common femoral artery.
9. Superficial femoral artery.
10. Symphysis pubis.
11. External circumflex artery.
12. Adductor longus (origin).
13. Vastus externus.
14. Pectineus.
15. Adductor longus (insertion).
16. Profunda (too large in the drawing).
17. Crureus.
18. Adductor brevis.
19. Femoral in Hunter's canal.
20. Gracilis.
21. Vastus internus.
22. Part of adductor magnus.
23. Patella.
24. Part of adductor magnus.
25. Ligamentum patellæ.
26. Semi-membranosus.
28. Anastomotica magna.
30. Superior internal articular.
32. Inferior internal articular.

in front of the adductor magnus. It is *supplied* either by the deep or by the superficial branch of the obturator nerve.

The *action* of the adductors longus and brevis is to some extent implied by their name, but they are also flexors and external rotators of the thigh. The adduction if combined with flexion can be carried beyond the middle line, so as to cross the thigh over the opposite limb. The pectineus is also an adductor, external rotator, and flexor of the thigh, and the gracilis is an adductor of the thigh, and in addition a flexor and an internal rotator of the knee. All the muscles of the inner side of the thigh are supplied by the obturator nerve, except the pectineus, which receives its nerve from the anterior crural, with sometimes an additional twig from the obturator or accessory obturator.

The **Profunda Artery** (Fig. 66, 16) has been seen to arise from the femoral artery in Scarpa's triangle, from one to two inches below Poupart's ligament; lying at first to the outer side of the femoral artery and against the iliacus, and then winding inwards on to the pectineus behind the femoral vessels and its own veins. It next passes below the border of the pectineus behind the adductor longus, which separates it from the superficial femoral vessels, and on to the adductor brevis and magnus, ending by piercing the latter. The profunda vein is superficial to its artery in the whole of its course.

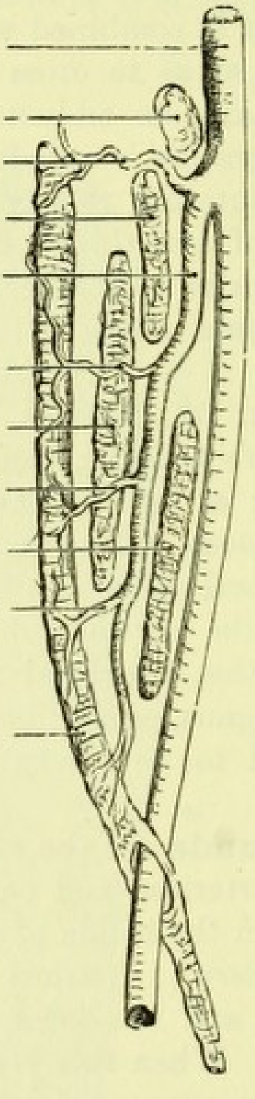
The **Branches of the Profunda** are the external and internal circumflex, three perforating arteries, and a terminal branch, besides branches to the muscles on the inside of the thigh.

1. The *External Circumflex artery* (11) arises from the outer side of the profunda near its origin, and has been already seen in the dissection of the thigh (p. 135). When this vessel, as is not unfrequently the case, springs from the common femoral, the upper part of the profunda is no longer external to the superficial femoral, but lies behind or internal to it.

2. The *Internal Circumflex artery* (Figs. 67, 68) arises from the inner side of the profunda near its origin, and passing backwards between the psoas and the pectineus, reaches the obturator externus muscle above the adductor brevis, where it divides into two terminal branches. It supplies twigs to the muscles on the inner side of the thigh, an anastomotic branch to the obturator artery, and an articular branch to the hip-joint. Of the terminal branches, one follows the tendon of the obturator externus to the digital fossa of the great trochanter, supplying the external rotator muscles and anastomosing with the gluteal, sciatic and first perforating arteries; the other passes to the back of the thigh between the quadratus femoris and

the adductor magnus, and supplies the upper part of the ham-strings, anastomosing with the sciatic and first perforating arteries, and occasionally with the external circumflex. The so-called "*crucial anastomosis*" between these four vessels is seldom demonstrable.

Fig. 67.



3. The *Perforating arteries* (Figs. 67, 68), typically three in number, pierce the adductor muscles to supply the ham-strings and the vasti. The *superior* and *middle* arteries perforate the adductors brevis and magnus; the *inferior* arises below the level of the adductor brevis, and therefore perforates only the adductor magnus. The nutrient artery to the femur generally comes from the middle perforating artery, and when entering the foramen in the linea aspera has a direction from the knee joint.

4. The *Terminal branch* (Fig. 67, 68) ends in the fibres of the adductor magnus, or pierces it to join with the inferior perforating and superior internal articular. The three perforating and terminal branches form a chain of anastomoses in and behind the adductor magnus.

The **Profunda Vein** receives branches corresponding to those of the artery and ends in the femoral vein. It is superficial to the profunda artery throughout.

[The adductor brevis is to be divided in order to expose the deep portion of the obturator nerve, the adductor magnus, and the obturator externus, which are to be cleaned.]

The **Obturator Nerve** (Fig. 69, 8) is derived from the second,

Fig. 67.—Diagram of the profunda artery of the thigh (drawn by J. T. Gray).

third and fourth lumbar nerves. It leaves the pelvis at the upper part of the obturator foramen with the obturator artery, and divides into superficial and deep portions before piercing the obturator externus. The *superficial* division lies upon the adductor brevis and supplies the adductor longus, the adductor brevis, and the gracilis, giving off filaments also to the subsartorial

Fig. 68.

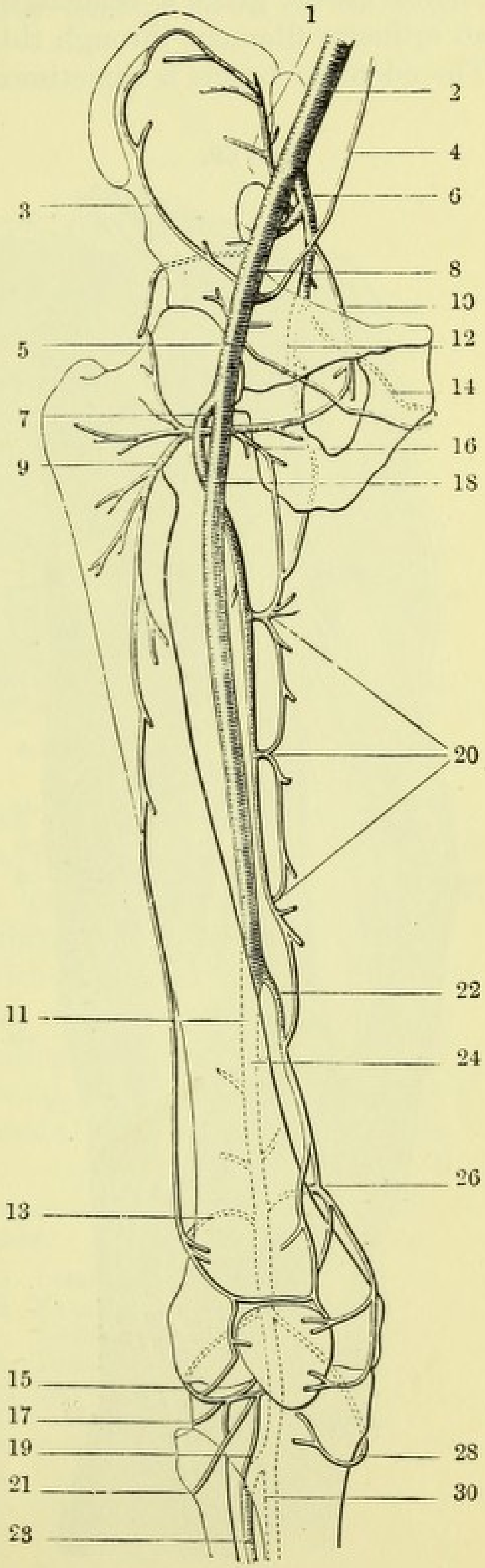


Fig. 68.—Diagram of arteries of thigh.

1. Ilio-lumbar artery.
2. Common iliac artery.
3. Deep circumflex iliac anastomosing with ilio-lumbar of internal iliac.
4. Deep epigastric.
5. Common femoral.
6. Internal iliac, dividing into anterior and posterior trunks.
7. Deep femoral (profunda). (Should be larger at origin.)
8. External iliac,
9. Descending branch of external circumflex.
10. Obturator. 11. Popliteal.
12. Sciatic.
13. Superior external articular, anastomosing with external circumflex, &c.
14. Internal pudic.
15. Inferior external articular.
16. Lower terminal branch of internal circumflex.
17. Posterior tibial recurrent (from anterior tibial).
18. Superficial femoral (muscular branches omitted).
19. Anterior tibial recurrent.
20. Perforating branches of deep femoral, forming anastomotic loops and supplying posterior muscles.
21. Superior fibular.
22. Anastomotica magna.
23. Anterior tibial.
24. Popliteal, giving off superior muscular branches.
26. Superior internal articular.
28. Inferior internal articular (sural arteries arising below this omitted).
30. Posterior tibial.

plexus and an articular branch to the hip-joint. The *deep* division supplies the obturator externus and, after passing behind the adductor brevis, gives a branch to the adductor magnus, and sends an articular filament through this muscle to the back of the knee. The adductor brevis is sometimes supplied by this division.

An *Accessory Obturator nerve* is occasionally found passing from the third and fourth nerves of the lumbar plexus, over the pubic bone to supply the pectineus, or to replace more or less the superficial division of the obturator nerve.

The **Adductor Magnus** (Fig. 66, 22) *arises* from the external part of the ramus of the os pubis, from the ramus of the ischium, and from the lower

Fig. 69.

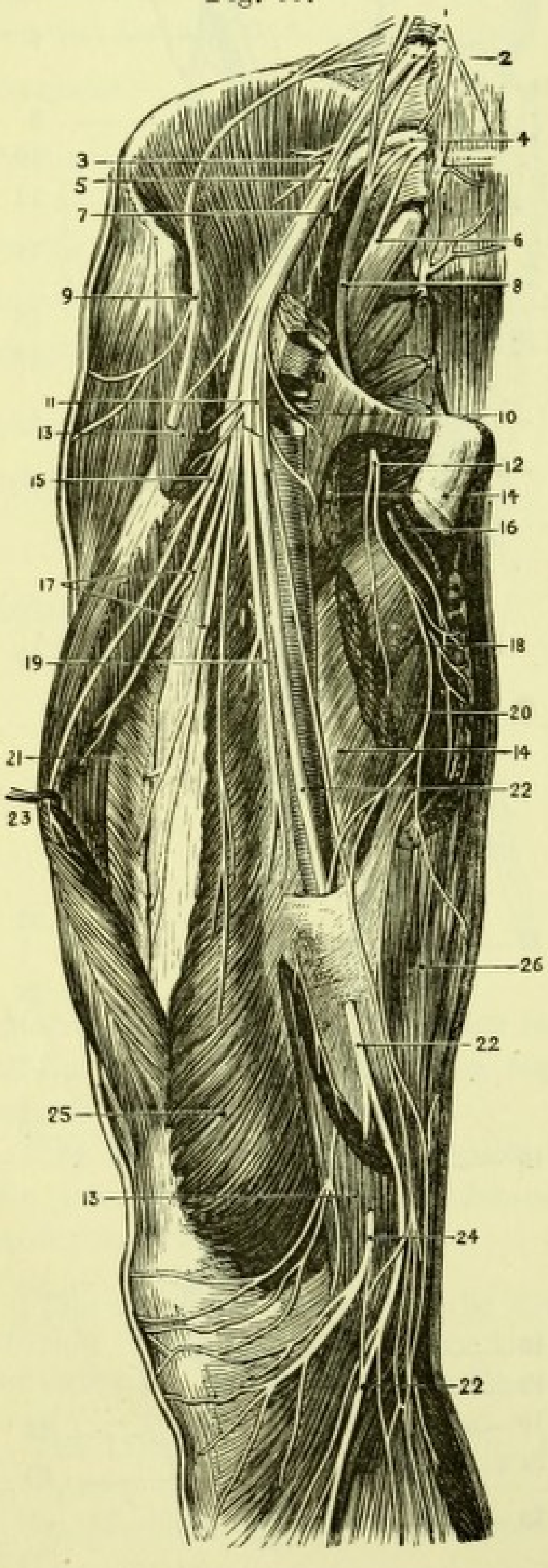


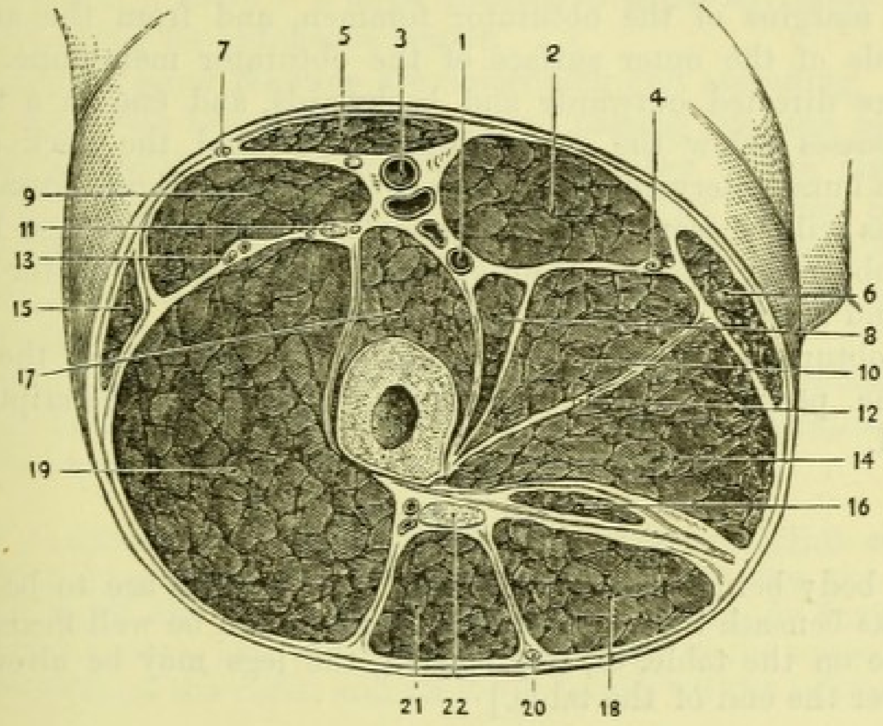
Fig. 69.—Nerves of the thigh (from Hirschfeld and Leveillé).

1. Gangliated cord of sympathetic.
2. Third lumbar nerve.
3. Branches to the iliacus internus.
4. Fourth lumbar nerve.
5. Anterior crural nerve.
6. Lumbo-sacral nerve.
7. Branch to psoas.
8. Obturator nerve.
9. External cutaneous nerve (cut).
10. Nerve to pectineus.
11. Superficial division of anterior crural nerve (cut).
12. Superficial division of obturator nerve.

13, 13. Sartorius.
14, 14. Adductor longus.
15. Branch to rectus.
16. Deep division of obturator nerve.
17. Branches to vastus externus and crureus.
18. Adductor brevis.
19. Branch to vastus internus.
20. Adductor magnus.
21. Vastus externus.
22, 22. Internal saphenous nerve.
23. Rectus femoris.
24. Patellar branch of saphenous nerve.
25. Vastus internus.
26. Gracilis.

part of the ischial tuberosity. Its anterior fibres pass outwards, with different degrees of obliquity, to be *inserted* into the back of the femur immediately below the quadratus femoris down to the linea

Fig. 70.



aspera, and may be separated from the rest to form an "adductor minimus"; the middle fibres pass into the whole length of the linea aspera, and a small portion of the line leading from it to the internal condyle; while the posterior ischial fibres (24) run vertically downwards to end in a round tendon, which is *inserted* into the tubercle above the inner condyle of the femur, and, by means of an expansion, into the lower part of the line leading to it. This tendon forms the arch for the passage of the femoral vessels into the popliteal space and gives origin to the lower fibres of the vastus internus. The

Fig. 70.—Section of the right thigh at the apex of Scarpa's triangle (drawn by G. E. L. Pearse).

1. Profunda vessels.
2. Adductor longus.
3. Femoral vessels.
4. Superficial obturator nerve.
5. Sartorius.
6. Gracilis.
7. External cutaneous nerve.
8. Pectineus.
9. Rectus femoris.
10. Adductor brevis.
11. Anterior crural nerve.
12. Deep obturator nerve.
13. External circumflex vessels.
14. Adductor magnus.
15. Tensor vaginæ femoris.
16. Semi-membranosus.
17. Vastus internus and crureus.
18. Semi-tendinosus.
19. Vastus externus.
20. Small sciatic nerve.
21. Biceps femoris.
22. Great sciatic nerve.

muscle is *supplied* by the obturator nerve, and also by the great sciatic. It is a powerful adductor and external rotator of the thigh, and its vertical posterior fibres also aid the hamstrings to extend the hip.

Above the upper border of the adductor magnus a portion of the **Obturator Externus** can be seen. It *arises* from the anterior and inferior margins of the obturator foramen, and from the anterior two-thirds of the outer surface of the obturator membrane. The fibres are directed outwards and backwards, and end in a tendon which passes below the acetabulum and behind the neck of the femur (a bursa intervening), to be *inserted* into the digital fossa of the femur, as will be seen in the dissection of the buttock (page 151).

The obturator externus is an external rotator and adductor of the thigh, and is *supplied* by the obturator nerve.

The obturator artery is best seen after the removal of the thigh from the pelvis, in the dissection of which its description is included.

The Buttock.

[The body being turned on its face, the buttocks are to be raised by blocks beneath the pelvis until the thigh can be well flexed with the knee on the table, or, if preferred, the legs may be allowed to hang over the end of the table.]

The dissector should recognize the crest of the ilium, which wil bound his dissection superiorly, also the sacrum and coccyx, and th tuberosity of the ischium. The latter can be felt through the gluteu maximus in the extended position of the limb, or immediatel beneath the integument when the hip joint is flexed. The relation of the trochanter to the several parts of the pelvis in the differen positions of the limb are of great practical importance in the diagnosi of fractures and dislocations, and should be carefully examined The "fold of the buttock" varies according to the amount of fa and the muscular development of the subject. It should be notice that it does not coincide in direction with the oblique lower borde of the gluteus maximus but when the limb is extended runs almos horizontally outwards, crossing the muscle near its middle (Fig. 52 The prominences of the inner and outer hamstrings and the hollo of the ham will be seen during flexion, and it should be noted ho readily the space can be explored in this position owing to the re laxation of the fascia.

[An incision is to be made along the crest of the ilium, and dow the middle of the sacrum to the tip of the coccyx, when, if th perinæum and thigh have been dissected, it will only be necessar to make another cut across the upper part of the back of the thigh, following the fold of the buttock obliquely downwards and outwards, to allow the large flap of skin to be reflected outwards.]

The amount of fat beneath the skin of the buttock varies considerably, and if there is a large quantity it is not advisable to spend time in looking for cutaneous nerves.

The **Cutaneous Nerves** are descending and ascending.

The *descending* branches will be found passing over the middle of the crest of the ilium, and are the iliac branches of the last dorsal and first lumbar (ilio-hypogastric) nerves, the former being in front of the latter. There are a few branches also derived from the posterior divisions of the upper sacral nerves, which pass from the back of the sacrum.

The *ascending* branches are derived from the lesser sciatic nerve and turn round the lower border of the gluteus maximus, to supply the integument over the lower part of the buttock.

[The portion of deep fascia covering the gluteus medius and seen in front of the gluteus maximus is to be cleaned, and then the gluteus maximus itself, the fibres being put on the stretch by flexing and inverting the thigh, and the dissector beginning at the upper border of the muscle on the right, and its lower border on the left limb.]

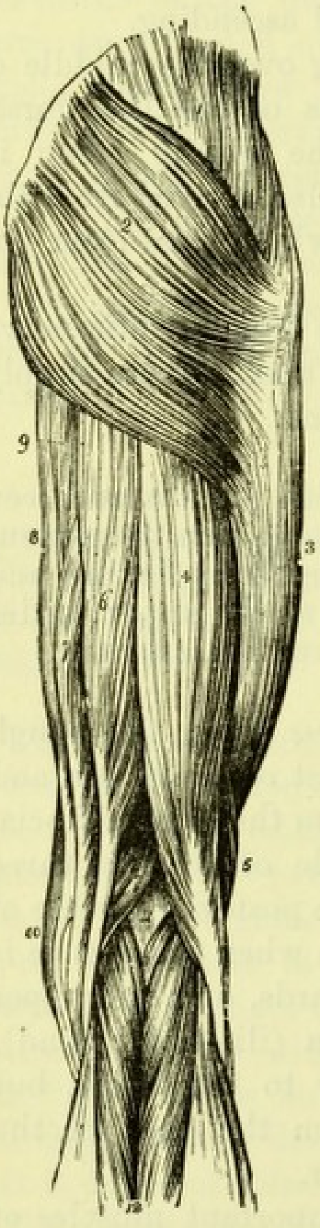
The **Gluteus Maximus** (Fig. 71, 2) *arises* from the rough triangle between the posterior third of the crest of the ilium and the superior curved line on the dorsum ilii; from the lumbar fascia, from the lower part of the sacrum, and the side of the first three pieces of the coccyx; and by deep fibres from the posterior surface of the great sacro-sciatic ligament, which will be seen when the muscle is divided. The fibres run downwards and outwards, and the upper half of the muscle is *inserted* into the fascia lata (ilio-tibial band), the lower half being also attached superficially to the fascia, but deeply to the rough gluteal ridge leading from the back of the trochanter major to the linea aspera of the femur.

The gluteus maximus is one of the most important muscles of the lower extremity. Acting from the pelvis it is a powerful extensor and external rotator of the thigh, and a tensor of the fascia lata, and its lower fibres aid in adduction. Acting from the femur it extends and rotates the trunk. It is *supplied* by the inferior gluteal nerve, a branch of the sacral plexus or of the small sciatic nerve.

[The gluteus is to be divided near its origin and turned down, when its attachment to the sacro-sciatic ligament above and the fascia below will be better seen. Some branches of the gluteal artery at the upper, and of the sciatic at the lower part of the muscle must necessarily be divided, but the nerves going to its under surface from the small sciatic should be preserved if possible.]

Three *bursæ* will be found in connection with the gluteus maximus: one between the upper part of its tendon and the great trochanter; a second between the tendon and the vastus externus; and a third over the tuberosity of the ischium. The latter is subcutaneous when the thigh is flexed, but is covered by the muscle during extension.

Fig. 71.



The **Parts beneath the Gluteus Maximus** (Figs. 72, 73) can now be seen, covered by loose cellular tissue, which is to be removed. They are from above downwards:—1, gluteus medius; 2, superficial branches of the gluteal vessels; 3, pyriformis muscle; 4, sciatic vessels and nerves (great and small) and inferior gluteal nerve; 5, pudic vessels and nerve, and nerve to obturator internus; 6, tendon of the obturator internus with the gemelli muscles above and below it; 7, the tendon of the obturator externus usually concealed by the inferior gemellus and quadratus; 8, quadratus femoris and upper border of adductor magnus; 9, great sacro-sciatic ligament; 10, tuber ischii and muscles attached to it; 11, terminal branches of internal circumflex vessels, appearing above and below the quadratus femoris; 12, the upper end of the femur with the vastus externus.

[These structures are to be cleaned as far as possible at once, and will be ex-

Fig. 71.—Muscles of the posterior femoral and gluteal region (from Wilson.)

1. Gluteus medius.
2. Gluteus maximus.
3. Vastus externus covered by fascia lata.
4. Long head of biceps.
5. Short head of biceps.
6. Semi-tendinosus.
7. Semi-membranosus.
8. Gracilis.
9. Part of the inner border of the adductor magnus.
10. Edge of sartorius.
11. Popliteal space.
12. Gastrocnemius.

amined in succession. In order to clean the muscles, the thigh must be well rotated inwards, and for the gluteus medius, it must be crossed beneath the opposite limb. Care should be taken to preserve an anastomosis of arteries between the tuber ischii and great trochanter.]

The **Gluteus Medius** (Fig. 71, 1) *arises* from an area upon the dorsum ilii bounded by the superior and middle curved lines and the anterior four-fifths of the external lip of the iliac crest ; and from the fascia lata covering it above the gluteus maximus. The fibres converge to be *inserted* into the diagonal line of the great trochanter, extending from its posterior superior angle obliquely downwards and forwards.

The anterior border of the gluteus medius is frequently united with that of the minimus and with the ilio-trochanteric band, which lies beneath it. The insertion of the gluteus medius is best seen when the muscle has been divided. Two *bursæ* will be found in connexion with its tendon, one separating it from the surface of the great trochanter above the diagonal line, the other from the tendon of the pyriformis.

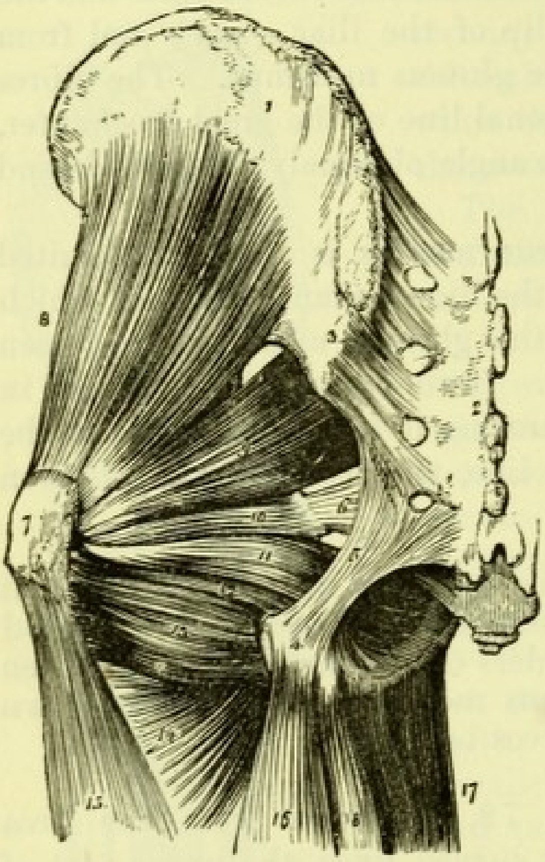
[The gluteus medius is to be divided close to its origin without injuring the gluteus minimus, the separation from which is marked by an artery ; and the anterior borders of the muscles having been separated with the scalpel, the gluteus medius is to be turned down without injuring the vessels and nerves beneath.]

The **Gluteus Minimus** (Fig. 72, 8) *arises* from the area bounded by the middle and inferior curved lines, the upper part of the anterior margin of the great sciatic notch, and the anterior border of the ilium as far as the anterior inferior spine. It is *inserted* into the anterior border of the great trochanter. A *bursa* is usually found between its tendon and the trochanter.

The two smaller glutei acting from their insertion incline the trunk laterally towards the same side, and aid also in flexion, extension, and rotation. If the pelvis be fixed, they act as abductors of the thigh and assist in the movements of flexion, extension, and rotation of the limb, the anterior portions of both muscles rotating inwards and flexing, the posterior portions rotating outwards and extending. They are both *supplied* by the superior gluteal nerve.

The **Pyriformis** (Fig. 72, 9) *arises* from the front of the lateral mass of the sacrum between the 1st, 2nd, 3rd, and 4th sacral foramina as well as from the grooves external to the foramina, also from the upper part of the great sciatic notch, and often from the great sacro-sciatic ligament ; passing out of the great sacro-sciatic foramen it ends in a round tendon, which crosses the tendons of the obturator internus and gemelli and is *inserted* into a distinct depression at the posterior part of the upper margin of the great trochanter. The muscle is occasionally divided into two parts by the passage of a portion of the great sciatic nerve through its fibres. It is an external rotator and abductor of the thigh in the extended position, and an abductor when the limb is flexed. It is *supplied* by a special branch of the sacral nerves within the pelvis.

Fig. 72.



The **Obturator Internus and Gemelli** (Fig. 72, 11).—Only the tendon of the obturator internus is now seen, the muscle *arising* from the inner surface of the true pelvis around the anterior two-thirds of the obturator foramen, and from the corresponding portion of the inner surface of the obturator membrane. The tendon winds out of the lesser sacro-sciatic foramen, and, being joined by the gemelli, passes forwards and outwards beneath the tendon of the pyriformis (with which it is more or less united) to be *inserted* in front of it into a depression at the anterior part of the upper margin of the great trochanter. The **gemelli** (twin muscles) (10, 12) are placed above and below the tendon of the obturator internus and are *inserted* into its margins and deep surface, but one or both may be absent ; the superior *arises*

Fig. 72.—Deep muscles of the gluteal region (from Wilson).

1. Ilium.
2. Sacrum.
3. Posterior sacro-iliac ligament.
4. Tuberosity of the ischium.
5. Great sacro-sciatic ligament.
6. Lesser sacro-sciatic ligament.
7. Trochanter major.
8. Gluteus minimus.
9. Pyriformis.
10. Gemellus superior.
11. Obturator internus, passing out of the lesser sacro-sciatic foramen.
12. Gemellus inferior.
13. Quadratus femoris.
14. Adductus magnus.
15. Vastus externus.
16. Biceps.
17. Gracilis.
18. Semi-tendinosus.

The tendon of the obturator externus appears between the gemellus inferior and the quadratus femoris.

from the external surface of the spine of the ischium and adjacent portion of the lesser sciatic notch ; the inferior *arises* from the upper and back part of the tuber ischii, and is the larger and more constant muscle.

If the tendon of the obturator internus be divided near its insertion without disturbing the gemelli, and drawn up from the margin of the sciatic foramen, a large bursa will be found, which, when opened, will be seen to lubricate the under surface of the tendon and the margin of the lesser sacro-sciatic foramen. A second bursa, sometimes communicating with the first, lies between the tendon and the capsule of the hip-joint. The ischial surface of the tendon is subdivided by two or three deep grooves, and the margin of the bone is encrusted with cartilage which presents ridges corresponding with these.

The obturator internus and gemelli are abductors and rotators outwards of the thigh when it is extended, but abductors only when it is already flexed. The obturator is *supplied* by a special branch from the upper part of the sacral plexus, which also gives a branch to the superior gemellus ; the inferior gemellus is *supplied* by the nerve to the quadratus from the sacral plexus.

The **Tendon of the Obturator Externus** (Fig. 73, 20) will be found lying deeply between the inferior gemellus and the quadratus muscle. The origin of the muscle has been already seen (p. 146), and the tendon, after passing through the groove below the acetabulum, is *inserted* into the digital fossa at the root of the great trochanter. It is in close relation to the upper terminal branch of the internal circumflex artery. The obturator externus is a rotator outwards and a feeble adductor of the thigh, and is *supplied* by the deep division of the obturator nerve.

The **Quadratus Femoris** (Fig. 73, 24), so named from its quadrilateral shape, *arises* from the outer side of the tuberosity of the ischium externally to the hamstring muscles, and passes horizontally outwards to be *inserted* on an eminence on the back of the femur below the middle of the posterior intertrochanteric line and immediately above the adductor magnus, with which it is sometimes continuous. The point of insertion has been termed the "linea quadrati" though a distinct line seldom exists at the spot. The muscle is an external rotator and adductor of the thigh, and is *supplied* by a special branch from the sacral plexus, which also gives a twig to the gemellus inferior. It is separated from the lesser trochanter by a bursa.

The **Gluteal Artery** (Fig. 73, 5) is a branch of the posterior division of the internal iliac artery, and emerges from the pelvis through the great sacro-sciatic foramen above the pyriformis. It appears at the lower border of the gluteus minimus, and breaks up into superficial and deep divisions. The *superficial* division is distributed to the under surface of the gluteus maximus, and its root may be found at the junction of the upper and middle thirds of a line running from the posterior superior iliac space to the posterior superior angle of the great trochanter (Fig. 52). It anastomoses in the gluteus maximus with the inferior gluteal branch of the sciatic artery, and with posterior branches of the lateral sacral. Unlike the deep division it is unaccompanied by a nerve. The *deep* division subdivides into superior and inferior branches. The *superior branch* (4) runs along the middle curved line of the ilium between the gluteus medius and minimus; both of which it supplies, and ends at the anterior border of the ilium by anastomosing with the superior branch of the external circumflex and with the deep circumflex iliac artery. The *inferior branch* (6) crosses the gluteus minimus to the great trochanter, to supply the parts in its neighbourhood and ends in the tensor vaginæ femoris, anastomosing with the external circumflex and sciatic arteries.

Venæ comites accompany the branches of the artery and open into the internal iliac vein. The branches of the deep division are accompanied by those of the superior gluteal nerve.

The **Sciatic Artery** (Fig. 73, 13) is a branch of the anterior division of the internal iliac artery, and emerges from the pelvis through the great sacro-sciatic foramen below the pyriformis, where its position is indicated by a point at the junction of the middle and lower thirds of a line running from the posterior superior iliac spine to the ischial tuberosity (Fig. 52). It gives large *inferior gluteal* branches to the gluteus maximus, and *muscular* branches to the other smaller muscles of the neighbourhood, accompanying their respective nerves; and anastomoses with both the external and internal circumflex arteries of the profunda femoris. Its named branches are, 1, the *coccygeal* (15), which pierces the great sacro-sciatic ligament to supply the parts about the coccyx; 2, the *comes nervi ischiadici* (28), which runs upon the great sciatic nerve and into its terminal branches, and appears to be the direct continuation of the main trunk; and 3, the *anastomotic branch* (16), which passes to the root of the great trochanter to anastomose with the gluteal and internal circumflex arteries and sometimes with the external circumflex in the so-called *crucial anastomosis*.

The *veins* corresponding to the sciatic artery open into the internal iliac vein.

The **Internal Pudic Artery** (Fig. 73, 9) is only seen in its course over the spine of the ischium, as it winds out of the great sacro-sciatic foramen below the pyriformis to re-enter the pelvis by the lesser sacro-sciatic foramen, above the tendon of the obturator internus. The artery is accompanied by its vein and by two nerves,

Fig. 73.

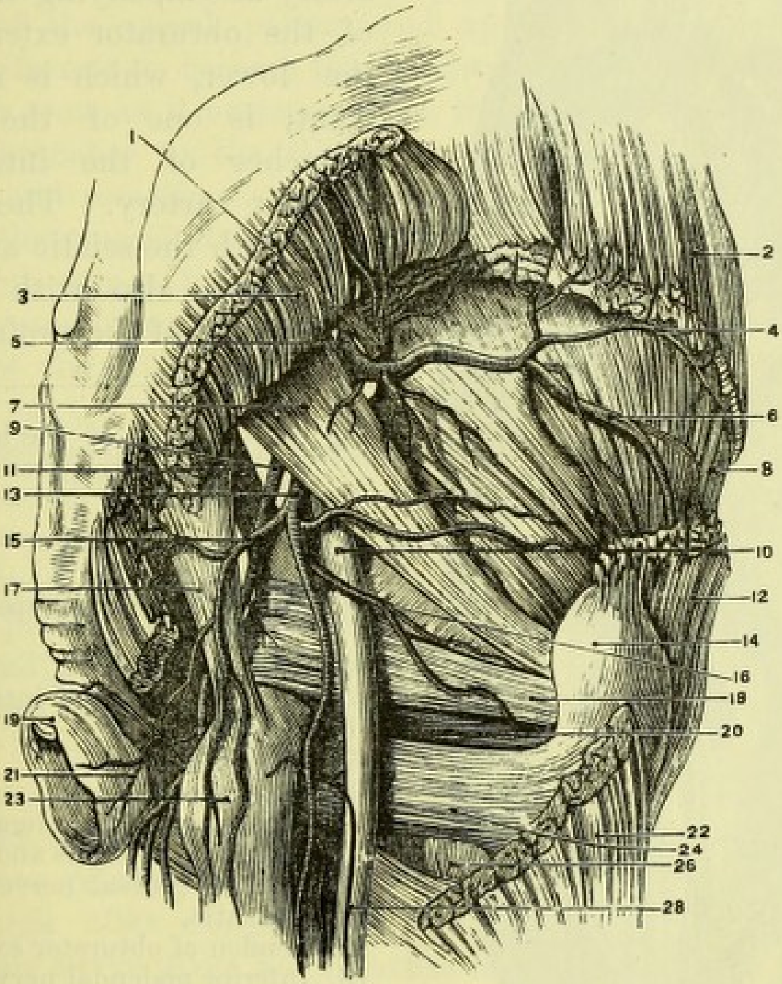


Fig. 73.—Arteries of the buttock (after Henle).

1. Glutealartery (superficial branch).
2. Gluteus medius (origin).
3. Gluteus maximus (origin).
4. Superior deep gluteal artery.
5. Trunk of gluteal artery.
6. Inferior deep gluteal artery.
7. Pyriformis.
8. Gluteus minimus.
9. Pudic artery.
10. Great sciatic nerve.
11. Small sacro-sciatic ligament.
12. Gluteus medius (insertion).
13. Sciatic artery.
14. Great trochanter.
15. Coccygeal branch of sciatic artery.
16. Anastomotic branch of sciatic artery.
17. Great sacro-sciatic ligament.
18. Obturator internus and the two gemelli.
19. External sphincter ani.
20. Tendon of obturator externus.
21. Inferior hæmorrhoidal artery.
22. Insertion of gluteus maximus.
23. Ischial tuberosity.
24. Quadratus femoris.
26. Small trochanter.
28. Comes nervi ischiadici.

the pudic nerve lying to its inner side and the nerve to the obturator internus externally.

A branch of artery will be found both at the upper and lower borders of the quadratus. The upper is a branch of either the internal circumflex or obturator artery accompanying the tendon of the obturator externus, and the lower, which is more constant, is one of the terminal branches of the internal circumflex artery. These anastomose with the sciatic artery, and the lower also with the first perforating of the profunda.

Fig. 74.

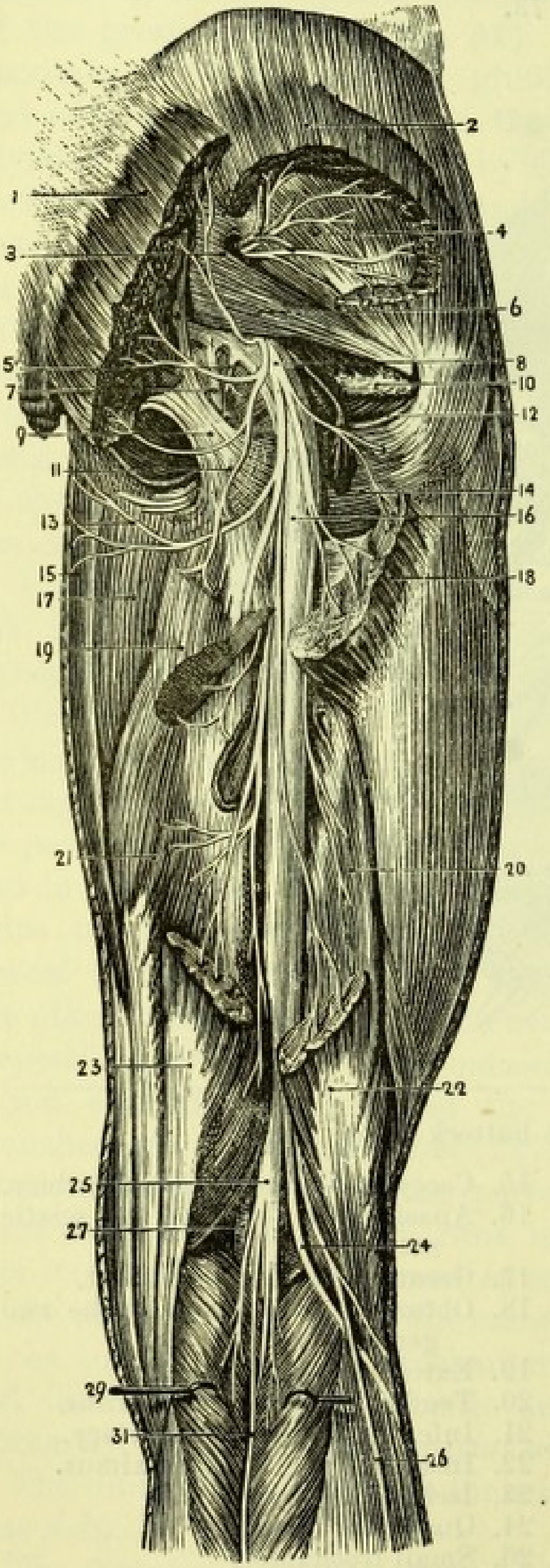


Fig. 74.—Nerves of the buttock and back of the thigh (from Hirschfeld and Leveillé).

1. Gluteus maximus.
2. Gluteus medius.
3. Gluteal artery and superior gluteal nerve.
4. Gluteus minimus.
5. Nerve to obturator internus.
6. Pyriformis.
7. Pudic nerve.
8. Small sciatic nerve.
9. Great sacro-sciatic ligament.
10. Obturator internus and gemelli.
11. Inferior gluteal nerve from small sciatic.
12. Tendon of obturator externus.
13. Inferior pudendal nerve (Soemmering).
14. Quadratus femoris.
15. Gracilis.
16. Great sciatic nerve.
17. Adductor magnus.
18. Insertion of gluteus maximus.
19. United origins of semi-tendinosus and biceps.
20. Short head of biceps.
21. Semi-membranosus.
22. Tendon of biceps.
23. Tendon of semi-tendinosus.
24. External popliteal nerve.
25. Internal popliteal nerve.
26. Communicans fibularis nerve.
27. Popliteal artery.
29. Gastrocnemius.
31. Communicans tibialis nerve.

The **Superior Gluteal Nerve** (Fig. 74, 3) is a branch of the lumbo-sacral cord, and emerges from the pelvis with the gluteal artery above the pyriformis. It divides into two branches, which accompany the deep division of the artery between the gluteus medius and minimus and supply these muscles, the lower one going forward to the tensor fasciæ femoris.

The **Small Sciatic Nerve** (Fig. 74, 8) is one of the main branches of the sacral plexus, and appears at the lower border of the pyriformis to become the cutaneous nerve at the back of the thigh. As soon as it emerges from the pelvis it gives recurrent cutaneous branches to the skin over the lower part of the gluteus maximus, and sometimes an *inferior gluteal* branch to the under surface of the muscle itself. It then gives off the *inferior pudendal* nerve which winds below the tuberosity of the ischium to the perinæum, and other cutaneous branches which descend to supply the back of the thigh, popliteal region and upper half or more of the calf (13).

The **Inferior Gluteal Nerve** most frequently has a distinct origin from the sacral plexus, and is not very intimately connected with the small sciatic: it is the nerve of supply to the gluteus maximus.

The **Great Sciatic Nerve** (Fig. 74, 16) is the largest trunk of the sacral plexus, and appears at the lower border of the pyriformis, or occasionally pierces the muscle. At the level of the hip-joint it lies upon the posterior lip of the acetabulum, then runs upon the obturator internus and gemelli, quadratus femoris, and adductor magnus between the ischial tuberosity and the great trochanter, close to the inner side of the neck and lesser trochanter of the femur, and becomes related posteriorly with the shaft about the middle of the thigh after disappearing beneath the hamstring muscles. Usually this nerve gives no branches in this region, but the nerves to the quadratus and hip-joint are sometimes derived from it, instead of from the sacral plexus itself. The position of the trunk must be remembered in making posterior counter openings in connexion with hip disease or after excision.

The **Nerve to the Obturator Internus** (Fig. 74, 5) arises from the upper part of the sacral plexus, and leaves the pelvis below the pyriformis, taking the same course as the pudic vessels and nerve over the spine of the ischium, but lying to their outer side. As it winds into the lesser foramen it gives a branch to the superior gemellus, and then supplies the fibres of the obturator within the pelvis.

The **Nerve to the Quadratus** (Fig. 74) arises from the anterior surface of the sacral plexus, and passes with a branch from the sciatic artery, beneath the obturator internus tendon to supply the quadratus and inferior gemellus. It lies against the back of the hip-joint, to which it gives a branch.

The **Pudic Nerve** (Fig. 74, 7) from the sacral plexus, is seen lying on the spine of the ischium internally to the pudic vessels. If the inferior hæmorrhoidal nerve should happen to arise separately from the sacral plexus, it will be found accompanying the pudic in this position.

The Popliteal Space.

The dissection of the popliteal space should be made before the skin on the back of the upper part of the thigh is removed, so that the relations of the parts in the ham may be undisturbed.

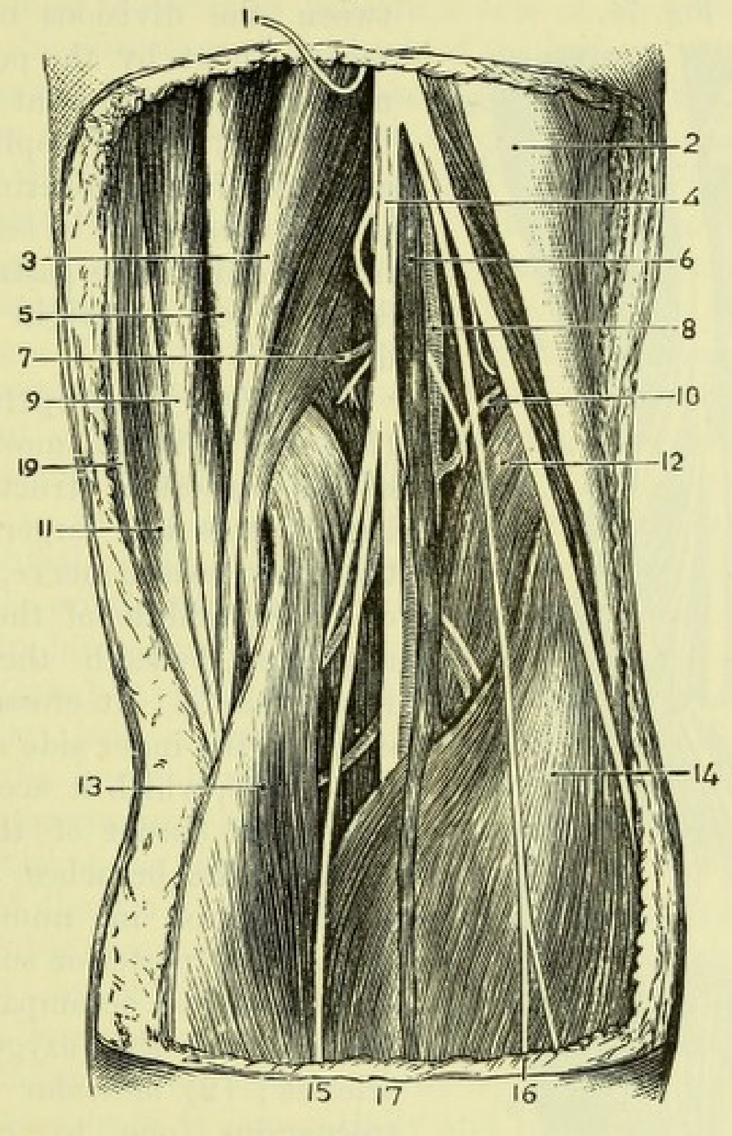
[A vertical incision is to be made in the middle line of the limb at the back of the knee, extending for six inches above and the same distance below the joint. A transverse incision at each end of this will allow the skin to be fully reflected. A few branches of the small sciatic and internal cutaneous nerves may be found in the superficial fascia, which is to be removed in order to expose the deep fascia.]

Deep or **Popliteal Fascia.**—This is continuous with the fascia lata, and strengthened by fibres from the hamstring tendons. It stretches across the popliteal space to protect the vessels and nerves beneath, and is tense when the limb is extended, but is at once relaxed on bending the knee. Branches of the small sciatic nerve are distributed to the integument over the space.

[The fascia being removed, the hollow of the ham will be brought into view filled with loose fat, which is to be removed to expose the popliteal vessels and nerves. The internal popliteal nerve and the popliteal vessels will appear in the middle of the space, the external popliteal nerve near its outer boundary. Imbedded in the fat of the popliteal space are some lymphatic glands, and it may be noted that there are no glands in the limb below this point except, perhaps, one with the anterior tibial vessels. The boundaries of the space are to be carefully cleaned, care being taken, at the lower part, of two small nerves and a vein which run on the back of the leg, as well as of some small articular twigs to the knee-joint at the sides of the space. The *upper articular arteries* are to be found running inwards and outwards above the condyles of the femur, and a third *azygos* branch piercing the posterior ligament of the knee-joint.]

The **Popliteal Space** (Fig. 75) is a lozenge-shaped cavity at the back of the knee, which in the dissected state extends for some distance above and a little below the joint. It is continuous above with Hunter's canal through the opening in the adductor magnus, and below with the deep intermuscular spaces of the leg. Its upper part is bounded *externally* by the biceps ; *internally* by the adductor

Fig. 75.



magnus and more superficially by the semi-membranosus and tendon of the semi-tendinosus. Its lower part has one of the fleshy

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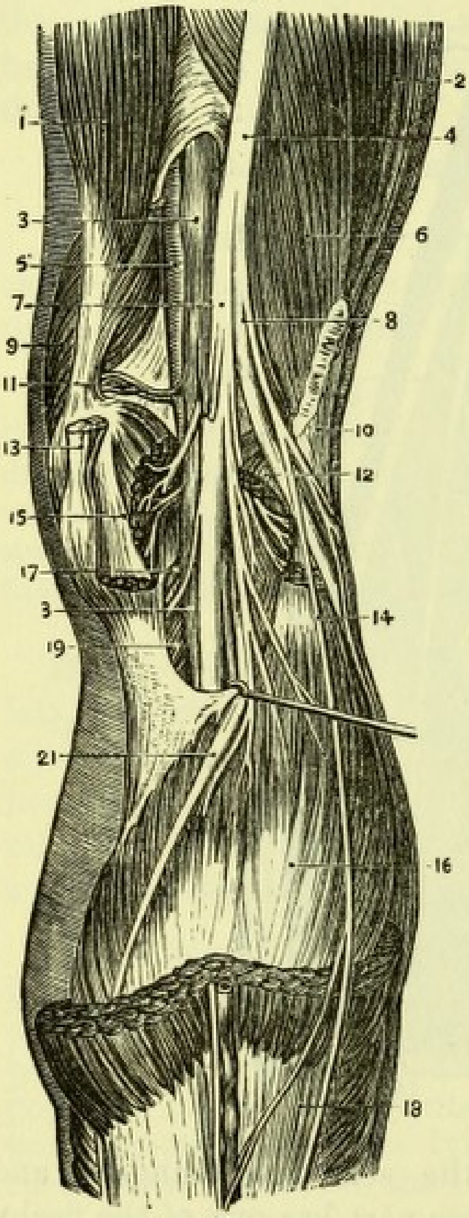
Fig. 75.—The popliteal space (from University College Museum).

1. Small sciatic nerve (turned up).
2. Biceps and external popliteal nerve.
3. Semi-tendinosus.
4. Internal popliteal nerve.
5. Semi-membranosus.
6. Popliteal vein.
7. Superior internal articular artery and articular branch of obturator nerve.
8. Popliteal artery.
9. Gracilis.
10. Superior external articular artery and articular nerve.
11. Sartorius.
12. Plantaris.
13. Gastrocnemius, inner head.
14. Gastrocnemius, outer head.
15. Communicans tibialis nerve.
16. Communicans peronei nerve.
17. External saphenous vein.
19. Internal saphenous nerve.

heads of the gastrocnemius muscle on *each* side, and on the *outer* side there is, in addition, the small plantaris muscle.

The *floor* of the space is formed at the upper part by the triangular popliteal surface of the femur between the divisions of the linea aspera; next by the posterior ligament of the knee-joint; and at the lower part by the popliteus muscle and the fascia covering it. The popliteus can only be seen when the inner head of the gastrocnemius is divided near its origin and turned down.

Fig. 76.



The **Internal Popliteal Nerve** (Fig. 75, 4) is the most superficial of the important structures in the ham. It is the larger division of the great sciatic nerve, and passes down the middle of the space, disappearing beneath the gastrocnemius muscle. It crosses from the outer to the inner side of the popliteal artery, which it accompanies to the lower border of the popliteus muscle. Its branches are (1) *articular*, three in number, which pierce the posterior surface of the knee-joint, and accompany the two internal and the azygos articular arteries; (2) *muscular* to the gastrocnemius (one to each head), soleus, plantaris and popliteus; the branch of the popliteus being

Fig. 76.—Deep dissection of the popliteal space (from Hirschfeld and Leveillé).

1. Adductor magnus.
2. Vastus externus.
3. Popliteal vein.
4. Great sciatic nerve.
5. Popliteal artery.
6. Short head of biceps.
7. Internal popliteal nerve.
8. External popliteal nerve.
9. Vastus internus.
10. Long head of biceps (cut).
11. Superior internal articular artery.
12. Outer head of gastrocnemius.
13. Tendon of semi-membranosus.
14. Communicans peronei nerve.
15. Inner head of gastrocnemius.
16. Soleus.
17. Inferior internal articular artery.
18. Gastrocnemius.
19. Popliteus.
20. External saphenous vein and nerve.
21. Tendon of plantaris.

peculiar in that it runs upon the posterior surface of the muscle, then turns upwards around its lower border to enter its anterior or deeper surface; and (3) the *external saphenous nerve* * or *ramus communicans tibialis*, which lies in the groove between the heads of the gastrocnemius (sometimes beneath a few of its fibres), and will be traced in the dissection of the back of the leg.

The **External Popliteal** or **Peroneal Nerve** (Fig. 75, 2), the other division of the great sciatic, is altogether under cover of the biceps at the upper part of the space, but becomes visible close to its tendon near the head of the fibula. It gives a communicating branch (*ramus communicans peronei vel fibularis*) down the back of the leg to join the external saphenous nerve, and two or three *articular* branches. Of these two, sometimes arising together, accompany the two external articular branches of the popliteal artery; the other (the recurrent articular) winds to the front of the joint with the recurrent branch of the anterior tibial artery. An external cutaneous nerve to the outer side of the leg arises either from the external popliteal itself, or more frequently from the communicans fibularis. The sciatic nerve may be found at the upper angle of the space when its bifurcation is unusually low.

The **Popliteal Artery** (Fig. 75, 8) is the continuation of the femoral artery, and extends from the opening in the adductor magnus to the lower border of the popliteus muscle, where it divides into anterior and posterior tibials. It lies near the bottom of the popliteal space, separated from the back of the femur by a layer of fat of about a quarter of an inch in thickness (an important fact to remember in connection with supra-condyloid osteotomy) but it is in direct contact with the posterior ligament of the knee, and the popliteus muscle and fascia. It has a direction from the inner side of the femur to the middle of the leg. Its vein is first to its outer side then crosses it superficially and lies slightly to its inner side below, whilst the internal popliteal nerve is still more superficial and also crosses the artery from without inwards. The commencement of the popliteal artery is under cover of the semimembranosus, the middle of the vessel is in the hollow of the ham, uncovered by muscles, and its lower part is beneath the gastrocnemius and plantaris muscles. A branch of the obturator nerve may be found on the upper part of the artery, and traced to the back of the knee joint.

The **Branches** (Figs. 75 and 76) of the popliteal artery are

* The term External Saphenous is sometimes limited to the nerve formed by the junction of the communicans tibialis with the communicans fibularis.

superior and *inferior muscular* to the hamstrings and muscles of the calf, and *articular* to the knee-joint.

1. The *Superior muscular* branches arise from the upper part of the artery, and are distributed to the adjacent hamstring muscles, anastomosing with the perforating and terminal branches of the profunda.

2. The *Articular* branches are five in number, viz., two superior, two inferior, and one azygos.

The *superior* arteries, internal and external, arise just above the condyles of the femur, and wind horizontally inwards and outwards to the front of the knee-joint, to supply it, and to anastomose with one another, with the anastomotica magna and the descending branch of the external circumflex and the other arteries about the joint. The external passes beneath the tendon of the biceps, the internal beneath those of the adductor magnus and inner hamstrings. The *inferior* articular arteries arise on the popliteus. The *internal* (the lower of the two) runs obliquely downwards and inwards below the inner tuberosity of the tibia following the upper border of the popliteus and passing beneath the long portion of the internal lateral ligament ; the *external* passes horizontally outwards altogether above the head of the fibula between the external lateral ligament and the semilunar fibro-cartilage to the front of the joint. The *azygos* arises about the middle of the artery and pierces the posterior ligament with the obturator nerve to supply the synovial membrane and crucial ligaments, and to join the other branches.

3. The *Inferior muscular* branches (sural) are distributed to the muscles of the calf,

Surgery.—The popliteal artery may be compressed by the hand or a tourniquet. The operation of tying the popliteal artery for aneurism is never performed, but it might be necessary to reach the vessel if wounded ; in which case an incision to the inner side of the space would enable the operator to reach the middle of the artery without injury to the nerves, or it may be readily accomplished through a 3-inch incision in the middle of the space.

The close relation of the artery to the posterior ligament of the knee should be remembered in excision of the joint ; and it is the separation of the vessel above this point from the popliteal surface of the femur by a pad of fat that has rendered feasible the operation of supra-condyloid osteotomy. The close contiguity of the external popliteal nerve to the biceps tendon and external lateral ligaments exposes the nerve trunk to some danger in arthrectomy for extensive tubercular disease of the knee.

The **Popliteal Vein** (Fig. 76, 3) is formed by the junction of the anterior and posterior tibial veins at the lower border of the popliteus. The vein is superficial to the artery, and lies slightly to its inner side at the lower part of the space, but crosses to the outer side above. It receives tributaries corresponding to the branches of the artery and, at a variable point, the *external saphenous vein*, which lies on the back of the leg between the heads of the gastrocnemius, opens into it. Like the superficial femoral vein it is sometimes represented by two venæ comites, one of which is much larger than the other.

Four or five small *lymphatic glands* are placed close to the artery. They receive the superficial lymphatics accompanying the external saphenous vein from the back of the leg and heel, and deep lymphatics accompanying the venæ comites of the anterior and tibial arteries from the bones, muscles, &c. The efferent vessels end in the deep femoral glands.

The Back of the Thigh.

[The skin left on the back of the thigh is to be removed, and some small branches of the small sciatic nerve may be found in the subcutaneous fascia ; the nerve itself will be seen on removing the deep fascia, after which the hamstring muscles and the great sciatic nerve, are to be cleaned.]

The **Hamstring Muscles** (Figs. 71 and 74) are three in number, viz., the biceps on the outer side, and the semi-tendinosus and semi-membranosus on the inner side. The gracilis and sartorius might also be regarded as inner hamstrings. The biceps and semi-tendinosus, which arise in common, are superficial to the semi-membranosus near the tuber ischii, and the semi-tendinosus maintains this relation to the semi-membranosus throughout. The short head of the biceps will be found on the outer side of the lower part of the femur.

The **Biceps** (Fig. 74, 19) or outer hamstring *arises* by its long head from the tuber ischii, in common with the semi-tendinosus, and from the great sacro-sciatic ligament, with the fibres of which it is in direct continuity. It crosses the great sciatic nerve and, by diverging from the semi-membranosus in the lower fourth of the thigh, forms the outer boundary of the popliteal space. The short head (20), which is fleshy, *arises* from the outer lip of the linea aspera, nearly as high as the insertion of the gluteus maximus, and from its outer division to within two inches of the condyle, and from the external intermuscular septum. The two heads having united opposite the lower end of the femur, the muscle is *inserted* into the bicipital tuberosity on the outer side of the head of the fibula, into the fascia of the leg, and by a slip which passes in front of the tibio-fibular joint into the adjacent portion of the tibial tuberosity. The tendon splits to enclose the lower end of the long external lateral ligament, from which it is separated by a *bursa* (Fig. 75, 2).

The **Semi-tendinosus** (Fig. 74, 19) *arises* by fleshy fibres from the tendon of the biceps, and in common with it from the inner portion of the back of the tuber ischii. It forms one of the inner boundaries of the popliteal space, and ends in a long slender tendon, which lies on the semi-membranosus posterior to the gracilis and passes to be *inserted* into the deep fascia of the leg and into the tibia below the inner tuberosity, lying there beneath the tendon of the sartorius and below that of the gracilis, and surrounded by a *bursa* common to it and the two muscles named. Its fibres are crossed by a tendinous intersection.

The **Semi-membranosus** (Fig. 74, 21), though one of the internal hamstrings, is external to the biceps at its origin. It *arises* by a strong tendon from the outer and upper part of the tuber ischii, and passing beneath the origins of the biceps and semi-tendinosus, from which it is separated by a *bursa*, spreads into a broad tendon from which the muscular fibres arise to form a thick belly that extends nearly as low as the knee. It is *inserted* by a short strong tendon into an impression at the back of the inner surface of the internal tuberosity of the tibia and into a horizontal groove in front of this, beneath the internal lateral ligament of the knee. It gives off two expansions, one running upwards and outwards to the femur above the outer condyle, forming the oblique fasciculus of the posterior ligament of the knee-joint, and the other to cover the popliteus muscle (Fig. 82, 9). Its tendon is separated from the inner head of the gastrocnemius and from the knee-joint by a *bursa* that frequently communicates with the articulation ; and a second *bursa* will be found between it and the internal lateral ligament.

Action.—The hamstring muscles flex the leg upon the thigh, and extend the thigh upon the pelvis, as in walking or running, and when the knee is flexed the inner hamstrings with the popliteus gracilis and sartorius rotate the leg inwards (pronation), and the biceps rotates it outwards (supination). When the knee is extended and the leg is the fixed point, they extend the trunk and aid in maintaining the erect posture of the body. They also assist the glutei in regulating the flexion of the trunk, by controlling the force of gravitation. If the thigh be flexed while the knee is extended, the hamstrings and great sciatic nerve become very tense, and when great force is used these structures may be ruptured. Hence the knees must always be flexed when the subject is placed in the lithotomy position for dissection of the perinæum. The hamstrings are *supplied* by the great sciatic nerve.

The **Great Sciatic Nerve** (Fig. 74, 16), see page 155, is continued from the buttock and, after leaving the quadratus femoris, lies on the posterior surface of the adductor magnus, to which it gives a branch, and passes beneath the biceps, supplying this and the semimembranosus and semitendinosus. At a variable point, but generally about the middle of the thigh, the nerve divides into the internal and external popliteal trunks, which have been already traced.

Beneath the sciatic nerve will be seen the posterior surface of the adductor magnus, and piercing the muscle at various points close to its insertion are the terminations of the *perforating arteries* from the profunda and the terminal branch of the artery itself, which are now seen to supply the hamstring muscles (*v.* p. 142). The terminal branch of the *internal circumflex artery,* between the quadratus and the adductor magnus, can now also be more fully traced out.

The POPLITEUS muscle is described on page 172.

[Before the subject is re-turned, the gluteus minimus, pyriformis, and obturator internus should be turned aside, and the back of the hip-joint dissected, but the joint itself should not be opened. Opportunity should now be taken to trace the reflected tendon of the rectus femoris, arising from a rough impression above the acetabulum. When the subject is replaced on its back, the front of the joint is also to be dissected by removing the psoas and iliacus and the remains of the pectineus. After learning the external ligaments, the joint may be opened and the intracapsular structures examined. The limb may then be removed.]

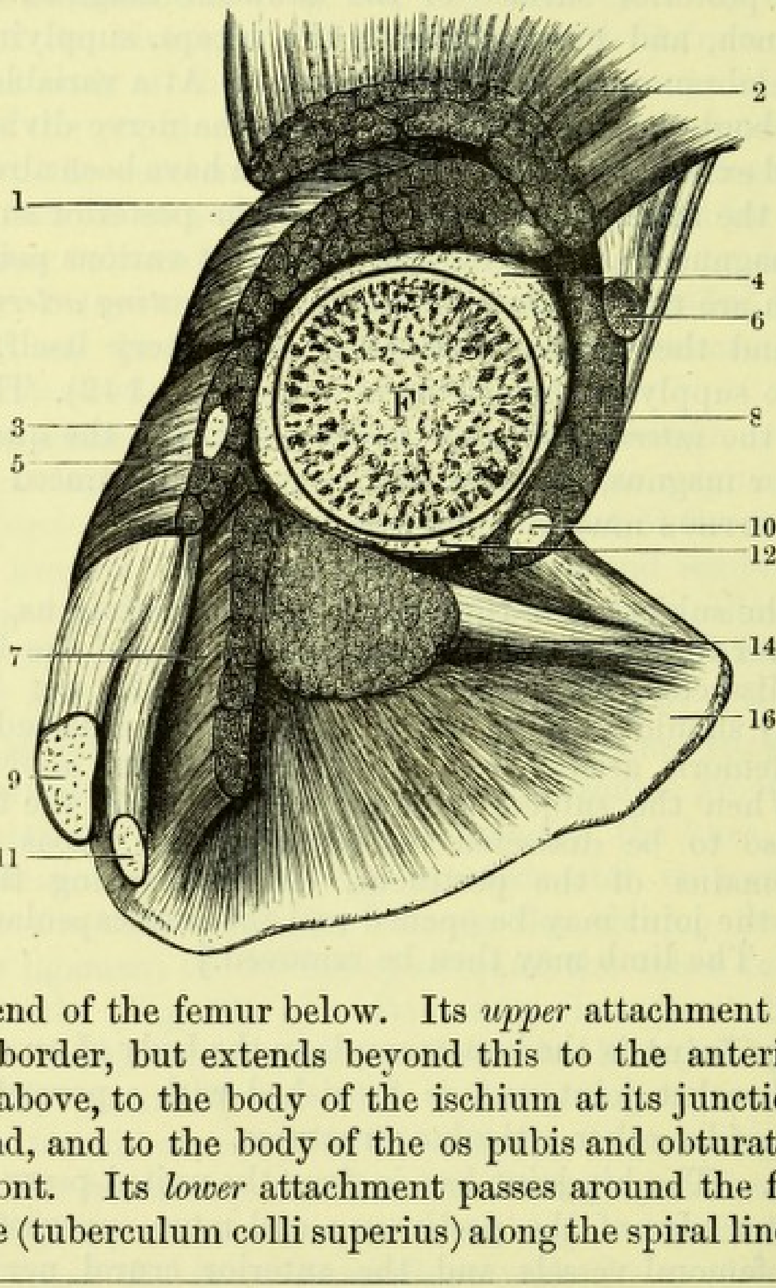
The **Hip-Joint** is the best example in the body of an enarthrodial or ball-and-socket joint, and is furnished with a powerful capsular ligament, besides other articular structures.

Relations.—The hip-joint has *in front* the united psoas and iliacus and the outer edge of the pectineus; and more superficially lie the rectus, the femoral vessels and the anterior crural nerve; *behind,* are the pyriformis, obturator internus, and gemelli, the obturator externus and upper fibres of the quadratus femoris, with the sciatic nerves and vessels lying upon them close to the posterior margin of the acetabulum; *above* and *externally,* lie the gluteus minimus and the ilio-trochanteric band; and *below* and *internally,* are the tendon of the obturator externus and the pectineus (Fig. 77).

The *ligaments of the hip-joint* are of two kinds, those which complete and deepen the socket—the transverse and cotyloid, and those which connect the two bones—the capsular and the round.

The **Capsular Ligament** (Fig. 79, 1) is attached to the margin of the acetabulum, and to the transverse ligament above; and surrounds

Fig. 77.



the upper end of the femur below. Its *upper* attachment follows the acetabular border, but extends beyond this to the anterior inferior iliac spine above, to the body of the ischium at its junction with the ilium behind, and to the body of the os pubis and obturator externus fascia in front. Its *lower* attachment passes around the femur, from the tubercle (tuberculum colli superius) along the spiral line to a rough

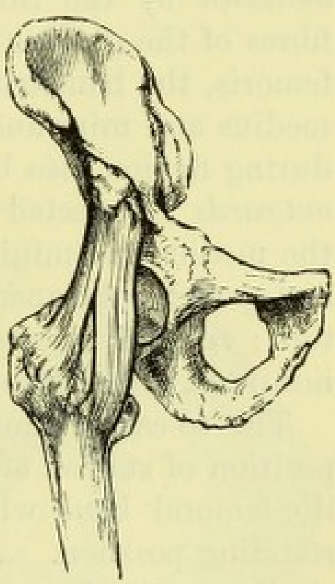
Fig. 77.—Vertical section through the hip-joint showing the head of the femur, the capsule, and the muscles surrounding the articulation (modified from Henle).

1, 2. Gluteus medius.
3. Obturator internus and gemelli.
4. Ilio-femoral band.
5. Ischio-femoral band.
6. Rectus femoris.
7. Quadratus femoris.
8. Iliacus.
9. Semitendinosus and biceps.
10. Psoas.
11. Semimembranosus.
12. Pubo-femoral band.
14. Obturator externus.
16. Symphysis pubis.
F. Section of head of femur.

elevation (tuberculum colli inferius) at the level of the lower part of the lesser trochanter. Thence it runs up the undescribed capsular line in front of the latter eminence, and crosses the middle of the back of the neck to reach the digital fossa and the superior tubercle. It is but feebly connected to the smooth posterior portion of the neck, but is strongly attached elsewhere, and some deep fibres are inserted into the front of the neck above the spiral line.

Three powerful bands, forming a part of the capsule, are differentiated, under the names of ilio-femoral, ischio-femoral, and pubo-femoral ligaments; these are separated at their acetabular attachments, but are continuous at their femoral insertions (see Figs. 77 and 78).

Fig. 78.



The *ilio-femoral band* passes from the lower part of the anterior inferior iliac spine and from the notch below it, to the superior tubercle of the neck, and to the spiral line as far as the inferior tubercle. Its fibres are often cleft opposite the middle of its lower attachment, and the band then assumes a form resembling an inverted V or Y (whence the name Y-shaped ligament sometimes given to the structure). It is of remarkable strength, and limits the movements of extension, adduction, and external rotation of the femur.

The *ischio-femoral band* is a broad fasciculus running from the back of the ischio-pubic junction, above the tuberosity, to become attached to the anterior superior angle of the great trochanter, blending there with the outer part of the ilio-femoral band. It limits internal rotation of the femur.

The *pubo-femoral band* springs from the pubic bone in front of the acetabulum, and from the obturator externus fascia, and becomes attached below to the tuberculum colli inferius, joining at this point the inner part of the ilio-femoral band, and to the unnamed capsular line running from it to the inner border of the neck. It limits the movement of abduction.

The portions of the capsular ligament between the three bands are relatively thin, the weakest point lying between the ischio-femoral and pubo-femoral bands over the head of the femur, and here an aperture of communication is sometimes found between the synovial cavity and a bursa beneath the ilio-psoas muscle. The

Fig. 78.—The ilio-femoral or Y-ligament of Bigelow (from Bryant).

capsule is, however, strengthened by the muscle, and some fibres of the iliacus commonly take origin from it. The relatively feeble portions of the back of the capsule lie above and below the ischio-femoral band.

Movements.—The hip-joint admits of the movements of flexion, extension, abduction, adduction, rotation and circumduction. *Flexion* is performed by the psoas and iliacus, the pectineus, the adductors longus and brevis, the tensor vaginæ femoris, the anterior fibres of the glutei medius and minimus, and by the rectus; *extension* by the gluteus maximus and posterior fibres of the other glutei, and less directly by the hamstrings and adductor magnus. It is *adducted* by the three adductor muscles, the pectineus, the lower fibres of the gluteus maximus, the obturator externus, the quadratus femoris, the hamstrings and the gracilis; and *abducted* by the glutei medius and minimus, pyriformis, and tensor vaginæ femoris; and during flexion also by the obturator internus and gemelli. Rotation *outwards* is effected by the gluteus maximus, the posterior fibres of the medius and minimus, the ilio-psoas, the pyriformis, the obturators and gemelli, the quadratus femoris, the sartorius, and the three adductors; *rotation inwards* by the anterior fibres of the glutei medius and minimus, and the tensor vaginæ femoris.

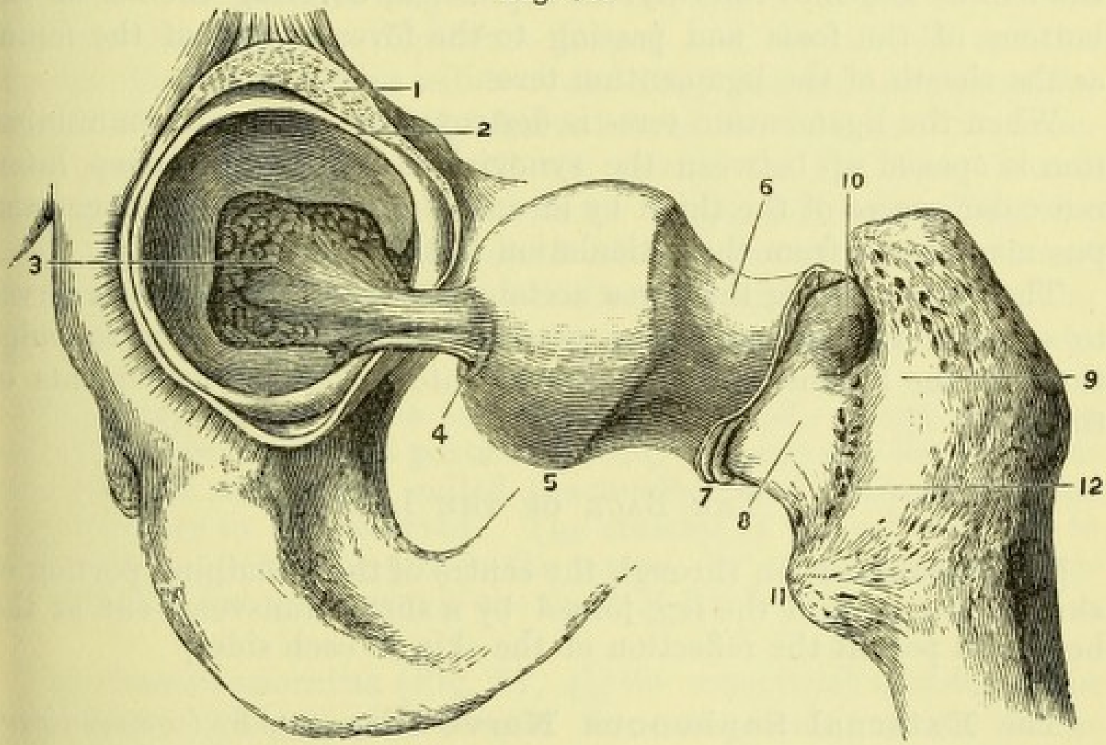
The so-called movement of *extension* is really a restitution to the position of station after flexion, and is arrested by the tension of the ilio-femoral band when the thigh reaches the vertical line in the standing position. *Adduction* is in like manner little more than a similar restitution after abduction, and is checked by the ilio-femoral band after about 15° of movement of the femoral axis beyond the vertical line. *Flexion* is very extensive, and is checked during life by the resistance of the extensors. It is greatly restricted by the tension of the hamstrings when the knee is extended, and if violence be used under these circumstances the muscles and sciatic nerves may be torn. *Abduction* is limited in most adults to 45° or 50° by the pubo-femoral band, but in children and acrobats the separation of the two limbs may be continued until the perinæum comes in contact with the ground. *Internal and external rotation* are very limited, unless combined with flexion, the former is checked by the ischio-femoral band, the latter by the upper portion of the ilio-femoral band. It will thus be seen that in the position of station, when the body rests upon one leg, the hip of that limb is almost completely fixed, so far as movements of extension, adduction, and external rotation are concerned, by the passive tension of the ilio-femoral band.

The **Transverse Ligament** consists of fibres bridging across the cotyloid notch, blending intimately with the cotyloid ligament, and giving attachment in this position to the capsule. It converts the notch into a foramen, which transmits articular vessels and nerves and is occupied by a mass of fat passing into the bottom of the cotyloid depression and into the ligamentum teres.

The **Cotyloid Ligament** (Fig. 79, 2) is a fibro-cartilaginous structure resembling the glenoid ligament in the shoulder-joint. It is triangular on section, presenting two free surfaces covered by synovial membrane, and an attached surface, firmly fixed to the margin of the acetabulum and to the transverse ligament where the bone is deficient.

The **Ligamentum Teres** (Fig. 79, 3) consists of a fold of

Fig. 79.



synovial membrane reflected from the margins of the cotyloid depression (fovea acetabuli) and notch, and from the transverse

Fig. 79.—Ligaments of the hip-joint (from Sappey).

1. Ilio-femoral band of capsular ligament, cut across.
2. Cotyloid ligament.
3. Ligamentum teres.
4. Insertion of ligamentum teres into the head of the femur.
5. Head of the femur.
6. Neck of the femur.
7. Attachment of capsular ligament to the back of the neck of the femur.
8. Neck of the femur external to attachment of capsular ligament.
9. Great trochanter.
10. Pit on the great trochanter.
11. Small trochanter.
12. Posterior inter-trochanteric line.

ligament, to the dimple (fovea capitis) on the head of the femur. It encloses two fibrous bands, and some adipose tissue continuous with that lying at the bottom of the fovea and filling the cotyloid foramen; the fibrous bands, to which the name "ligamentum teres" is sometimes limited, are attached one on each side of the cotyloid notch, the stronger slip coming from the posterior margin, and both pass to the head of the femur. The use of this structure is very doubtful. It becomes tense during flexion with external rotation, but in many cases is so feebly developed that it could offer no serious resistance to a force capable of producing dislocation. It contains a small vessel which passes to the head of the femur.

The *synovial membrane* covers over the inner surface of the capsular and cotyloid ligaments, and is reflected on to the neck of the femur and into the cotyloid depression, covering the fat at the bottom of the fossa and passing to the fovea capitis of the femur as the sheath of the ligamentum teres.

When the ligamentum teres is destroyed by disease a communication is opened up between the synovial cavity and the deep intermuscular spaces of the thigh by means of the cotyloid foramen, and pus may escape from the articulation at this point.

The fat occupying the fovea acetabuli and cotyloid foramen serves to equalise the intra-articular pressure, and may be seen to bulge through the foramen or to be drawn into it during movements of the joint.

The Back of the Leg.

[A vertical incision through the centre of the remaining portion of skin on the back of the leg, joined by a short transverse cut at the heel, will permit the reflection of the skin to each side.]

The **External Saphenous Nerve** (Fig. 80, 8) (*communicans tibialis*) will be found piercing the deep fascia of the leg about half-way down the limb, to join the *communicans fibularis* (4), which becomes cutaneous near the knee. The nerve thus formed runs along the outer side of the tendo Achillis, to pass behind the external malleolus to the outer side of the foot and little toe.

This nerve or the external popliteal gives off one or more *external cutaneous* branches to the outer side of the leg.

A branch or two of the *internal saphenous nerve* (7) may be found on the inner side of the back of the leg. The termination of the *small sciatic* nerve may also be seen at the middle of the back of the leg.

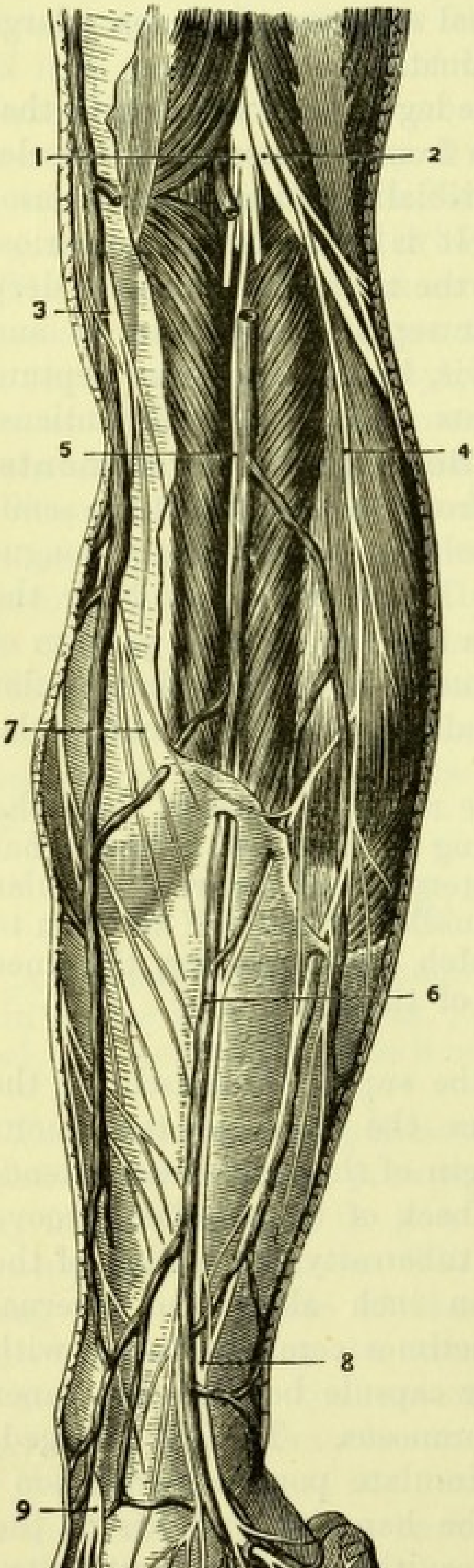
The **External Saphenous Vein** (Fig. 80, 6) arises from the outer side of the dorsal venous arch of the foot, and passes behind the external malleolus close to the external saphenous nerve, thence, running up the centre of the leg, it pierces the deep fascia at the point where the communicans tibialis nerve emerges, or at the level of the popliteal space; it has been already traced to the popliteal vein. It is often joined to the internal saphenous vein by a large branch which leaves it close to its termination.

The **External Deep Fascia** of the leg is continuous with that of the thigh. It receives reinforcements from the hamstring muscles and gives origin to the fibres of the tibialis anticus and extensor longus digitorum in front of the leg. It is adherent to the periosteum of the subcutaneous surface of the tibia, and from its deep surface pass two principal intermuscular septa, one in front of and one behind the peronei longus and brevis, besides a smaller septum between the extensor digitorum longus and the tibialis anticus. Beneath the gastrocnemius will be found **deep fascial investments**, one for the popliteus, mainly derived from the tendon of the semi-membranosus, the other, beneath the soleus, for the flexor longus digitorum, tibialis posticus, and flexor longus hallucis. Near the ankle this subsoleal intermuscular fascia and the anterior portion of the external deep fascia become continuous, and form the annular ligaments which bind down the foot tendons to the tibia and fibula.

[The deep fascia of the leg is to be removed, except near the malleoli, where thickened portions passing on each side between that bone and the calcaneum, called the internal and external annular ligaments, are to be preserved. The muscles of the calf are then to be dissected, after being put on the stretch by supporting the knee and drawing the toes towards the front of the leg.]

The **Gastrocnemius** (Fig. 81, 4), the superficial muscle of the calf, has a double-headed *origin* from the back of the femur immediately above the condyles, the origin of the outer head extending into a little depression above the back of the popliteal groove upon the external surface of the outer tuberosity, while that of the inner head runs upwards for about an inch along the internal supra-condyloid ridge. A bursa, sometimes communicating with the knee-joint, lies upon the back of the capsule beneath the inner head and the tendon of the semi-membranosus. This, if enlarged, may overlap the popliteal artery and simulate popliteal aneurism; and it may give rise to a swelling in the ham in synovitis of the knee when the synovial and bursal cavities are in continuity. The two heads (with the plantaris on the outer side), are the lower boundaries of the popliteal space, and unite to form one large muscle, the fibres of which end about the middle of the leg in a broad thin tendon that is joined anteriorly and laterally by the soleus. The conjoined tendon contracts near the heel into the thick rounded *tendo Achillis* (6), which expands again slightly, to be *inserted* into the middle part of the posterior surface of the calcaneum, a *bursa* intervening between it and the upper part of this surface of the bone.

Fig. 80.



[The inner head of the gastrocnemius has previously been cut; if the remaining head be now carefully divided near its origin, and the muscle turned down as far as possible, the plantaris and soleus, with the popliteus covered by its fascia, will be brought into view.]

The **Plantaris** (Fig. 75, 12) *arises* from above the external condyle of the femur and from the external supracondyloid ridge for about an inch, the muscle lying internally to and above the outer head of the gastrocnemius. Its fleshy fibres are about three inches long, but its tendon is the longest in the body and is very slender. It is placed between the gastrocnemius and soleus, and crosses obliquely to reach the inner side of the tendo Achillis, by the side of or in common with which it is *inserted* into the os calcis. It is homologous to the palmaris longus of the upper extremity, and is subject to like variations (p. 51).

Fig. 80.—Superficial nerves of the back of the leg (from Hirschfeld and Leveillé).

1. Internal popliteal nerve.
2. External popliteal nerve.
3. Internal saphenous vein.
4. Nervus communicans fibularis.
5. Nervus communicans tibialis.
6. External saphenous vein.
7. Branch of internal saphenous nerve.
8. External saphenous nerve.
9. Calcanean branch of posterior tibial nerve.

The **Soleus** (Fig. 81, 5) is tendinous on its surface, and between it and the corresponding tendinous expansion on the deep surface of the gastrocnemius is a quantity of loose areolar tissue. It *arises* from the oblique line of the tibia, from the middle third of the inner border of the bone, from the posterior surface of the head and upper third or more of the shaft of the fibula, from the intermuscular septum between it and the peroneus longus, and from a tendinous arch between the tibial and fibular origins over the vessels and nerves. The fibres end in a broad tendon, which joins that of the gastrocnemius below the middle of the leg to form the tendo Achillis, the *insertion* of which has been seen. The muscular fibres are inserted into the deep surface of the common tendon to within two inches of the heel.

By dividing the fibres of the soleus vertically and with care, a tendinous expansion on the deep surface of the muscle will be brought into view, which stretches across the deep muscles and the posterior tibial vessels and nerve. This deep tendon is an important guide in the operation of tying the posterior tibial artery, and must be divided to reach it.

The muscles of the calf are plantar flexors * of the foot, *i.e.*, point the toes, the gastrocnemius and plantaris, in addition, flexing the leg upon the thigh; or, when taking their fixed point below they may act upon the thigh. They are *supplied* by the internal popliteal nerve, a separate branch passing to each head of the gastrocnemius, and the soleus receives an additional branch from the posterior tibial nerve.

The form of club-foot known as 'talipes

Fig. 81.

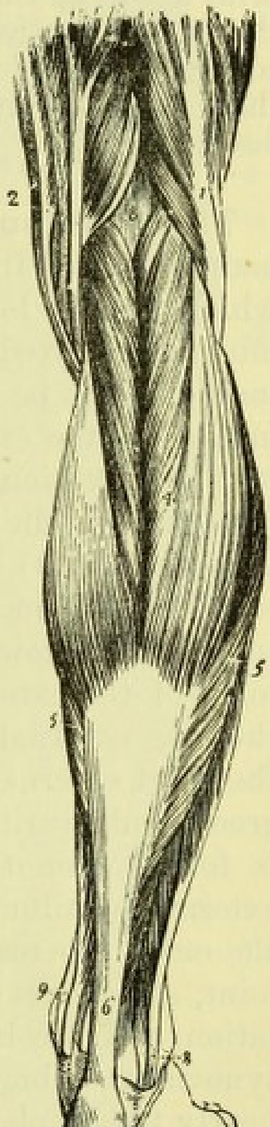


Fig. 81.—Superficial muscles of the back of the leg (from Wilson).

1. Tendon of biceps.
2. Tendons of inner hamstrings.
3. Popliteal space.
4. Gastrocnemius.
5, 5. Soleus.
6. Tendo Achillis.
7. Tuberosity of os calcis.
8. Tendons of the peroneus longus and brevis.
9. Tendons of the tibialis posticus and flexor longus digitorum.

* The terms flexion and extension as applied to the ankle are applied in opposite senses by different anatomists, and it is hence desirable to avoid their use altogether. "Dorsal flexion" and "plantar flexion" are self-explanatory.

equinus' is associated with contraction of the muscles of the calf, and division of the tendo Achillis is practised for its relief.

[The plantaris is to be divided and the soleus cut near its attachments to the tibia and fibula, when those muscles and the gastrocnemius are to be turned down, and the bursa between the tendon and the os calcis noticed. The posterior tibial vessels and nerve, partially covered by the deep layer of fascia, will now be exposed, and beneath them the deep muscles of the leg, with the popliteus covered by its fascia above.]

The **Popliteus** (Fig. 82, 9) is covered by a strong fascia which is mainly derived from the tendon of the semi-membranosus, and upon which rest the lower parts of the popliteal vessels and nerve. This must be removed to expose the oblique fibres of the muscle, and an incision must be made through the capsule of the knee immediately in front of the external lateral ligament if it be desired at this stage of the dissection to see its tendinous origin. The popliteus *arises* from within the general capsule of the knee (though outside the synovial cavity) by a round tendon, which is fixed to the anterior extremity of the popliteal groove on the outer side of the external tuberosity, below and a little in front of the tubercle for the attachment of the external lateral ligament. The tendon passes beneath the long external lateral ligament, and is intimately connected with the short external lateral ligament. It occupies the long popliteal groove only during flexion, but occasionally a short extension groove is found upon the border of the outer condyle. It grooves the external semilunar cartilage and runs obliquely over the back of the outer tuberosity of the tibia just above the superior tibio-fibular joint, sometimes establishing a communication between this articulation and the knee-joint by means of the bursal extension of the synovial membrane of the knee which invests it. It is *inserted* into nearly the whole of the triangular surface on the back of the upper part of the tibia, above the oblique line.

The popliteus is a flexor of the leg upon the thigh, and pronates or rotates the tibia inwards during flexion. It is supposed also to produce that slight rotation inwards of the tibia, which takes place at the commencement of flexion of the knee. It is *supplied* by a branch of the internal popliteal nerve, which winds round the lower border to reach the anterior surface of the muscle.

[The deep subsoleal or intermuscular layer of fascia of the leg being removed, the posterior tibial vessels and nerve are to be cleaned, when the subjacent muscles will be found in the following positions:

—flexor longus digitorum most internally, tibialis posticus in the middle, and flexor longus hallucis to the outer side.]

The **Flexor Longus Digitorum** (Fig. 82, 13) is a penniform muscle *arising* from the posterior surface of the tibia below the oblique line, and internally to the attachment of the tibialis posticus (from which it is separated by an indistinct vertical ridge and an intermuscular septum), the lower fibres of the muscle reaching to within three inches of the lower end of the tibia. It ends in a single tendon, which crosses to the outer side of that of the tibialis posticus at the ankle, and passes through a separate division of the internal annular ligament; then upon the inner surface of the sustentaculum tali to the sole of the foot, where it will be seen breaking up into four tendons, which give origin to the lumbricales and afterwards perforate the tendons of

Fig. 82.

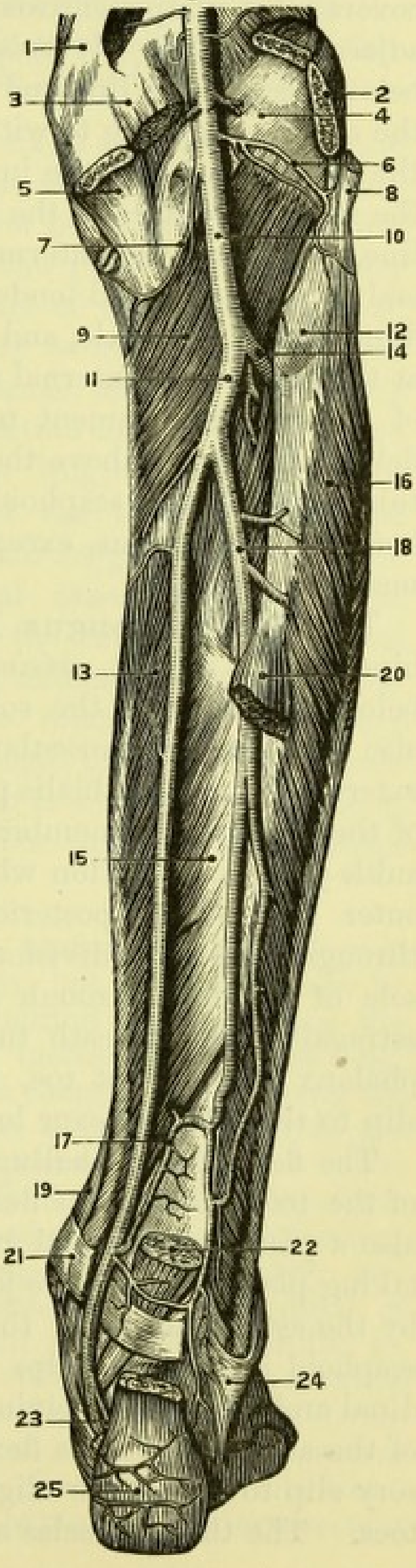


Fig. 82.—Arteries of the back of the leg (from Bonamy and Beau).

1. Adductor magnus.
2. Outer head of gastrocnemius.
3. Inner head of gastrocnemius.
4. Capsule of knee-joint.
5. Semi-membranosus.
6. Inferior external articular artery.
7. Inferior internal articular artery.
8. Tendon of biceps.
9. Popliteus.
10. Popliteal artery.
11. Posterior tibial artery.
12. Head of fibula.
13. Flexor longus digitorum.
14. Anterior tibial artery.
15. Tibialis posticus.
16. Peroneus longus.
17. Communicating branch with peroneal
18. Peroneal artery.
19. Tendon of tibialis posticus.
20. Flexor longus hallucis.
21. Internal annular ligament.
22. Tendon of flexor longus pollicis.
23. Calcanean branch of posterior tibial artery.
24. External annular ligament.
25. Anastomosis on the back of the os calcis.

the short flexor, to become inserted into the ungual phalanges of the four outer toes. In the sole it will be found reinforced by a fibrous slip from the tendon of the flexor longus hallucis.

The **Tibialis Posticus** (Fig. 82, 15) is the only one of the deep muscles which is attached to both bones of the leg. It is covered by an aponeurosis which forms septa between it and the adjacent muscles. It *arises* from the posterior surface of the tibia, below the oblique line and externally to the flexor longus digitorum, the origin extending to within two inches of the ankle; from nearly the whole length of the interosseous membrane; from the whole of the internal surface of the fibula immediately behind the interosseous line, and from the intermuscular septa on each side. The fibres end in a single broad tendon, which passes beneath that of the flexor digitorum at the ankle, and then to its inner side, running in a groove at the back of the internal malleolus and in the most internal division of the annular ligament to the sole, where, after passing over the deltoid ligament (above the sustentaculum tali) it is *attached* to the tuberosity of the scaphoid bone and gives slips to all the other bones of the tarsus, except the astragalus, and to the three middle metatarsal bones.

The **Flexor Longus Hallucis** (Fig. 82, 20) is a well-marked bipenniform muscle, *arising* from the posterior surface of the fibula below the origin of the soleus to within an inch of the ankle; and also from the intermuscular septa between it and the peronei muscles externally and the tibialis posticus internally, and from the lower part of the interosseous membrane. The muscle ends, at the level of the ankle-joint, in a tendon which lies on the back of the tibia to the outer side of the posterior tibial vessels and nerve, and, passing through a separate division of the annular ligament, winds to the sole of the foot through a groove on the posterior surface of the astragalus and beneath the sustentaculum tali to reach the ungual phalanx of the great toe, where it is inserted. Its tendon gives a slip to that of the flexor longus digitorum in the sole.

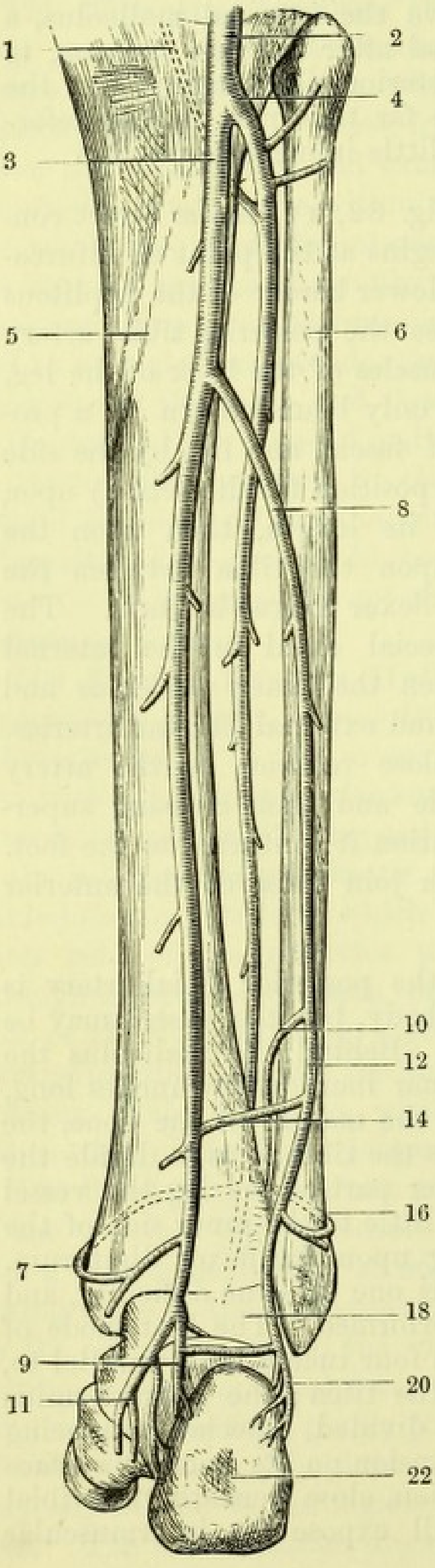
The flexor longus hallucis and flexor digitorum are direct flexors of the toes and plantar flexors of the foot. The tibialis posticus is also a plantar flexor and an adductor of the foot, the first movement taking place at the ankle-joint, the second at the articulation formed by the astragalus with the calcaneum and scaphoid (talo-calcaneo-scaphoid joint), and helps the other tendons to maintain the longitudinal arch of the foot, giving powerful support to the keystone (head of the astragalus). The flexor longus hallucis, by means of its accessory slip to the flexor digitorum, aids in the flexion of the smaller toes. The three muscles are *supplied* by the posterior tibial nerve.

Surgery.—The form of club-foot called 'talipes varus' which causes the patient to walk on the outside or even on the dorsum of the foot, is associated with a contraction of the tibialis posticus and sometimes of the flexor digitorum. The operation of dividing these tendons is performed immediately above the internal malleolus, a blunt-pointed tenotomy knife being used after the first incision, to avoid all danger of wounding the posterior tibial artery, but the ligaments, fasciæ and even the bones so far take part in the deformity that the tenotomy alone produces little immediate results.

The **Posterior Tibial Artery** (Fig. 82, 11) is the direct continuation of the popliteal artery, and begins at the point of bifurcation of that vessel, which is usually the lower border of the popliteus muscle. In the upper part of its course the posterior tibial artery lies between the superficial and deep muscles of the back of the leg, but below the origin of the soleus it is only bound down by a prolongation of the intermuscular layer of fascia, and lies by the side of the tendo Achillis. It rests (in the position for dissection) upon the tibialis posticus for two-thirds of its length, then upon the flexor digitorum, and at the ankle upon the tibia between the tendons of the flexor digitorum and flexor longus hallucis. The vessel afterwards passes through a special canal in the internal annular ligament to the interval between the inner malleolus and the heel, where it divides into internal and external plantar arteries. The posterior tibial nerve is in a close relation to the artery throughout, lying first to its inner side and then crossing superficially to its outer side, in which relation it continues to the foot. The artery has two *venæ comites,* which join those of the anterior tibial artery to form the popliteal vein.

Surgery.—The operation of tying the posterior tibial artery is seldom performed except on the dead body, but the vessel may be reached in three parts of its course. Behind the malleolus the artery is readily exposed by a semilunar incision two inches long, made three quarters of an inch behind the margin of the bone, the edge of the knife being directed towards the tibia so as to divide the internal annular ligament. At the lower part of the leg the vessel may be reached by a vertical incision a little to the inner side of the tendo Achillis, and will be found lying upon the flexor digitorum. In the middle of the leg the operation is one of some difficulty, and somewhat damages the dissection if performed. The best mode of proceeding is to make a vertical incision four inches long, parallel to, and half an inch behind, the edge of the tibia; the gastrocnemius slips aside and the soleus is then to be divided, especial care being taken to cut through the tendinous expansion on its anterior surface but to go no deeper. A little dissection, close beneath this tibial attachment and towards the fibula, will expose the intermuscular fascia and beneath it the posterior tibial artery lying upon the tibialis posticus, with the posterior tibial nerve to its outer side.

Fig. 83.



The **Branches** (Figs. 82, 83) of the posterior tibial artery are (1) peroneal ; (2) muscular ; (3) medullary to the tibia ; (4) communicating ; and (5) internal calcanean.

1. The *Peroneal* (Fig. 82, 18), always of considerable size and sometimes larger than the posterior tibial, comes off about two inches below the popliteus. It lies at first between the tibialis posticus and the soleus, but afterwards passes into the fibres of the flexor hallucis and runs close to the inner border of the fibula almost as far as the lower end of that bone. In this part of its course it gives *muscular* branches, and the *medullary* artery to the fibula, which has a downward direction ; *i.e.*, runs *from* the knee-joint. It then gives a good-sized *anterior*

Fig. 83.—Anastomoses of tibial arteries.

1. Anterior tibial recurrent.
2. Popliteal.
3. Posterior tibial, giving off muscular and medullary branches.
4. Anterior tibial, giving off posterior tibial recurrent and superior fibular before piercing interosseous membrane and anterior tibial afterwards.
5. Tibia.
6. Fibula.
7. Anastomosis of internal malleolar of anterior tibial with posterior internal malleolar.
8. Peroneal.
9. Internal calcanean.
10. Anterior peroneal.
11. Internal and external plantar.
12. Posterior peroneal.
14. Communicating.
16. External malleolar of anterior tibial joining posterior peroneal.
18. Astragalus.
20. External calcanean.
22. Calcaneum.

peroneal branch, through the interosseous membrane, to the front of the leg, where it will afterwards be dissected ; and is joined by a *communicating* branch from the posterior tibial. Its terminal branch is the *external calcanean*, which passes over the posterior inferior tibio-fibular ligament to anastomose with the malleolar arteries and supply the outer side of the calcaneum, there joining with the calcanean branches of the posterior tibial and with the external plantar.

2. *Muscular* branches are given to the deep muscles and also to the soleus. The highest of these may send a twig to join the anastomosis about the knee.

3. The *Medullary* artery to the tibia is of large size, and enters the foramen on the posterior surface of that bone ; it arises from the upper part of the posterior tibial, and has a direction *from* the knee-joint.

4. A *Communicating* (17) branch runs transversely immediately above the ankle to join the peroneal artery or its posterior terminal branch.

5. A *Posterior Internal Malleolar* is usually found a little above the malleolus, running transversely beneath the tendons of the flexor digitorum and tibialis posticus to reach the front of the leg, and anastomose with the internal malleolar of the anterior tibial.

6. The *Internal Calcanean* (23) is a branch of variable size, and may be replaced by two or more separate arteries. It arises from the posterior tibial beneath the internal annular ligament, piercing the latter to supply the inner side of the os calcis, with the adjacent structures and the integument, and to anastomose with the calcanean branches of the peroneal and external plantar. These calcanean vessels nourish the heel flap after Symes' amputation at the ankle, and must hence be dealt with gently in this operation.

The **Anterior Tibial Artery** (Fig. 83, 4) is seen just before it pierces the interosseous membrane to reach the front of the leg. It gives off two branches while in this position : the *posterior tibial recurrent*, which runs upward over the head of the fibula, to anastomose with the inferior external articular ; and the *superior fibular*, which winds around the neck of the fibula to anastomose with the anterior tibial recurrent.

The **Posterior Tibial Nerve** (Fig. 84, 19) is the continuation of the internal popliteal trunk, and passes with the artery beneath the soleus, to lie on the deep muscles of the back of the leg. It is placed at first to the inner side of the posterior tibial artery, but crosses that vessel in the upper part, and lies to its outer side at the ankle, and in the same division of the annular ligament. The nerve divides near the joint into internal and external plantar branches, and if the division takes place above the inner malleolus, the nerves are usually found on either side of the artery.

The posterior tibial nerve gives *muscular* branches to the tibialis posticus, flexor longus digitorum, flexor longus hallucis, and soleus, and small branches to the vessels, bones, and interosseous membrane; finally, near the ankle, it sends off a cutaneous *calcaneo-plantar* nerve (20), which pierces the internal annular ligament and fascia at the inner side of the tendo Achillis, and may be traced to the skin of the heel and sole.

Parts behind and below the Inner Malleolus (Fig. 85). Although the several parts behind the internal malleolus are only continuations of those which have been already dissected, especial notice should be taken

Fig. 84.

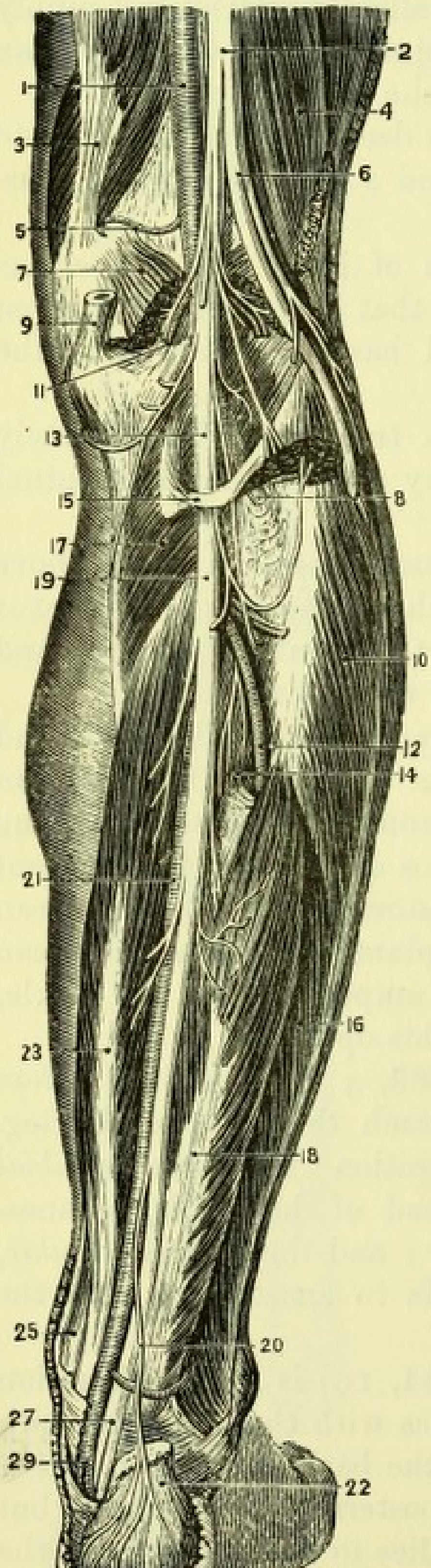


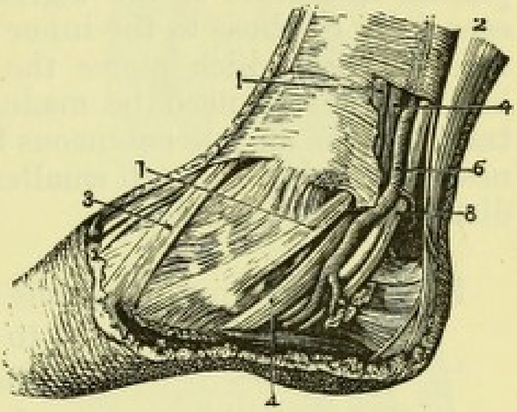
Fig. 84.—Deep dissection of the back of the leg (from Hirschfeld and Leveillé).

1. Popliteal artery.
2. Great sciatic nerve.
3. Adductor magnus.
4. Biceps.
5. Superior internal articular artery.
6. External popliteal nerve.
7. Gastrocnemius (cut).
8. Anterior tibial artery.
9. Tendon of semi-membranosus.
10. Peroneus longus.
11. Sural arteries and nerves.
12. Peroneal artery.
13. Internal popliteal nerve.
14. Tibialis posticus.
15. Portion of soleus.
16. Peroneus brevis.
17. Popliteus.
18. Flexor longus hallucis.
19. Posterior tibial nerve.
20. Calcanean branch of posterior tibial nerve.
21. Posterior tibial artery.
22. Tendo Achillis.
23. Flexor longus digitorum.
25. Tendon of tibialis posticus.
27. Plantar nerves.
29. Plantar arteries.

of them in this part of their course, as their relations are important.

A portion of the skin on the inner side of the heel and sole is to be reflected if necessary, so as to expose the whole breadth of the *internal annular ligament*, which is a thickened portion of the deep fascia of the leg stretching from the inner malleolus to the os calcis, and giving origin by its lower border to the abductor hallucis.

Fig. 85.



The divisions in the annular ligament are four in number, and are occupied as follows, at the level of the ankle. In the first and innermost division is the tibialis posticus; in the second the tendon of the flexor longus digitorum; in the third the posterior tibial vessels and nerve; and in the fourth and most external the tendon of the flexor longus hallucis (Fig. 86). Below the malleolus (Fig. 85), the tibialis posticus tendon is highest, and crosses the internal lateral ligament of the ankle above the sustentaculum tali to reach the tubercle of the scaphoid; the flexor longus digitorum, next in order, runs over the outer surface of the sustentaculum tali (but rarely grooves it) before disappearing beneath the sole; lastly, the flexor longus hallucis runs in a groove behind the astragalus and beneath the sustentaculum tali. The order then of these three tendons is here the same from above downwards as it was from within outwards at the back of the ankle. The plantar vessels and nerves are superficial to the flexor longus hallucis tendon as they approach the sole. Each of the tendons is lubricated by a distinct synovial membrane.

The Sole of the Foot.

[The foot being raised on a block so that the sole may be fully

Fig. 85.—Relation of parts behind and below the inner malleolus (from Hirschfeld and Leveillé).

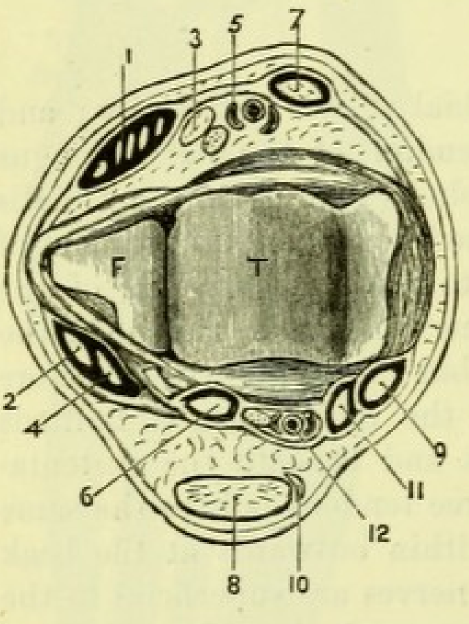
1, 1. Tibialis posticus.
2. Tendo Achillis.
3. Tibialis anticus.
4, 4. Flexor longus digitorum.
6. Posterior tibial artery.
8. Posterior tibial nerve.

The tendon of the flexor longus hallucis is too deeply placed to be shown in his view.

exposed, an incision is to be made down its centre from the heel to the bases of the toes, the knife being carried at once down to the glistening plantar fascia through the thick lobulated fat which is always found beneath the skin in this region. A transverse incision at the roots of the toes will allow the skin and fat to be reflected to each side, if the knife is kept close to the fascia and parallel to its fibres. Near the toes care must be taken of the divisions of the plantar fascia and of the digital nerves which appear between them, especially of those to the inner side of the first and the outer side of the fifth toes, which pierce the fascia further back than the others; but no attempt need be made, except by the advanced dissector, to trace out the minute cutaneous branch from the posterior tibial nerve near the heel or the still smaller twigs of the internal plantar nerve distributed to the sole.]

In the description the terms superficial, deep, &c., necessarily refer to the position of the parts as seen in the dissection, and not to that which they would hold if the body were in the upright position.

Fig. 86.



The **Plantar Fascia** (Fig. 87, 2) closely resembles the fascia of the palm, and is divisible into three portions. The *central*, which is the strongest, is attached to the under surface of the great tuberosity of the os calcis, but, as it passes forwards, expands to nearly the entire width of the foot. It splits into five portions opposite the heads of the metatarsal bones, and at this point distinct transverse fibres will be seen passing across the foot, beneath the longitudinal fibres. The five processes are attached to the sides of the proximal phalanx, and to the sheath of the flexor tendons of each toe, and between them pass the several digital vessels and nerves.

A *superficial transverse ligament*, like the fascia of Gerdy in the

---

Fig. 86.—Section of the right ankle (drawn by G. E. L. Pearse).

1. Extensor longus digitorum and peroneus tertius.
2. Peroneus longus.
3. Extensor proprius pollicis.
4. Peroneus brevis.
5. Anterior tibial vessels and nerves.
6. Flexor longus hallucis.
7. Tibialis anticus.
8. Tendo Achillis.
9. Tibialis posticus.
10. Plantaris.
11. Flexor longus digitorum.
12. Posterior tibial vessels and nerves.

hand, may be seen in the skin of the web of the toes, passing over the digital vessels and nerves, and becoming continuous with the fascia of the toes and dorsum of the foot.

The central portion of the fascia gives origin to muscular fibres by its deep surface, and also by two intermuscular septa, which will subsequently be seen on each side of the flexor brevis digitorum. The *lateral* portions of the plantar fascia are much thinner than that in the centre, and mainly cover the muscles of the great and little toes on the inner and outer sides of the foot, but there is a strong band on the outer side running from the outer tubercle of the calcaneum to the base of the fifth metatarsal bone.

[The central portion of the fascia is to be cut across about two inches from the heel, and may then be turned down over the toes without injuring the digital nerves, when the flexor brevis digitorum will be exposed in part, and the intermuscular septa on each side may be seen. The lateral portions of the fascia are to be removed, and the abductor hallucis and abductor minimi digiti cleaned.]

Fig. 87.

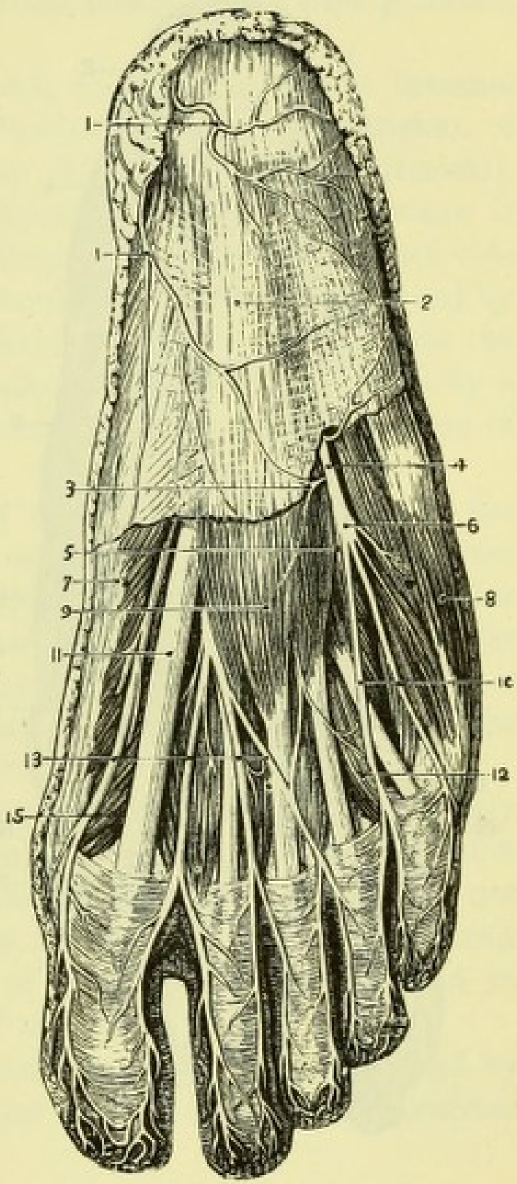
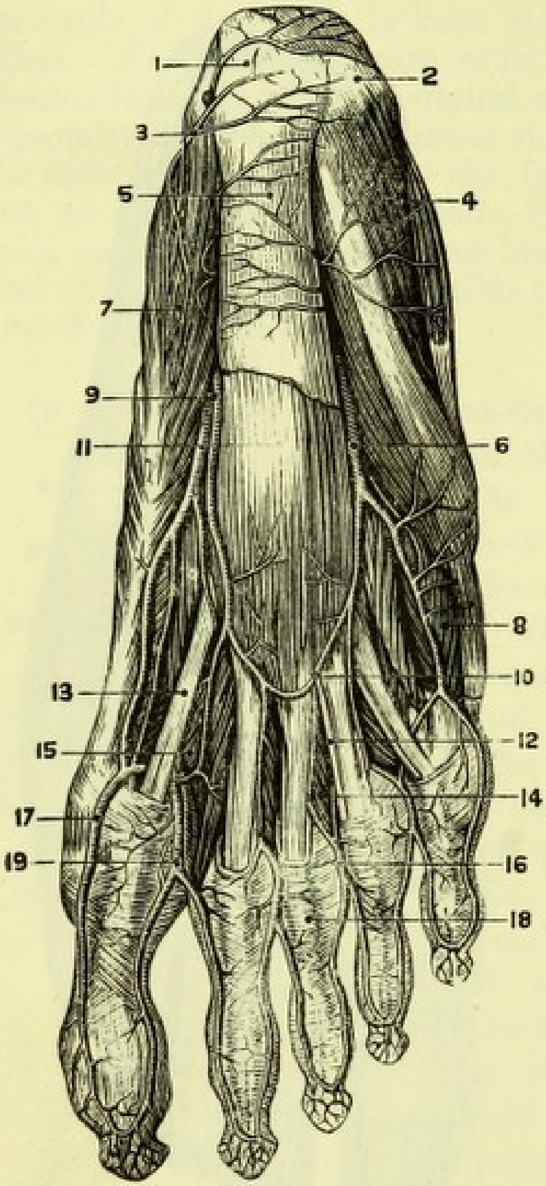


Fig. 87.—Superficial nerves of the sole of the foot (from Hirschfeld and Leveillé).

1, 1. Cutaneous plantar branches of posterior tibial nerve.
2. Plantar fascia.
3. Cutaneous branch of external plantar nerve.
4. External plantar nerve.
5. Its deep division.
6. Its superficial division.
7. Abductor hallucis.
8. Abductor minimi digiti.
9. Flexor brevis digitorum.
10. Digital branches of external plantar nerve.
11. Tendon of flexor longus hallucis.
12. One of the lumbricales muscles.
13. Digital branches of internal plantar nerve.
15. Flexor brevis hallucis.

The **First Layer of Muscles** consists of the flexor brevis digitorum in the middle, the abductor hallucis to the inner side, and the abductor minimi digiti to the outer side.

Fig. 88.



The **Flexor Brevis Digitorum** (Fig. 88, 11) *arises* from the anterior border of the inner tuberosity of the os calcis; from the plantar fascia covering it (which has therefore been left undisturbed); and from the intermuscular septa on each side. It divides into four tendons, which pass into tendinous sheaths on the under surfaces of the four smaller toes, and are perforated by the tendons of the long flexor as in the hand (*q. v.*); and are *inserted*, each by two slips, into the sides of the second phalanges. The tendon to the little toe is often a mere thread.

The sheaths of the tendons resemble those of the hand, but are smaller. Beginning over the heads of the metatarsal bones, each sheath is joined by a process of plantar fascia, and then extends to the base of the terminal phalanx. The sheath is strong opposite

Fig. 88.—Superficial dissection of the sole of the foot (from Bonamy and Beau).

1. Greater tuberosity of os calcis.
2. Lesser tuberosity of os calcis.
3. Calcanean branch of posterior tibial artery.
4. Abductor minimi digiti.
5. Plantar fascia.
6. External plantar artery.
7. Abductor hallucis.
8. Flexor brevis minimi digiti.
9. Internal plantar artery.
10. Arch between plantar arteries (not constant).
11. Flexor brevis digitorum.
12. Third tendon of flexor longus digitorum.
13. Flexor longus hallucis.
14. Lumbricalis of 3rd space.
15. Flexor brevis hallucis.
16. Digital artery of 3rd space.
17. Digital branch from dorsal artery of foot.
18. Sheath of tendons.
19. Digital artery of 1st space (from dorsal artery of foot).

the shaft of each phalanx (*ligamentum vaginale*), but thinner over the joints, so as not to impede their motion; and, when divided, will be found to be lined by a synovial membrane which is reflected over the tendons. Small elastic bands (*vincula vasculosa*) connect each tendon of the flexor brevis with the front of the first phalanx, as in the hand.

The **Abductor Hallucis** (Fig. 88, 7) *arises* from the internal annular ligament, from the inner tuberosity on the under surface of the os calcis (internal to the origin of the flexor brevis digitorum), from the plantar fascia, from the intermuscular septum between it and the flexor brevis digitorum, and from the fascia on the inner side of the foot. The muscle ends in a broad tendon, which is joined by the inner head of the flexor brevis hallucis, and is *inserted* into the inner side of the base of the first phalanx of the great toe, and by a fibrous expansion into the inner side of the long extensor tendon of the same toe.

The **Abductor Minimi Digiti** (Fig. 88, 4) *arises* from the outer and inner tuberosities of the os calcis in front of the flexor brevis digitorum; from the plantar fascia and intermuscular septum; and from the fascia of the outer border of the foot as far forward as the base of the fifth metatarsal bone. Its tendon is *inserted* into the outer side of the base of the first phalanx of the little toe.*

The actions of the superficial muscles of the foot are partly indicated by their names, but it should be remarked that abduction and adduction are from and to the median plane of the foot and not of the body. The abductors are also flexors of the toes with which they are connected, and the whole of the plantar muscles aid in maintaining the longitudinal arch of the foot.

The flexor brevis digitorum and abductor hallucis are *supplied* by the internal plantar nerve; the abductor minimi digiti by the external plantar nerve.

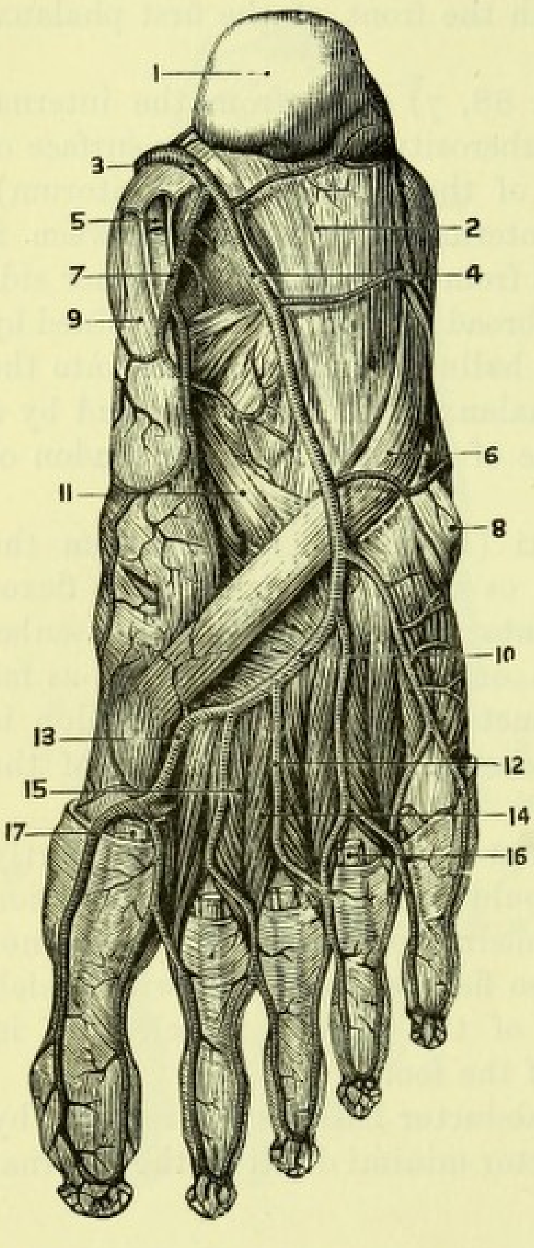
[To bring the deeper parts into view, the best way will be to remove with the saw a thin slice of the os calcis, including the attachments of the superficial muscles, when, if the attachment of the abductor hallucis to the internal annular ligament be divided, they can be turned forwards, and the plantar nerves and vessels will be seen.]

The **Plantar Arteries** (Fig. 89), internal and external, are the

* Mr. John Wood has described an *abductor ossis metatarsi quinti*, which is occasionally found beneath the abductor and attached to the base of the fifth metatarsal bone.

terminal branches of the posterior tibial, and enter the foot beneath the abductor hallucis and in close relation with the plantar nerves. The internal plantar artery, which is the smaller of the two, is accompanied by the large internal plantar nerve, the large external plantar artery going with the smaller external nerve. Both vessels are accompanied by venæ comites.

Fig. 89.



The *Internal plantar artery* (7) is usually of small size, and runs forward in the fascial septum between the abductor hallucis and flexor brevis digitorum to the great toe, where it anastomoses with the internal and communicating branches of the dorsal artery of the foot. If well-injected it may sometimes be traced with the nerve to the third interosseous space, joining the digital branches to the three inner toes.

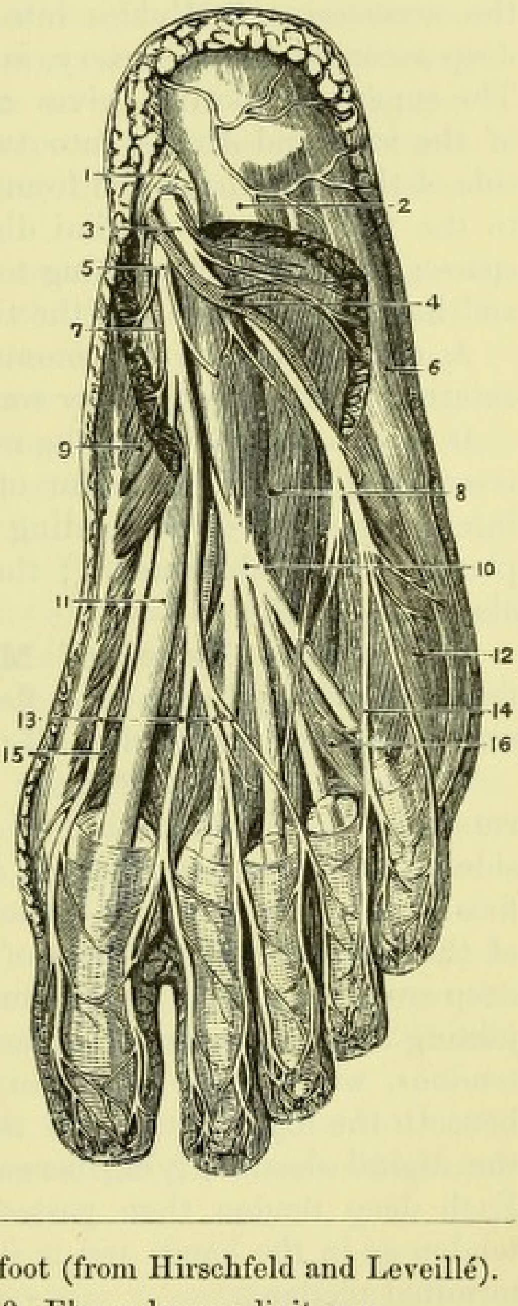
The *External plantar artery* (4) runs obliquely outwards across the foot between the flexor brevis digitorum and the accessorius muscle, and, turning round the outer border of the latter, courses inwards beneath the digital tendons towards the

Fig. 89.—Deep dissection of the sole of the foot (from Bonamy and Beau).

1. Os calcis.
2. Ligamentum longum plantæ.
3. Posterior tibial artery.
4. External plantar artery.
5. Tendon of flexor longus hallucis.
6. Tendon of peroneus longus.
7. Internal plantar artery.
8. Base of 5th metatarsal bone.
9. Tendon of tibialis posticus.
10. Plantar arch.
11. Prolongation of tendon of tibialis posticus.
12. Digital artery.
13. Communicating branch of dorsal artery of foot.
14. Plantar interosseous of 2nd space.
15. Dorsal interosseous of 2nd space.
16. Tendon of flexor longus digitorum.
17. Tendon of flexor longus hallucis.

great toe, where it will be subsequently traced, joining the communicating branch of the dorsal artery of the foot and completing the deep plantar arch. It is accompanied by the external plantar nerve (which also gives a deep branch across the foot) and supplies the adjacent muscles, giving a branch to the outer side of the foot to anastomose with the external calcanean branch of the peroneal artery.

Fig. 90.



The **Plantar Nerves** (Fig. 90), internal and external, are the branches of the posterior tibial nerve; their relation to the arteries has been mentioned.

The *Internal plantar nerve* (5) is the larger of the two, and after supplying small cutaneous twigs to the sole and muscular branches, to the abductor hallucis and flexor brevis digitorum, gives off a digital branch to the inner side of the great toe, and breaks up into three other digital branches, which lie between the plantar fascia and the tendons of the flexor brevis digitorum; each of these bifurcates at the roots of the toes and they thus *supply* the outer side of the great toe, both sides of the second and third toes, and the inner half of the fourth toe. The first digital branch also supplies the flexor brevis hallucis, the

Fig. 90.—Deep nerves of the sole of the foot (from Hirschfeld and Leveillé).

1. Internal annular ligament.
2. Flexor brevis digitorum (cut).
3. External plantar nerve.
4. External plantar artery.
5. Internal plantar nerve.
6. Abductor minimi digiti.
7. Internal plantar artery.
8. Accessorius muscle.
9. Abductor hallucis.
10. Flexor longus digitorum.
11. Flexor longus hallucis.
12. Flexor brevis minimi digiti.
13. Digital branches of internal plantar nerve.
14. Digital branches of external plantar nerve.
15. Flexor brevis hallucis.
16. One of the lumbricales.

second and third supply the first and second lumbricales respectively, and the fourth is joined by a twig from the external plantar nerve.

The *External plantar nerve* (3) crosses the foot with and in front of the external plantar artery, giving branches to the abductor minimi digiti and accessorius in its course. At the outer border of the accessorius it divides into superficial and deep portions; the deep accompanies the artery, and will be seen in a later dissection. The superficial portion gives cutaneous branches to the outer part of the sole, and divides into two digital branches, one to the outer side of the little toe,—and from this commonly are derived branches to the flexor brevis minimi digiti and the interossei of the fourth space; the other, bifurcating to supply the inner side of the little and half the next toe and the two outer lumbricales.

A slender branch of communication between the internal and external plantar nerves may sometimes be found.

It may be noticed that the nerves of the sole of the foot closely resemble those of the palm of the hand in their distribution, the internal plantar corresponding to the median, and the external plantar to the ulnar nerve; the deep branches of the latter nerves also correspond.

The **Second Layer of Muscles** includes the tendons of the flexor longus digitorum and flexor longus hallucis, with the accessorius and the lumbricales, all of which should now be cleaned.

The tendon of the **Flexor Longus Digitorum** (Fig. 90, 10) runs upon the inner surface of the sustentaculum tali to the inner side of the vessels and nerves, and crosses beneath these and superficial to the tendon of the flexor longus hallucis to reach the centre of the foot, where the fibres of the accessorius are attached to its deep surface; a small slip from the flexor longus hallucis tendon joining it at a somewhat higher level. It then divides into four tendons, which give origin to the lumbricales muscles and pass beneath the digital nerves to the four small toes, where they enter the digital sheaths, lying beneath the tendons of the short flexor. Each deep tendon then passes through the slit in the superficial tendon as in the hand, and is *inserted* into the base of the third or terminal phalanx.

The **Accessorius** (Fig. 90, 8) *arises* from the under surface of the os calcis by two heads, between which is seen the long plantar ligament. The inner head, which is fleshy and the larger of the two, is attached to the concave line separating the inferior from the internal surface of the calcaneum, and to the inner edge of the long plantar ligament; the outer head, which is tendinous, is attached to the bone in front of the lesser tuberosity and to the long plantar ligament. The muscle is *inserted* into the deep surface and outer border of the flexor longus digitorum, and sends slips to the tendons connected with the second, third, and fourth toes.

The **Lumbricales** (Fig. 90, 16) are four small muscles, which are so named from their fancied resemblance to earth-worms. They *arise* from the tendons of the flexor longus digitorum, the most internal from one, and the rest from two tendons each, and wind to the inner sides of the four small toes to reach their dorsal aspects, where they are *inserted* into the corresponding sides of the bases of the proximal phalanges, seldom joining the extensor tendons as in the hand.

The *action* of the accessorius is essentially to supplement the long flexor and to flex the toes when the flexor longus is relaxed by the elevation of the heel in plantar flexion. Its tendency to bring the line of traction of the flexor tendons into the centre of the foot is probably of very trifling service. The degenerate lumbricales of the foot are less important than those in the hand, and their function is usually limited to slight flexion and tibial adduction of the proximal phalanges. The accessorius and the two outer lumbricales are *supplied* by the external plantar nerve ; and the two inner lumbricales by the internal plantar.

The tendon of the **Flexor Longus Hallucis** (Fig. 90, 11), after lying in the groove behind the astragalus and below the sustentaculum tali of the os calcis, runs forward to the great toe, under cover of the plantar vessels and nerves, and is crossed superficially by the tendon of the flexor digitorum, to which it gives a slip of reinforcement. It then lies between the two heads of the flexor brevis hallucis, and the two sesamoid bones with their connecting ligament form a deep channel for it ; finally it runs in the sheath formed by the ligamentum vaginale until its *insertion* into the base of the terminal phalanx of the great toe.

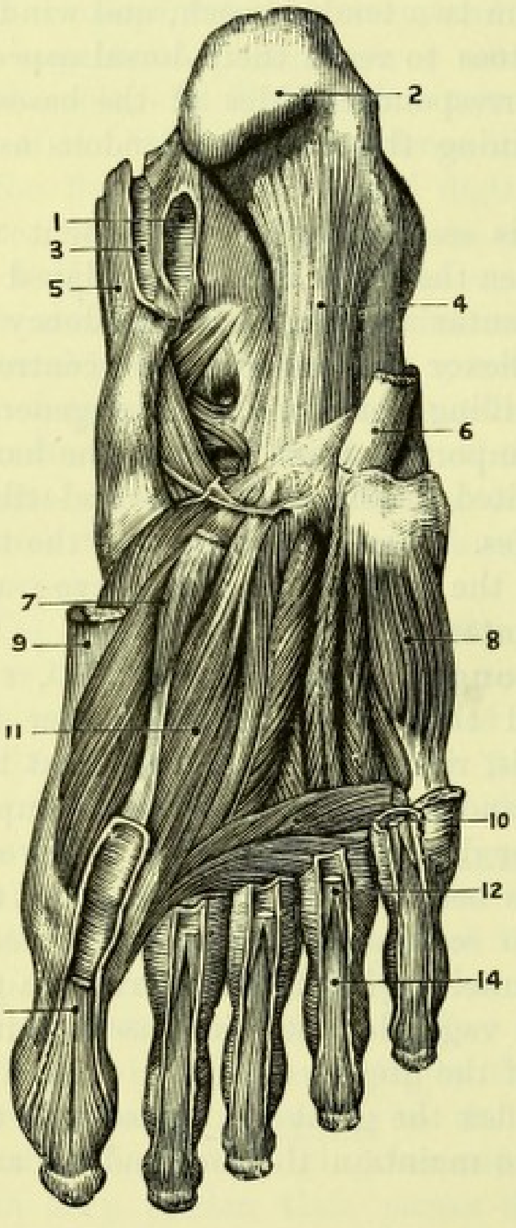
The action of the muscle is to flex the great toe, to assist in the plantar flexion of the ankle, and to maintain the longitudinal arch of the foot.

[The long tendons and the accessorius muscle are to be cut about the middle of the foot and turned down, when the muscles of the third layer are to be cleaned. In doing this the external plantar vessels and nerve will be more fully, but not yet completely, exposed.]

The **Third Layer of Muscles** consists of the flexor brevis hallucis, adductor hallucis, flexor brevis minimi digiti, and transversus pedis.

The **Flexor Brevis Hallucis** (Fig. 91, 7) *arises* by a narrow tendinous origin from the inner side of the cuboid, the long calcaneo-cuboid ligament, and from the prolongation of the tendon of the tibialis posticus to the external and middle cuneiform bones. Its fibres form two heads, which diverge from each other near the head of the metatarsal bone, to be *inserted* into opposite sides of the base of the first phalanx of the great toe with the abductor and adductors respectively, and by means of fibrous expansions derived in part from the abductor and adductors into the sides of the extensor longus hallucis. Each head has developed in its tendon a large sesamoid bone, which enters into the formation of the metatarso-phalangeal joint. The tendon of the long flexor lies between the two heads of this muscle. The sesamoid bones in the tendon form the anterior resting point or pier of the inner side of the plantar arch.

Fig. 91.



The **Adductor Obliquus Hallucis** (Fig. 91, 11) *arises* from the bases of the second, third, and fourth metatarsal bones, and from the long plantar ligament where it bridges over

Fig. 91.—Deep muscles of the sole of the foot (from Sappey).

1. Sheath of flexor longus hallucis.
2. Os calcis.
3. Sheath of flexor longus digitorum.
4. Ligamentum longum plantæ.
5. Sheath of tibialis posticus.
6. Tendon of peroneus longus.
7. Flexor brevis hallucis.
8. Flexor brevis minimi digiti.
9. Tendon of abductor hallucis.
10. Adductor transversus hallucis.
11. Adductor obliquus hallucis.
12. Tendon of flexor brevis digitorum to 4th toe.
13. Tendon of flexor longus hallucis.
14. Tendon of flexor longus digitorum to 4th toe.

the peroneus longus tendon. It is *inserted* into the outer side of the base of the first phalanx of the great toe, with the outer head of the flexor brevis, and sends a dorsal slip to the tendon of the extensor longus hallucis.

The **Adductor Transversus Hallucis** (Transversus pedis) (Fig. 91, 10) is of variable size, and consists of three or four small bundles, which *arise* from the plantar transverse metatarsal ligament over the heads of the three or four metatarsal bones, and separate the tendons and nerves from the interossei and vessels. It is *inserted* into the outer side of the first phalanx of the great toe, with the adductor obliquus and part of the flexor brevis hallucis.

Actions.—The flexor brevis, abductor, and adductores hallucis act together in flexing the proximal phalanx of the great toe, and by means of the dorsal slips aid in extending the ungual phalanx; the adductors draw the toe towards the middle line of the foot, the abductor in the opposite direction. All help to maintain the plantar arch. The flexor brevis hallucis is *supplied* by the internal plantar nerve, the other muscles by the external plantar nerve.

The **Flexor Brevis Minimi Digiti** (Fig. 91, 8) *arises* from the under surface of the projecting base of the fifth metatarsal bone and from the sheath of the peroneus longus, and is *inserted* into the outer side of the base of the first phalanx of the little toe with the abductor.*

[The adductor and flexor brevis hallucis are to be cut near their origins and turned down, after which the plantar arch of the external plantar artery, with the accompanying nerve, is to be fully traced out, and the lower aspect of the interossei may be defined.]

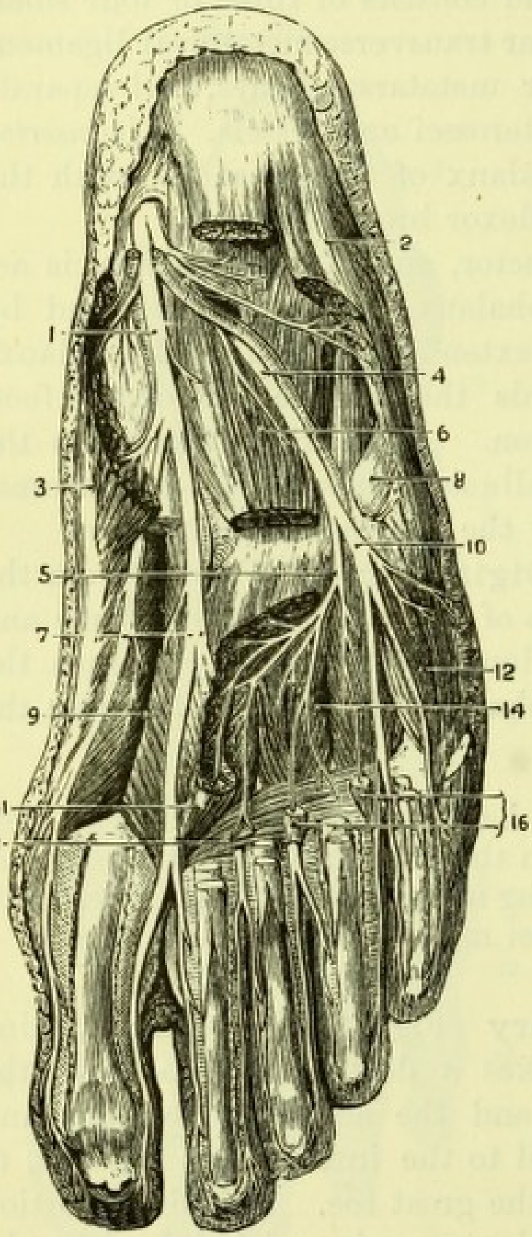
The **External Plantar Artery** (Fig. 89, 4) after turning around the accessorius muscle takes a deep course beneath the flexor tendons of the lesser toes and the adductor obliquus and flexor brevis pollicis, and superficial to the interosseous muscles, to the base of the metatarsal bone of the great toe. This deep portion of the artery has been called the *plantar arch*, and is joined by the *communicating* branch of the dorsalis pedis artery which enters the sole between the first and second metatarsal bones.

Branches.—Small *recurrent* twigs pass backward from the concavity of the arch to supply the tarsus. Three small *posterior perforating arteries*, given off by the plantar arch, pierce the intervals behind the origins of the 2nd, 3rd and 4th dorsal inter-

* A *flexor ossis metacarpi minimi digiti* attached to the metatarsal bone may occasionally be found.

osseous muscles and anastomose with the interosseous arteries on the dorsum of the foot. Four *digital arteries* arise from the anterior part of the arch; the outer one goes to the outer side of the little toe, the others bifurcate to supply the adjacent sides of four inner toes, and, at the point of bifurcation, send *anterior perforating* arteries to the back of the foot. The digital arteries run on the sides of the toes with the digital nerves, and anastomose in the pulp of the terminal phalanges.

Fig. 92.



The *communicating branch of the dorsalis pedis* artery (13) enters the sole between the heads of the first dorsal interosseous muscle, and besides completing the plantar arch, gives off an inner branch, which runs beneath the long flexor tendon to supply the inner side of the great toe, and an outer branch which bifurcates to supply the adjacent sides of the great and next toe, all anastomosing with the corresponding dorsal branches of the dorsalis pedis.

The **External Plantar Nerve** (Fig. 92, 5).—The deep portion of the nerve accompanies the artery beneath the adductor obliquus hallucis, in which it ends. It gives small branches to the adductor trans-

Fig. 92.—Deep dissection of the sole of the foot (from Hirschfeld and Leveillé).

1. Internal plantar nerve.
2. Abductor minimi digiti.
3. Abductor hallucis.
4. External plantar nerve.
5. Its deep division.
6. Accessorius muscle.
7. Digital branches of internal plantar nerve.
8. Tendon of peroneus longus.
9. Flexor brevis hallucis.
10. Superficial division of external plantar nerve.
11. Adductor transversus hallucis.
12. Flexor brevis minimi digiti.
13. Adductor obliquus hallucis.
14. Interosseous muscles.
16. Two outer lumbricales.

versus hallucis, and to all the interosseous muscles, except those of the fourth or outermost interosseous space, which are supplied by the superficial portion, and the two inner dorsal interossei, which usually receive their branches from the anterior tibial.

The **Fourth Layer of Muscles** consists of the plantar interossei, which will be better seen when the dorsal interossei are dissected.

Front of the Leg and Foot.

[The skin remaining on the front and outer side of the leg and on the back of the foot is to be removed, and the superficial veins and nerves dissected out of the superficial fascia, after which the deep fascia should be cleaned.]

The **Superficial Veins** form an arch across the back of the foot, ending in the internal and external saphenous veins on opposite sides. The *internal saphenous vein* is to be traced from the inner side of the dorsal arch upwards in front of the internal malleolus to the posterior part of the inner side of the knee. The *external saphenous vein* passes from the outer side of the arch behind the external malleolus to the middle of the back of the leg.

Cutaneous Nerves.—On the outer side of the leg are a few cutaneous branches from the *external popliteal nerve*; and on the inner side from the long saphenous.

The **Musculo-Cutaneous Nerve** (Fig. 94, 13) pierces the deep fascia about the lower third of the outer side of the front of the leg, and just before or after doing so divides into two portions. The internal division (15) gives branches to the inner side of the ankle and foot, then to the inner side of the great toe, the outer side of the second, and the inner side of the third toe; frequently also giving a small branch to join the anterior tibial nerve between the first and second toes. The outer division (17) supplies the outer side of the third toe, both sides of the fourth, and the inner side of the fifth toe, and gives a communicating branch to the external saphenous nerve. In some cases its area of distribution is encroached upon by the latter (Fig. 94).

The **External Saphenous Nerve** (Fig. 94, 21) winds around the external malleolus from the back of the leg, and is distributed to the outer side of the little toe, or occasionally to both sides of the little toe and half the next, joining the musculo-cutaneous nerve.

The **Anterior Tibial Nerve** (Fig. 94, 16) runs beneath the annular ligament and to the outer side of the dorsalis pedis artery, after giving off an *articular* branch to the ankle and an *external* branch beneath the extensor brevis digitorum to supply it and the tarsal and tarso-metatarsal articulations, often presenting a pseudo-ganglionic enlargement due to thickening of its sheath. The *terminal* branch receives a branch of communication from the inner division of the musculo-cutaneous, and is then prolonged upon the first dorsal interosseous to end by bifurcation into two digital branches to the adjacent sides of the first and second toes, sometimes also supplying the first and second dorsal interossei.

The **Internal Saphenous Nerve** lies in front of the internal malleolus with the internal saphenous vein, which it accompanies. It may be traced along the inner side of the foot, as far as the ball of the great toe.

The **Fascia of the Leg** is dense and white, and is attached to the subcutaneous surface of the tibia on the inner side and to the anterior and posterior external borders of the fibula on the outer side, forming intermuscular septa between the peronei longus and brevis and the adjacent muscles. It gives origin to muscular fibres at the upper part of the leg, where it should therefore be allowed to remain undisturbed; but the rest should be removed, except a thickened band over the ankle joint, the *anterior annular ligament* (Fig. 94). The anterior annular ligament consists of two parts, one passing from the tibia to the fibula, and having a separate compartment lined with a synovial sheath for the tibialis anticus tendon, while the rest of the structures pass beneath it; the other being attached externally to the upper surface of the os calcis in front of the calcaneo-astragalar interosseous ligament, and reaching internally, by two more or less distinct bands, the inner malleolus and the inner row of tarsal bones. This latter portion has three compartments lined by synovial sheaths, for (1) the tibialis anticus, (2) extensor longus hallucis, and (3) extensor longus digitorum and peroneus tertius; the anterior tibial vessels and nerve pass beneath the ligament, and are crossed superficially by the tendon of the extensor longus hallucis. A similar band between the external malleolus and the outer surface of the calcaneum is called the *external annular ligament*, and encloses the tendons of the peroneus longus and brevis at first in a single sheath which, afterwards, is divided into two on reaching the peroneal tubercle.

The *internal annular ligament* passing from the inner malleolus to the calcaneum has been described (p. 179).

[After defining the anterior annular ligament, the fascia is to be taken from the muscles on the front of the leg, and the latter, together with their tendons on the dorsum of the foot, as well as the vessels and nerves, are to be cleaned.]

The **Extensor Muscles** (Fig. 93) are the tibialis anticus on the inner side; the extensor longus digitorum with the peroneus tertius on the outer side; and between the two, the extensor longus hallucis, appearing below the middle of the leg.

The **Tibialis Anticus** (Fig. 93, 3) *arises* from the upper two-thirds of the outer surface of the shaft of the tibia and from its outer tuberosity; from the inner half of the interosseous ligament for the same distance; from the fascia covering the muscle, and from a septum prolonged between it and the extensor longus digitorum. The fibres end in a broad tendon, which becomes narrower near the ankle and passes through the most internal division of the anterior annular ligament, to be *inserted* into the under-surface of the internal cuneiform bone and the base of the metatarsal bone of the great toe. Just before its insertion it grooves the inner side of the internal cuneiform bone. The tibialis anticus is a dorsal flexor of the foot at the ankle-joint, and an adductor at the talo-calcaneo-scaphoid joint. It is one of the muscles which is often divided to relieve the form of club-foot called 'talipes varus.' It is *supplied* by the anterior tibial nerve.

The **Extensor Longus Digitorum** (Fig. 93, 4) *arises* from the upper three-fourths of the anterior surface of the fibula and for about an inch from

Fig. 93.

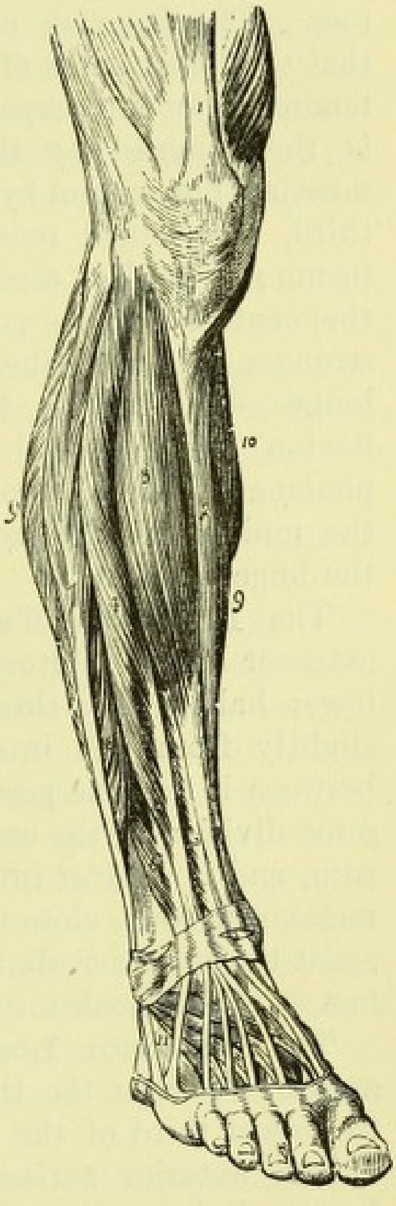


Fig. 93.—Muscles of the front of the leg (from Wilson).

1. Quadriceps extensor inserted into the patella.
2. Subcutaneous surface of the tibia.
3. Tibialis anticus.
4. Extensor longus digitorum.
5. Extensor longus hallucis.
6. Peroneus tertius.
7. Peroneus longus.
8. Peroneus brevis.

9, 9. Borders of the soleus muscle.
10. Part of the inner belly of the gastrocnemius.
11. Extensor brevis digitorum; the tendon in front of the figure is that of the peroneus tertius; that behind it, the peroneus brevis.

the adjacent part of the interosseous membrane, from the outer tuberosity of the tibia close to the tibialis anticus, from the fascia upon the upper part of the muscle, and from the inter-muscular septa on either side. The muscular fibres extend nearly as low as the annular ligament, through the outer division of which the tendon passes, and at once divides into four for the four smaller toes. The *insertion* of the extensor into the toes is similar to that of the extensor of the fingers, but on a smaller scale. Each tendon forms an expansion on the back of the first phalanx, and is there joined by the tendons of the corresponding interossei muscles (but seldom by the lumbricalis), and in the case of the second, third, and fourth toes, by a tendon of the extensor brevis digitorum; it is then continued forwards, and divides into three parts, the central portion going to the second phalanx and the lateral stronger pieces to the third phalanx. The *action* of the extensor longus digitorum is to draw up the foot at the ankle (dorsal flexion) and to extend the four outer toes, chiefly at the metatarso-phalangeal joints; the interossei being the principal extensors of the middle and ungual phalanges. (Compare the description of the fingers, p. 65.)

The **Peroneus Tertius** (Fig. 93, 6) is often a part of the extensor longus digitorum. It *arises*, below the extensor, from the lower half or two-thirds of the anterior surface of the fibula;* slightly from the interosseous membrane; and from the septum between it and the peroneus brevis. Its tendon passes through the same division of the annular ligament as the extensor longus digitorum, and is *inserted* into the upper surface of the base of the fifth metatarsal bone, close to the intermetatarsal joint. Its *action* is to assist the extensor digitorum as a dorsal flexor, and to abduct the foot at the talo-calcaneo-scaphoid joint.

The **Extensor Longus Hallucis vel Proprius** (Fig. 93, 5) appears between the tibialis anticus and the extensor digitorum in the lower third of the leg. It *arises* from the middle two-fourths of the anterior surface of the fibula, internally to the extensor longus digitorum; and from the adjacent part of the interosseous membrane. Its tendon passes beneath the annular ligament and, crossing the anterior tibial vessels and nerve and the insertion of the innermost tendon of the extensor brevis digitorum, is *inserted* into the base of the terminal phalanx of the great toe. It is joined opposite the proximal phalanx by expansions from the plantar

* It is usually said to arise from the lower fourth only, but its fibres will in most cases be found blending with those of the long extensor high in the leg.

muscles of the great toe. This muscle is an extensor of the great toe, and a dorsal flexor of the ankle.

The **Extensor Brevis Digitorum** (Fig. 93, 11) is the only muscle of the dorsum of the foot. It *arises* from the upper surface of the greater process of the os calcis; from the interosseous calcaneo-astragaloid ligament; and from the lower border of the anterior annular ligament. It ends in four tendons, the three outer passing obliquely across the foot to be *inserted* into the second, third, and fourth toes, joining the general expansion of the extensor tendons; the innermost slip passing to a separate attachment into the base of the proximal phalanx of the great toe, after crossing over the dorsal artery of the foot.

The innermost portion of the muscle is a short extensor of the great toe, acting with the long extensor upon the proximal phalanx, and assisting slightly in adduction at the metatarso-phalangeal joint. The remaining segment extends the second, third, and fourth toes, supplementing the long extensor more essentially when this muscle is relaxed during dorsal flexion.

The five muscles last described are all *supplied* by the anterior tibial nerve.

The **Anterior Tibial Artery** (Fig. 94, 2) is a branch of the popliteal, and reaches the front of the leg by piercing the interosseous membrane between the two heads of the tibialis posticus, and below the popliteus. Its direction is from a point midway between the inner tuberosity of the tibia and the head of the fibula to the centre of the instep. It lies at first upon the interosseous membrane between the tibialis anticus and extensor longus digitorum, and then between the tibialis anticus and extensor proprius hallucis; in the lower part of the leg it winds on to the tibia, and becomes superficial above the ankle-joint. It passes beneath the annular ligament and is crossed by the extensor longus hallucis near the level of the joint. Its continuation upon the foot is known under the name of *dorsalis pedis* (p. 196).

It is accompanied by two *venæ comites*; the anterior tibial nerve runs to its outer side as far as about the middle third of the leg, then lies in front of it, but again gets to its outer side in the lower third. A small lymphatic gland is sometimes found close to the artery about the middle of the leg.

Surgery.—The anterior tibial artery may be readily tied above the ankle, by an incision three inches long upon the outer side of the tendon of the tibialis anticus and parallel to it. The artery will be found upon the front of the tibia between the tendons of the tibialis anticus and the extensor proprius hallucis, with the nerve to its outer side.

The artery may also be reached on the dead body in the upper part of its course, but it lies so deeply between the muscles that the operation is seldom, if ever, undertaken on the living subject. An indistinct white line, indicating the position of the intermuscular septum, sometimes marks the outer border of the tibialis, but it is well to make the incision a little obliquely and not less than four inches long, beginning about one inch below the head of the fibula, at a point midway between the bone and the outer tuberosity of the tibia. The fascia should be divided in the same direction as the skin, when, if the fore-finger is introduced into the wound, it will probably pass into the cellular interval between the two muscles, there being no intermuscular septum to guide the operator. The tibialis anticus and extensor digitorum must be drawn apart, and the artery will be found upon the interosseous membrane with the nerve to its outer side.

Branches of the anterior tibial artery in front of the leg:—

The anterior tibial *Recurrent* arises as soon as the artery reaches the front of the leg, and winds through the fibres of the tibialis anticus or extensor digitorum to the front of the knee, to anastomose with the articular arteries.

Muscular branches to the adjacent muscles arise at various points.

The *Malleolar arteries*, internal and external, the latter being the larger and more constant, pass beneath the tendons to the malleoli, in the neighbourhood of which they are distributed. The *external* anastomoses with the anterior and posterior peroneal arteries, and with the tarsal branch of the dorsalis pedis, the *internal* with the internal malleolar of the posterior tibial artery.

Two small branches are usually to be found arising from the artery before it pierces the interosseous membrane, the *posterior tibial recurrent*, passing over the back of the head of the fibula, and the *superior fibular*, passing outwards over the neck of the bone (p. 177).

The *Anterior Peroneal* branch of the **peroneal artery** (p. 176) appears between the tibia and fibula through an opening in the lower part of the interosseous membrane, running upon the anterior inferior tibio-fibular ligament and beneath the peroneus tertius to supply the outer malleolus, and to anastomose with the external malleolar and tarsal arteries. The inferior tibio-fibular joint thus separates the anterior and posterior peroneal arteries.

The **Dorsalis Pedis Artery** (Fig. 94, 12) is the continuation of the anterior tibial from the ankle-joint to the base of the 1st metatarsal bone, opposite which it divides into the *communicating* branch to the sole of the foot and the *dorsal artery of the great toe.* Its direction is from the centre of the instep to the first interosseous space, and it lies at first superficially between the tendons of the extensor proprius pollicis and the extensor longus digitorum, but is crossed near the point of bifurcation by the innermost tendon of the extensor brevis digitorum. It lies upon the astragalus, scaphoid and middle cuneiform bones and their dorsal ligaments, and has the anterior tibial nerve to its outer side. Two *venæ comites* accompany the vessel.

Surgery.—The dorsal artery may be tied in the upper part of its course by an incision on the outer side of, but parallel to, the tendon of the extensor proprius pollicis. It occasionally happens, however, that the artery is displaced to the middle of the foot beneath the tendons of the extensor digitorum.

Branches of the dorsalis pedis artery.

A few small unnamed tarsal branches spring from the inner side of the vessel and anastomose with the internal plantar. The *Tarsal artery* arises from the outer side of the vessel immediately below the annular ligament, and crosses the foot beneath the extensor brevis digitorum to anastomose with the arteries about the external malleolus.

The *Metatarsal artery* arises lower than the preceding and near the bases of the metatarsal bones. It also runs outwards beneath the extensor brevis digitorum, and gives off three *interosseous* branches to the outer spaces. These run forward upon the dorsal interossei muscles, and bifurcate at the roots of the toes to supply the adjacent sides of two toes each, the outer one giving off a branch also to the outer side of the little toe. The anterior and posterior perforating arteries, derived from the plantar arch and its digital branches, join these interosseous arteries near their origins and points of bifurcation.

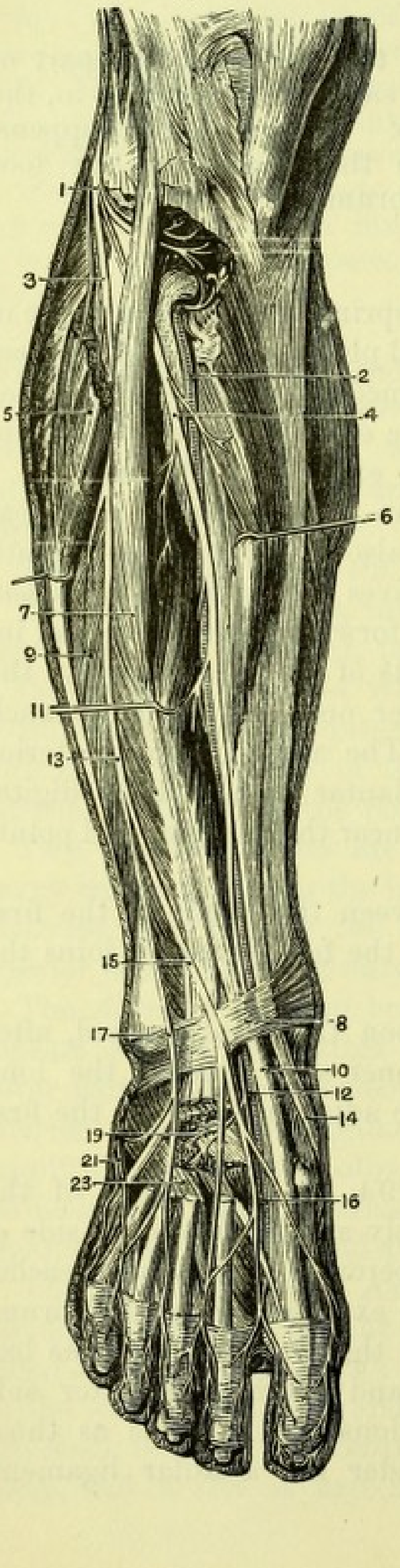
The *Communicating branch* passes between the heads of the first dorsal interosseous muscle to the sole of the foot, where it joins the plantar arch (p. 184).

The *Dorsalis hallucis* runs forward upon the great toe and, after giving a branch which passes to its inner side beneath the long extensor tendon, bifurcates to supply the adjacent sides of the first and second toes.

The **Anterior Tibial Nerve** (Fig. 94, 4) is a branch of the external popliteal nerve; it runs obliquely around the outer side of the neck of the fibula in the fibres of the peroneus longus, and reaches the anterior tibial artery by piercing the extensor longus digitorum. It lies to the outer side of the artery in the upper part of the leg, but in front of it about the middle, and reaches its outer side again at the ankle. Its muscular relations are the same as those of the artery, with which it passes under the annular ligament.

In the leg it supplies the four extensor muscles, and as soon as it enters the foot gives a filament to the ankle-joint and divides into two branches. The *outer branch* (19) is distributed to the extensor brevis digitorum, the 2nd dorsal interosseous, and the articulations of the tarsal and tarso-metatarsal joints, having a pseudo-gangliform thickening of its sheath; the *inner branch* (16) lies to the outer side of the dorsal artery, supplies the 1st dorsal interosseous muscle, and becoming cutaneous is distributed to the adjacent sides of the great and second toes.

Fig. 94.



[The peroneal muscles are to be exposed on the outer side of the leg by removing the fascia covering them, when a strong intermuscular septum will be found on each side attached to the fibula, separating them from the muscles of the front and back of the leg. A portion of the fascia is to be left below the malleolus to form an external annular ligament.]

Fig. 94.—Deep dissection of the front of the leg (from Hirschfeld and Leveillé).

1. External popliteal nerve.
2. Anterior tibial artery.
3. Musculo-cutaneous nerve.
4. Anterior tibial nerve.
5. Peroneus longus.
6. Tibialis anticus.
7. Extensor longus digitorum.
8. Anterior annular ligament.
9. Peroneus brevis.
10. Tendon of extensor proprius hallucis.
11. Extensor proprius hallucis.
12. Dorsal artery of foot.
13. Point at which musculo-cutaneous nerve pierces the fascia and divides.
14. Tendon of tibialis anticus.
15. Internal branch of musculo-cutaneous nerve.
16. Cutaneous branch of anterior tibial nerve.
17. External branch of musculo-cutaneous nerve.
19. Deep branch of anterior tibial nerve.
21. External saphenous nerve.
23. Extensor brevis digitorum.

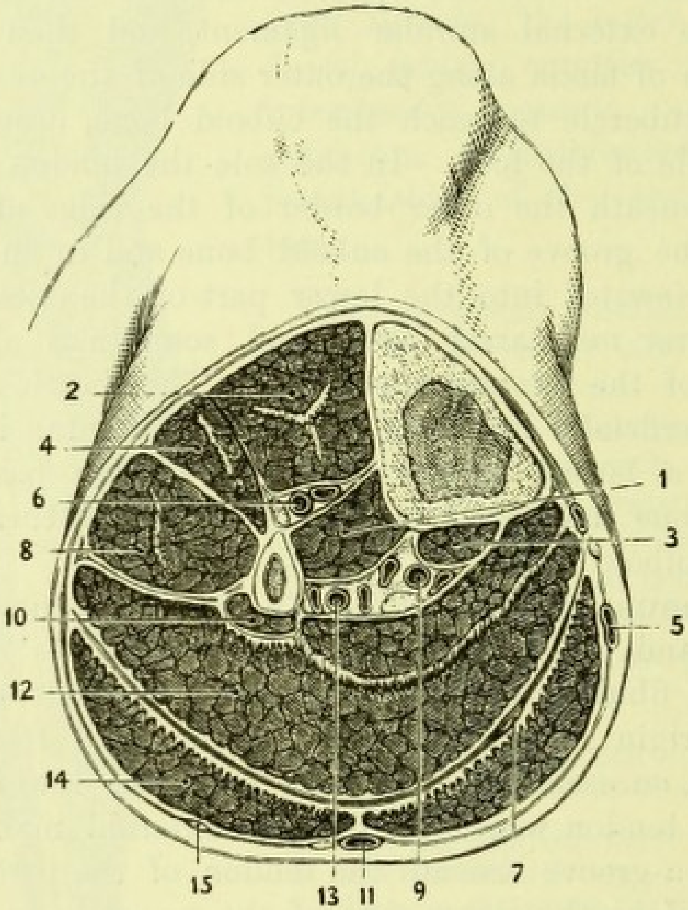
The **Peroneus Longus** (Fig. 93, 7) *arises* slightly from the outer tuberosity of the tibia; from the head and upper two-thirds of the outer surface of the fibula, its origin in the middle third lying behind that of the peroneus brevis and overlapping it; from the intermuscular septum on each side; and from the fascia covering it. It ends in a strong tendon, which lies superficial to that of the peroneus brevis and runs behind the external malleolus and under the external annular ligament, and then passes in a separate sheath of fascia along the outer side of the os calcis behind the peroneal tubercle to reach the cuboid bone, around which it turns to the sole of the foot. In the sole the tendon runs at first over a facet beneath the outer border of the ridge of the cuboid, then lies in the groove of the cuboid bone and in an osseo-fibrous sheath, and is *inserted* into the lower part of the outer side of the base of the first metatarsal bone, and sometimes also into the adjacent part of the internal cuneiform. The sheath of the tendon is formed superficially by fibres of the long plantar ligament, and is lined with a bursal membrane. The tendon has a sesamoid cartilage or bone developed in its fibres where it turns round the border of the cuboid bone.

The **Peroneus Brevis** (Fig. 93, 8) lies beneath the peroneus longus, and *arises* from the lower two-thirds of the outer surface of the fibula, its upper part being in front of the lower part of the origin of the peroneus longus; and from the intermuscular septa on each side. It rests upon the lower part of the fibula, and its tendon winds behind the external malleolus, where it is lodged in a groove beneath the tendon of the peroneus longus. It then runs along the outer side of the os calcis in a sheath of fascia in front of the long tendon and peroneal tubercle, and is *inserted* into the most prominent part of the tuberosity at the base of the fifth metatarsal bone.

The peronei act as plantar flexors of the foot, *i.e.*, they point the toes. Both muscles, but especially the peroneus longus, abduct the foot at the talo-calcaneo-scaphoid joint, and the peroneus longus in addition forms an important diagonal tie for the longitudinal arch of the foot. The peronei are shortened in the form of club-foot called 'talipes valgus.' Both are *supplied* by the musculo-cutaneous nerve. The synovial membrane under the annular ligament is common to the two peronei, but it divides into two parts as the tendons approach the peroneal tubercle of the calcaneum.

The **External Popliteal Nerve** (Fig. 94, 1) is to be followed along the inner border of the biceps tendon into the fibres of the peroneus longus, to which point it was traced in the dissection of the popliteal space. It gives off an *external patellar cutaneous* branch to the outer side of the knee-joint before entering the muscle, and afterwards a *recurrent articular branch*, which pierces the extensor longus digitorum to reach the upper part of the tibialis anticus and

Fig. 95.



the front of the knee. It then divides into *anterior tibial* (p. 197), and *musculo-cutaneous* (3).

The **Musculo-cutaneous Nerve** gives branches to the peroneus longus and peroneus brevis, and then appears between the peroneus longus and extensor longus digitorum, finally becoming cutaneous by piercing the fascia in the lower third of the leg.

Fig. 95.—A section of the right leg in the upper third (altered from Béraud).

1. Tibialis posticus.
2. Tibialis anticus.
3. Flexor longus digitorum.
4. Extensor longus digitorum.
5. Internal saphenous vein.
6. Anterior tibial vessels and nerve.
7. Tendon of plantaris.
8. Peroneus longus.
9. Posterior tibial vessels and nerve.
10. Flexor longus hallucis.
11. External saphenous vein and nerve.
12. Soleus with fibrous intersection.
13. Peroneal vessels.
14. Gastrocnemius.
15. Communicans peronei nerve.

[The tendons on the back of the foot are to be divided or held aside, and the transversus pedis in the sole is to be removed to permit a clear view of all the interossei.]

Beneath the transversus pedis will be found the *plantar transverse ligament of the metatarsus*, from which its fibres arise, and over which the digital vessels and nerves pass. It connects the heads of the metatarsal bones together and crosses beneath (on the plantar side of) the tendons of the interossei muscles. The *dorsal transverse*

Fig. 96.

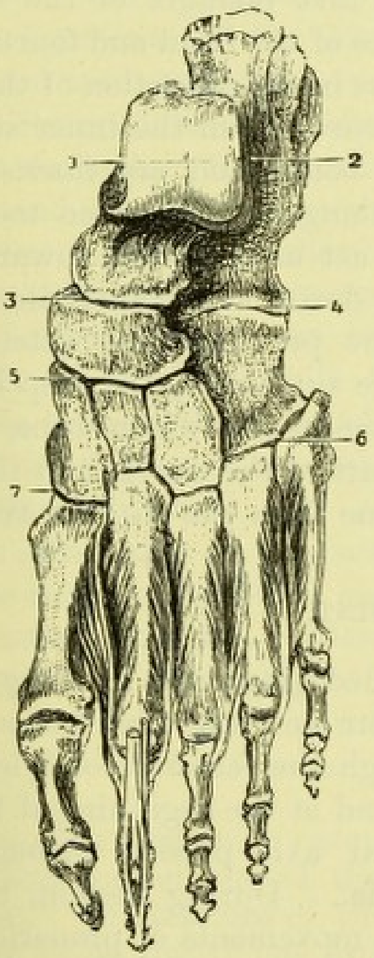
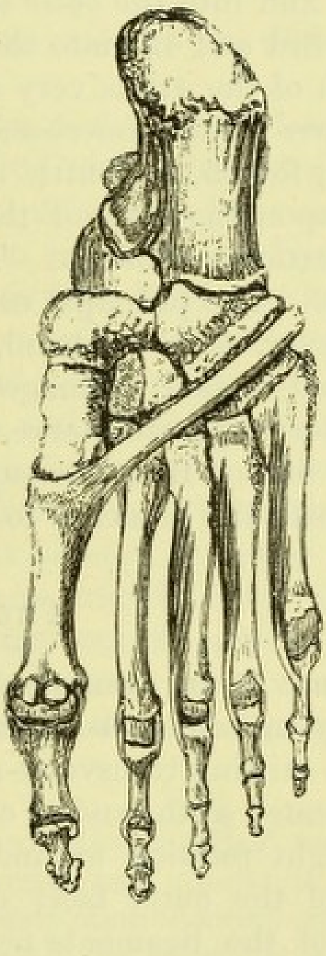


Fig. 97.



ligaments, much weaker than the last, join the dorsal aspect of the heads of the metatarsal bones and between the two ligaments pass the tendons of the interossei as in the hand (see p. 89).

The **Interosseous Muscles** are seven in number, viz., four dorsal and three plantar, the former being between the bones, while the

Fig. 96.—The dorsal interosseous muscles of the foot (J. T. Gray). The figures refer to the seven synovial membranes.

Fig. 97.—The plantar interosseous muscles (J. T. Gray).

latter lie rather on their under surfaces. The dorsal are bipenniform muscles and are seen on both surfaces of the foot; the plantar are seen only on the sole.

The *four dorsal interossei* (Fig. 96) *arise* from the adjacent sides of the metatarsal bones in nearly the whole length of their shafts, and are *inserted* into the bases of the first phalanges in such a manner as to abduct from an imaginary line prolonged through the second metatarsal bone (instead of the third as in the hand), and into the extensor tendon over the proximal phalanx. Thus the 1st is inserted into the *inner* side of the first phalanx of the second toe; the 2nd into the *outer* side of the first phalanx of the second toe; the 3rd and 4th into the *outer* sides of the third and fourth toes. A portion of the 4th is very conspicuous in the dissection of the sole.

The *three plantar interossei* (Fig. 97) *arise* from the inner sides of the third, fourth, and fifth metatarsal bones, and are *inserted* into the corresponding sides of the first phalanges of the same toes and into the extensor tendons. They thus act as adductors towards the *second* toe. The principal uses of both dorsal and plantar interossei are, however, as in the hand, to flex the proximal and extend the middle and ungual phalanges. They are *supplied* by the deep branch of the external plantar nerve, except those in the fourth space, which receive a branch from the superficial part of the nerve, and the two inner dorsal, the branches to which come from the anterior tibial.

The Knee-Joint.

The knee is an example of a modified ginglymus or hinge-joint. The hinge movement between the femur and the tibia takes place around a shifting transverse axis through the femoral condyles, and is complicated at the end of extension and at the beginning of flexion by a slight rotation around a vertical axis passing through the middle of the outer facet of the tibia. During flexion, the relaxation of the ligaments permits also movements of pronation and supination of the leg around a vertical axis passing through the inner tubercle of the tibial spine. Its synovial membrane is the most extensive in the body.

The knee-joint has *in front* the patella and ligamentum patellæ, with the expansion of the extensor muscles and the fascial bands (internal and external patellar ligaments) which help to form its capsule. *Behind* are the popliteal vessels and nerves and their branches, some lymphatic glands, with the two heads of the gastrocnemius, the plantaris, and the tendon of the popliteus. To the *inner* side of the joint, near the back, are the tendons of the sartorius, gracilis, semi-tendinosus, and semi-membranosus, with the long saphenous vein and nerve and a branch of the anastomotica magna ; and on the *outer* side the biceps, with the external popliteal nerve, occupies a similar position, and the inferior external articular artery runs between the external semi-lunar cartilage and the external lateral ligaments.

The knee is *flexed* by the biceps, semi-membranosus, semi-tendinosus, gracilis, sartorius, popliteus, gastrocnemius, and plantaris. It is *extended* by the quadriceps extensor. *Pronation* is effected by the semi-membranosus, semi-tendinosus, gracilis, sartorius and popliteus ; and *supination* by the biceps only.

The ligaments of the knee may conveniently be divided into extra- and intra-articular.

The **Extra-articular Ligaments** are posterior and lateral.

The **Anterior Ligaments** (Fig. 98) are represented by the patella and the *ligamentum patellæ* in the middle, and the expansions of the vasti and the patellar ligaments on either side. The *external patellar ligament* is a process of the ilio-tibial band attached to the outer border of the bone below the vastus externus and to the ligamentum patellæ, while the *internal patellar ligament*, derived from the internal intermuscular septum and inner tuberosity of the femur, is similarly connected on the inner side. Some deep supplementary fibres may also pass from the tuberosities of the tibia to either side of the patella, and it should be noted that the patellar attachment of the vastus internus extends lower than that of the vastus externus. Between the ligamentum patellæ and the upper part of the tubercle of the tibia is a bursa (*bursa sub-patellaris*), which must not be confounded with the proper *bursa patellæ* in front of the bone.

[To see the remaining external ligaments, the popliteal vessels and nerves and the remains of the gastrocnemius and plantaris must be removed. The tendons of the biceps, semi-membranosus and popliteus are to be traced out fully, and should be carefully preserved, but cut short. The internal lateral ligament will be found to be incorporated with the capsule, the external is beneath the tendon of the biceps and external patellar ligament, and is not seen until these have been divided.]

The **Posterior Ligament** (Fig. 99, 8) (ligamentum posticum Winslowii) is a flat band, attached above the condyles of the femur and to the back of the head of the tibia ; it is closely connected with the tendon of the semi-membranosus, from which a large band of fibres passes obliquely upwards and outwards across the back of the joint (Fig. 99, 13) and on the outer side it receives a slip from the short external lateral ligament. It is extremely thin beneath the heads of the gastrocnemius, and is frequently perforated where the inner head of this muscle and the semi-membranosus tendon are separated from the back of the internal condyle by a bursa, which in this case communicates with the cavity of the joint.

The **External Lateral Ligaments** (Fig. 98, 5 ; 99, 2) are two in number, the *long* and *short*, the long being the anterior one of the two. The *long ligament* is a round cord extending from the margin of the gastrocnemius impression upon the side of the external condyle immediately above the posterior extremity of the depression for the popliteus, to the middle of the bicipital tuberosity on the outer side of the head of the fibula, between the divisions of the biceps tendon and above the peroneus longus origin. The tendon of the popliteus and the external inferior articular artery pass beneath it. The *short ligament* is placed behind the long, and reaches from the condyle to the styloid process of the fibula, blending with the outer part of the posterior ligament above ; and is connected by means of a curved band (ligamentum popliteum arcuatum), which passes from the middle of its inner border to the posterior ligament and to the tendon of the popliteus. Above this lies the popliteal aperture in the capsule.

The **Internal Lateral Ligament** (Fig. 98, 6 ; 99, 1) is a strong band closely connected with the internal patellar ligament and internal semilunar cartilage. It is attached to the most prominent part of the inner tuberosity of the femur above, and is in more or less direct continuity at the adductor tubercle with the tendon of the adductor magnus. It expands as it descends, and may be divided into two portions, anterior and posterior, the posterior attached to the inner tuberosity of the tibia and covering in the tendon of the semi-membranosus ; while the anterior segment, also fixed to the tuberosity, is continued on to the upper part of the inner surface of the shaft of the tibia, leaving an interval through which pass the inferior internal articular vessels of the knee.

There is reason to believe that the internal and long external lateral ligaments are degenerate tendons, the former of the adductor magnus, the latter of the peroneus longus (Sutton).

The posterior and lateral ligaments aid the crucial ligaments in limiting extension. The lateral ligaments in addition check the movement of supination (external rotation) of the leg that is permitted during flexion of the knee. The capsule of the joint is deficient where the tendon of the popliteus passes downwards over the

Fig. 98.

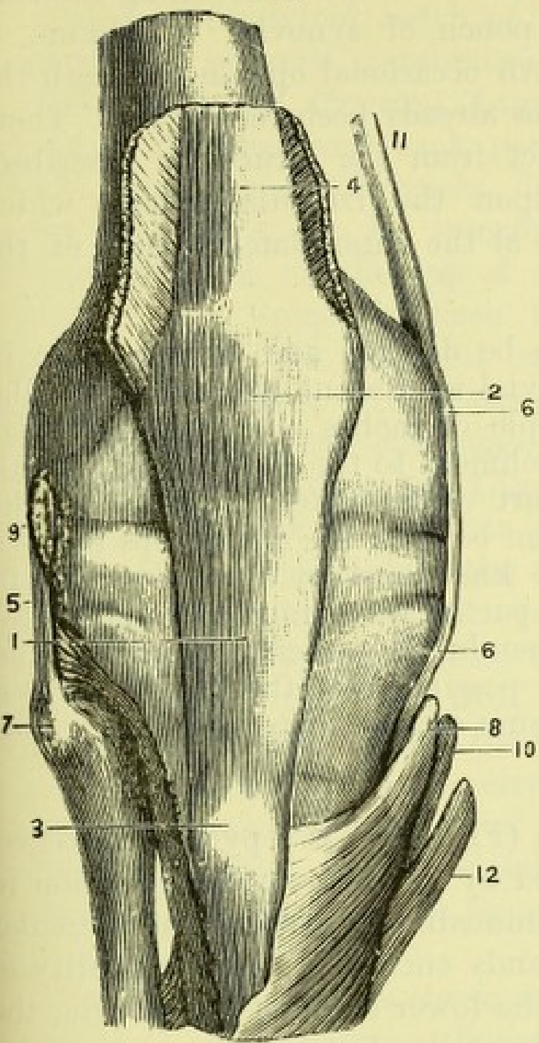


Fig. 99.

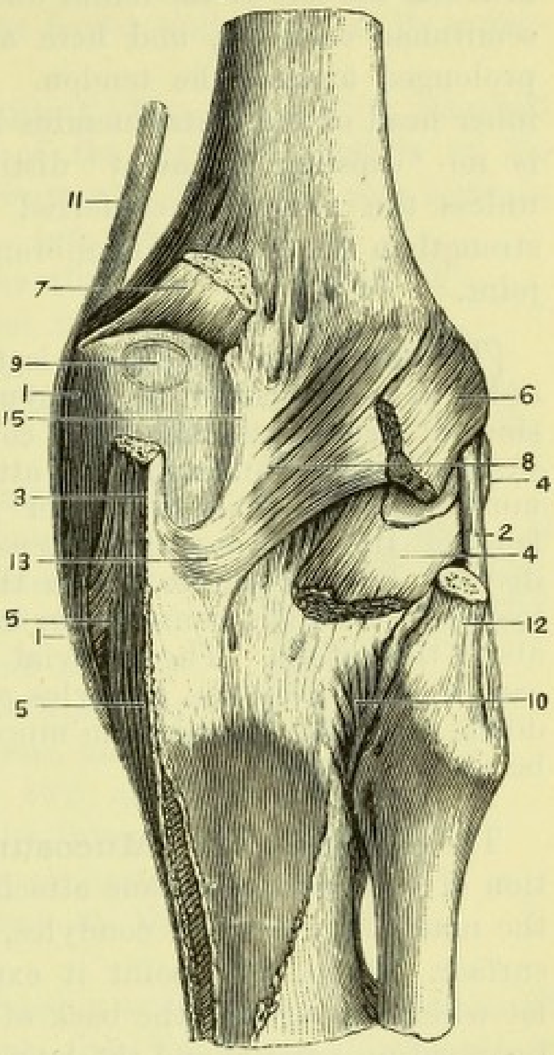


Fig. 98.—Anterior view of the ligaments of the knee-joint (from Sappey).

1. Ligamentum patellæ (the lateral patellar ligaments have been removed).
2. Patella covered by tendinous fibres derived from the rectus and vasti.
3. Tubercle of tibia.
4. Tendon of rectus with vasti.
5. Long external lateral ligament.
6, 6. Internal lateral ligament.
7. Bicipital tuberosity of head of fibula receiving attachment of long external lateral ligament.
8. Insertion of sartorius.
9. Tendon of popliteus.
10. Insertion of gracilis.
11. Tendon of adductor magnus prolonged into internal lateral ligament.
12. Insertion of semi-tendinosus.

Fig. 99.—Posterior view of the ligaments of the knee-joint (from Sappey).

1, 1. Internal lateral ligament.
2. Long external lateral ligament. (The short external lateral ligament should be shown on the inner side of this, connected with the popliteus tendon.)
3. Tendon of semi-membranosus.
4, 4. Popliteus tendon. (An aperture in the capsule lies beneath this tendon.)
5, 5. Prolongations of tendon of semi-membranosus.
6. Outer head of gastrocnemius.
7. Inner head of gastrocnemius.
8. Posterior ligament (of Winslow).
9. Opening in capsule.
10. Posterior superior tibio-fibular ligament.
11. Tendon of adductor magnus.
12. Tendon of biceps.
13. Prolongation from tendon of semi-membranosus to posterior ligament.
15. Posterior ligament (of Winslow).

articular borders of the femur and tibia and the intervening external semilunar cartilage, and here a pouch of synovial membrane is prolonged around the tendon. An occasional opening beneath the inner head of the gastrocnemius has already been referred to. There is no 'capsular ligament' distinct from the structures described, unless the name be conferred upon the irregular bands which strengthen the synovial membrane at the antero-lateral parts of the joint.

[The tendon of the rectus is to be divided and drawn down in order to see the extent of the synovial membrane above the patella, since it usually reaches for a couple of inches above the articular surface of the femur and gives attachment to the *Subcrureus*, a small muscle arising from the lower part of the anterior surface of the femur. In some cases this extension beneath the quadriceps forms a distinct bursa separated from the knee-joint by a septum, and in many cases a little constriction or partial dissepiment is found just above the patella. The synovial membrane is then to be divided on each side, as near the condyles as possible, and the patella turned down, when the ligamentum mucosum and the ligamenta alaria will be seen.]

The **Ligamentum Mucosum** (Fig. 101) is a pyramidal reflection of synovial membrane attached by its apex to a depression in the notch between the condyles, immediately behind the articular surface. From this point it expands enclosing a large quantity of fat which lies against the back of the lower angle of the patella, the ligamentum patellæ and the lateral patellar ligaments.

The **Ligamenta Alaria** are merely two fringes of synovial membrane appended, one on each side, to the ligamentum mucosum, and running upwards as far as the lateral border of the patella.

The ligamenta mucosa and alaria represent a septum which in some animals, but very rarely in man, divides the knee joint into three segments, a femoro-patellar and two condylo-tibial (Sutton).

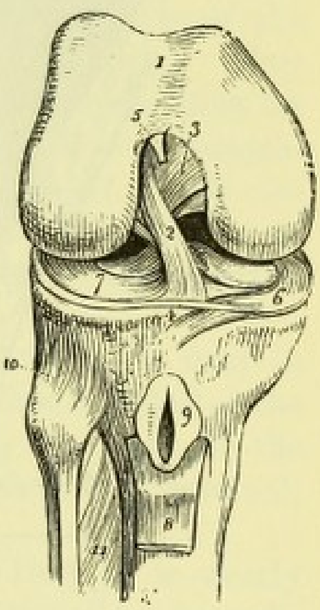
[The ligamentum mucosum is to be divided and the patella turned down completely, when the bursa of the ligamentum patellæ can be opened and seen. The capsular and posterior ligaments are to be removed, but the lateral ligaments are to be preserved and the crucial ligaments dissected.]

The **Intra-articular Ligaments** are the two crucial and the transverse ligaments. Within the joint also are two semilunar cartilages which are partly ligamentous.

The **Crucial Ligaments** are two powerful bands extending from the upper inter-articular surface of the tibia to the two sides of the inter-condyloid notch of the femur and invested by a prolongation of synovial membrane.

The **Anterior Crucial Ligament** (Fig. 100, 2) is attached above to the inner and back part of the external condyle of the femur, and passes obliquely downwards, forwards, and inwards across the joint, to be inserted into the triangular space on the top of the tibia in front of the spine, between the anterior attachments of the internal and external semilunar cartilages. It receives a slip from the external semilunar cartilages.

Fig. 100.



The **Posterior Crucial Ligament** (Fig. 100, 3) is broader and stouter than the anterior. It is attached to the anterior and outer part of the internal condyle, and passes downwards, backwards, and slightly inwards, to the top of the tibia between the articular facets and behind the spine, and to the popliteal notch. It receives two slips from the posterior extremity of the internal semilunar cartilage, and is closely connected with the anterior crucial ligament at the point of decussation.

The crucial ligaments check extension and resist dislocation in all directions. The anterior ligament also limits the movement of pronation (internal rotation) of the leg that is permitted during flexion of the knee.

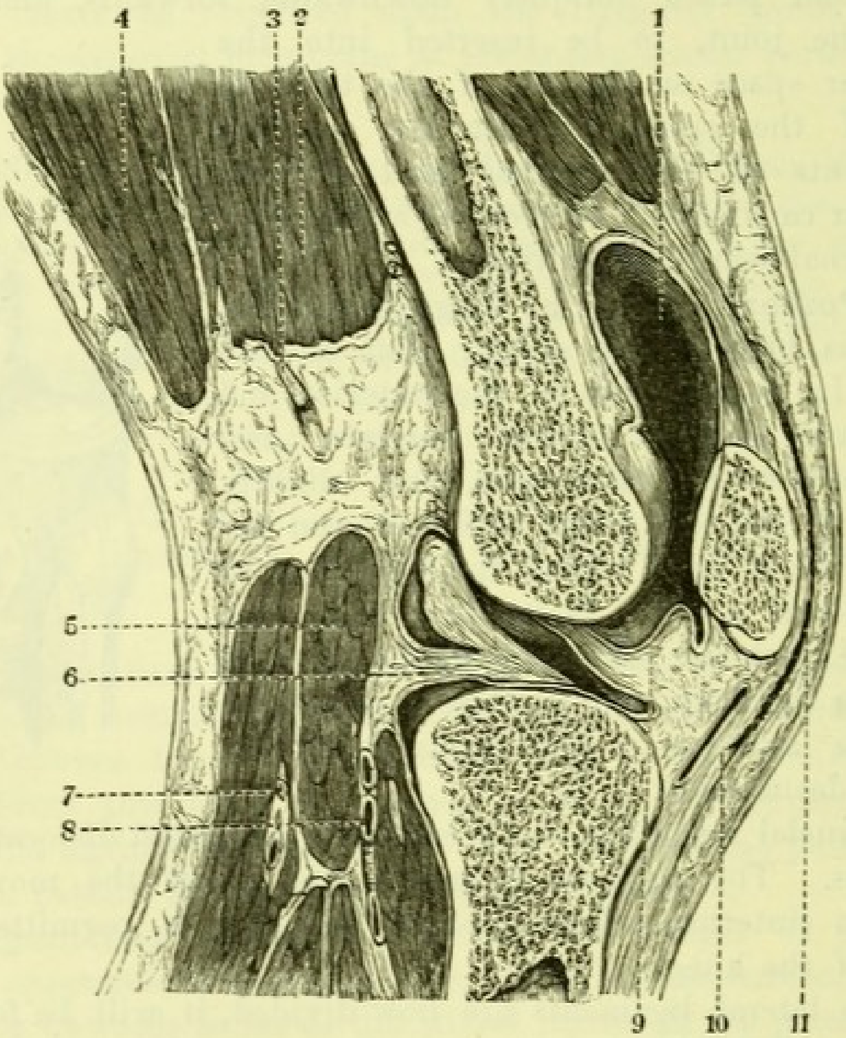
If the lateral ligaments are now divided, it will be found that the femur and tibia become more separated than before, showing that the object of the crucial ligaments is not simply to maintain the articular surfaces in apposition. It will also be seen that whilst rotation of the tibia outwards can now be carried to an

Fig. 100.—The right knee-joint laid open from the front, and dissected to show the internal ligaments (from Wilson).

1. Cartilaginous surface of the lower extremity of the femur.
2. Anterior crucial ligament.
3. Posterior crucial ligament.
4. Transverse ligament.
5. Attachment of the apex of the ligamentum mucosum; the rest has been removed.
6. Internal semilunar cartilage.
7. External semilunar cartilage.
8. Part of the ligamentum patellæ turned down.
9. Bursa situated between the ligamentum patellæ and head of the tibia laid open.
10. Anterior superior tibio-fibular ligament.
11. Interosseous membrane.

extreme degree (so as to bring the crucial ligaments almost parallel), rotation inwards is immediately checked by the tension of the anterior ligament, and it is thus that the tendency of the popliteus muscle to rotate the leg inwards is counterbalanced.

Fig. 101.



The **Transverse Ligament** (Fig. 100, 4) is a small band connecting the anterior extremities of the two semilunar cartilages, and often not distinct.

The **Semilunar Cartilages** (Fig. 100, 6, 7), which can be partly seen now, but will be fully exposed by dividing the crucial ligaments, are two fibro-cartilages interposed between the tibia and femur.

Fig. 101.—Vertical section of knee-joint (after Braune).

1. Synovial membrane.
2. Short head of biceps.
3. Peroneal nerve.
4. Long head of biceps.
5. Plantaris.
6. External semilunar cartilage.
7. Sural vessels.
8. Popliteal vessels.
9. Anterior crucial ligament with bursa subpatellaris.
10. Ligamentum patellæ.
11. Bursa præpatellaris.

They are triangular on section and present each two free surfaces, superior and inferior, turned towards the femur and tibia respectively, and an outer attached surface or base connected with the inner aspect of the capsule, and following the curvature of the outer border of the corresponding tuberosity of the tibia. They are fixed to the tibia partly by marginal fibres (coronary ligaments), derived from the capsule, partly by the direct attachment of their fibrous extremities to impressions in front of and behind the tibial spine; and are also connected to the intercondylar notch of the femur by fibrous bands, which join the crucial ligaments. They serve to deepen the tibial facets, and at the same time to form for each femoral condyle a shallow socket, which is capable of adaptation in shape and position to the surface opposed to it in all the different movements of the joint. Their attributed function as buffers cannot be important, as they are deficient at the point of maximum contact between the two bones.

The **Internal Semilunar Cartilage** (Fig. 100, 6) is oval in form. Its anterior extremity is attached to the tibia in front of the anterior crucial ligament; its posterior extremity in front of the posterior crucial ligament. It is less moveable than the external, but is more liable to traumatic displacement.

The **External Semilunar Cartilage** (Fig. 100, 7) is nearly circular. Its anterior extremity is attached to the tibia immediately in front of the spine; its posterior extremity behind the spine; and the latter is connected with the posterior crucial ligament by one or two distinct slips. It is less extensively attached to the tibial margin than the internal cartilage.

The popliteus is indirectly connected with the external cartilage, and the semi-membranosus with the internal cartilage, through the attachment of their tendons to the posterior part of the capsule, and the cartilages are to some extent acted upon by these muscles.

The **Structures upon the top of the Tibia** from before backwards are as follows:—

1, Transverse ligament; 2, Anterior extremity of internal semilunar cartilage; 3, Anterior crucial ligament; 4, Anterior extremity of external semilunar cartilage; 5, Posterior extremity of external semilunar cartilage, separated from 4 by the tibial spine; 6, Posterior extremity of internal semilunar cartilage; 7, Posterior crucial ligament.

The **Synovial Membrane** (Fig. 101) extends for at least two inches above the articular surface of the femur, forming a pouch beneath the extensor muscles. It is reflected from the margins of the articular surfaces of the femur and tibia on to the inner aspect of the capsule, and thence over the crucial ligaments and over the upper and lower surfaces of the semilunar cartilages. It gives a tubular investment to the tendon of the popliteus where this lies within the capsule, and has already been seen to form the ligamentum mucosum and ligamenta alaria; and small pouches may be found on either side of the lower attachment of the posterior crucial ligament.

By means of its reflection over the crucial ligaments it forms a partial mesial septum attached to the capsule behind, and dividing the joint cavity into two lateral halves which inter-communicate in front. In rare cases the septum is complete.

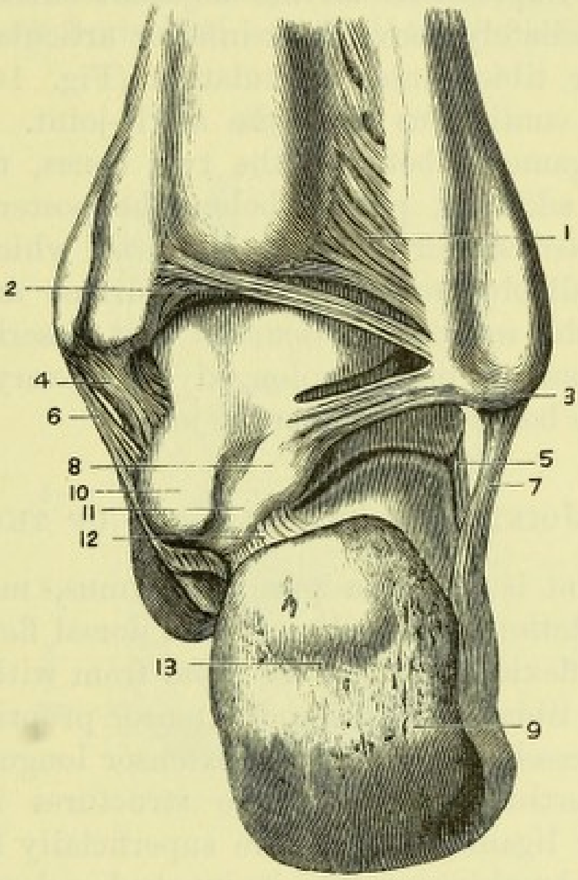
The **Bursæ** in the neighbourhood of the knee (Fig. 101) are as follows:—1. The *subcrureus bursa*, which extends two inches or more above the patella, and is usually, but not always, continuous with the synovial cavity. 2. The *popliteus bursa*, a prolongation of synovial membrane which surrounds the tendon of the popliteus and passes with it over the back of the external semilunar cartilage and of the internal tuberosity of the tibia, and may establish a communication with the superior tibio-fibular joint where the muscle crosses the posterior tibio-fibular ligament. 3. The *gastrocnemius bursa*, lying beneath the inner head of the gastrocnemius and the tendon of the semimembranosus, and often named after the latter muscle. It sometimes communicates with the synovial cavity (most frequently in male adults), probably in consequence of absorption of the capsule by long-continued pressure against the back of the condyle. 4. The *anterior semimembranosus bursa*, between the tibial attachment of the tendon and the internal lateral ligament. 5. The *prepatellar bursæ* (B. subcutanea, B. subfascialis, and B. subtendinosa (occasional)). 6. The *infra-patellar bursa* between the ligamentum patellæ and the upper part of the tibial tubercle. 7. The *biceps bursa*, separating the tendon of the muscle from the long external lateral ligament. 8. The *sartorius bursa*, common to the tendons of the sartorius, semi-tendinosus and gracilis. This lies below the level of the joint. Occasional bursæ may also exist in front of the tubercle of the tibia and ligamentum patellæ, and beneath the outer head of the gastrocnemius.

Tibio-Fibular Articulations.

[The whole of the muscular fibres connected with the bones of the leg and foot must be removed, but the tendinous insertions about the foot should be kept to be examined with the ligaments.]

The **Superior** tibio-fibular articulation (Fig. 99) is a simple arthrodial joint, the synovial membrane of which is occasionally continuous with that of the knee through the medium of the popliteal bursa. The *anterior* and *posterior* (10) ligaments are

Fig. 102.



short bands connecting the anterior and posterior surfaces of the head of the fibula with the outer tuberosity of the tibia, and forming a capsule. The joint is strengthened by the tendon of the biceps.

The **Middle** tibio-fibular articulation is formed by the *interosseous ligament* or membrane, and is the great bond between the shafts

Fig. 102.—Posterior view of the ankle-joint (from Sappey).

1. Posterior inferior tibio-fibular ligament.
2. Transverse ligament.
3. Posterior fasciculus of the external lateral ligament.
4, 6. Internal lateral ligament.
5. External calcaneo - astragalar ligament.
7. Middle fasciculus of external lateral ligament.
8. Tubercle on outer side of groove for flexor longus pollicis.
9. Posterior tuberosity of os calcis.
10. Tubercle on inner side of groove for flexor longus pollicis.
11. Groove on astragalus for flexor longus pollicis.
12. Posterior calcaneo - astragalar ligament.
13. Point of insertion of tendo-Achillis.

of the bones of the leg. Its fibres run downwards from the tibia to the fibula, and are attached to the sharp interosseous borders of both bones. It is pierced above by the anterior tibial vessels, and near its lower part by the anterior peroneal vessels.

Below the interosseous membrane is the *inferior interosseous ligament*, which consists of very short fibres passing between the triangular rough impressions on the adjacent surfaces of the tibia and fibula, immediately above their inferior articulation.

The **Inferior** tibio-fibular articulation (Fig. 102) is a simple arthrodial joint, continuous with the ankle-joint. It has *anterior* and *posterior* ligaments between the two bones, resembling those above, and in addition, placed below the posterior and distinct from it; a *transverse* (or *inferior*) *ligament* which reaches from the external malleolus to the posterior surface and malleolus of the tibia; and the *interosseous ligament* just described. A fold of synovial membrane is often prolonged for a very short distance between the two bones from the ankle-joint.

Ankle-Joint and Articulations of the Foot.

The ankle-joint is almost a pure ginglymus, moving 15° (from the position of station), in the direction of dorsal flexion, and 45° in that of plantar flexion. It has *in front* from within outwards the tendons of the tibialis anticus and extensor proprius hallucis, the anterior tibial vessels and nerve, the extensor longus digitorum, and the peroneus tertius. Fixing these structures in place is the anterior annular ligament, and more superficially lies the musculo-cutaneous nerve breaking up into its internal and external branches. *Behind*, arranged from within outwards are the tendons of the tibialis posticus and flexor digitorum longus, the posterior tibial vessels and nerve (or it may be the plantar vessels and nerves), the flexor longus hallucis, and behind the external malleolus, the tendons of the peroneus longus and brevis (Fig. 103). The ankle-joint has anterior, posterior, and two lateral ligaments.

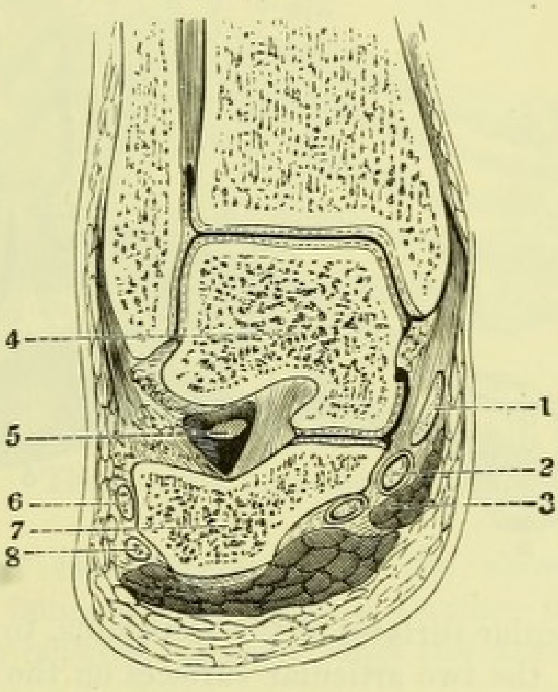
The **Anterior Ligament** is a broad thin membrane which is seldom seen entire. It is attached to the lower margin of the tibia, and to the superior surface of the astragalus, close to its head, and joins the lateral ligament on each side.

The **Posterior Ligament** is not described by many authors, and it is seldom represented by more than a few fibres stretching over the synovial membrane between the back of the tibia and the astragalus.

The **Internal Lateral Ligament** (Fig. 104, 1, 2, 3, 4) is triangular in shape, and hence has been called *deltoid*. The apex is attached to the tip and borders of the internal malleolus, and the base to the posterior part of the astragalus, the lesser process of the os calcis, the inferior calcaneo-scaphoid ligament, and the tuberosity of the scaphoid bone. A strong *deep portion* passes from the apex of the malleolus to the side of the astragalus.

The **External Lateral Ligament** (Fig. 105) consists of three slips; two almost horizontal attached to the astragalus, and one

Fig. 103.



running downwards and backwards to the os calcis. The *anterior* slip (3) runs from the anterior border of the external malleolus to the side of the astragalus in front of the malleolar facet; the *middle* (2) is a round cord which passes downwards and backwards from the tip of the malleolus to an eminence on the outer side of the os calcis, behind the peroneal tubercle; the *posterior* (Fig. 102, 3) is attached to the deep groove behind the articular surface of the external malleolus, and passes horizontally to the external tubercle on the posterior surface of the astragalus, behind the tibial facet.

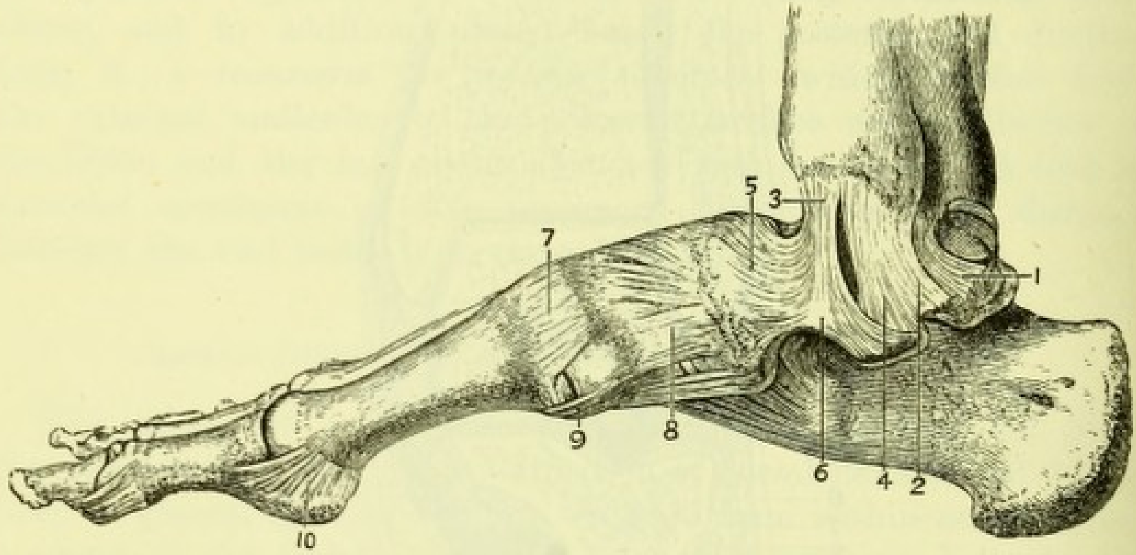
The **Calcaneo-astragalar Articulation** has *external*, *posterior*,

Fig. 103.—Vertical section of ankle-joint (after Henle).

1. Tibialis posticus.
2. Flexor longus digitorum.
3. Flexor longus hallucis.
4. Astragalus.
5. Astragalo-calcanean ligament.
6. Peroneus brevis
7. Os calcis.
8. Peroneus longus.

and *interosseous* ligaments. The *external* (Fig. 105, 4) is a short band passing obliquely backwards from the side of the astragalus below the fibular facet to the adjacent part of the outer surface of the os calcis. The *posterior* (Fig. 102, 12) is placed between the posterior parts of the two bones, close to the groove in the astragalus through which the tendon of the flexor longus hallucis passes. The *interosseous* (Fig. 103, 5) ligament will be seen when the joint is opened. It is a strong thick band, passing from the groove between the

Fig. 104.



two inferior articular surfaces of the astragalus, to the corresponding groove between the two articular surfaces on the superior aspect of the calcaneum, and divides the sub-astragalar synovial cavity into two parts, an anterior continuous with the astragalo-scaphoid joint, and a posterior directly beneath the ankle-joint. The double articulation, to which the name *talo-calcaneo-scaphoid* joint may be given, is the seat of nearly the whole of the lateral motion (abduction and adduction) of the foot (Fig. 107).

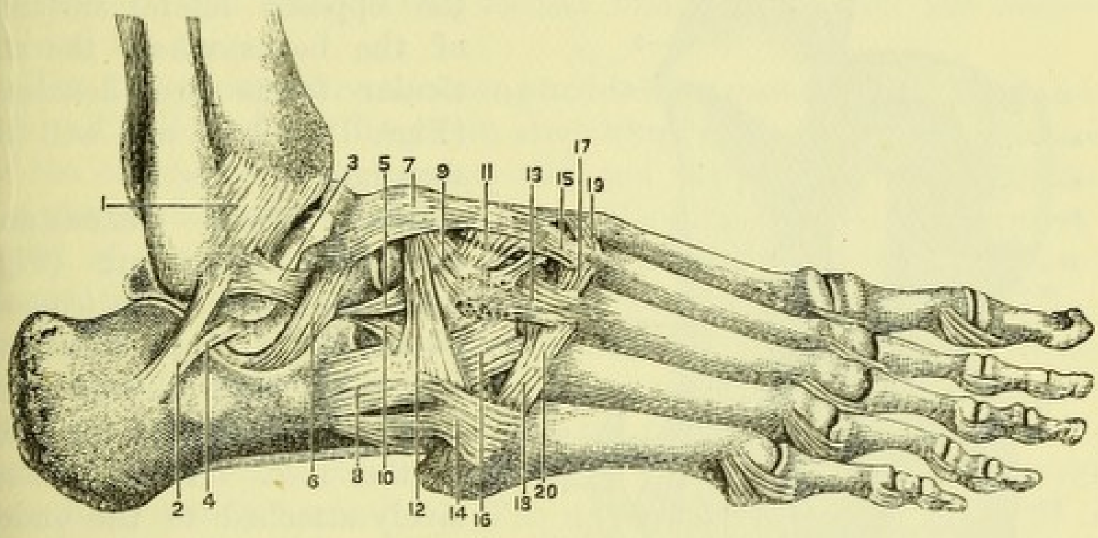
The *tendon of the tibialis posticus* may now be seen crossing the deltoid ligament, and will be found to have a fibro-cartilage developed

Fig. 104.—Ligaments of the inner side of the ankle and foot (from Sappey).

1, 2, 3, 4. Different parts of internal lateral ligament of ankle.
5, 6. Inferior calcaneo-scaphoid ligament, joined by anterior fibres of internal lateral ligament.
7. Internal ligament between internal cuneiform and first metatarsal.
8. Ligament between scaphoid and internal cuneiform.
9. Inferior ligament between internal cuneiform and first metatarsal.
10. Inferior ligament of first metatarso-phalangeal joint.

in it where it passes under the head of the astragalus and reinforces the inferior calcaneo-scaphoid ligament. It is attached to the tuberosity of the scaphoid bone and the adjacent internal cuneiform bone, and gives slips also to all the other bones of the tarsus, with

Fig. 105.



the exception of the astragalus, and to the second, third, and fourth metatarsal bones. These must be removed to see the true ligaments of the joints.

Ligaments of the Tarsus.—On the *dorsal* aspect of the remaining tarsal bones will be found a number of short bands of fibres, which pass between adjacent bones and have received names

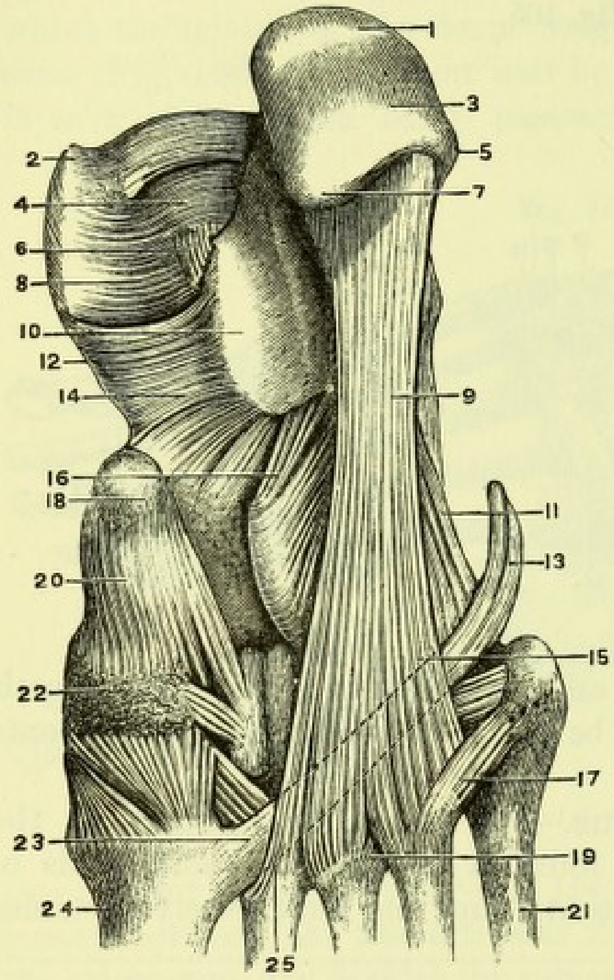
Fig. 105.—Ligaments of the outer side of the ankle and foot (from Sappey).

1. Anterior inferior tibio-fibular ligament.
2. Middle fasciculus of external lateral ligament of ankle.
3. Anterior fasciculus of external lateral ligament of ankle.
4. External calcaneo - astragalar ligament.
5. External calcaneo-scaphoid ligament.
6. Interosseous calcaneo-astragalar ligament.
7. Superior astragalo-scaphoid ligament.
8. External calcaneo-cuboid ligament.
9. Dorsal ligament between scaphoid and external cuneiform.
10. Internal calcaneo-cuboid ligament.
11. Dorsal ligament between external and middle cuneiform.
12. Dorsal ligament between scaphoid and cuboid.
13. Dorsal ligament between external cuneiform and third metatarsal.
14. Dorsal ligament between cuboid and fifth metatarsal.
15. Dorsal ligament between middle cuneiform and second metatarsal.
16. Dorsal ligament between cuboid and third and fourth metatarsals.

17, 18, 19, 20. Dorsal ligaments between bases of metatarsal bones.

as ligaments accordingly : on the *plantar* aspect there are similar but stronger ligaments, three of which are worthy of special notice, viz., the long and short calcaneo-cuboid ligaments, and the calcaneo-scaphoid ligaments. Another set of ligaments, called *interosseous,* connect the opposed lateral surfaces of the bones where the articular facets are deficient (Figs. 107, 109) and will be seen later.

Fig. 106.



The **Long Calcaneo-Cuboid Ligament** (Fig. 106, 9)—*ligamentum longum plantæ*—is a broad ligament which has been already seen in the dissection of the sole of the foot. It is extensively attached to the under surface of the os calcis in front of the tuberosities, and passes forward to be fixed to the posterior margin of the peroneal groove in the cuboid bone, some of the fibres passing over the tendon of the peroneus longus (for which they form a sheath), to be-

Fig. 106.—Ligaments of the sole of the foot (from Sappey).

1. Point of attachment of tendo-Achillis.
2. Internal malleolus.
3. Posterior tuberosity of os calcis.
4. Posterior part of astragalus.
5. External tubercle on under surface of os calcis.
6. Posterior calcaneo - astragalar ligament.
7. Internal tubercle on under surface of os calcis.
8 and 12. Internal lateral ligament of ankle.
9. Long plantar ligament.
10. Groove on sustentaculum tali for flexor longus pollicis.
11 Short plantar ligament.
13 and 23. Tendon of peroneus longus.
14. Inferior calcaneo-scaphoid ligament.
15. Sheath of peroneus longus.
16. Short plantar ligament.
17. Plantar ligament between fourth and fifth metatarsals.
18. Tubercle of scaphoid.
19. Plantar ligament between third and fourth metatarsals.
20. Plantar ligament between scaphoid and internal cuneiform.
21. Fifth metatarsal.
22. Internal cuneiform bone.
24. First metatarsal bone.
25. Sheath of peroneus longus.

come attached to the bases of the second, third, and fourth metatarsal bones.

The **Short Calcaneo-Cuboid Ligament** (Fig. 106, 11, 16), more deeply placed, lies to the inner side and under cover of the long ligament. It reaches from the anterior tubercle on the under surface of the greater process of the os calcis, a little behind the calcaneo-cuboid articulation, to the under surface of the cuboid behind the ridge.

The **Inferior Calcaneo-scaphoid Ligament** (Fig. 106, 14) is a broad yellow elastic ligament, stretching between the lesser process of the calcaneum (*sustentaculum tali*) and the posterior border of the inferior surface of the scaphoid bone, blending internally with a segment of the internal lateral ligament of the ankle-joint. It performs the important function of supporting the keystone of the longitudinal arch of the foot, the head of the astragalus, which rests upon it between the anterior calcanean and the scaphoid facets; and in this is materially assisted by the tendons of the tibialis posticus and of the long flexors of the great and lesser toes, which pass immediately beneath it. The upper surface of the ligament is lined with the synovial membrane of the talo-calcaneo-scaphoid articulation.

The *interosseous* ligaments will be seen when the joints are opened.

The **Metatarsal Bones** (Fig. 105, 17) are connected with the tarsus by strong dorsal, plantar, and interosseous ligaments.

The *dorsal* ligaments run to each metatarsal bone from the tarsal bone with which it articulates; but the second metatarsal, in addition to its ligament from the middle cuneiform, has extra slips from the internal and external cuneiform bones, between which its base is wedged.

The *plantar* ligaments are less regular, and are united with the slips from the calcaneo-cuboid ligament.

The *interosseous* ligaments are short strong bands, and vary slightly in different subjects. There is always one between the internal cuneiform and the second metatarsal bone; a second may exist between the external cuneiform and the same metatarsal bone; and a third between the external cuneiform and the fourth metatarsal bone (Fig. 107).

Transverse dorsal, *plantar*, and *interosseous* ligaments connect the bases of the metatarsal bones.

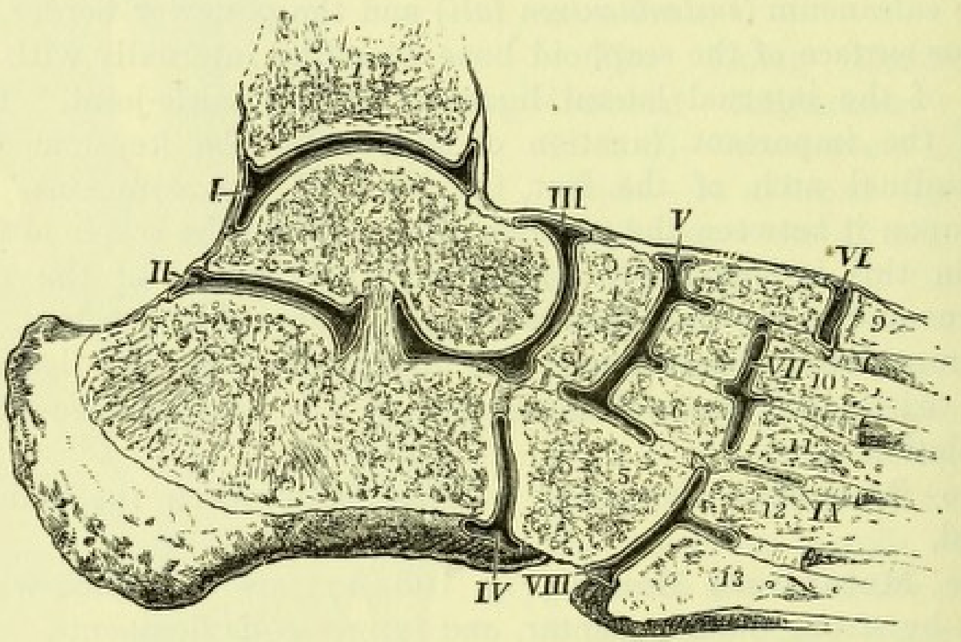
The **Synovial Membranes** (Fig. 107) of the foot, including the ankle-joint, are seven in number, and will be seen by opening the several joints in succession.

The 1st is the synovial membrane of the ankle (I), reflected over the inner surface of ligaments of the joint, and may pass also for a short distance between the tibia and fibula into the inferior tibio-fibular articulation.

The 2nd synovial membrane lines the posterior part of the astragalo-calcaneo-scaphoid joint (omitting, of course, the opposed cartilaginous surfaces) (II).

The 3rd synovial membrane belongs in like manner to the

Fig. 107.



anterior part of the same articulation and lines the inferior calcaneo-scaphoid and the superior astragalo-scaphoid ligaments (III).

The strong *interosseous ligament* connecting the under surface of the astragalus and the upper surface of the os calcis will now be seen occupying the deep groove between the two articulations in each bone. Two *interosseous* ligaments, the *internal calcaneo-cuboid* and the *external calcaneo-scaphoid*, will also be seen, when the astragalus is displaced, passing from the upper border of the greater

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Fig. 107.—Section to show the seven synovial membranes of the foot (from Wilson). The reflection of the membrane over the articular cartilages is erroneous.

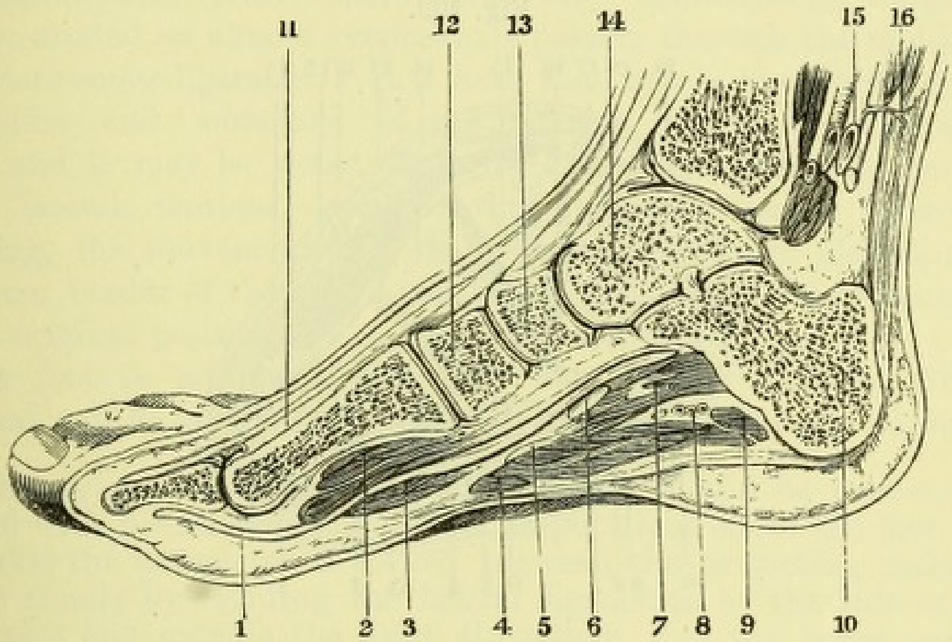
1. Tibia.
2. Astragalus.
3. Calcaneum.
4. Scaphoid.
5. Cuboid.
6. External cuneiform.
7. Middle cuneiform.
8. Internal cuneiform.
9. First metatarsal.
10. Second metatarsal.
11. Third metatarsal.
12. Fourth metatarsal.
13. Fifth metatarsal.

process of the os calcis to the cuboid and scaphoid bones respectively.

The 4th synovial membrane (IV) belongs to the calcaneo-cuboid articulation, and when it is opened, the peculiar manner in which the two bones are locked together will be seen.

The 5th synovial membrane (V) is common to the scapho-cuneiform, inter-cuneiform, and cubo-cuneiform articulations, and to

Fig. 108.



the joints between the middle and external cuneiform and the corresponding metatarsal bones (VII), and is also prolonged into the articulations between the second, third, and fourth metatarsal bones (IX).

Interosseous ligaments will be found between the scaphoid and cuboid bones; between the internal and middle cuneiform bones; between the middle and external cuneiform bones; and between the external cuneiform and cuboid bones.

Fig. 108.—Longitudinal section of foot (after Braune).

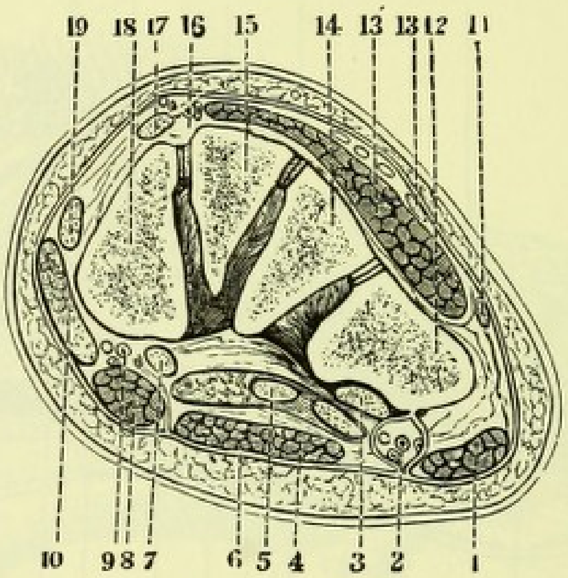
1. Flexor longus hallucis.
2. Flexor brevis hallucis.
3. Lumbricalis.
4. Flexor brevis digitorum.
5. Internal plantar nerve.
6. Flexor communis digitorum.
7. Accessorius.
8. External plantar vessels and nerve.
9. Adductor minimi digiti.
10. Os calcis.
11. Extensor proprius hallucis.
12. Internal cuneiform.
13. Scaphoid.
14. Astragalus.
15. Posterior tibial vessels and nerve.
16. Tendo-Achillis.

The 6th synovial membrane (VIII) is connected with the joint between the cuboid bone and the bases of the fourth and fifth metatarsal bones, and is prolonged into the articulation between the latter.

The 7th is a separate synovial membrane (VI) for the joint between the first metatarsal bone and the internal cuneiform bone.

The mechanism of the *arch* of the foot may now be studied, and

Fig. 109.



the value of the powerful tendons, muscles, fasciæ, and ligaments beneath the sole as chords and ties to connect the elements of the arch, will be readily appreciated. It is the insufficiency of these muscular and ligamentous structures that permits the sinking of the astragalar key-stone which constitutes the essence of "flat foot." The so-called "transverse arch" of the foot is not an arch in the same sense as the true or longitudinal arch.

Fig. 109.—Vertical section through the cuneiform and cuboid bones (after Henle).

1. Abductor minimi digiti.
2. External plantar vessels and nerve.
3. Tendon of peroneus longus.
4. Flexor brevis digitorum.
5. Flexor longus digitorum.
6. Plantar fascia.
7. Flexor longus hallucis.
8, 10. Abductor hallucis.
9. Internal plantar vessels and nerve.
11. Peroneus tertius.
12. Cuboid.
13. Dorsal aponeurosis.
13′. Extensor brevis digitorum.
14. External cuneiform.
15. Middle cuneiform.
16. Dorsalis pedis vessels and nerve.
17. Extensor longus hallucis.
18. Internal cuneiform.
19. Tibialis anticus.

The term *transverse tarsal joint* is a surgical misnomer for the line of articulations separating the astragalus and calcaneum from the cuboid and scaphoid. The astragalar and calcanean portions of this " joint " are quite distinct from each other, both anatomically and physiologically.

The *movements* of the tarsal and tarso-metatarsal joints are for the most part restricted to a slight gliding of the surfaces of each bone over the opposed surfaces of its neighbours, but in the articulation of the astragalus with the calcaneum and scaphoid (talo-calcaneo-scaphoid joint) there is a very considerable range of motion, around an almost vertical axis passing through the middle of the interosseous ligament. It is here that nearly the whole of the '*abduction*' and '*adduction*' of the anterior part of the foot takes place, and it may be noted that the ankle-joint takes no part in these lateral motions, even during plantar flexion. Strictly speaking, the movement is one of adduction with elevation of the inner border of the foot, and the abduction is merely restitution to the original position.

The foot is *adducted* chiefly by the tibialis anticus, tibialis posticus, and flexor longus digitorum, and *abducted* by the peronei.

Surgery.—The shape of the articulations should be particularly noticed with reference to the several amputations about the foot. At the ankle the astragalus is locked between the projecting malleoli, and it is only by dividing the lateral ligaments, by the side of the astragalus and outside the joint altogether, that the bones can be separated, as in Syme's or Pirogoff's amputations.

The astragalo-scaphoid and calcaneo-cuboid articulations will be seen to be nearly in the same line, and are easily opened in Chopart's amputation. The guides for this operation are a point immediately behind the tubercle of the scaphoid bone on the inner side, and a point midway between the external malleolus and the tubercle at the base of the fifth metatarsal bone on the outer side. If, in performing this operation, the articulation in front of the scaphoid should be opened by mistake, the operator would at once see the three articular surfaces for the cuneiform bones instead of the single spheroid surface of the astragalus.

The operation of disarticulating the metatarsus from the tarsus (Hey's or Lisfranc's amputation) is rendered very difficult by the fact that the base of the second metatarsal bone is firmly wedged between the internal and external cuneiform bones, projecting farther into the tarsus than the other bones, and being also attached to the internal cuneiform by a strong interosseous ligament. In amputating at this point therefore, after opening the articulation of the first and three outer metatarsal bones, it is necessary to thrust the point of the knife between the internal cuneiform and second metatarsal bones to divide this ligament, or there will be danger of dragging away the internal cuneiform bone. The articulations are placed obliquely, that of the fifth being posterior to that of the first metatarsal bone, the bases of these two bones forming the guides to the surgeon.

The articulations between the metatarsal bones and the phalanges, and between the phalanges themselves, are similar to those in the hand. They are, however, on a smaller scale, and therefore more difficult of dissection, except in the case of the great toe where the articular elements are well defined. Physiologically the great toe differs from the thumb in its adaptation to sustain the greater part of the weight of the body in walking, and in its incapability of opposition to the other toes.

A shortening of the inferior portions of the lateral ligaments of the metatarso-phalangeal joint in the great toe is present in the deformity known as "hallux flexus," and a similar condition exists in the inter-phalangeal joints of the smaller toes in the analogous complaint called "hammer toe."

TABLE IV.—MUSCLES OF LOWER EXTREMITY.

Muscle.	Origin.	Insertion.	Nerve.
Tensor vaginæ femoris	Ilium, outer lip of anterior fourth of crest	Fascia lata	Superior gluteal. Int. R.
Sartorius	Ilium, anterior superior spine and notch	Tibia, below inner tuberosity; fascia of leg	Anterior crural.
Rectus femoris	Ilium, anterior inferior spine Ilium, impression above acetabulum	Patella, superior border and anterior surface, and tibial tubercle	Anterior crural.
Vastus externus	Femur, outer side, linea aspera and septum	Patella, upper third of lateral border	Anterior crural. Q. Ext.
Vastus internus	Femur, inner side, linea aspera and septum	Patella, upper half of lateral border	Anterior crural.
Crureus	Femur, anterior surface	Patella, upper border, with rectus	Anterior crural.
Sub-crureus	Femur, lower anterior surface	Synovial pouch of knee	Anterior crural.
Gracilis. Adductor	Rami of os pubis and ischium	Tibia, below inner tuberosity	Obturator.
Pectineus	Os pubis, pectineal triangle	Femur, half the line from lesser trochanter to linea aspera	Anterior crural, sometimes Obturator.
Adductor longus	Os pubis, angle below crest	Femur, linea aspera	Obturator.
Adductor brevis	Os pubis, front of ramus	Femur, line from lesser trochanter to linea aspera	Obturator.
Adductor magnus	Os pubis, ramus Ischium, ramus and tuberosity	Femur, from linea quadrati to linea aspera, and linea aspera to adductor tubercle above inner condyle	Obturator & G. Sciatic.
Obturator externus	Margin of obturator foramen, anterior ½ membrane	Femur, digital fossa	Obturator.
Gluteus maximus	Ilium between crest and sup. curved line; sacrum; coccyx; great sacro-sciatic ligament	Femur, from trochanter major to linea aspera; fascia lata	Inferior gluteal (small sciatic).
Gluteus medius	Ilium between superior and middle lines and crest; fascia	Femur, diagonal line of great trochanter.	Superior gluteal. Int. R.
Gluteus minimus	Ilium between middle and inferior lines	Femur, front of great trochanter	Superior gluteal. Int. R.
Pyriformis	Sacrum, front. Margin of great sciatic notch	Femur, upper border of great trochanter.	Sacral plexus.
Obturator internus	Margin of obturator foramen and anterior ½ membrane	Femur, upper border of great trochanter.	Branch of sacral plexus
Gemellus superior	Ischium, spine	....	Nerve to obturator internus.
Gemellus inferior	Ischium, tuberosity	Tendon of obturator internus	Nerve to quadratus.
Quadratus femoris	Ischium, tuberosity	Femur, linea quadrati	Branch of sacral plexus

TABLE IV—MUSCLES OF LOWER EXTREMITY—*continued.*

Muscle.	Origin.	Insertion.	Nerve.
Biceps femoris	Ischium, tuberosity; great sciatic ligament Femur, outer lip of linea aspera and line to external condyle	Fibula, outer side of head; tibia, outer tuberosity; fascia of leg	Great sciatic.
Semi-tendinosus	Ischium, tuberosity	Tibia, below gracilis fascia of leg; fascia.	Great sciatic.
Semi-membranosus	Ischium, tuberosity	Tibia, inner tuberosity; posterior ligament of knee; over popliteus	Great sciatic.
Gastrocnemius	Femur, outer side of outer condyle Femur, above inner condyle	Calcaneum	Internal popliteal.
Plantaris	Femur, above outer condyle	Calcaneum	Internal popliteal.
Soleus	Tibia, oblique line and inner border Fibula, posterior head and upper $\frac{1}{3}$	Calcaneum with gastrocnemius	Internal popliteal and posterior tibial.
Popliteus	Femur, front of depression on outer tuberosity	Tibia, above oblique line	Internal popliteal.
Flexor longus digitorum	Tibia, below oblique line	Four outer toes, 3rd phalanges (perforans)	Posterior tibial.
Tibialis posticus	Tibia, below oblique line; interosseous membrane; fibula, internal surface	Scaphoid, tuberosity; slips to tarsal bones except astragalus, and to 2nd, 3rd, and 4th metatarsal bones	Posterior tibial.
Flexor longus hallucis	Fibula, posterior surface; interosseous membrane; septa	Great toe, terminal phalanx	Posterior tibial.
Tibialis anticus	Tibia, $\frac{2}{3}$ outer surface and tuberosity; $\frac{1}{2}$ interosseous membrane; fascia	Internal cuneiform and 1st metatarsal	Anterior tibial.
Extensor longus digitorum	Fibula, $\frac{3}{4}$ anterior; interosseous membrane; tibia, outer tuberosity; fascia and septa	Four outer toes, distal phalanges	Anterior tibial.
Peroneus tertius	Fibula, $\frac{1}{3}$ anterior; interosseous membr.; septum	5th metatarsal, base	Anterior tibial.
Extensor proprius hallucis	Fibula, $\frac{2}{4}$ anterior; interosseous membrane	Great toe, distal phalanx	Anterior tibial.
Extensor brevis digitorum	Calcaneum, calcaneo-astragalar ligament and annular ligament	Hallux, 1st phalanx; 2nd, 3rd, and 4th toes, extensor tendon	Anterior tibial.
Peroneus longus	Fibula, upper $\frac{2}{3}$ outer; septa; fascia	1st metatarsal and internal cuneiform	Musculo-cutaneous.
Peroneus brevis	Fibula, lower $\frac{2}{3}$ outer; septa	5th metatarsal	Musculo-cutaneous.

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TABLE IV.—MUSCLES OF LOWER EXTREMITY—*continued.*

Muscle.	Origin.	Insertion.	Nerve.
Flexor brevis digitorum	Calcaneum; fascia; septa	Four outer toes, 2nd phalanges (perforatus)	Internal plantar.
Abductor hallucis	Calcaneum, inner tuberosity; fascia Internal annular ligament	Great toe, 1st phalanx; long extensor tendon	Internal plantar.
Abductor minimi digiti	Calcaneum, both tuberosities; fascia and septum	Little toe, 1st phalanx	External plantar.
Accessorius	Calcaneum (2 heads); long plantar ligament	Tendon of flexor longus digitorum	External plantar.
Lumbricales (4)	Tendons of flexor longus digitorum	1st phalanges	2 Internal plantar. 2 External plantar.
Flexor brevis hallucis	Ext. cuneiform; cuboid; tibialis post. tendon	Great toe, 1st phalanx (sesamoids)	Internal plantar.
Adductor obliquus hallucis	Bases of metatarsals, 2, 3, 4; peroneal sheath	Great toe, 1st phalanx, extensor tendon	Deep external plantar.
Flexor brevis minimi digiti	5th metatarsal	Little toe, 1st phalanx	Deep external plantar.
Adductor transversus hallucis	Transverse metatarsal ligament	Great toe, 1st phalanx with adductor	Deep external plantar.
Plantar interossei (3)	Metatarsals, 3, 4, 5	Corresponding 1st phalanges; extensor tendons	Deep external plantar.
Dorsal interossei (4)	Adjacent sides of metatarsals	2nd toe, 1st phalanx (both sides), 3rd and 4th toes, outer side; extensor tendons	Deep external plantar and anterior tibial.

TABLE V.—THE ARTERIES OF THE LOWER EXTREMITY.

Common Femoral Artery. Bifurcates into superficial and deep femorals.
1. Superficial epigastric.
2. Superficial circumflex iliac.
3. Superficial external pudic.
4. Deep external pudic.

Deep Femoral (profunda).
1. External Circumflex. Ascending, transverse, and descending branches.
2. Internal Circumflex. Muscular, articular, and two terminal branches.
3. Perforating. Four, including terminal branch.

Superficial Femoral. Becomes popliteal.
1. Muscular.
2. Anastomotic. Superficial and deep branches.

Popliteal. Bifurcates into anterior and posterior tibial.
1. Superior muscular to hamstrings, &c.
2. Five articular. Superior and inferior external, superior and inferior internal, and azygos.
3. Inferior muscular or sural to calf muscles.

Anterior Tibial.

At back of leg	1. Posterior tibial recurrent. 2. Superior fibular.
In front of leg	1. Anterior tibial recurrent. 2. Muscular. 3. Two malleolar, internal and external.
On foot ...... (Dorsalis pedis artery)	1. Tarsal, internal and external. 2. Metatarsal. Interosseous branches to three outer spaces. 3. Dorsalis hallucis (first dorsal interosseous). 4. Communicating (first plantar digital) to plantar arch.

Posterior Tibial. Bifurcates into external and internal plantar.

1. Peroneal	Muscular. Medullary to fibula. Anterior peroneal. Posterior peroneal or external calcaneal.

2. Medullary to tibia.
3. Muscular.
4. Communicating to peroneal.
5. Internal calcaneal.

Internal Plantar. Muscular.

External Plantar. Forms plantar arch.
1. Calcaneal. Internal and recurrent branches.
2. Muscular.
3. Posterior perforating.
4. Digital.
5. Anastomotic.

From Internal Iliac	*Gluteal artery.* Superficial and deep divisions. *Sciatic artery.* Inferior gluteal, coccygeal, comes nervi ischiadici, anastomotic.

TABLE VI.—NERVES OF THE LOWER EXTREMITY.

L[illegible] Dorsal. Cutaneous to outer side of buttock.

L[illegible]bar Plexus. 1st, 2nd, 3rd, and 4th lumbar, and branch from 12th dorsal.

- Cutaneous to thigh:
  - 12th dorsal and 1st lumbar:
    1. *Ilio-hypogastric*, iliac branch
    2. *Ilio-inguinal*
  3. *Crural Branch of genito-crural.* 1st and 2nd lumbar
  4. *External Cutaneous.* 2nd and 3rd lumbar

5. *Obturator.* 2nd, 3rd, and 4th lumbar.
   - *Superficial division*
     - Articular to hip.
     - Muscular to adductors longus, brevis and gracilis.
     - Subsartorial to plexus.
     - Cutaneous to thigh—occasionally.
   - *Deep division*
     - Articular to knee.
     - Muscular to obturator externus and adductor magnus.
6. *Anterior crural.* 1st, 2nd, 3rd, and 4th lumbar.
   - *Superficial division*
     - Cutaneous to thigh—middle and internal.
     - Muscular to sartorius (middle cutaneous).
   - *Deep division*
     - Muscular to pectineus, rectus, vasti, and crureus.
     - Articular to hip and knee from the above.
     - Long saphenous (internal cutaneous to knee, leg, and foot).

Sa[illegible]al plexus. 5th lumbar, 1st, 2nd, 3rd, and 4th sacral, and branch from 4th lumbar.

1. *Superior gluteal*, to glutei medius and minimus, and tensor vaginæ femoris.
2. *Inferior gluteal* (occurs from small sciatic) to gluteus maximus.
3. *Muscular* to obturator internus and gemellus superior.
4. *Muscular* to quadratus femoris and gemellus inferior, gives *articular* nerve to hip.
5. *Lesser sciatic*
   - Internal cutaneous (inferior pudendal) to perinæum.
   - Recurrent cutaneous to buttock.
   - Descending cutaneous to back of thigh and leg.
6. *Greater sciatic.* Ends by bifurcation into external and internal popliteal.
   - α. *Muscular* to biceps, semitendinosus, semimembranosus, and adductor magnus.
   - β. *External popliteal;* bifurcates into musculo-cutaneous and anterior tibial.
     - Articular to knee. Superior external, inferior external, and recurrent.
     - Cutaneous to outer side of knee and leg.
     - Communicans peronei.
     - *Musculo-cutaneous* to peronei longus and brevis.
       skin of dorsum of foot.
     - *Anterior tibial*
       - Muscular to tibialis anticus, extensor longus digitorum, extensor longus hallucis, peroneus tertius, extensor brevis digitorum, and 1st and 2nd dorsal interossei.
       - Articular to knee, ankle, and tarsus.
       - Cutaneous to foot.
   - γ. *Internal popliteal.* Becomes posterior tibial at lower border of popliteus.
     - Articular to knee. Superior internal, inferior internal, and azygos.
     - Muscular to gastrocnemius (2), plantaris, popliteus and soleus.
     - Communicans poplitei, joining communicans peronei to form short saphenous nerve.
     - *Posterior tibial*
       - Muscular to soleus, flexor longus digitorum, flexor longus hallucis, and tibialis posticus.
       - Internal calcaneal.
       - Internal plantar
         - Muscular to abductor and flexor brevis hallucis, flexor brevis digitorum, and 1st and 2nd lumbricals.
         - Cutaneous—plantar.
         - Digital to 3½ inner toes.
         - Communicating to external plantar.
       - External plantar
         - Muscular to all other muscles of sole.
         - Cutaneous and digital.

PART III.

DISSECTION OF THE ABDOMEN.

[*The Student is requested to read the 'Introduction' before commencing the dissection, unless he has done so on a previous occasion.*]

Surgery.—Before the subject is tied up for the dissection of the perinæum, the student should practise the operation of introducing the catheter.

In the case of the **Male Subject** the operator should stand on the left side of the body, and having oiled a perfectly smooth and clean staff or sound, should grasp the end of the penis with the left hand, and draw it upwards so as to stretch the urethra whilst introducing the instrument. The sound is to be held lightly in the right hand, and is to be passed at first along the fold of the groin, but when it has entered the urethra for a few inches it is to be brought parallel to the median line of the body and pressed onwards, keeping its point constantly against the upper wall of the urethra. The introduction of an instrument is more difficult on the dead than on the living body, owing to the want of the mucous secretion of the urethra and the relaxed condition of the canal; and it is advisable therefore to withdraw the instrument and oil it afresh if any obstruction should occur.

If an obstruction be encountered, the left hand should be placed upon the perinæum at the point to which the staff has reached, and may be made to grasp the urethra and guide the instrument in its right course.

When the staff has passed the bulb, the handle is to be depressed between the thighs, and the point will probably enter the bladder. If it is found impossible to depress the handle, the student may be certain that he is stopped by the triangular ligament, and should be very gentle in his manipulations, or he will very probably perforate the bulb. By a series of cautious efforts, aided by the left hand on the perinæum, the staff may at last be passed, but if an organic stricture should exist, it will be necessary to use a smaller instrument.

When the handle of the instrument can be depressed between the thighs, the student may judge of its having entered the bladder by the readiness with which it passed, and by the ease with which the end of the staff can be rotated in the bladder. In all cases, however, it is advisable for the student to introduce his left fore-finger into the rectum, in order to ascertain that the instrument is not in a false passage, and also in order to appreciate the thickness of the coats of the bladder, the size of the prostate, and the course the catheter would take on the living body.

In the **Female Subject** it will be advisable to examine the position of the urethra by separating the labia, before attempting to introduce an elastic catheter. It will be seen that the orifice of the urethra is separated from the clitoris by the space known as the vestibule, and that it is close above the entrance to the vagina. To pass the catheter, the student should stand on the right side of the subject, and having passed the left fore-finger between the thighs and labia, should place it at the anterior edge of the orifice of the vagina; a flexible catheter being then passed along the fore-finger can be slightly raised so as to enter the urethra, and will be felt in its passage through that canal by the finger at the orifice of the vagina. It will be well to practise the operation once or twice with the parts exposed to view, and then to repeat it with a cloth thrown over the pubes, as would be done in actual practice.

The Perinæum.

[The perinæum is now to be fully exposed by bringing the buttocks of the subject to the edge of the table, where they are to be raised upon a block. The thighs are then to be flexed upon the abdomen, with the legs bent; and the body is to be secured upon the table with a cord passing beneath it from one knee to the other, a block being placed lengthways between the knees to keep them sufficiently apart. The staff is to be retained in the male urethra, and secured in its place by tying a loop of string round the penis and fastening it to the handle of the instrument. It is necessary to flex the knees, when the thighs are bent, in order to remove the tension that would otherwise occur in the hamstrings and sciatic nerve.]

External Appearances.—*In the male* the skin is of a darker tint than that of the rest of the body, and is more or less covered with hair, which should be removed. In front will be found the *scrotum*, containing the two testes, and obscuring at present the root of the penis and deeper portion of the urethra. Behind the scrotum is the *anus* or orifice of the bowel, and between the two is the true *perinæum*, which will be seen to be marked by a median raphé. Around the anus the skin is thrown into folds, which may be much enlarged in one variety of external piles. By drawing the anus open, a white line will be seen about half an inch above the margin of the aperture, marking the junction of the skin with the mucous membrane, and corresponding to the separation between the internal and external sphincter muscles.

In the *female* the external parts of generation are termed collectively the vulva. They comprise two labia majora, two labia minora or nymphæ, the clitoris, and the vestibule. The two *labia majora* may be considered to represent the scrotum, cleft in the median line by the genital fissure. These are continuous above with the *mons Veneris*, a prominent portion of the fat-bearing integument over the pubes (only partially seen in this view). The labia are united in front by the *anterior commissure;* they bound the *rima genitalis* and are continued backwards to the posterior boundary of the perinæum, where they are united by the *posterior commissure.* In a female who has not borne children, a small transverse fold of mucous membrane may be seen just within the posterior commissure, which is called the *fourchette,* and between the two is the *fossa navicularis.*

By separating the labia the *clitoris* will be seen at the upper part of the vulva, resembling a diminutive penis in appearance and structure, and having only a small and ill-defined *glans* and *prepuce,* and no urethral perforation.

The *nymphæ* or *labia minora* extend obliquely downwards from each side of the clitoris, being connected both with the organ itself and its prepuce, and are lost in the labia majora about midway between the anterior and posterior commissures.

The *vestibule* is a triangular interval, with the apex at the clitoris and the base at the orifice of the vagina, the sides being formed by the nymphæ. An inch below the clitoris is the *meatus urinarius,* the margin of which is slightly prominent, and is placed immediately above the orifice of the vagina.

The entrance of the vagina may be more or less occluded by a *hymen,* which is a reduplication of mucous membrane, usually of a crescentic form with the concave border upwards. The *carunculæ myrtiformes* are little projections from the vaginal wall left by the rupture of the hymen. On each side of the vagina, midway between its anterior and posterior walls, immediately in front of the hymen, or its remains, are the orifices of the *vulvo-vaginal glands* (or glands of Bartholin). The orifices of numerous sebaceous follicles will also be found scattered over the vulva.

The tissues separating the lower ends of the vagina and rectum are known as the *perinæal body,* and sometimes under the ill-selected term of perinæum. The base of the perinæal body, formed by the integument intervening between the posterior commissure of the labia and the anal orifice, is from an inch to an inch and a half long, but becomes greatly stretched during labour. The finger should be introduced into the vagina to ascertain the position and condition of the cervix and os uteri.

Boundaries of the Perinæum.—These are the same in both sexes, and can be best ascertained by placing a pelvis, on which the ligaments are preserved, in the same position as the subject, when the space under examination will be seen to correspond with the inferior aperture of the pelvis. In front is the symphysis pubis, with the divergent ischio-pubic rami extending to the tuberosities of the ischia, which form the lateral boundaries. Posteriorly are the inferior borders of the great sacro-sciatic ligaments, in the recent subject overlapped by the margins of the glutei maximi; and forming the posterior mesial limit of the space is the extremity of the coccyx.

The perinæum has been generally considered to resemble the heraldic lozenge, but has more aptly been compared to an inverted ace-of-hearts. The inferior aperture of the pelvis is larger in the female than in the male, but considerable variation in the space between the rami of the pubes will be found in different individuals. As a rule the subpubic angle is one of 90° or more in the female, but is less than a right angle in the male.

The perinæal space may be conveniently divided into halves, by a line passing from the anterior border of one tuberosity of the ischium to the other; the anterior or urethral half, the *perinæum proper*, contains the urino-genital organs, and the posterior half, or *ischio-rectal region*, the lower extremity of the bowel and the ischio-rectal fossæ. It will be seen, however, that this arbitrary line does not coincide exactly with the true anatomical limits between the two segments of the perinæal structures.

Posterior Space in both Sexes.

[A little cotton-wool is to be introduced into the rectum, and the anus is to be carefully sewn up, the stitches being placed as near the white line mentioned above as possible. A transverse incision is then to be made in front of the anus, connecting the two tuberosities, and a similar one across the lower extremity of the coccyx. These are to be joined by a vertical median incision, which at the anus splits into two parts to surround that orifice, close to the sutures, and the skin is to be reflected on each side.]

The integument surrounding the anus is pigmented and beset with hairs and large sebaceous follicles. It moreover possesses scattered bundles of smooth muscular fibre (corrugator cutis ani) continuous with the dartos of the scrotum and perinæum; and small furrows which radiate from the anal aperture. The veins in this region are very liable to varicose dilatation.

The **External Sphincter Ani** (Fig. 111, 16) surrounds the anus and lies close beneath the skin. It consists of two symmetrical halves, which are attached to the tip of the coccyx behind, and meet about an inch in front of the anus at the tendinous centre of the perinæum; some fibres encircling the anus without attachment to bone. The muscle closes the lower end of the bowel, and is *supplied* by the inferior hæmorrhoidal nerve and by a branch of the fourth sacral nerve.

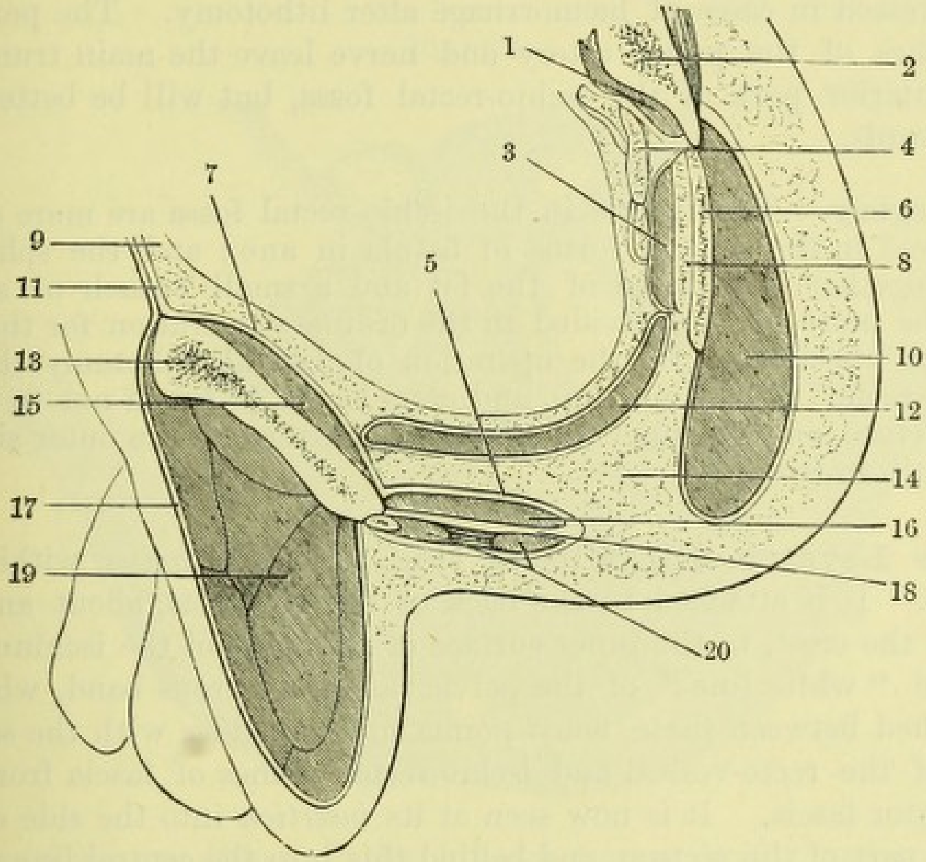
The **Tendinous Centre of the Perinæum** is the name applied to a spot in front of the anus, corresponding to the point of meeting of the sphincter ani with the bulbo-cavernosi and transversi perinæi.

The **Internal Sphincter** cannot be seen at present. It is merely a thickened band of the unstriped circular fibres of the rectum, and differs therefore in structure from the external sphincter, which is a voluntary muscle. It lies above the latter.

[The edge of the gluteus maximus is now to be defined, since it forms the boundary of the dissection; it will be found extending obliquely upwards and outwards (in this position) from the tip of the coccyx. The fat filling the interspace between the anus and the edge of the muscle (ischio-rectal fossa) is to be carefully removed piecemeal, care being taken to preserve the inferior hæmorrhoidal vessels and nerve, which run transversely towards the bowel, and also a little branch of the fourth sacral nerve near the posterior part of the space, as well as the small sciatic nerve and vessels which escape under cover of the muscle. Other branches of the pudic vessels and nerve may be seen running forwards towards the scrotum, and should be avoided.]

The **Ischio-rectal Fossa** (Fig. 111) is the space on each side of the rectum, bounded superficially by the gluteus maximus, ischial tuberosity, and great sacro-sciatic ligament behind; by the junction of the fascia of Colles with the triangular ligaments in front, and by the sphincter ani internally. Its deep boundaries are, on the *inner* side the levator ani and coccygeus, and on the *outer* side the obturator internus lying on the internal surface of the wall of the pelvis. Both these muscles are covered by processes derived from the pelvic fascia; that covering the obturator and coccygeus being called the *obturator fascia*, and that upon the levator ani being the *anal fascia* (*see* diagram of pelvic fascia). When the finger is pushed into this space, it is arrested by the junction of these two fasciæ above, in front, and behind. Superiorly it extends to a depth of from two to three inches, while anteriorly it may be traced forward nearly as far as the symphysis, above the ledge of tissues constituting the perinæum

Fig. 110.



proper; and posteriorly it runs for some distance over the sacro-sciatic ligaments to the coccyx. The fossa then is pyramidal in frontal section, anvil-shaped in sagittal section (Fig. 110, 14).

The space is filled with loose granular fat, which is traversed by

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Fig. 110.—Diagrammatic section of the perinæum and ischio-rectal fossa, to the left of the median line (W.A.).

1. Pyriformis.
2. Sacrum.
3. Coccygeus.
4. Nerves.
5. Deep triangular ligament.
6. Great sacro-sciatic ligament.
7. Obturator fascia.
8. Lesser sacro-sciatic ligament.
9. Subperitoneal tissue.
10. Gluteus maximus.
11. Fascia transversalis.
12. Levator ani with its fasciæ.
13. Os pubis.
14. Ischio-rectal fossa.
15. Obturator internus.
16. Deep perinæal interspace with deep transversus perinæi.
17. Fascia lata of thigh.
18. Superficial triangular ligament.
19. Muscles of thigh.
20. Superficial perinæal interspace with muscles of penis.

the inferior hæmorrhoidal vessels and nerve. On the outer side, and lying above the inner border of the ischial tuberosity and the falciform process of the great sacro-sciatic ligament, are found the pudic vessels and nerve giving off hæmorrhoidal and perinæal branches, and lying in a fibrous channel (canal of Alcock) formed by the obturator fascia. It is here that the artery can be effectually compressed in cases of hæmorrhage after lithotomy. The perinæal branches of the pudic artery and nerve leave the main trunks in the anterior part of the ischio-rectal fossa, but will be better seen afterwards.

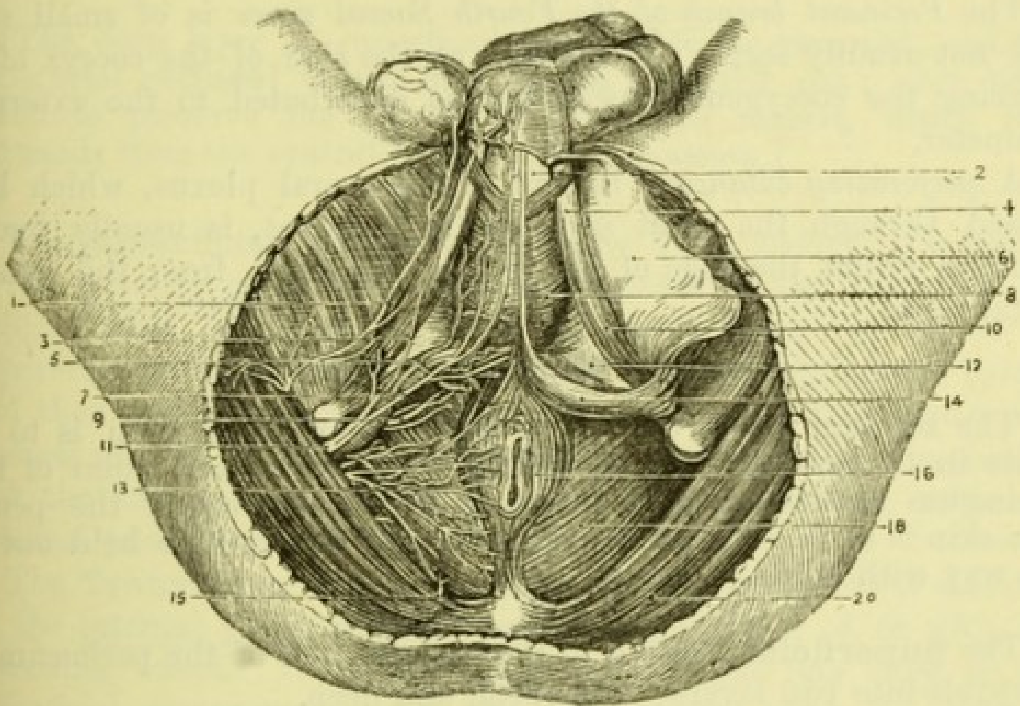
Surgery.—The tissues in the ischio-rectal fossa are more or less involved in the several forms of fistula in ano; and the sphincter ani, together with some of the fat and a small branch of artery, will be more or less divided in the ordinary operation for the cure of that affection. In the operation of lateral lithotomy the left ischio-rectal fossa is cut into, and care has to be taken not to injure the rectum on the inner side, the pudic artery on the outer side, or the bulb in front.

The **Levator Ani Muscle** (Fig. 111, 18) *arises* within the pelvis. It is attached to the back of the os pubis, about an inch below the crest, to the inner surface of the spine of the ischium, and to the "white line" of the pelvic fascia, a fibrous band, which is stretched between these bony points and coincides with the separation of the recto-vesical and ischio-rectal planes of fascia from the obturator fascia. It is now seen at its *insertion* into the side of the lower part of the rectum, and behind this into the central line of the perinæum (where it meets its fellow of the opposite side in a median raphé),and into the anterior surface of the extremity of the coccyx. Its free anterior border runs by the side of the prostate; its posterior border is opposed to the anterior margin of the coccygeus. It is covered on its upper surface by the recto-vesical fascia, and on its lower surface by the ischio-rectal fascia, the two laminæ meeting at its free anterior border (Fig. 110, 12).

The levator ani supports the abdomino-pelvic viscera, and, when in contraction, helps to compress them, and so takes a part in the expulsion of their contents. It is also an extraordinary muscle of expiration, since it assists in forcing the viscera into the concavity of the diaphragm; and it may compress the prostatic veins, and so conduce to the erection of the penis and the expulsion of the prostatic secretion. It is doubtful whether it has any direct influence upon the anal aperture either as a dilator or constrictor. It is *supplied* by branches from the third and fourth sacral nerves.

The **Inferior Hæmorrhoidal Artery** (Fig. 111, 13) arises from the internal pudic artery under cover of the ischium, and takes a nearly transverse course inwards to the anus and lower end of the rectum, where it anastomoses with the middle hæmorrhoidal branch of the internal iliac. *Venæ comites* run with the artery, and join the pudic vein.

Fig. 111.



A varicose condition of the inferior hæmorrhoidal veins, where they lie beneath the mucous membrane of the lower end of the rectum and around the anal margin, constitutes the affection called hæmorrhoids or piles. The enlarged vessels may be ligatured, or dissected away with the superjacent mucous membrane.

Fig. 111.—Superficial dissection of male perinæum (drawn by J. T. Gray).

1. Inferior pudendal nerve.
2. Urethra.
3. External or posterior superficial perinæal nerve.
4. Crus penis.
5. Superficial perinæal artery.
6. Deep layer of superficial fascia reflected (Fascia of Colles).
7. Internal or anterior superficial perinæal nerve.
8. Bulbo-cavernosus.
9. Muscular branches of pudic nerve.
10. Ischio-cavernosus.
11. Pudic artery and nerve.
12. Deep perinæal fascia or triangular ligament.
13. Inferior hæmorrhoidal artery and nerve.
14. Reflection of the deep layer of superficial perinæal fascia round transversus perinæi.
15. Branch of fourth sacral nerve.
16. Sphincter ani.
18. Levator ani.
20. Gluteus maximus.

The **Inferior Hæmorrhoidal Nerve** (Fig. 111, 13) is a branch of the internal pudic nerve, or may arise separately from the lower part of the sacral plexus, taking the same course as the pudic nerve in the same sheath of fascia. In the ischio-rectal fossa it runs transversely superficial to the inferior hæmorrhoidal vessels, and is distributed to the external sphincter and skin of the anus, giving a branch forward to join the superficial perinæal nerves.

The *Perinæal branch of the Fourth Sacral nerve* is of small size and not readily seen. It appears at the side of the coccyx after piercing the coccygeus muscle, and is distributed to the external sphincter.

A *perforating cutaneous* branch of the sacral plexus, which has passed through the great sacro-sciatic ligament, is usually found winding round the edge of the gluteus maximus, from the ischio-rectal fossa.

Anterior Space in the Male.

[The scrotum being drawn up with hooks, an incision is to be made in the median line, extending from the central point of the perinæum to within three inches of the extremity of the penis. The skin is to be reflected to each side, and the testicles held out of the way with hooks.]

The **Superficial Fascia** of the anterior half of the perinæum is divisible into two layers—superficial and deep.

The *superficial layer* of superficial fascia is continuous with that of the scrotum, and like the latter is fatless and contains a layer of involuntary muscular fibre, the *dartos*.

The *deep layer* of superficial fascia (Fig. 111, 6) or *Fascia of Colles*, is brought into view by the removal of the superficial layer as a distinct membrane in thin subjects, but is not easily defined in fat ones. It is continuous in front with the fascia of the scrotum and penis, and over the root of the penis with the fascia of the abdomen; laterally it is attached on each side to the margin of the ischio-pubic rami as far back as the tuberosity; and posteriorly turns around the transversi perinæi muscles, and joins the posterior border of the deep perinæal fascia or ant. layer of triangular ligament (Fig. 110). A pouch, which may be called the *superficial perinæal interspace*, is thus formed between the fascia of Colles and the triangular ligament, and encloses the root of the penis (the bulb of the corpus spongiosum and the crura of the corpora cavernosa) with its surrounding muscles, vessels, and nerves. This interspace is of importance surgically with regard to extravasation of urine. If extravasation should occur from rupture of the bulbous or adjacent portion of the urethra, either from external violence or from the unskilful use of a catheter or other cause, the urine is effused into the pouch, and, being prevented by the union of the two fasciæ posteriorly from running back to the anus, and by their lateral attachment to the rami of the pubes and ischium from extending on to the thighs, it necessarily distends the pouch and creeps into the scrotum and groin and on to the abdomen.

[The deep layer of superficial fascia is to be removed, and the superficial perinæal vessels and nerves dissected out; care being taken to preserve the superficial transverse muscle, which runs outwards from the central point of the perinæum.]

The **Superficial Perinæal Artery** (Fig. 111, 5) is a branch of the internal pudic, and arises under cover of the ramus of the ischium near the front of the ischio-rectal fossa. It enters the superficial perinæal pouch of fascia by piercing its hinder border, and then passes forwards, over or under the superficial transversus perinæi muscle, to supply the superficial muscles of the perinæum and the integuments of the scrotum and anastomose with the external pudic arteries.

The **Transverse Perinæal Artery** (Fig. 111, 11) is a branch of the internal pudic, arising immediately in front of, or with, the preceding vessel. It runs towards the median line close to the superficial transverse muscle, and anastomoses with the opposite artery and with the neighbouring branches. *Veins* corresponding to the arteries open into the internal pudic vein.

The **Perinæal Nerve** (Fig. 111) generally leaves the pudic as a single large trunk in the ischio-rectal fossa, and supplies two *superficial perinæal* nerves; *muscular* branches to the external sphincter, levator ani, and the three muscles in the corresponding half of the superficial perinæal interspace (transversus perinæi, ischio-cavernosus and bulbo-cavernosus); and a branch which may be followed through the accelerator urinæ to the bulb of the urethra (*bulbo-urethral* nerve of Cruveilhier).

The *external* or *posterior superficial perinæal* (3) nerve has a short course in the ischio-rectal fossa, where it gives a branch to the anus. It then pierces the reflection of the deep layer of superficial fascia, and gives branches to the scrotum, forming a junction with the inferior pudendal nerve and usually with the inferior hæmorrhoidal nerve.

The *internal* or *anterior* (7) nerve accompanies the superficial perinæal artery either over or under the transversus perinæi muscle, and is distributed to the scrotum near the median line, where it unites with its fellow of the opposite side, giving also one or two small branches to the levator ani. The before named *muscular* and *urethral* twigs may spring from this branch instead of from the perinæal trunk.

The **Inferior Pudendal Nerve** (Fig. 111, 1) (Soemmering) is a branch of the small sciatic nerve, which pierces the deep fascia of the thigh about an inch in front of the tuberosity of the ischium. It varies a good deal in size and distribution, but generally runs inwards and forwards to the scrotum to join the external superficial perinæal nerve.

[The superficial vessels and nerves are to be turned aside, and the muscles dissected out. The accelerator urinæ is in the median line, the erector penis parallel to the ramus of the pubes, and the transversus perinæi crosses between them posteriorly ; the muscles thus bounding a triangular space in which a part of the triangular ligament is seen.]

Superficial Muscles of the Perinæum.

The muscles in the superficial perinæal interspace are invested, each by a fascia proper to itself.

The **Bulbo-cavernosus** (Fig. 111, 8) (*ejaculator seminis* or *accelerator urinæ*) is a single muscle, composed of two symmetrical halves united in the middle line by a delicate fibrous raphé. The fibres *arise* from the central point of the perinæum and from the fibrous raphé superficial to the bulb, and are *inserted* as follows :—the posterior fibres, which are nearly transverse in their direction, overlie the bulb and are lost upon the superficial triangular ligament ; the middle fibres encircle the corpus spongiosum and meet those of the opposite side in a median raphé under cover of the corpora cavernosa ; and the anterior fibres (inconstant) pass obliquely outwards and forwards, enclosing the entire circumference of the root of the penis and the dorsal vessels (*compressor venæ dorsalis*).

The **Ischio-cavernosus** (Fig. 111, 10) (*erector penis*) a paired muscle, covers the crus penis. It *arises* from the anterior and inner surface of the tuberosity of the ischium, from the ramus of the ischium and also from the fibrous origin of the crus, and ends in an aponeurosis which is *inserted* into the sides of the crus penis, and sometimes sending a slip over the dorsal vessels.

The **Transversus Perinæi** (Fig. 111, 14), also a paired muscle, is very variable in its character. It *arises* from the inner side of the ramus of the ischium, and running forwards and inwards meets its fellow muscle of the opposite side in the central point of the perinæum, where it often blends with the fibres of the accelerator urinæ and sphincter ani.

The action of the *bulbo-cavernosus* is to expel the contents of the urethra by its sudden and spasmodic contraction. It is not put in action during the greater part of the act of micturition; but when the flow of urine has ceased, it serves to eject the small remaining portion; or it may be used to arrest the flow of urine suddenly, when its action gives rise to considerable pain. Its action during coition is expressed by the name ejaculator seminis, and its anterior fibres, when present, aid in producing erection of the penis by compressing the dorsal vein. The *ischio-cavernosi* may assist somewhat in the production of erection by compressing the corpus cavernosum, and more directly by compressing the dorsal vein when its accessory slip is developed. It may, too, impress some voluntary motion upon the penis after erection. The *transversi perinæi* aid the action of the bulbo-cavernosus by fixing the tendinous centre of the perinæum.

Surgery.—The triangular space bounded by the three superficial muscles is important surgically as being the point to which the knife reaches in the incision for lateral lithotomy. In the first incision the surgeon cuts freely through the superficial structures, dividing the superficial perinæal and inferior hæmorrhoidal vessels and nerves, and aiming at the lower part of this space, at which point the finger will feel somewhat indistinctly the staff in the urethra. The deeper incision necessarily divides the transverse muscle and artery, together with the lower part of the triangular ligament, and enables the operator to reach the staff in the membranous portion of the urethra.

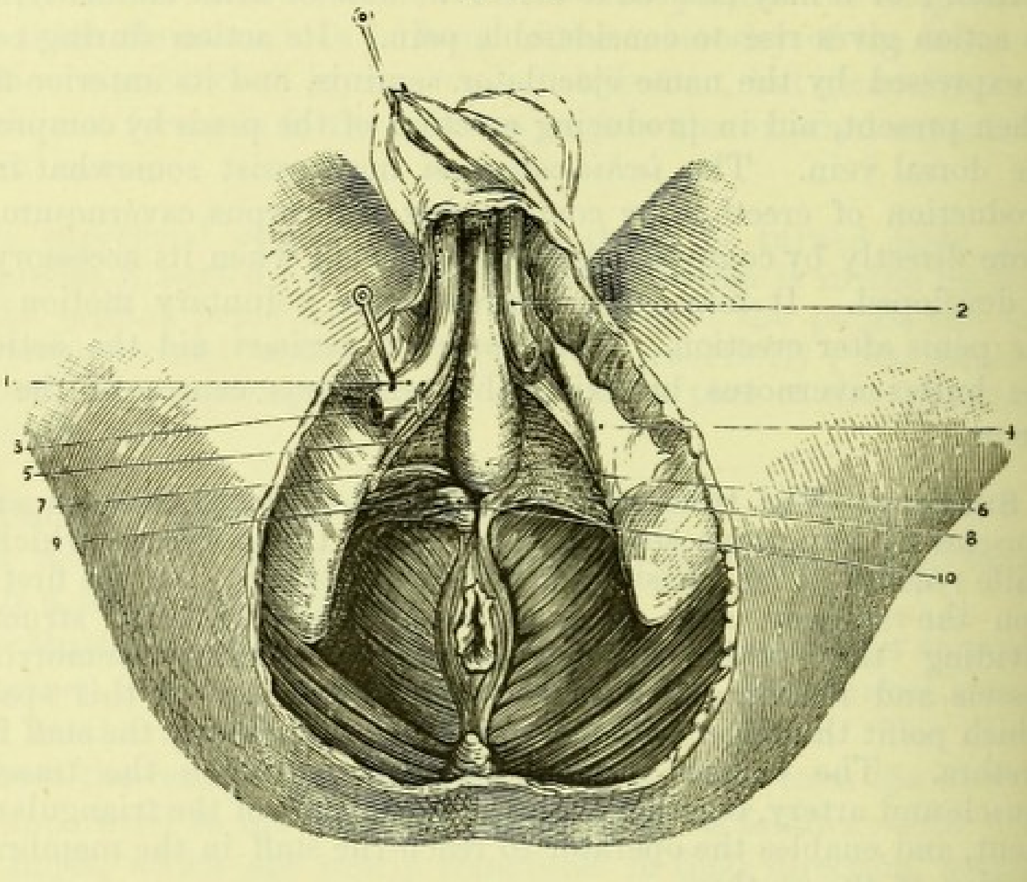
It should be noticed how the small interval between the anus and the bulb of the urethra can be increased by drawing the whole penis upwards; this fact is of importance in relation to median lithotomy, which is performed in this space, and in which operation there is some risk of wounding the bulb. It is obvious that any cutting operation in the median line of the perinæum would be accompanied by but little hæmorrhage, until the vascular structure of the bulb or corpus spongiosum urethræ is reached.

[The bulbo-cavernosus is to be divided in the middle line, and dissected from the bulb beneath and from the triangular ligament, but its anterior fibres must not be interfered with. The transversus perinæi is to be removed, and the ischio-cavernosus detached from the bone with the crus penis, which will be seen to be attached to the ischio-pubic rami for nearly an inch. The crus is to be drawn forward, a branch of artery going to it being carefully preserved;

the superficial triangular ligament will then be exposed. It may be well to leave the crus penis undisturbed on the right side.]

The posterior part of the **Corpus Spongiosum Urethræ** will be seen to be a dark, vascular body, which expands to form the bulb, immediately in front of the triangular ligament.

Fig. 112.



The **Bulb** (Fig. 112, 6) is slightly expanded from side to side, and consists of two halves united by a delicate septum of fibrous tissue. It is closely connected above with the triangular ligament, with which its delicate fibrous covering is continuous, and is embraced by the two halves of the bulbo-cavernosus.

The **Superficial Triangular Ligament** or **Deep Perinæal Fascia** (Fig. 112, 8) is a strong process of fibrous tissue stretching

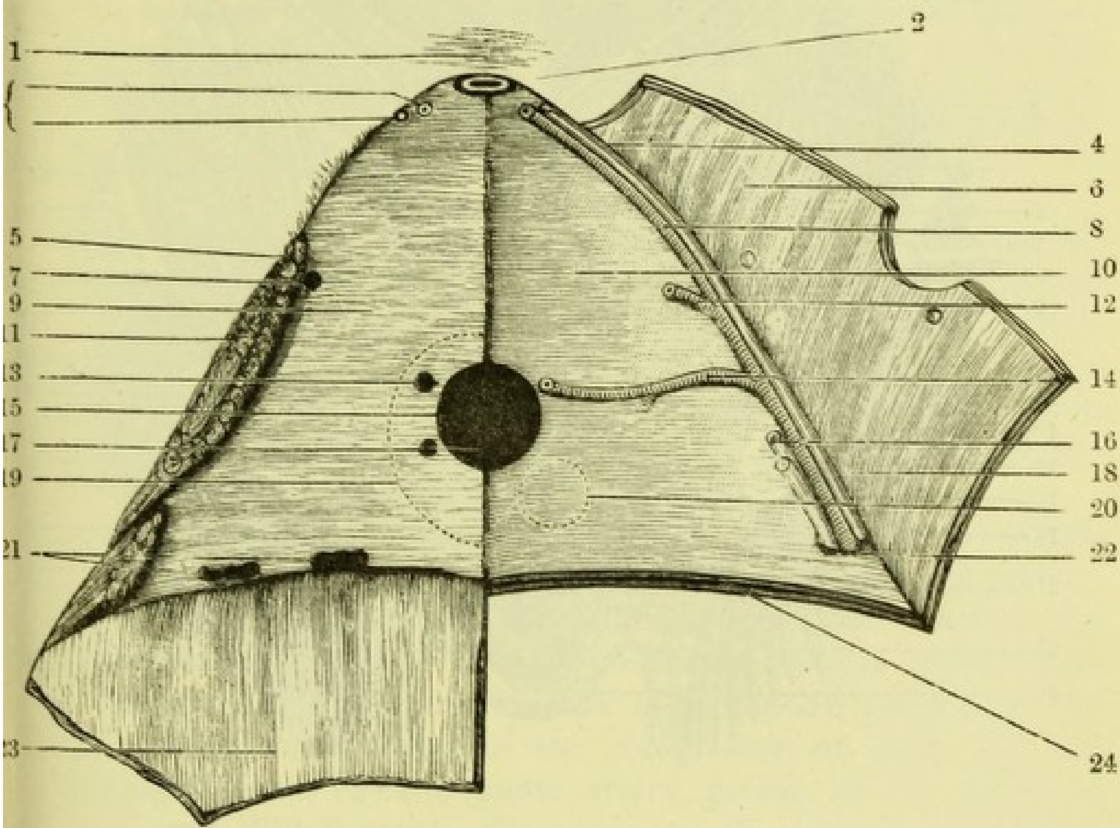
Fig. 112.—Deep dissection of the male perinæum, the anterior triangular ligament being removed on the right side (drawn by J. T. Gray).

1. Right crus penis (cut).
2. Left crus penis (cut).
3. Pudic nerve.
4. Deep layer of superficial fascia reflected (Fascia of Colles).
5. Pudic artery.
6. Bulb of urethra.
7. Artery of the bulb.
8. Superficial triangular ligament.
9. Deep transversus perinæi muscle.
10. Position of Cowper's gland (right).

across the pubic arch, being attached to the rami of the os pubis and ischium on each side, behind the crura penis. It is almost horizontal in the erect posture.

The apex of the ligament is separated from the sub-pubic liga-

Fig. 113.



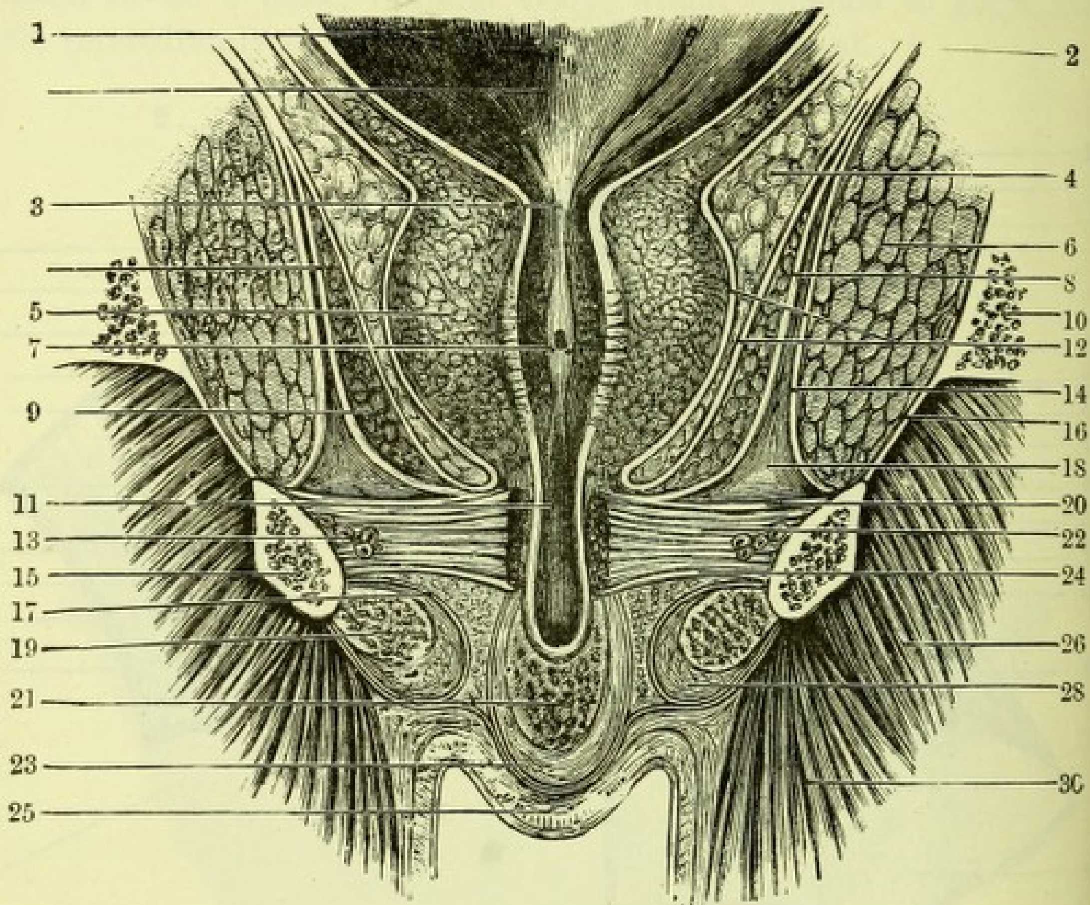
ment by an aperture for the dorsal vein of the penis; and the base, which has the form of an inverted **V** with the angle at the tendinous centre of the perinæum, is continuous with the fascia of Colles where

Fig. 113.—Diagram of the superficial and deep triangular ligaments (W.A.).

1. Sub-pubic ligament with aperture for dorsal vein of the penis.
2. Dorsal vein of penis.
3. Apertures for dorsal artery and nerve of the penis.
4. Dorsal nerve.
5. Crus penis.
6. Anterior layer of triangular ligament.
7. Aperture for artery of corpus cavernosum.
8. Dorsal artery of penis.
9. Superficial triangular ligament.
10. Deep triangular ligament.
11. Ischio-cavernosus.
12. Artery of corpus cavernosum.
13. Aperture for artery to bulb.
14. Artery to bulb.
15. Urethral aperture.
16. Pudic veins.
17. Aperture for Cowper's duct.
18. Dorsal nerve.
19. Position of bulb.
20. Position of Cowper's gland.
21. Apertures for superficial perinæal vessels and nerve.
22. Internal pudic artery.
23. Fascia of Colles, turned backwards.
24. Posterior border of perinæal ledge (junction of triangular ligaments with fascia of Colles).

this turns around the superficial transversi perinæi, and also with the base of the deep triangular ligament.

Fig. 114.



It is perforated about an inch below the symphysis by the membranous urethra ; above this point, close to the pudic rami, by the dorsal arteries and nerves of the penis ; and slightly behind and

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Fig. 114.—Vertical frontal section of the pelvis, showing fasciæ, modified from Braune (W.A.).

1. Bladder.
2. White line.
3. Uvula vesicæ.
4. Subperitoneal fat.
5. Prostate.
6. Obturator internus.
7. Verumontanum.
8. Ischio-rectal fascia.
9. Levator ani.
10. Os innominatum.
11. Membranous urethra.
12. Recto-vesical fascia, parietal and visceral layers.
13. Pudic vessels.
14. Obturator fascia.
15. Pubic arch.
16. Obturator membrane.
17. Fascia of ischio-cavernosus.
18. Ischio-rectal fossa, anterior extension.
19. Crus penis.
20. Deep triangular ligament.
21. Bulb.
22. Deep transversus perinæi.
23. Bulbo-cavernosus with its fascia.
24. Superficial triangular ligament.
25. Integument.
26. Muscles of thigh.
28. Ischio-cavernosus.
30. Muscles of thigh.

external to the urethra on each side by the duct of Cowper's glands and the artery to the bulb (Fig. 113).

[It is advisable not to proceed any further with the dissection of the *left* side of the perinæum, in order that a good side view of this region may be obtained in a subsequent dissection. On the right side the superficial triangular ligament is to be carefully detached from the bone and from its attachments below, and turned towards the median line; the bulb should also be drawn over to the left side with the hooks, so as to increase the space brought into view as much as possible. The minute structures behind the superficial triangular ligament are then to be carefully dissected.]

The *deep perinæal pouch* or *interspace*, between the superficial and deep triangular ligaments, is now opened up. The contents are the deep transversus perinæi (compressor urethræ); the membranous portion of the urethra; Cowper's glands; portions of the pudic vessels and dorsal nerve of the penis, and the artery to the bulb. The sub-pubic ligament and dorsal vein of the penis lie at the anterior angle or apex of the interspace.

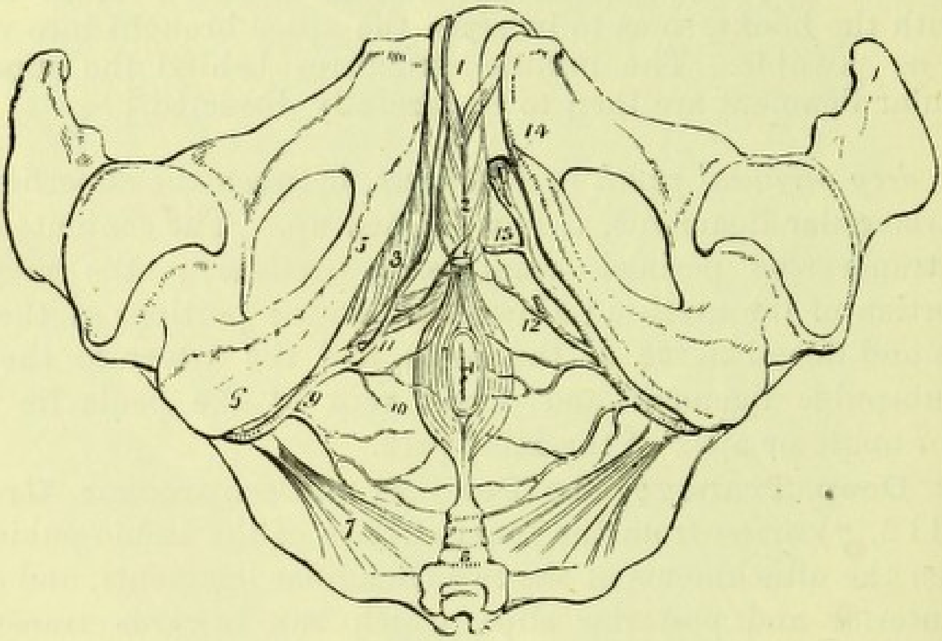
The **Deep Transversus Perinæi** or **Compressor Urethræ** (Fig. 112, 7) *arises* from the inner surface of the ischio-pubic rami, between the attachments of the two triangular ligaments, and divides into anterior and posterior slips, which run inwards transversely across the median line to enclose the membranous portion of the urethra. Within the fibres of the compressor on each side are (1) Cowper's gland, (2) the pudic artery, giving off the artery to the bulb, and dividing into the artery to the corpus cavernosum and the dorsal artery of the penis, (3) the corresponding veins, and (4) the dorsal nerve of the penis, a branch of which supplies the muscle. The duct of Cowper's gland and the other structures named have been seen to pierce the superficial triangular ligament to reach the superficial pouch.

[The muscular fibres are to be divided near the urethra in order to see one of Cowper's glands, and the pudic artery and nerve with their branches are to be followed out close to the ischio-pubic rami.]

Cowper's Glands (Fig. 112, 10) lie close to the membranous portion of the urethra, one on each side of the median line, and are most readily found by tracing the small branch of supply to each gland from the artery to the bulb. The gland resembles a pea in size and shape, and consists of numerous minute lobules. Although it is so close to the membranous urethra, the duct pierces the superficial triangular ligament to open into the bulbous portion of the canal, and is nearly an inch long.

The membranous portion of the urethra will be more satisfactorily examined afterwards, but opportunity should be taken to feel the staff in the urethra at this point, since it is here that tube would be opened, on the left side in the operation of lateral lithotomy, or in the middle line in the median operation.

Fig. 115.



The **Pudic Artery** (Fig. 115, 9), one of the two terminal branches of the anterior division of the internal iliac, will be found under cover of the pubic arch. After running in Alcock's canal (p. 234) in the outer wall of the ischio-rectal fossa, and giving off its inferior hæmorrhoidal and superficial perinæal branches, it pierces the deep triangular ligament near its base to enter the deep perinæal interspace. Here it runs in the fibres

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Fig. 115.—Arteries of the perinæum (from Wilson). On the right side the superficial arteries are seen, on the left the deep.

1. The penis; the crus penis of the left side is cut through.
2. Accelerator urinæ muscle.
3. Erector penis.
4. Anus surrounded by the sphincter ani.
5. Rami of ischium and pubes.
6. Tuberosity of ischium.
7. Lesser sacro-sciatic ligament.
8. Coccyx.
9. Internal pudic artery, crossing the spine of the ischium and entering the perinæum.
10. Inferior hæmorrhoidal branches.
11. Superficial perinæal artery, giving off the transverse artery upon the transversus perinæi muscle.
12. The same artery on the left side cut off.
13. Artery of the bulb.
14. The artery of the corpus cavernosum and the dorsal artery of the penis.

of the compressor urethræ, close to the ischio-pubic rami, and gives off the arteries to the bulb and corpus cavernosum, and terminates in the dorsal artery of the penis.

The **Artery to the Bulb** (Fig. 112, 7) passes transversely inwards to supply the bulb, to reach which it has to pierce the superficial triangular ligament close to the middle line. It generally gives a branch to Cowper's gland of the same side.

The size and position of the artery to the bulb vary considerably, and are of importance with reference to lateral lithotomy. When the origin is as far forwards as represented in Fig. 115 the artery must be free from danger, but if it should arise farther back (and it is occasionally found in the ischio-rectal fossa), it would be liable to be cut, and might give rise to troublesome or even fatal hæmorrhage.

The **Artery to the Corpus Cavernosum** (Fig. 115, 14) pierces the superficial triangular ligament to enter the crus. It is accompanied by a *vein*.

The **Dorsal Artery of the Penis** pierces the fore part of the superficial triangular ligament, and then the suspensory ligament, to reach the upper surface of the organ, where it will be subsequently traced.

When the pudic artery is small, the dorsal arteries are derived from the trunks of the internal iliacs, and reach the penis by piercing both triangular ligaments on each side of the dorsal vein.

The **Dorsal Vein of the Penis** runs between the sub-pubic and triangular ligaments to join the prostatic plexus of veins.

The **Internal Pudic Vein** receives tributaries corresponding to the branches of the pudic artery, and terminates in the internal iliac vein.

The **Pudic Nerve** (Fig. 112, 3) lies below the artery in the ischio-rectal fossa, where it gives off its hæmorrhoidal and perinæal branches, and ends in the **dorsal nerve of the penis.** The latter accompanies the pudic artery through the deep perinæal interspace, lying to its outer side in the fibres of the compressor urethræ and supplying the muscle, finally piercing the superficial triangular ligament with and external to the dorsal artery. Its course and distribution on the penis will be seen later.

The **Deep Triangular Ligament** (Figs. 110, 113) closely resembles the superficial triangular ligament in its mode of attachment to the ischio-pubic rami, but is placed higher and may be regarded as a continuation of the obturator fascia across the sub-pubic arch. It is in contact *below* with the deep transversus perinæi, and *above* with the fat of the anterior extension of the ischio-rectal fossa, the apex of the prostate, the recto-vesical fascia, and the anterior fibres of the levator ani. It is pierced by the internal pudic vessels and dorsal nerve of the penis, and by the urethra. The dorsal vein of the penis runs between its apex and the sub-pubic ligament.

[The flaps of skin should be carefully sewn together before the body is removed from its position.]

Anterior Space in the Female.

[A little cotton-wool is to be inserted in the vagina, and the margins of the labia majora are to be fastened together by a few stitches. An incision is then to be carried transversely above the junction of the labia, from which two vertical incisions, as near the margin of each labium as convenient, are to be prolonged to the central point of the perinæum. The flaps of skin can now be reflected from the middle line, if the transverse incision behind the labia has been already made.]

The **Superficial Fascia** of the anterior half of the female perinæum resembles that of the male, in being divisible into two layers—superficial and deep.

The *superficial layer* of superficial fascia is continuous with the fascia of the body generally, and usually contains much fat beneath the integument of the labium.

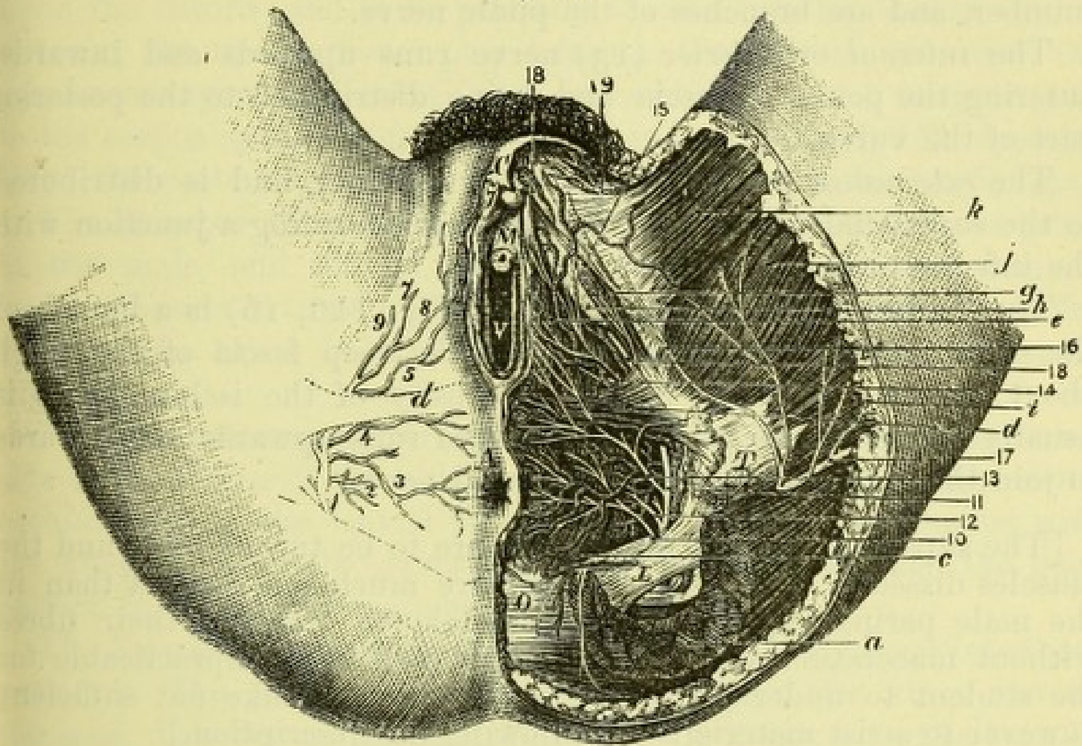
The *deep layer* of superficial fascia is not so strongly marked as in the male, but has the same connections. It is continuous with the deep fascia of the groin, and is attached on each side to the margins of the rami of the os pubis and ischium, nearly to the tuberosity. It then makes a turn around the superficial transversus perinæi muscle on each side, and joins the triangular ligament.

Owing to the position of the vulva, the deep layer of superficial fascia is divided in the middle line and becomes continuous with the sheath of the vagina ; and the pouch between the deep layer of superficial fascia and the triangular ligament (p. 236) is divided into two parts, which have been named the *pudendal* or *vulvo-scrotal sacs* of Broca.

[The deep layer of superficial fascia is to be removed, and the superficial perinæal vessels and nerves dissected out, care being taken to preserve the transversus perinæi muscle, which passes outwards and backwards from the central point of the perinæum.]

The **Superficial Perinæal Artery** (artery of the labium) (Fig. 116, 5) is a branch of the internal pudic artery, and is larger than in the male. It arises under cover of the ramus of the ischium and runs forwards and inwards, to enter the pouch of fascia by piercing the hinder border of the triangular ligament, then

Fig. 116.



passing over or under the superficial transversus perinæi muscle to supply the superficial muscles of the perinæum and the labium.

The **Transverse Artery** (Fig. 116, 4) is a branch of the internal pudic, arising immediately in front of or with the preceding vessel.

Fig. 116.—The female perinæum (from Savage).

1. Pudic artery.
2. Branch to levator ani.
3. Inferior hæmorrhoidal artery.
4. Transverse artery.
5. Great labial (superficial perinæal) artery.
7. Dorsal artery of clitoris.
8. Artery of bulb.
9. Artery to crus clitoridis.
10. Inferior hæmorrhoidal nerve.
11. Pudic nerve.
12. Muscular branch.
13. Internal superficial perinæal nerve.
14. External superficial perinæal nerve.
15. Its junction with—
16. Inferior pudendal nerve.
17. Small sciatic nerve.

18, 18. Dorsal nerve of clitoris.
19. Ilio-inguinal nerve.
A. Anus.
C. Clitoris.
M. Meatus urinarius.
L. Great sacro-sciatic ligament.
V. Vagina.
O. Coccyx.
T. Tuberosity of ischium.
a. Gluteus maximus.
c. Levator ani.
d. Transversus perinæi.
e. Compressor bulbi.
g. Erector clitoridis.
h. Triangular ligament (cut).
i. Biceps and semi-tendinosus.
j. Adductor magnus.
k. Gracilis.

It runs towards the median line close to the superficial transverse muscle, and anastomoses with the opposite artery and with the neighbouring branches. *Veins* corresponding to the arteries open into the internal pudic vein.

The **Superficial Perinæal Nerves** (Fig. 116) are two in number, and are branches of the pudic nerve.

The *internal* or *anterior* (13) nerve runs upwards and inwards, entering the pouch of fascia and being distributed to the posterior part of the vulva.

The *external* or *posterior* (14) nerve is larger, and is distributed to the superficial muscles of the perinæum, forming a junction with the inferior pudendal nerve.

The **Inferior Pudendal Nerve** (Fig. 116, 16) is a branch of the small sciatic nerve, which pierces the deep fascia of the thigh about an inch in front of the tuberosity of the ischium. It is usually of small size in the female, and runs upwards and inwards to join the external superficial perinæal nerve.

[The superficial vessels and nerves are to be turned aside and the muscles dissected out. The muscles are much less distinct than in the male perinæum, and it is impossible to trace all their fibres without maceration and preparation, which it is impracticable for the student to undertake; he will be able to make out sufficient however to assist materially in following the description.]

The **Perinæal Body** of Savage (Fig. 117, 14), peculiar to women, consists of an elastic mass of tissue placed between the orifices of the vagina and rectum, and uniting all the structures which meet in the central point of the perinæum. Its use appears to be to allow of great stretching, without tearing, during parturition.

The **Superficial Muscles** (Figs. 116 and 117) of the female perinæum closely resemble those of the male, with the exception that the two portions of the central muscle, corresponding to the bulbo-cavernosus, are separated by the vulva. On each side therefore of the vulva will be found the half of the bulbo-cavernosus; lying on the ramus of the os pubis, the erector clitoridis; and, passing from the tuber ischii to the central point of the perinæum, the transversus perinæi.

The **Bulbo-Cavernosus** (sphincter vaginæ) (Fig. 117, 5) *arises* on each side from the elastic perinæal body between the anus and vagina, a few of its superficial fibres being prolonged into the sphincter ani; it also arises from the reflection of the deep layer of superficial fascia (ischio-perinæal ligament of Savage) for nearly an inch, and decussates with the inner fibres of the transversus. The fibres of the muscle overlie the bulbus vestibuli and glands of Bartholin, and are divisible into three sets, corresponding to those of the bulbo-cavernosus of the male. The anterior fibres pass forward on each side of the vulva to meet those of the opposite muscle upon the clitoris, and to be partially *inserted* into the sheath of the clitoris; the middle fibres pass beneath the clitoris and over the great veins upon the urethra (*pars intermedialis*), which are analogous to the corpus spongiosum of the male, and meet those of the opposite side; the posterior fibres pass on to the triangular ligament (Savage).

The **Erector Clitoridis** (Fig. 117, 3) resembles the erector penis in the male, and though actually smaller in size, bears a much larger proportion to its organ than that muscle. It *arises* from the front of the tuber ischii, and is *inserted* on the sides of the crus clitoridis.

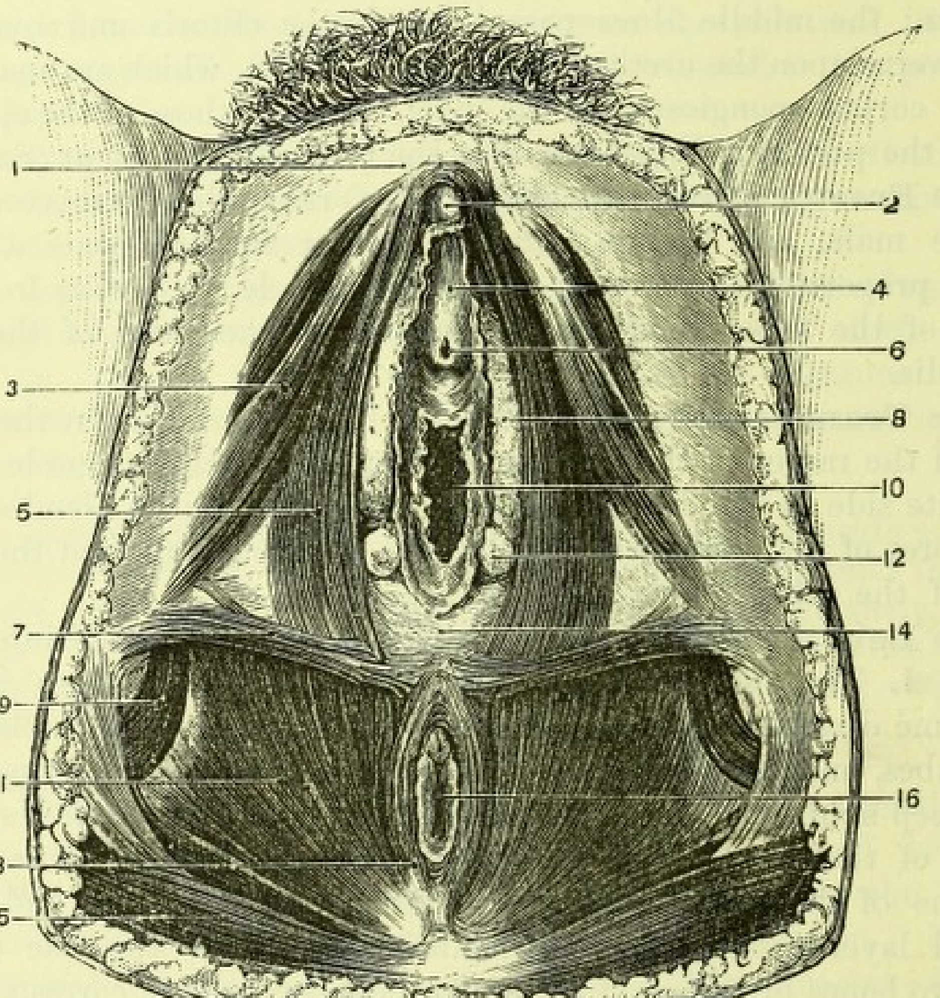
The **Transversus Perinæi** (Fig. 117, 7) *arises* from the inner side of the ramus of the ischium, and meets its fellow muscle of the opposite side in the central perinæal body, where it is blended with the fibres of the bulbo-cavernosus and sphincter ani, and the deep part of the sphincter vaginæ.

The **Levator Ani** (Fig. 117, 11) is divided by Savage into three parts: 1. The *pubo-coccygeus*, now seen in part, its fibres having the same direction as the sphincter ani. It *arises* from the back of the pubes, and its fibres cross the rectum between the superficial and deep sphincters, and are *inserted* into the side of the last two bones of the coccyx. 2. The *obturato-coccygeus*, which *arises* from the line of division of the pelvic fascia into obturator and recto-vesical layers (*white line*), and is also *inserted* into the side of the last two bones of the coccyx. 3. The *ischio-coccygeus*, corresponding to the **coccygeus** muscle as ordinarily described, and extending from the spine of the ischium to the side of the coccyx.

[The bulbo-cavernosus muscle is to be divided at its origin and turned up, after being dissected from the bulbus vestibuli beneath and from the triangular ligament. The superficial transversus perinæi is to be removed, and the erector clitoridis detached from the bone with the crus clitoridis, which will be seen to be a vascular body attached to the ramus of the pubes for half an inch. This is to be drawn forward, a branch of artery going to it being preserved, and the triangular ligament will be exposed.]

The **Bulb of the Vagina** (Fig. 117, 8) or **bulbus vestibuli** of Kobelt corresponds precisely to one half of the bulb of the male. It is a vascular body placed on the side of the orifice of the vagina, and enclosed in a sheath of fascia derived from the triangular ligament or deep perinæal fascia. Each bulb is about an inch long, and is composed of a plexus of veins, which communicate with those of

Fig. 117.



the opposite side beneath the clitoris. The forepart of the plexus is sometimes known as the *pars intermedialis.*

The **Superficial Triangular Ligament** resembles that of the male, and is a strong process of fibrous tissue stretching across the

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Fig. 117.—The superficial muscles of the female perinæum (from Savage).

1. Pubes,
2. Clitoris.
3. Erector clitoridis.
4. Vestibule.
5. Bulbo-cavernosus muscle.
6. Urethra.
7. Superficial transverse muscle.
8. Bulb of vagina.
9. Obturator internus muscle.
10. Vagina.
11. Levator ani muscle.
12. Vulvo-vaginal gland.
13. Sphincter ani externus.
14. The perinæal body.
15. Gluteus maximus.
16. Anus.

pubic arch, to be attached to the rami of the os pubis and ischium on each side beneath the crura clitoridis. It is perforated by the urethra and is divided posteriorly by the vagina, with the coats of which it is firmly incorporated; it gives passage also to the terminal branches of the pudic arteries and nerves, as in the male, and to the large veins of the clitoris and bulbi vestibuli, which pass to the plexus around the base of the bladder.

[The superficial triangular ligament is to be carefully detached from the bone and removed, when the deep transversus perinæi and the terminal branches of the pudic artery and nerve are to be dissected.]

The **Deep Transversus Perinæi** (Compressor Urethræ) has the same attachments as in the male, but consists largely of unstriped fibre.

Involuntary circular fibres surround the whole length of the female urethra, and may correspond to a portion of the prostate in the male.

The **Glands of Bartholin** (Fig. 117, 12) correspond to Cowper's glands in the male, but are more superficially placed. Each gland is of the size of a small bean, and is situated behind the bulb. Its minute duct opens on the mucous surface in front of the hymen about midway between the clitoris and posterior commissure.

Pudic Artery and Nerve (Fig. 116). The terminations of the pudic artery and nerve in the female correspond closely to those of the male, but are much smaller. The artery lies under cover of the ramus of the os pubis with the nerve, and gives off arteries to the bulb and crus clitoridis, and the dorsal artery of the clitoris.

The *artery of the bulb* (8) runs transversely inwards, and terminates in the bulb of the vagina.

The *artery to the crus clitoridis* (9) is very small, and is lost in that organ. It is accompanied by a vein.

The *dorsal artery of the clitoris* (7) reaches the dorsum of the organ with the corresponding nerve.

The *Dorsal Vein* of the clitoris is of large size, and passes backwards to open into the great veins around the neck of the bladder.

The *Pudic Nerve* (11) gives off muscular branches (12), and ends in the dorsal nerve of the clitoris (18), which bears a much larger proportion to that organ than the corresponding nerve of the penis.

The *Deep Triangular Ligament* differs from that in the male only in being pierced by the vagina.

[The flaps of skin should be carefully fastened together with stitches before the body is moved from its position.]

Dissection of the Abdominal Wall.

The dissection of the Perinæum having been completed, the student should proceed to examine the abdominal wall, the condition of which will vary considerably in different subjects. In a fat subject the wall of the abdomen will be smooth and uniform, but in a thin muscular subject the prominences of the muscles will be readily recognised. In all bodies the umbilicus will be seen in the median line about midway between the pubes and the ensiform cartilage of the sternum, and nearly in a line with the highest point of the iliac crest, and it should be noted whether there is any protrusion at this point, constituting an *exomphalos* or umbilical hernia. The median line above the umbilicus will be found to be slightly depressed, corresponding, as will be afterwards seen, to the *linea alba.* Below the umbilicus is performed the operation of paracentesis or tapping the abdomen, and it should be noticed that no mesial furrow exists in this situation.

On each side of the median line and parallel to it, is the prominence caused by the rectus abdominis muscle, bounded externally by the *linea semilunaris,* and occasionally the markings in that muscle known as the *lineæ transversæ* can be seen through the skin. Immediately above the pubes and close to the median line is occasionally seen the prominence of the pyramidalis muscle on each side. The pubic crest and spine will be recognised with the finger, and *Poupart's ligament,* attached to the latter, will be followed along the fold of the groin to the anterior superior spinous process of the ilium. On the sides of the lower part of the thorax, the interdigitations of the obliquus externus with the serratus magnus may be seen through the skin, in a well-developed subject, and a *lateral subcostal fossette* indicates the upper end of the linea semilunaris. Below, the iliac crest will be found curving backwards and upwards from the anterior superior spine, and a tubercular prominence is felt a little in front of its midpoint between its two extremities.

The condition of the abdominal rings and inguinal canal should be carefully examined before the skin is removed. If the *spermatic cord* be traced up from the testis, it may be felt to disappear through an opening known as the *external abdominal ring,* and even in a perfectly well formed subject the fore-finger can be passed into the ring with tolerable facility, if pushed up from below, carrying the scrotum before it. In a subject with a tendency to hernia, the finger can be carried along the inguinal canal to the internal abdominal ring, or if a rupture actually exists, may be passed into the abdominal cavity, pushing the loose skin before it. If any tumour of the scrotum should happen to be present, it should be carefully examined and its nature diagnosed, with a view to confirmation by subsequent examination.

In the female, the abdominal ring is usually of small size, and generally too contracted to admit the finger, but may be enlarged by a hernia. The projection above the pubes, which is covered with hair and known as the *mons Veneris*, is due simply to a development of fat in the superficial fascia at this point. The skin of the abdomen of women who have borne children is marked by numerous small white scars, the result of its over-distension during pregnancy.

Percussion and palpation should be carefully practised, in order to make out the limits of the principal organs of the abdomen before the dissection is begun. The presence of fluid in the peritoneal cavity may be ascertained by the production of fluctuation, between the hands applied on opposite sides of the abdomen.

[In order to dissect the abdominal wall, it is necessary to distend the abdomen fully with air. To do this, a narrow knife should be thrust through the umbilicus into the peritoneal cavity, and a blowpipe should be inserted. A circular incision should previously be made through the skin round the umbilicus, and a piece of whipcord tied round the blowpipe in the groove cut in the skin. When the abdomen has been fully distended, the blowpipe is to be withdrawn, and the opening carefully secured.

One incision is to be carried from the ensiform cartilage to the pubes (avoiding the umbilicus), and another along the crest of the ilium and from the anterior superior spine of the ilium horizontally to the middle line, joining the first at right angles. A third at the level of the ensiform cartilage is to reach well back to the loins. The skin is then to be reflected from the median line by these incisions.]

The **Superficial Fascia** in this region resembles that throughout the body, but is sometimes much loaded with fat; it is to be reflected by the same incisions as the skin, and in doing this there will be found in it the cutaneous nerves.

The **Cutaneous Nerves** (Fig. 118) consist of two sets, anterior and lateral. The *anterior* nerves, which are very small, will be found in two rows, one close to the linea alba, and the other piercing the tendon of the external oblique two inches from the median line; the *lateral* branches will be found of greater length, running along the fibres of the same muscle and also giving a few small twigs backwards. Both sets are derived from the seven lower dorsal spinal

Fig. 118.

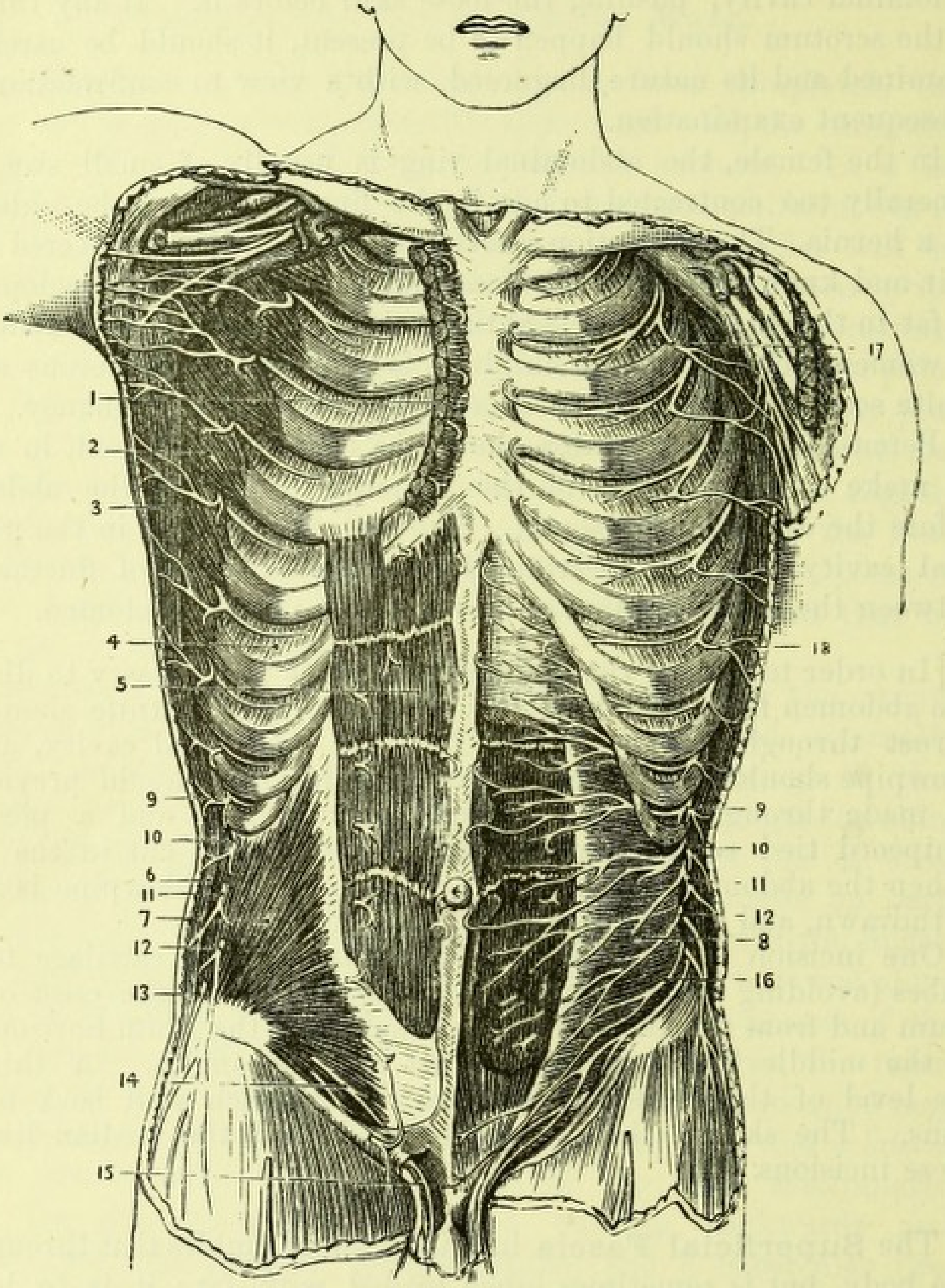


Fig. 118.—The nerves of the abdominal wall (from Hirschfeld and Leveillé).

1. Pectoralis major (cut).
2. Serratus magnus.
3. Latissimus dorsi.
4. Intercostal muscles.
5. Rectus abdominis.
6. Section of obliquus externus.
7. Obliquus internus.
8. Transversalis abdominis.

9, 9. Ninth dorsal nerve.
10, 10. Tenth dorsal nerve.
11, 11. Eleventh dorsal nerve.
12, 12. Twelfth dorsal nerve.

13. Lateral cutaneous branch of first lumbar (ilio-hypogastric).
14. Anterior cutaneous branch of ilio-hypogastric.
15. Anterior cutaneous branch of ilio-inguinal.
16. Ilio-hypogastric and ilio-inguinal nerves.
17. Lateral cutaneous branch of second intercostal nerve.
18. Lateral cutaneous branch of intercostal nerve.

nerves. About two inches behind the anterior spine of the ilium and half an inch above the crest will be found the lateral cutaneous branch of the *last dorsal* nerve, and close upon the crest of the bone, a little posterior to the preceding nerve, will be seen the *iliac branch of the ilio-hypogastric* nerve (1st lumbar), both of them going to the buttock (13), while the *hypogastric branch* of the latter nerve may be traced in the hypogastric region over the lower part of the rectus.

Accompanying the nerves will be found (in a well injected body only) small branches of arteries derived from the intercostal, internal mammary, and epigastric arteries.

[The external oblique muscle is to be cleaned, the dissector beginning from below on the right side, and from above on the left, and taking care not to remove its tendon near the median line by mistake. The interdigitations with the serratus magnus and latissimus dorsi are to be carefully defined.]

The **Obliquus Externus** (Fig. 119, 12) has its *upper attachment* * from the outer surfaces of the bony portions of the eight lower ribs, and from the intercostal fascia between the bones, and interdigitates with the serratus magnus by four or five points above, and with the latissimus dorsi by three or four points below. Its fibres pass downwards to the middle line and pelvis (p. 257).

[In order to see the whole of the insertion of this muscle, it will be necessary to continue the dissection by reflecting the triangle of skin left upon the groin.]

The **Superficial Fascia of the Groin** (Fig. 120) is divisible into two layers—superficial and deep.

The *superficial layer of superficial fascia* (*a*) resembles that found elsewhere, but the *deep layer* (*b*) (Scarpa's fascia) is more membranous. It is directly continuous with the deep layer of the superficial fascia in the perinæum (p. 236), opposite the upper limit of the attachment of the genitals, and is attached firmly to the fascia lata of the thigh below Poupart's ligament, thus preventing any urine which may have been infiltrated into the tissues from passing down the thigh.

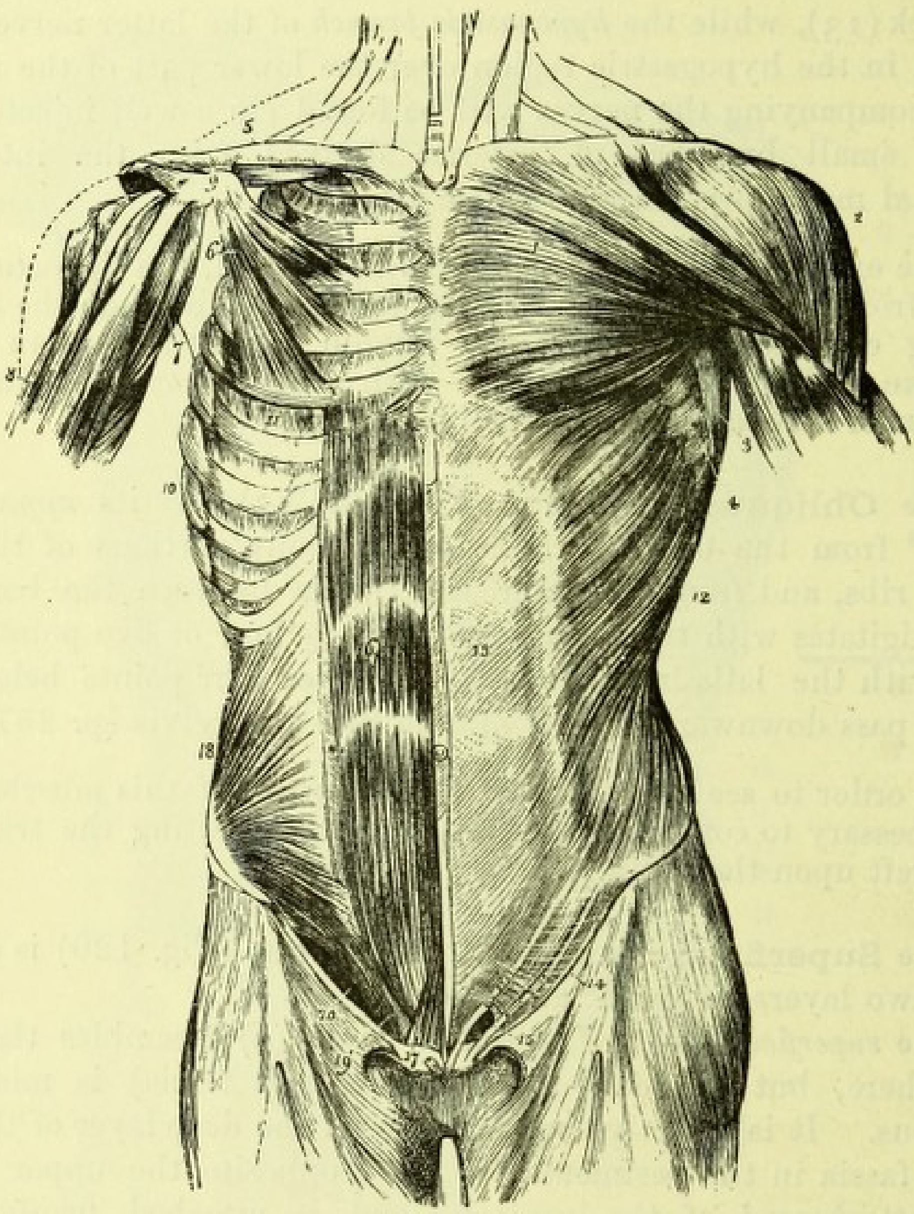
Superficial Vessels and Nerves (Fig. 120).—Between the layers of superficial fascia will be found three small branches of the femoral artery, with their accompanying veins.

The *superficial circumflex iliac* (*d*) runs outwards about the level

* This is frequently termed the 'origin,' but the pelvic attachment is rather to be regarded as the more fixed point for the action of the muscle under ordinary circumstances.

of Poupart's ligament to the anterior superior spine; the *superficial epigastric* (*e*) runs upwards for a short distance on the abdominal wall; and the *superior external pudic* (*f*) runs over the spermatic

Fig. 119.



cord to the scrotum. The veins corresponding to these arteries join the saphenous vein as it opens into the femoral. Upon, or a little

Fig. 119.—Muscles of the anterior aspect of the trunk (from Wilson); on the left side of the body the superficial layer is seen, on the right the deeper layer.

1. Pectoralis major.
2. Deltoid.
3. Anterior border of the latissimus dorsi.
4. Serratus magnus.
5. Subclavius, right side.
6. Pectoralis minor.
7. Coraco-brachialis.
8. Upper part of the biceps, showing its two heads.
9. Coracoid process of the scapula.
10. Serratus magnus, right side.
11. External intercostal muscle of the fifth intercostal space.

below, Poupart's ligament will be found two or three glands, which receive the lymphatics from the penis and scrotum, and the parts around the anus.

The tendon of the obliquus externus being exposed, a nerve will be found piercing it about two inches above the pubes—the *hypogastric branch of the ilio-hypogastric* from the 1st lumbar; and another may be seen issuing from the external abdominal ring upon the spermatic cord—the *ilio-inguinal* (*n*), also from the 1st lumbar (Fig. 120). The former is distributed to the skin above the pubes, the latter to that of the scrotum and penis or labium, according to the sex, and to the inner side of the upper part of the thigh.

Lower Attachment of Obliquus Externus (Fig. 119).—(1) To the anterior half of the outer lip of the crest of the ilium; Poupart's ligament succeeding this attachment is merely the thickened lower border of the aponeurosis of the external oblique, reaching from the anterior superior spine of the ilium to the spine of the os pubis, and receiving the attachment of the falciform process of Burns from the fascia lata of the thigh. (2) The pubic spine and crest of the same side, the symphysis, the pubic crest of the opposite side, and a small portion of the ilio-pectineal line beyond. The fibres crossing the median line, often very difficult to demonstrate, decussate with those of the opposite muscle, and so form a mesial triangular area of thickened aponeurosis—the "triangular fascia." A triangular band of strong fibres runs from the inner extremity of Poupart's ligament to the innermost part of the ilio-pectineal line of the same side immediately internal to the femoral sheath. This is known as Gimbernat's ligament, and will be met with in the dissection of femoral hernia. (3) To the whole length of the median line from the ensiform cartilage to the symphysis pubis, blending with the aponeurosis of the internal oblique. The posterior free border of the muscle between the ribs and ilium is usually separated from the anterior free border of the latissimus dorsi by a triangular interval the "*triangle of Petit*," the base of

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12. External oblique.
13. Its aponeurosis; the median line to the right of this number is the linea alba; the curved line to its left, the linea semilunaris; the transverse lines above and below the number, the lineæ transversæ.
14. Poupart's ligament.
15. External abdominal ring.
16. Rectus muscle of the right side brought into view by the removal of the anterior segment of its sheath; *posterior segment of its sheath with the divided edge of the anterior segment.
17. Pyramidalis muscle.
18. Internal oblique.
19. Conjoined tendon of the internal oblique and transversalis.
20. The lower curved border of the internal oblique muscle.

which is formed by the iliac crest, and the floor by the obliquus internus.

Immediately above and external to the pubic spine, the spermatic cord (or the round ligament of the uterus in the female) will be seen to emerge from an opening in the tendon, the *external abdominal ring*, the outline of which is obscured by the *intercolumnar*

Fig. 120.

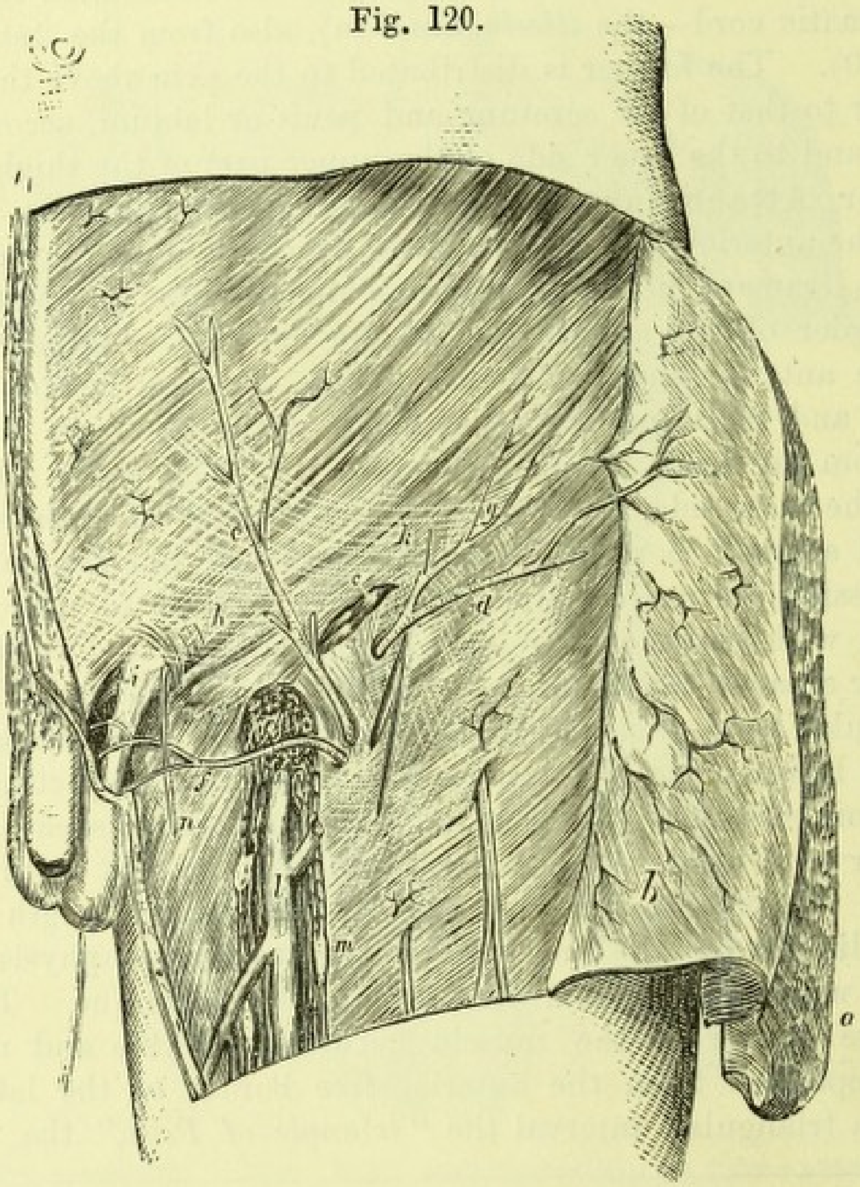


Fig. 120.—Superficial dissection of the inguinal and femoral regions (from Wood).

a. Superficial layer of fascia (reflected).
b. Deeper layer of fascia (reflected), the superficial vessels being left attached to the external oblique.
c. Inguinal lymphatic glands.
d. Superficial circumflex iliac artery.
e. Superficial epigastric artery.
f. Superior external pudic artery.
g. Poupart's ligament.
h. Intercolumnar fascia.
i. External abdominal ring.
k. Arciform fibres of external oblique.
l. Internal saphenous vein.
m. Femoral lymphatic glands.
n. Ilio-inguinal nerve.
o. Saphenous opening.

or *external spermatic fascia.* This must be removed to expose the abdominal ring.

The **External Abdominal Ring** (Fig. 120, *i*) is merely a cleft in the external oblique tendon, placed obliquely immediately above and to the outer side of the pubic spine. In the healthy subject it is triangular with the base downwards and inwards at the pubic crest, and is about an inch in length and half an inch across. The tendinous fibres limiting it above and below have been named the *pillars* or *columns of the ring.* It will be observed that the outer pillar is flat and triangular at the upper part, but becomes round and thick below, where it is attached to the pubic spine and corresponds to the inner extremity of Poupart's ligament; whilst the internal pillar attached to the pubic crest is flat and continuous with the rest of the tendon. At the upper part of the ring may be seen some curved fibres running in a transverse direction and called the *intercolumnar fibres,* the continuation of which forms the intercolumnar or external spermatic fascia, and is prolonged as a covering of the cord and testicle. It should be noticed that the spermatic cord does not lie in the centre of the ring, but upon the outer pillar or Poupart's ligament, which is slightly drawn down by the weight of the testis.

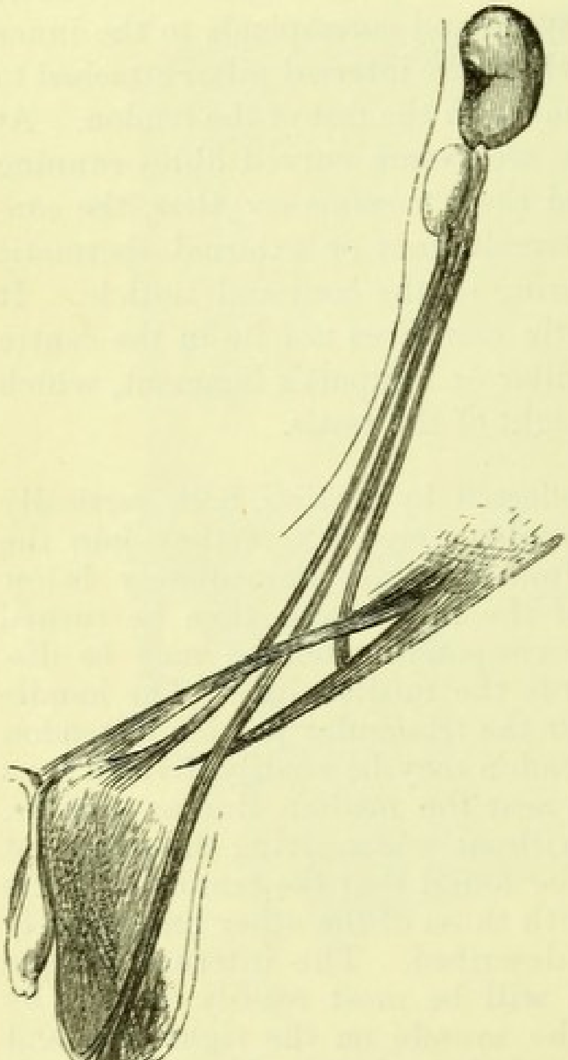
[The external oblique is to be reflected by cutting, both vertically and horizontally, through its muscular fibres where they join the tendon, and by detaching them from the ribs immediately below their origin. The greater part of the muscle can then be turned back towards the loin, and the corresponding tendon may be dissected up as far as possible towards the median line. The handle of the knife should be passed under the triangular portion of tendon left in the groin, after which the tendon may be readily divided by a vertical incision, parallel to and as near the median line as possible, and reflected towards the thigh without endangering the subjacent parts. When this is done, it will be found that the tendinous fibres of one side decussate or interlace with those of the other immediately above the pubes in the manner described. The internal oblique muscle will then be exposed, and will be most readily cleaned by beginning at the lower border of the muscle on the right side, and at the upper border on the left side of the subject. Near Poupart's ligament, a little more of the ilio-hypogastric and ilio-inguinal nerves will be seen.]

The **Obliquus Internus** (Fig. 119, 13).—The fibres of this muscle take a direction opposite to those of the obliquus externus. The *origin* is from the posterior tendon of the transversalis muscle (the so called "fascia lumborum" or "lumbar aponeurosis"), from the anterior two-thirds of the crest of the ilium, and the outer half of Poupart's ligament. The upper fibres pass to be *inserted*

middle part of

into the lower margins of the cartilages of the last four ribs, where they fall into a line with those of the internal intercostal muscles. Below this the muscle is inserted into the xiphoid appendix, and into the mesial line by an aponeurosis, which splits to enclose the rectus in its upper two-thirds and passes in front of the muscle below (see p. 270); while the lower fibres, becoming gradually more and more horizontal in their course to the middle line, in the end arch downwards to be *inserted* into the pubic crest, and into the ilio-pectineal line behind the attachment of Gimbernat's ligament, blending with a part of the attachment of the transversalis to form the *conoined tendon.*

Fig. 121.



In the male subject, some pale muscular fibres will be found to be continuous with the lower border of the internal oblique, and to descend upon the spermatic cord and testicle. These form the *cremaster.*

The **Cremaster** (Fig. 120, *h*) consists of a series of thin muscular loops united by delicate fascial tissue, spread over the spermatic cord and upper part of the testicle. It is attached *externally* to the inner part of Poupart's ligament, where it is continuous with the origin of the internal oblique, and *internally* to the spine and crest of the pubes. This musculo-fascial lamina constitutes one of the investments of the cord and testicle, and as it separates the fascia spermatica externa (intercolumnar fascia) from the fascia spermatica interna (infundibuliform process of fascia transversalis), it might be termed the fascia spermatica media. The cremaster is *supplied* by the genital branch of the genito-crural nerve.

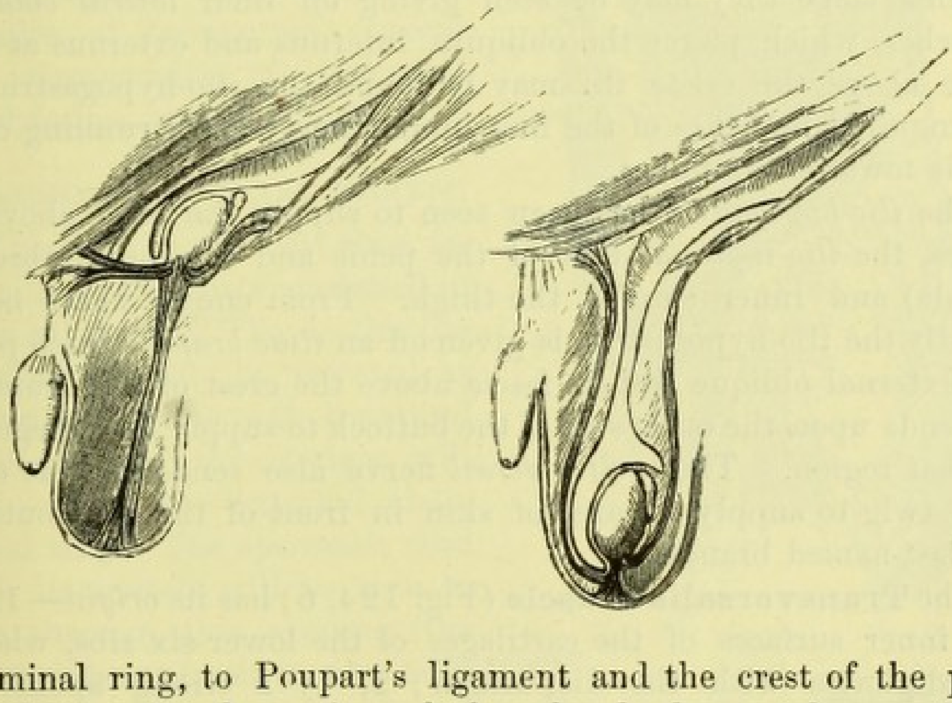
Figs. 121, 122, 123.—Diagrams to illustrate the descent of the testis and the formation of the tunica vaginalis (drawn by J. T. Gray).

To explain the formation of this muscle it will be necessary to refer to the early stage of fœtal life, when the testis was situated within the abdomen and immediately below the kidney.

About the seventh month of fœtal life the testis passes through the internal abdominal ring, and by the eighth month reaches the scrotum, a process of peritoneum (*processus vaginalis*) preceding it. The looped fibres of the cremaster would appear to be fibres of the internal oblique drawn down by the testicle in its descent.

According to Curling, a muscular band, consisting of three sets of fibres and called the *gubernaculum testis*, passed from the pubes to the testis, and its divisions had the following attachments—one to the bottom of the scrotum, and one on each side of the external

Fig. 122. Fig. 123.



abdominal ring, to Poupart's ligament and the crest of the pubes (Fig. 121). By the action of these bands the testicle was drawn down as far as the external abdominal ring, but it is obvious that when it had reached this point the lateral bands must have become horizontal, and thus have lost all power of traction ; and the further progress of the testis depended therefore upon the middle band, which continued to draw the gland to the bottom of the scrotum (Fig. 122). The effect of this was to stretch the lateral bands attached to the pubes on each side, and thus they were drawn down with the cord, in which they are probably represented in the adult by some unstriped muscular fasciculi called by Henle the "internal cremaster." The external cremaster is formed by the lower fibres of the internal oblique, which were carried down with the testicle in its progress (Fig. 123). It must be added, however, that more recent observations render it doubtful if the descent of the testis is actually accomplished by these means.

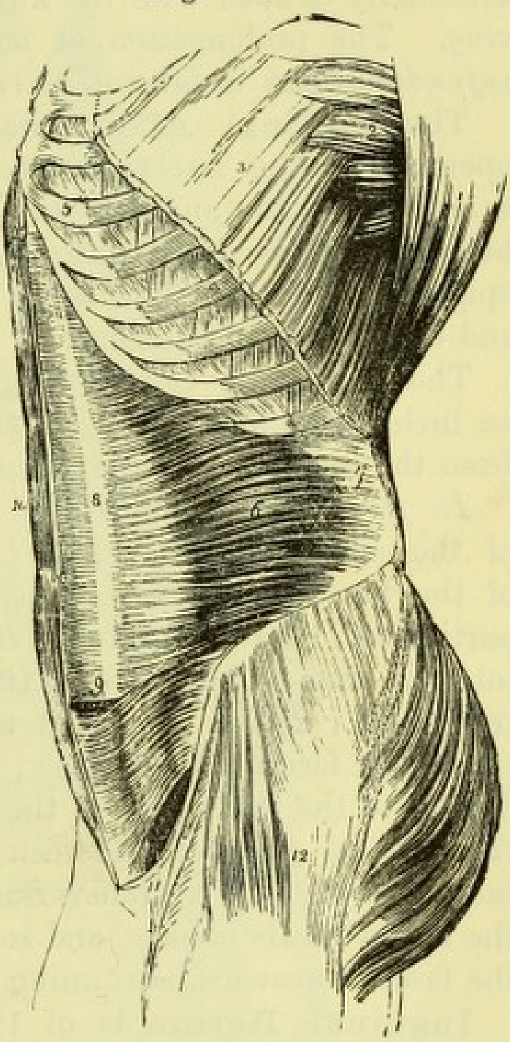
[The internal oblique is to be divided by a vertical incision from the last rib to the middle of the crest of the ilium, and this is to be carried along the crest and Poupart's ligament to near the lower border of the muscle. The muscular fibres must be carefully divided until a cellular interval is reached, in which, near the crista ilii, will be found the branches of an artery (deep circumflex iliac). The muscle is then to be turned backwards and forwards, care being taken not to injure the exposed nerves or the subjacent transversalis muscle.]

The **Nerves** (Fig. 118), five or six in number, are branches of the lower dorsal nerves, which run horizontally forwards to pierce the rectus muscle and emerge on the front of the abdomen. At this stage they may be seen giving off their *lateral cutaneous* branches, which pierce the obliquus internus and externus at once. Close above the crista ilii may be found the ilio-hypogastric and ilio-inguinal branches of the first lumbar nerve (16), running downwards towards the pubes.

The *ilio-hypogastric* has been seen to supply the skin above the pubes, the *ilio-inguinal* that of the penis and scrotum (labium in female) and inner side of the thigh. From one of these nerves, usually the ilio-hypogastric, is given off an *iliac branch* which pierces the external oblique and its fascia above the crest of the ilium, and descends upon the outer side of the buttock to supply the integument of that region. The *twelfth dorsal* nerve also sends an iliac cutaneous twig to supply an area of skin in front of the distribution of the last-named branch.

The **Transversalis Muscle** (Fig. 124, 6) has its *origin*—1, from the inner surfaces of the cartilages of the lower six ribs, where it interdigitates with the diaphragm; 2, by a strong aponeurosis, which posteriorly is divided into three laminæ, the anterior of which is attached to the intertransverse ligaments and anterior surfaces of the transverse processes; the middle to the tips of the transverse processes; and the posterior to the spinous processes and supraspinous ligaments of all the lumbar vertebræ (forming the greater part of what is sometimes called the *lumbar aponeurosis* or *fascia lumborum*) (Fig. 130); 3, from the anterior ~~two-thirds~~ of the inner lip of the crest of the ilium, and 4, from the outer third of Poupart's ligament. Its tendon of *insertion* passes to the middle line behind the rectus, from the ensiform cartilage to about the junction of the middle and lower thirds of the muscle, and in front of it below this point as far as the pubes, being inseparably united with the aponeurosis of the internal oblique; and into the pubic crest and ilio-pectineal line, forming with the internal oblique the *conjoined tendon*. *Action.*—The transversalis is essentially a contractile abdominal belt, and has little or no influence upon the movements of the trunk. The obliqui aid the transversalis in constricting the abdominal cavity and are also direct and lateral flexors of the lumbar portion of the vertebral column; and all these muscles aid in expiration, partly by drawing down the ribs and sternum, and partly by upward pressure of the diaphragm through the medium of the viscera. They are hence muscles of locomotion (except the transversalis), of abdominal constriction, and of expiration.

Fig. 124.



Anatomy of Inguinal Hernia.

This will be the best time for examining the parts concerned in inguinal hernia. To do this the muscles should be restored as nearly as possible to their natural positions, and the student will again study the external abdominal ring. The spermatic cord with its vessels will be seen to pass through this opening (the intercolumnar fascia having been previously removed), and on tracing up the cord by turning the muscles aside in their order, it will be found to disappear

Fig. 124.—Lateral view of the transversalis abdominis muscle (from Wilson).

1. Latissimus dorsi.
2. Serratus magnus.
3. Upper part of the external oblique.
4. Two of the external intercostal muscles.
5. Two of the internal intercostals.
6. Transversalis.
7. Its posterior aponeurosis.
8. Its anterior aponeurosis passing behind the sheath of the rectus.
9. Lower part of the left rectus, with the aponeurosis of the internal oblique and transversalis passing in front.
10. Right rectus muscle.
11. Poupart's ligament.
12. Tensor vaginæ femoris and gluteus medius invested by fascia lata.]

beneath the sharp arched border of the transversalis muscle. The tissue beneath this muscle is the *fascia transversalis* (Fig. 125, *f*), and between this and the peritoneum, is the subperitoneal tissue. Both of these layers are prolonged upon the cord and testicle as an infundibuliform sheath, and the internal orifice of the funnel, when artificially defined with the knife, is called the *internal abdominal ring*. The prolongation of fascia transversalis itself is called the *infundibuliform* or *internal spermatic fascia* (Fig. 125, *i*).

The **Internal Abdominal Ring** (Fig. 126), an artificial opening in the fascia transversalis, is placed midway between the symphysis pubis and the anterior superior iliac spine, and about half an inch above Poupart's ligament, immediately outside the deep epigastric vessels. The fascia is distinctly thickened at the lower and outer parts of the ring.

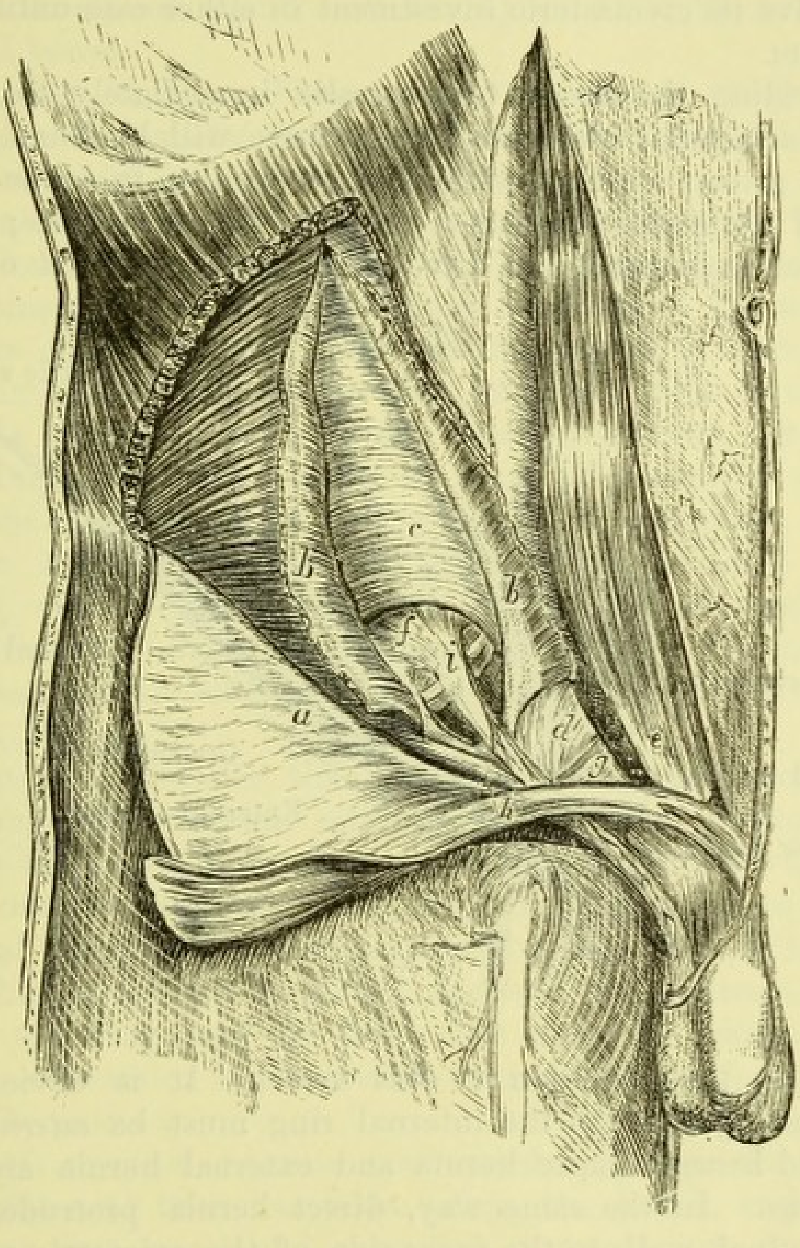
The **Inguinal Canal** (Figs. 125, 126) is an interspace about an inch and a half in length, transmitting the cord and extending from the internal to the external abdominal ring.

In front it is bounded by 1, (in its whole length) the tendon of the external oblique; 2, (in its outer third) the lowest part of the muscular fibres of the internal oblique; and 3, a small portion of the cremaster. *Behind* are—beginning nearest the internal ring—1, the fascia transversalis (for the whole length of the canal); 2, the conjoined tendon (in its inner third); and the triangular fascia (if it exists); 3, the deep epigastric vessels (immediately to the inner side of the internal abdominal ring). *Below* is the line of junction between Poupart's ligament and the lower border of the fascia transversalis. *Above* are the arched border of the transversalis muscle, and sometimes a stronger band of fibres in the fascia transversalis running over the vascular sheath (Fig. 131).

Inguinal Hernia is of two kinds, *oblique* and *direct*. The oblique passes through the internal abdominal ring, along the inguinal canal and out of the external ring. The direct hernia breaks through or pushes before it the posterior wall of the inguinal canal at its inner part in a triangular space called *Hesselbach's triangle*, bounded by the deep epigastric artery, the rectus, and Poupart's ligament; and emerges at the external ring, thus taking a more *direct* course than the *oblique* variety.

The *coverings* of each hernia will be best seen by tracing them from within outwards; thus the oblique hernia would push before it (1) parietal peritoneum, forming the sac; (2) subperitoneal fascia; (3) in coming through the internal ring, fascia transversalis, or infundibular fascia; (4) in passing beneath the internal oblique, the cremaster muscle, the fibres of which are united by cellular tissue and are sometimes known as the cremasteric fascia; (5), in emerging from the external ring, the intercolumnar or external

Fig. 125.



spermatic fascia; and finally (6) the superficial fascia and skin.

A *direct hernia* has precisely the same coverings as the oblique

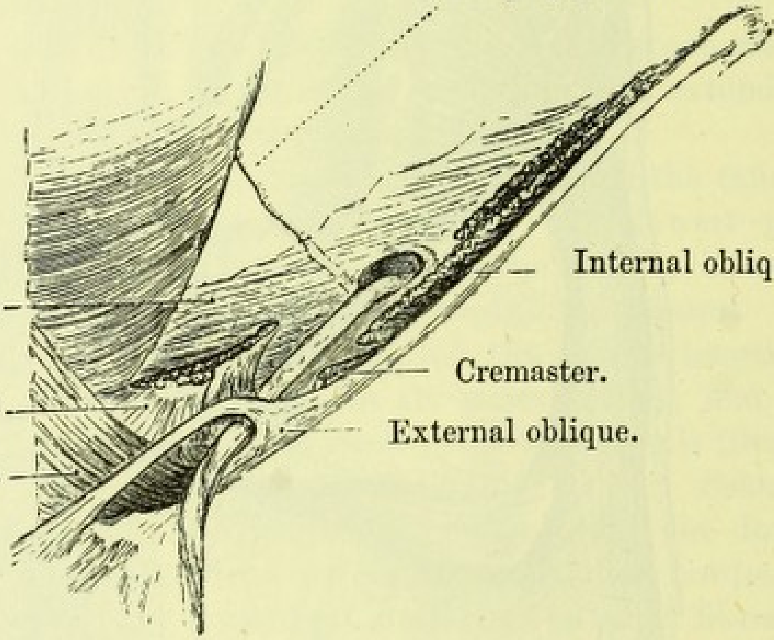
Fig. 125.—Dissection of the inguinal canal (from Wood).

a. External oblique (turned down).
b, *b*. Internal oblique.
c. Transversalis.
d. Conjoined tendon.
e. Rectus abdominis with sheath opened.
f. Fascia transversalis.
g. Triangular fascia.
h. Cremaster.
i. Infundibular fascia.

form, when it passes through the outer portion of Hesselbach's triangle, but should it force its way through the inner part of the triangle it would derive an additional lamina (superficial to the fascia transversalis) from the conjoined tendon. It would not, however, receive its cremasteric investment in either case until it enters the scrotum.

By dividing the fascia transversalis immediately to the inner side of the internal abdominal ring, there will be found the deep epigastric artery, running with its venæ comites in a line from the middle of Poupart's ligament towards the umbilicus; and the varieties of inguinal hernia have been named *external* or *internal*

Fig. 126.



according to their relation to this vessel. It is obvious that a hernia, passing through the internal ring must be *external* to this artery, and hence oblique hernia and external hernia are synonymous terms. In the same way, direct hernia protrudes through the abdominal wall to the *inner* side of the epigastric artery, and thus internal is the same as direct hernia.

The anatomy of the parts concerned in hernia being fully comprehended, it will be readily seen that the direction in which force is to be applied to return the protruded bowel into the abdomen—commonly called the *taxis*—must differ in the two cases; and the student should notice the effect which the position of the body

Fig. 126.—Diagram of the inguinal canal, showing its anterior and posterior boundaries (drawn by J. T. Gray).

and limbs has upon the tissues near the groin. Thus, with the body and legs extended at full length, the lower part of the abdomen is rendered tense ; whilst if the thigh is flexed upon the pelvis and adducted, and the body bowed forward, the structures become relaxed, and would more readily admit of the return of the protruded bowel.

Varieties of Hernia.—There are two varieties of oblique inguinal hernia termed *congenital hernia* and *infantile* or *encysted hernia*, the anatomy of which requires explanation.

To understand these fully it will be necessary to refer again to the descent of the testis (p. 261). When the testicle is in the abdomen it has the peritoneum attached to its surface, and during its descent into the scrotum it accordingly carries a fold of peritoneum down with it, so that at first a tube extends along the whole length of the inguinal canal (Fig. 123). By a natural process during the later months of fœtal life, however, an obliteration of the portion of tube within the canal takes place, and thus a small sac is formed around the testis, which is called the *tunica vaginalis*, while a mere dimple is left in the peritoneum at the internal ring. Thus in the ordinary condition of the parts when a hernia descends, its sac is above and quite distinct from the tunica vaginalis (Fig. 127).

Occasionally, however, this obliteration does not occur, and the tunica vaginalis remains continuous with the peritoneum. In that case the hernia descends at once into the tunica vaginalis and lies in contact with the testis, and being the consequence of a congenital defect it is termed *congenital hernia* (Fig. 128).

In what is termed *congenital hydrocele* the anatomical arrangement is the same, and the fluid runs from the peritoneal cavity into the scrotum or in the reverse direction, according to the position of the patient.

Infantile or *encysted hernia* exists when only a partial obliteration of the peritoneal tube has taken place, the tunica vaginalis being left larger than usual and extending upwards, towards or into the inguinal canal. Should a hernia descend, it passes down behind this portion of the tunica vaginalis, and there are then three layers of serous membrane in front of that covering the intestine, two being formed by the tunica vaginalis and one by the peritoneal sac (Fig. 129).

Surgery.—*Operation for Strangulated Hernia.*—In this operation the object is to reach and divide any tissue which presses upon the bowel and prevents its return within the abdomen. An incision is made over the external ring, and the surgeon dissects carefully down through the several layers (never distinctly recognisable in practice) until he reaches the peritoneal sac, which is sometimes known by its bluish appearance. The sac is then carefully opened and the contents inspected, and dealt with according to their condition. Passing the forefinger carefully inside the neck of the sac he feels for the stricture, which may possibly be at the external ring (where it is easily divided), or more probably within the inguinal canal. Having discovered it, he next passes the hernia-knife along the finger, and, using the digit or a director as a guide, insinuates the knife, held flat, beneath the stricture, and divides it by bringing the edge upwards and pressing it against the tissues with the finger.

The direction in which the superficial incision is made is of little

Fig. 127.

Fig. 128.

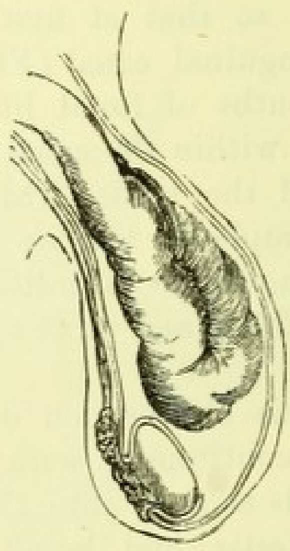
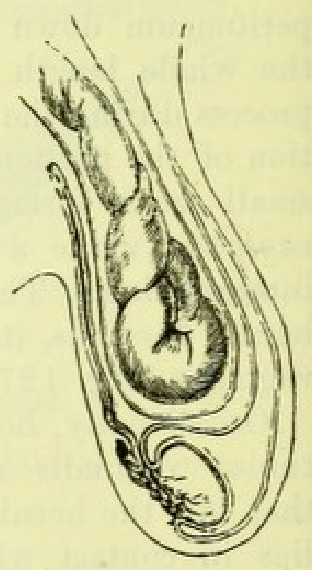


Fig. 129.



consequence, but in the deep incision the rule is to cut *upwards* and a little *inwards*, so as to be parallel to the epigastric artery; for since a mistake in the diagnosis between an external and an internal hernia may occur, owing to the parts becoming distorted and the abdominal rings drawn together in old-standing herniæ, an incision in almost any other direction might lead to a wound of the artery.

Radical Cure of Hernia.—Various operations for the radical cure of hernia have been employed of late, the principle of all being to isolate the sac as high as possible and obliterate it by ligature; and usually also to draw together more or less completely the walls of the inguinal canal. The operation can be done either by a free incision exposing the external ring, the pillars of which may then be stitched together, and by some operators the conjoined tendon is also included

Fig. 127.—Diagram of a common scrotal hernia, showing the relation of the sac to the tunica vaginalis testis (J. T. Gray).

Fig. 128.—Diagram of a congenital hernia, the sac being continuous with the tunica vaginalis testis (J. T. Gray).

Fig. 129.—Diagram of an infantile hernia, showing the tunica vaginalis prolonged in front of the sac (J. T. Gray).

in the suture. The older subcutaneous operations of Wood and Wurtzer are now practically abandoned.

The **Spermatic Cord** may now be examined, and will be found to consist of (1) the *vas deferens* or duct of the testicle, together with the deferential branch of the superior vesical artery and the deferential veins with lymphatics ; (2) the spermatic artery with its complicated plexus of veins and the testicular lymphatics ; (3) the internal cremaster, small bands of unstriped muscular fibre, probably the relics of the lateral bands of the gubernaculum testis ; (4) the obliterated processus vaginalis of the peritoneum ; (5) sub-peritoneal connective tissue surrounding all the structures named and sometimes bearing more or less fat in its meshes.

The **Coverings of the Cord** from within outwards are as follows :—(1) infundibuliform fascia, from the fascia transversalis ; (2) cremasteric fascia with the supplying branch of the genito-crural nerve and the cremasteric artery from the deep epigastric ; (3) intercolumnar fascia ; (4) superficial fasciæ and integument. These various laminæ are for the most part capable of subdivision into secondary layers, and hence it is always difficult to identify the numerous planes that are encountered in dissection or operation. The cremaster may, however, be made out by its muscular fasciculi.

The vas deferens may readily be felt through the coverings as a hard cord, lying as a rule behind the other elements and easily separable from them.

Tunica Vaginalis Testis (Fig. 127).—By drawing the testicle out of the scrotum and making an incision over the anterior part of it, the *tunica vaginalis* will be opened, and will be seen to consist of two parts, the tunica vaginalis *propria* (visceral lamina) upon the testis, and the tunica *reflexa* or part around (parietal lamina). The tunica vaginalis propria adheres intimately to the subjacent tunica albuginea.

The **Penis** should now be examined, and the student may advantageously practise the operation of circumcision. It should be noticed that the skin assumes somewhat the aspect of mucous membrane at the margin of the fore-skin or *prepuce*, and that it retains this appearance as it covers the *glans penis:* the true mucous membrane, however, terminates at the distal part of the urethra, before reaching the external orifice or *meatus*. Below the orifice of the urethra will be found the fold called the *frænum præputii*, and around the base of the glans penis is a circular ridge, the *corona glandis*, upon which open a number of sebaceous glands, the *glandulæ odoriferæ*, that secrete the *smegma præputii*. An incision is to be carried along the upper surface of the penis, when there will be found in the middle line the single *dorsal vein*, with the *dorsal artery* and *nerve* on each side of it, the nerve being most external. The artery and nerve are the terminations of the pubic artery and nerve, and the vein passes between the sub-pubic ligament and the two triangular ligaments to open into the prostatic plexus (p. 241).

The structure of the penis will be described hereafter.

The *Suspensory Ligament* of the penis is a strong triangular band of fibrous tissue, attached to the front of the symphysis pubis, and divides into two layers to give passage to the dorsal vessels and nerves, and embrace the adjacent part of the penis. The *angle of the penis* lies immediately beyond the suspensory ligament.

[Returning to the abdominal wall the dissector will find the rectus muscle close to the median line and still enclosed in its sheath, through which it is indistinctly visible. The line between the recti as low as the umbilicus is known as the *linea alba,* that at the outer border of each muscle as the *linea semilunaris*, and the transverse markings, three or four in number, are the *lineæ transversæ.* The median line below the umbilicus presents no furrow but is often marked by a line of pigment, and in the male by a growth of hair.]

The **Sheath of the Rectus** (Fig. 130) having been opened by a vertical incision, will be found to exist in its complete form only over the upper two-thirds of the muscle. It is here formed by the tendon of the internal oblique, which splits at the linea semilunaris to enclose it, and to blend with the tendons of the transversalis and external oblique. Thus in front of the muscle, up to its insertion, are the tendon of the obliquus externus and one-half of the tendon of the obliquus internus, whilst behind are the other half of the tendon of the obliquus internus and the tendon of the transversalis. This arrangement terminates a little below the umbilicus (seldom so low as midway between the umbilicus and pubes), and the sheath is wanting behind over the rest of the muscle, *i.e.* the aponeurosis does not split, but passes entirely in front, and there is nothing between the muscle and the peritoneum but the fascia transversalis and sub-peritoneal tissue. It should be understood that the distinction of the aponeuroses of the obliqui and transversalis from each other is virtual only and cannot be demonstrated by the dissector.

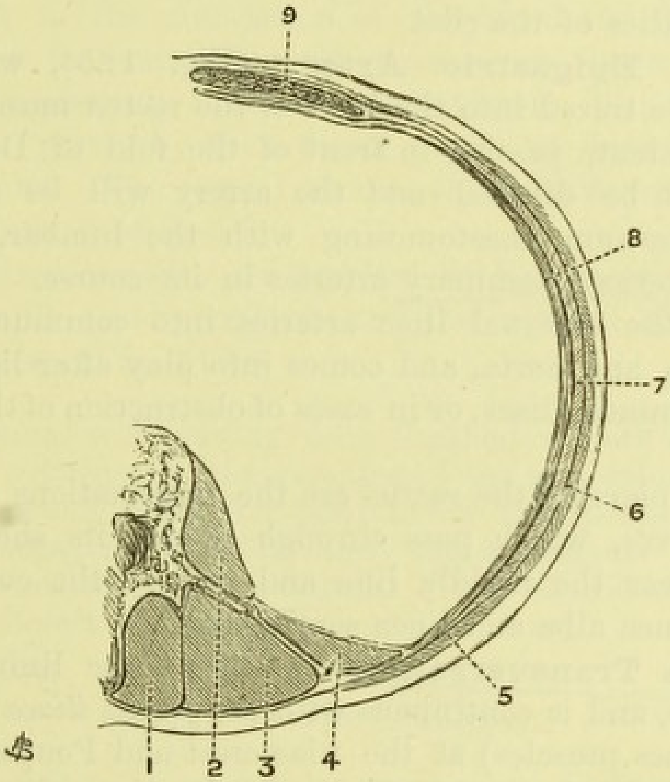
The point where the sheath ceases to pass behind the rectus is marked by a sharp curved margin (fold of Douglas), in front of which the epigastric vessels will be seen to pass, and enter the substance of the muscle. This will be afterwards seen from behind (Fig. 120, *c*).

[In many subjects immediately above the pubes, in front of the rectus and enclosed in its sheath, will be found a little muscular slip, the pyramidalis. Both muscles are to be cleaned in the direction of their fibres.]

The **Pyramidalis** (Fig. 119, 17) *arises* from the crest of the pubes close to the median line, and passes up for about two inches to be *inserted* into the linea alba. Tensor of Linea Alba

The **Rectus Abdominis** (Fig. 119, 16) *arises* from the pubic crest and supra-pubic ligament, and by an interlacement from the front of

Fig. 130.



the pubic bones and interpubic joint. The inner fibres of origin are fleshy, the outer tendinous, but there is no division into two 'heads.' It expands into a broad muscle, and is *inserted* into the ensiform cartilage and into the anterior surface of the cartilages of the last three true ribs (5th, 6th and 7th). onto 3rd of 5th itself too.

Fig. 130.—Arrangement of lumbar aponeurosis at level of third lumbar vertebra.

1. Sacro-lumbalis.
2. Psoas magnus.
3. Longissimus dorsi.
4. Quadratus lumborum.
5. Latissimus dorsi.
6. External oblique.
7. Internal oblique.
8. Transversalis.
9. Rectus.

The *lineæ transversæ* are tendinous intersections corresponding to abdominal ribs; one is placed nearly opposite the umbilicus, a second at the level of the ensiform cartilage, a third between these, and a fourth is occasionally found between the umbilicus and the pubes. They seldom extend through the whole of the muscular fibres and are distinct only in front, where they adhere firmly to the sheath. strengthen the Rectus, by ÷ ing it into short bits

The rectus is a powerful *flexor of the lumbar vertebræ*, inclining the thorax upon the pelvis or vice versâ. It acts as *abdominal compressor* mainly by increasing the resistance of the anterior abdominal wall during the action of the other muscles of the region,* and it assists *expiration* by drawing down the sternum and sternal extremities of the ribs.

The **Deep Epigastric Artery** (Fig. 125), with its venæ comites, will be traced into the back of the rectus muscle, where the sheath is deficient, passing in front of the fold of Douglas. The muscle should be divided and the artery will be seen running towards the sternum, anastomosing with the lumbar, lower intercostal, and internal mammary arteries in its course. This anastomosis brings the external iliac arteries into communication with the subclavian and aorta, and comes into play after ligature of the external or common iliacs, or in cases of obstruction of the descending aorta.

The nerves piercing the rectus are the terminations of the lower intercostal nerves, which pass through it and its sheath to reach the surface near the middle line and supply the cutaneous area between the linea alba and linea semilunaris.

The **Fascia Transversalis** is the membrane lining the transversalis muscle, and is continuous with the *fascia iliaca* (covering the iliacus and psoas muscles) at the iliac crest and Poupart's ligament, and with the diaphragmatic fascia at the line of origin of this muscle. Opposite the point at which the external iliac vessels pass beneath Poupart's ligament it gives a process to strengthen the anterior wall of the femoral sheath, while the fascia iliaca passes upon the ilio-psoas beneath the sheath ~~but without~~ aiding its formation. (The sheath itself is a continuation of the sub-peritoneal investment of the external iliac and other abdominal vessels.) It is usually thin and transparent, and is sometimes difficult to demonstrate on account of its intimate connexion with the sub-peritoneal tissue. At the internal abdominal ring the transversalis

* If the abdomen be sunken the line of the rectus presents a forward concavity, and during contraction the muscle becomes more widely separated from the spine and will hence tend to reduce the pressure upon the viscera.

fascia is prolonged over the elements of the spermatic cord as the infundibuliform fascia, in the manner described (p. 269).

Action of the Abdominal Muscles.—The actions of the abdominal muscles may be subdivided into two groups, locomotive and constrictive. As *organs of locomotion* the muscles incline the thorax upon the pelvis or the pelvis upon the thorax in the antero-posterior, lateral, or oblique directions, mainly at the lumbar and dorso-lumbar articulations. As *organs of abdominal constriction* they compress the various organs in the abdomino-pelvic cavity, and so aid in the expulsion of the contents of the stomach, bladder, intestines, and uterus, and pathologically in the production of hernial protrusions ; while by their influence upon the vessels they play an important part in the circulation of the blood and lymph. They moreover assist in contracting the thoracic cavity in all *expiratory* acts, partly by pressing the abdominal viscera into the hollow of the diaphragm, partly by their direct power of drawing down the sternum and ribs. The special actions of the transversalis and recti have already been described.

The abdominal muscles are *supplied* by the lower six intercostal nerves, and by the ilio-hypogastric and ilio-inguinal branches of the first lumbar nerve (Fig. 118).

[The abdominal wall having been finished on both sides, the dissectors should cut through the remains of the abdominal muscles in two or three places until the peritoneum is exposed, but without injuring the latter, in order to study the appearance of the membrane which forms the sac of a hernia. They should then open the abdomen and dissect the viscera.]

Cavity of the Abdomen.

[The abdomen is to be opened by a transverse incision at the level of the umbilicus, and another cut is to be carried from the umbilicus to the sternum, a little to the left of the median line.]

By holding up the lower portion of the abdominal wall before dividing it in the median line, and viewing it from behind, the dissectors will perceive through the peritoneum five cords taking a course towards the umbilicus (Fig. 131). The central cord is the obliterated urachus (*m*), those on each side of it are the obliterated hypogastric arteries (*i*), and the most external correspond to the two epigastric arteries (*b*). The peritoneum is raised into distinct folds by the obliterated hypogastric arteries, and in the membrane external to the epigastric artery on each side, a little above the middle of Poupart's ligament, may be seen a small dimple (occasionally the orifice of a minute tube, the *processus vaginalis*), marking the position of the internal abdominal ring. The shallow peritoneal depressions bounded by these cords are called *inguinal pouches*, the *middle* pouch lying between the epigastric and hypogastric folds, the *internal* between the hypogastric fold and the urachus, and the *external* on the outer side of the epigastric fold. The term "*Hesselbach's triangle*" (*d*) has been applied to the triangular space bounded by

Fig. 131.

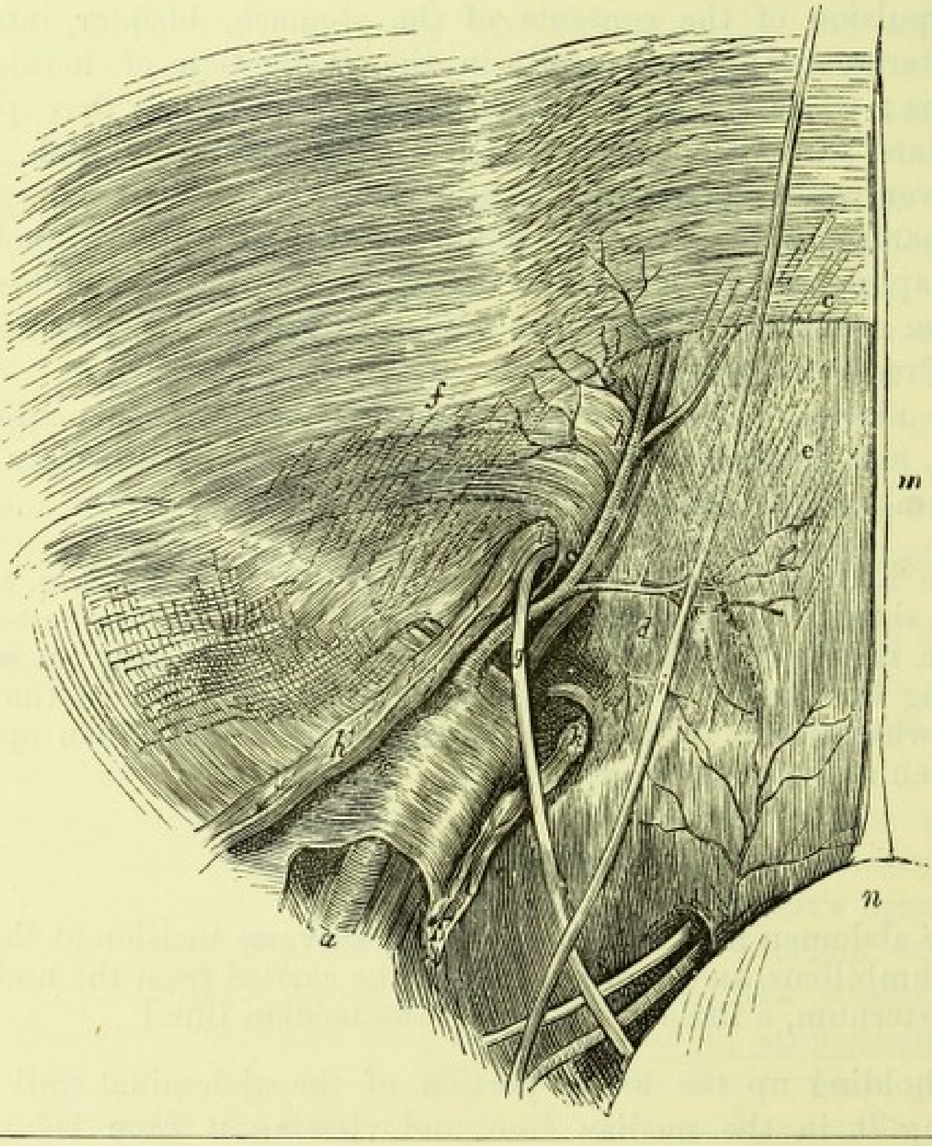


Fig. 131.—Dissection of the lower part of the abdominal wall from within, the peritoneum having been removed (from Wood).

a. External iliac artery.
b. Epigastric artery.
c. Border of the posterior part of the sheath of the rectus (fold of Douglas).
d. Conjoined tendon in the triangle of Hesselbach.
e. Posterior surface of rectus.
f. Fascia transversalis.
g. Vas deferens.
h. Spermatic vessels.
i. Obliterated hypogastric artery.
k. Lymphatics in crural ring.
l. Internal abdominal ring.
m. Urachus.
n. Bladder.

the border of the rectus internally, the epigastric artery externally, and Poupart's ligament below, and it is through this that direct inguinal hernia forces its way. It is subdivided into two parts by the obliterated hypogastric artery, which, like the epigastric artery, is often supported by a distinct fold of peritoneum. The *fold of Douglas* (*c*), or sharp lower margin of the posterior sheath of the rectus, will be readily perceived through the peritoneum.

Fig. 132.

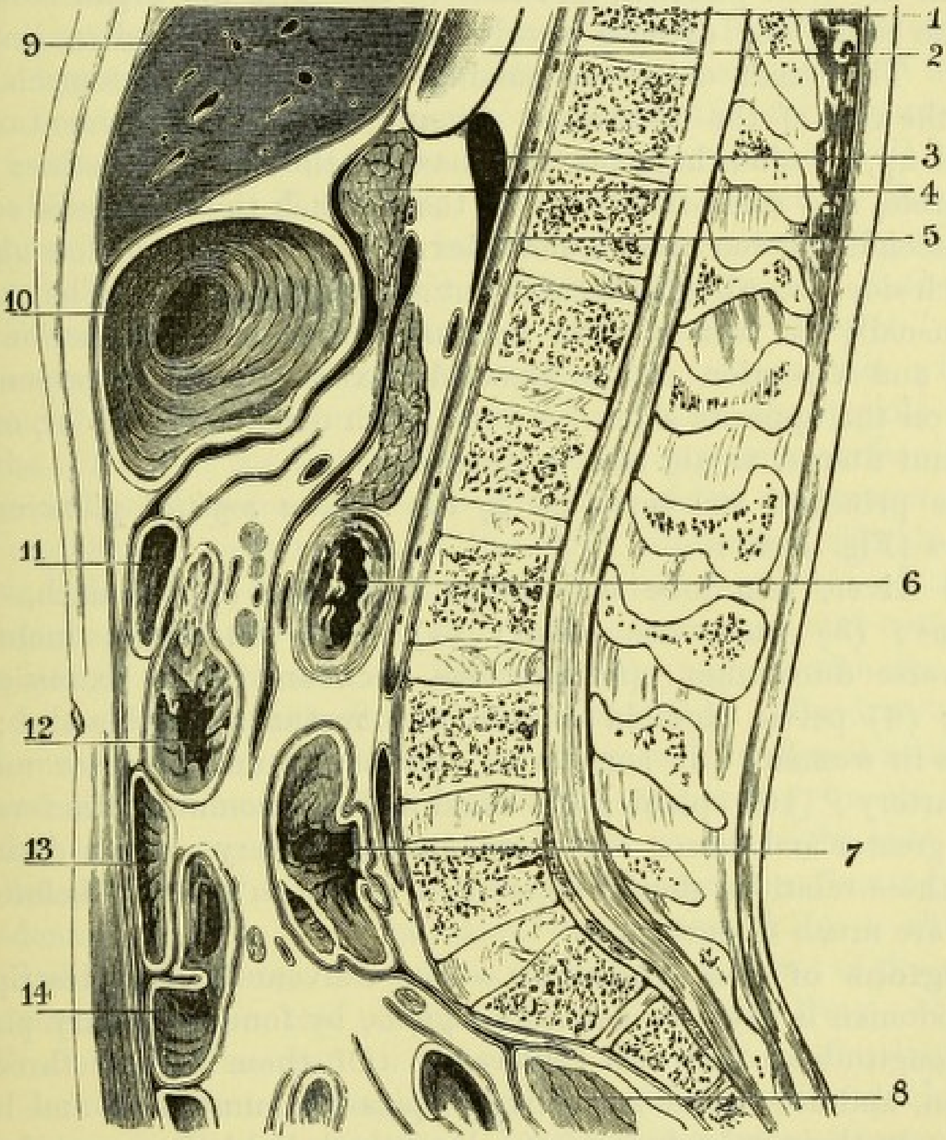


Fig. 132.—Median sagittal section of abdomen (after Braune). For lower segment see Pelvis.

1. Tenth dorsal vertebra.
2. Œsophagus.
3. Crus of diaphragm.
4. Head of pancreas, surrounding superior mesenteric vessels.
5. Aorta.
6. Transverse duodenum.
7. Sigmoid flexure.
8. Rectum.
9. Liver.
10. Stomach.
11. Transverse colon.
12. Jejunum.
13, 14. Ileum.

[By dividing the lower portion of the abdominal wall in the median line, it can be reflected on each side, and the abdominal contents will be exposed.]

Abdominal Cavity.—The parts first seen on opening the abdomen are the stomach and portions of the right and left lobes of the liver; and the gall-bladder if distended generally lies at the right costal margin where this is joined by the linea semilunaris; but it must be remembered that the liver is higher in the recumbent than in the erect position, and that in the child the organ is larger and the right lobe extends nearly or quite to the median line in front. The great omentum passing down from the stomach conceals the rest of the intestines. Should, however, the omentum be turned up, as often happens, the mass of the small intestines will be visible, and immediately below the stomach the transverse colon. The ascending colon and sigmoid flexure will be more or less visible on each side, according to the amount of their distension. The cæcum may usually be seen a little internal to the anterior superior iliac spine, and a portion of the sigmoid flexure at the corresponding point on the opposite side. A very much distended bladder, or the pregnant uterus, would also be apparent.

The principal *structures cut by the median sagittal plane* are as follows (Fig. 132):—

(1) Liver, left lobe and lobus Spigelii; (2) stomach, near pylorus; (3) transverse colon; (4) small intestines, including transverse duodenum; (5) pancreas, neck and lower extension of head; (6) pelvic sigmoid flexure and rectum; (7) bladder; (8) uterus in women; (9) aorta with cœliac axis and superior mesenteric artery; (10) splenic, left renal and left common iliac veins; (11) greater and lesser omentum and mesentery. It is desirable that these relations should be studied as far as possible before the parts are much disturbed.

Regions of the Abdomen.—For convenience of description the abdomen is divided into nine regions, by four imaginary planes, two longitudinal and two transverse. Of these regions three are median, and are called respectively epigastric, umbilical, and hypogastric, in their order from above downwards, and the remaining six lie three on each side, and are named hypochondriac, lumbar, and iliac or inguinal. So far all anatomists have been agreed for some centuries, but unfortunately even at the present day there is no universally accepted rule for the position of the subdividing planes, and consequently the epigastric, lumbar, or other region of one textbook may differ very widely in dimensions from that described in another. Under these circumstances it is doubtful whether it would not be better to abandon altogether the use of terms which have no precise meaning.

The following scheme of delimitation is perhaps the most convenient. The *upper transverse plane* corresponds to the lowest point of the costal margin on each side, the *lower plane* to the anterior superior iliac spines. The intersecting *longitudinal planes* are drawn upwards, one on each side, from the pubic spine along the outer border of the rectus. The position of the viscera in relation to the regions so marked out may be formulated as follows:

Beginning at the upper part, the *liver* will be found to occupy the right hypochondriac, the epigastric, and a small part of the left hypochondriac regions, and may descend into the upper part of the left lumbar region; passing to it from the umbilicus will be seen the obliterated umbilical vein. Its anterior margin is sharp; its "upper" surface, which may be divided into anterior, superior and right lateral faces, corresponds to the diaphragm and to the abdominal wall in the sub-costal angle; its visceral or "lower" surface looks backwards as well as downwards, and is in contact with the stomach, the commencement of the duodenum, the hepatic flexure of the colon and the right kidney; and its posterior surface will be afterwards seen to be adapted to the crura of the diaphragm, and to the œsophagus, vena cava, and the right suprarenal capsule. The lower end of the thoracic aorta lies behind the crura of the diaphragm, opposite the interval between the vena cava and œsophagus. The *stomach* will be seen in the epigastric region, with its greater cul de sac reaching into the left hypochondrium. By drawing this end out from beneath the ribs, the spleen will be found attached to it, and is sometimes bound firmly to the diaphragm by old inflammatory adhesions. Tracing the stomach to the right side it will be found to reach almost to the gall-bladder, terminating in the duodenum, the line of demarcation being marked by a thickened band of annular fibres, the pyloric sphincter. In front of the stomach are the diaphragm, the abdominal wall, and the liver; behind it will afterwards be seen the pancreas, the crura of the diaphragm, the aorta and vena cava, and the left kidney and capsule. The *duodenum* can be followed for a short distance only at present. By drawing up the great omentum, the transverse *colon* will be exposed crossing the umbilical region, and continuous on the right side with the hepatic flexure (right hypochondriac region) and ascending colon, and on the left with the splenic flexure (left hypochondriac region) and descending colon, which should be traced out. Occupying chiefly the hypogastric, but extending into all the middle and lower regions, are the coils of the *small intestine*, two-fifths of which

from middle of clavicle to middle of Poupart's Ligament.

constitute the *jejunum*, and the remainder the *ileum*; the latter may be found to end in the large intestine in the right iliac fossa, where the commencement of the colon (*caput cæcum coli*, or *cæcum*) will be recognised by its little appendage, the *appendix vermiformis*. In the left iliac fossa will be seen the tortuous portion of the large intestine, called the *sigmoid flexure*, which may be traced into the pelvis to its termination in the *rectum*. The inguinal canals lie in the inguinal regions.

TABLE OF ABDOMINAL CONTENTS.

Right Hypochondriac Region.	*Epigastric Region.*	*Left Hypochondriac Region.*
Part of right lobe of liver, part of gall bladder and hepatic flexure of colon, right supra-renal capsule, and part of right kidney.	Stomach (with both orifices), left lobe and a part of right lobe of liver, part of gall bladder, 1st and part of 2nd parts of duodenum, abdominal aorta, vena cava, semi-lunar ganglia, receptaculum chyli, vena azygos, pancreas, upper and inner part of spleen, parts of kidneys, and both supra-renal capsules.	Stomach (cardiac end), spleen and tail of pancreas, splenic flexure of colon, left supra-renal capsule, part of left kidney, and a part of the left lobe of the liver.
Right Lumbar Region.	*Umbilical Region.*	*Left Lumbar Region.*
Ascending colon with cæcum in some cases, small intestine, part of right kidney and sometimes part of right lobe of liver.	Great omentum, transverse colon, 2nd (lower part) and 3rd portion of duodenum, part of right kidney and sometimes part of left, ureters, small intestine, bifurcation of aorta, formation of vena cava.	Descending colon, small intestine, part of sigmoid flexure, sometimes part of left kidney.
Right Inguinal Region.	*Hypogastric Region.*	*Left Inguinal Region.*
Cæcum coli, with vermiform appendix and part of ileum in most cases. Inguinal canal.	Small intestines, uterus, upper part of bladder in distension and in young children, and the pregnant uterus. These lie above the oblique plane of the inlet of the true pelvis. Below it are the bladder, small intestine, part of sigmoid flexure, rectum, and in the female, the uterus, vagina, and ovaries.	Part of sigmoid flexure and small intestines. Inguinal canal.

The above table of necessity includes organs whose positions cannot be seen at present but will be subsequently studied.

It will be well for the student to notice the distinctive appearances of the several parts of the intestinal canal, and particularly the differences between the large and small intestines. The condition of the intestines varies so much according to the mode of death, that mere size is no criterion, the small intestines being occasionally distended to a much greater size than the large; but attention to the following points will prevent all possibility of error.

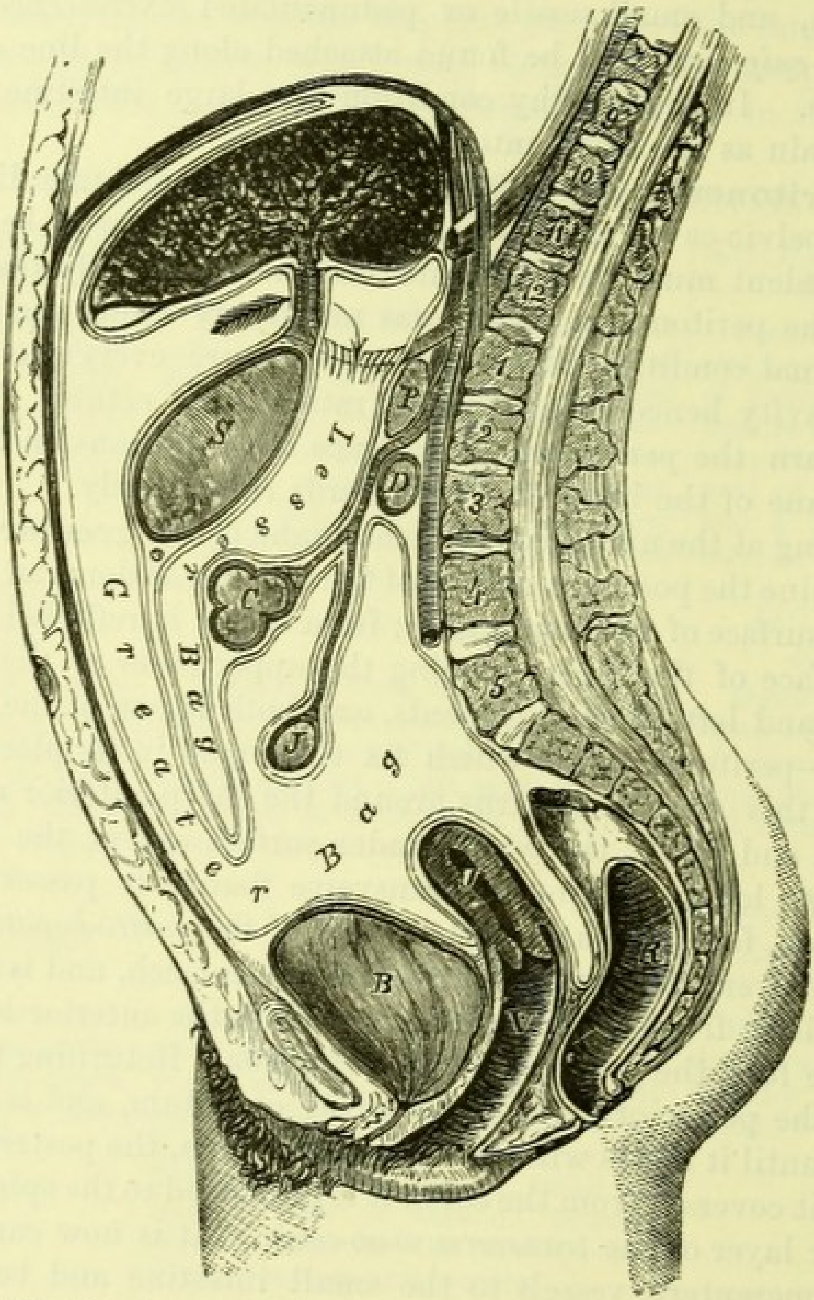
The cylinder of the small intestine is uniform throughout, and the surface is perfectly smooth, while the large intestine is pouched or slightly constricted at short intervals throughout, excepting the rectum, and is marked by three distinct bands of longitudinal muscular fibres, and small sessile or pedunculated excrescences of fat (*appendices epiploicæ*) will be found attached along the line of one of these bands. In the healthy condition the large intestine is about as large again as the small intestine.

The **Peritoneum** (Fig. 133).—The serous membrane lining the abdomino-pelvic cavity and covering the viscera is now to be studied, and the student must bear in mind that he has already opened the cavity of the peritoneum, which was previously a shut sac, and that in the normal condition the serous surfaces are everywhere in contact, the cavity hence being virtual rather than actual. The best way to learn the peritoneum is to trace the reflexions on the longitudinal plane of the body, and afterwards transversely.

Beginning at the umbilicus the membrane of the **greater sac** will be seen to line the posterior surface of the anterior abdominal wall, and the under surface of the diaphragm ; from this it is reflected on to the upper surface of the liver, forming the upper layer of the coronary and right and left lateral ligaments, and both layers of the falciform ligament—peritoneal folds which fix the organ in its place. After investing this surface, it turns around the sharp anterior margin of the organ, and covers the whole under surface except the Spigelian ~~and caudate~~ lobes. From the transverse fissure it passes down to the stomach, forming the anterior layer of the *gastro-hepatic* or *lesser omentum*, covers the anterior surface of the stomach, and is prolonged downwards in front of the intestines to form the anterior layer of an apron-like fold, the *great omentum* or *epiploön*. Returning upon itself it forms the posterior layer of the great omentum, and is continued upwards until it meets with the transverse colon, the posterior surface of which it covers. From the colon it is prolonged to the spine, forming the under layer of the *transverse meso-colon*. It is now carried down over the mesenteric vessels to the small intestine and back to the spine, forming the two layers of the *mesentery* ; thence passing over the posterior abdominal wall into the pelvis, it invests the upper part of the rectum (*meso-rectum*) and in the male passes from that tube to the bladder, forming the *recto-vesical pouch*, while in the female it is reflected from the rectum on to the upper part of the vagina, as the deep *recto-vaginal pouch* (*cul-de-sac of Douglas*), then over the uterus and between the uterus and bladder, forming the *utero-vesical pouch*. Lastly, it is carried over the bladder to the lower part of the anterior abdominal wall and so to the umbilicus.

It should be noticed that when the peritoneum approaches the intestine its two laminæ diverge, leaving a triangular interval (on

Fig. 133.



section), with its base at the intestinal wall and its apex towards the root of the mesenteric fold. This interval is occupied by fat

Fig. 133.—Diagram of vertical section of the peritoneum (drawn by J. T. Gray).

The continuation of the greater with the lesser bag through the foramen of Winslow is marked by an arrow.

L. Liver.
S. Stomach.
C. Colon.
J. Jejunum.
P. Pancreas.
D. Duodenum.
B. Bladder.
U. Uterus.
R. Rectum.

(continuous with the subperitoneal tissue), and by the vessels and nerves supplying the gut. As a result of this arrangement, about a fourth or a fifth of the circumference of the intestinal wall has no serous coat; a fact which the surgeon must remember in applying sutures in resection of the gut, or the "interserous triangle" may be invaded by extravasated fæcal matter.

In the female the cavity of the greater sac communicates with the genital passages by means of the open mouths of the two Fallopian tubes.

The *greater sac* of the peritoneum has now been traced, but there is another pouch called the **lesser sac** behind it, and continuous with it through a tube named the *foramen of Winslow.* This foramen will be found by passing the finger behind the right free border of the gastro-hepatic omentum, immediately below the lobus caudatus of the liver. To expose the cavity of the lesser sac, a longitudinal incision should be carefully made in the middle line through the two layers of the lesser omentum, the pyloric end of the stomach, and the double anterior layer of the great omentum. If the edges of this incision be now widely opened the interior of the sac will be visible. It will be noticed that it forms above a deep but narrow pouch, embracing the lobus Spigelii, and expands transversely below, where it lies behind the stomach and between the layers of the great omentum. Tracing it in the longitudinal direction from the transverse fissure of the liver, the membrane of the lesser sac will be found to form the posterior layer of the lesser omentum, and cover the posterior surface of the stomach; thence it is prolonged downwards to form the second layer of the great omentum as far as the lower edge of this fold, and upwards again as the third layer; after which it covers the front of the transverse colon and forms the upper layer of the transverse mesocolon. It then invests the anterior surface of the pancreas and is reflected upon the lobus Spigelii and lobus caudatus of the liver, to reach the transverse fissure. It will be noticed that the lobus Spigelii is the only portion of the liver covered by the peritoneum of the lesser sac, and that the lobus caudatus coincides in position with the foramen of Winslow.

The **Foramen of Winslow** (Figs. 134 and 135) is simply a kind of hour-glass constriction of the peritoneum dividing it into two parts, and is caused by the passage of the hepatic artery forwards and upwards from the posterior abdominal wall to the transverse fissure. When the finger is in the foramen it will feel the following boundaries. *In front*, the lesser omentum, containing the hepatic artery, portal vein, bile duct, and hepatic nerves and lymphatics ; *behind*, the right crus of the diaphragm and the inferior vena cava ; *below*, the hepatic artery (as it passes forwards from the aorta) ; *above*, the lobus caudatus of the liver.

The two sacs of the peritoneum may be traced together in the following way. Beginning at the liver, one layer covers the front and the other the back of the under surface of the organ, and the two meet at the transverse fissure to form the lesser omentum. They then separate to enclose the stomach, uniting at its lower border to form the anterior double layer of the great omentum ; reflected upon themselves, they next form the two posterior layers, which separate to enclose the transverse colon, and form the transverse meso-colon as they are prolonged to the spine. The two layers now separate. The upper one (lesser sac) is prolonged over the pancreas to the under surface of the liver ; the under layer (greater sac) covers the lower part of the duodenum in front ; then forms the mesentery, the recto-vesical pouch in the male, and the recto-vaginal and utero-vesical pouches in the female, and passes over the abdominal wall to the diaphragm, from which it is reflected on to the liver, where the description commenced.

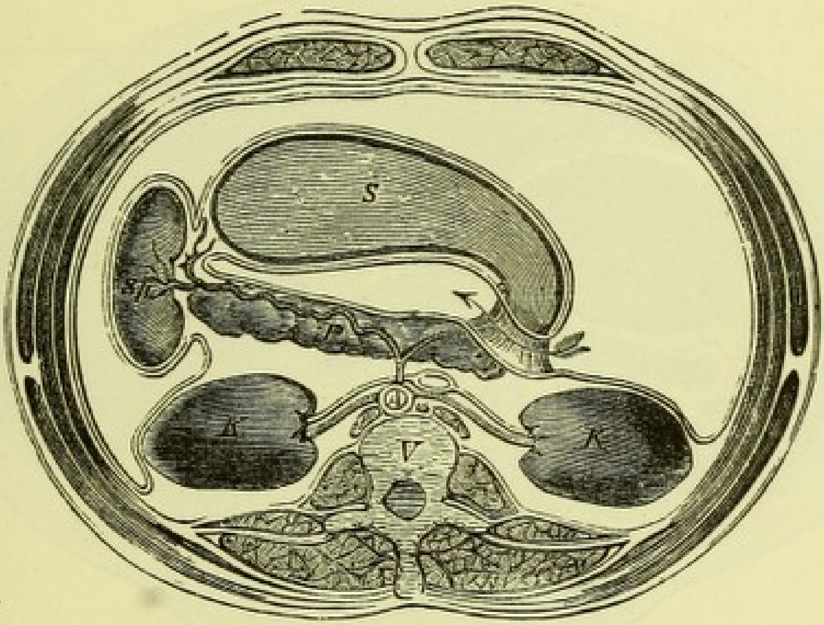
On passing the hand into the lesser sac its cavity is found to be shut off from that of the greater sac on the left side by a double lamina of peritoneum. This septal fold is the *gastro-phrenic* or *lieno-phrenic omentum*, and will presently be described.

The peritoneum should now be traced horizontally. Below the level of the transverse colon the circle will be found to be exceedingly simple. Beginning at the median line of the anterior abdominal wall, the peritoneum may be followed to the right iliac region, where it will be found to surround the cæcum and to cover the front of the ascending colon, binding the latter to the posterior abdominal wall ; it then forms the *mesentery ;* and lastly, covering the anterior surface of the descending colon and the sigmoid flexure (binding the former to the posterior abdominal wall, and forming for the latter a *sigmoid meso-colon*), it is brought round again to the anterior abdominal wall. Either the ascending or the descending colon or both may be surrounded by peritoneum, and connected to the posterior abdominal wall by a *meso-colon ;* but in some instances, where a contracted portion of the colon seems to possess a short mesentery, the fold completely disappears after inflation of the tube, and an uncovered portion of the wall comes into contact with the parietes. This fact probably accounts for the discrepancies between the observations of different anatomists as to the frequency of an ascending or descending *meso-colon.*

phreno
A ~~costo~~-*colic* fold attaches the splenic flexure of the descending colon to the under surface of the diaphragm ; it passes below the spleen and limits the movements of that organ.

Above the colon the arrangement is complicated by the existence of the two sacs, the continuity of which may here be demonstrated (Fig. 134). Beginning at the median line of the abdominal wall, the peritoneum may be traced into the right hypochondrium and over the right kidney ; it then passes into the foramen of Winslow

Fig. 134.



and across the body in front of the pancreas, and runs forward to the cardiac end of the stomach from the diaphragm and kidney, forming the right layer of the *gastro-phrenic omentum.* It then covers the posterior surface of the stomach and returns to the foramen of Winslow as the posterior layer of the lesser omentum. Reflected at this point upon itself, the membrane runs to the left as the anterior layer of the lesser omentum, and is continued over the front of the stomach ; thence, forming the anterior layer of the *gastro-splenic omentum,* it reaches the spleen and encloses it, then forms the posterior layer of the gastro-splenic omentum and reaches the back of the cardiac end of the stomach, from which it

Fig. 134.—Transverse section of the abdomen at the level of the foramen of Winslow (drawn by J. T. Gray).

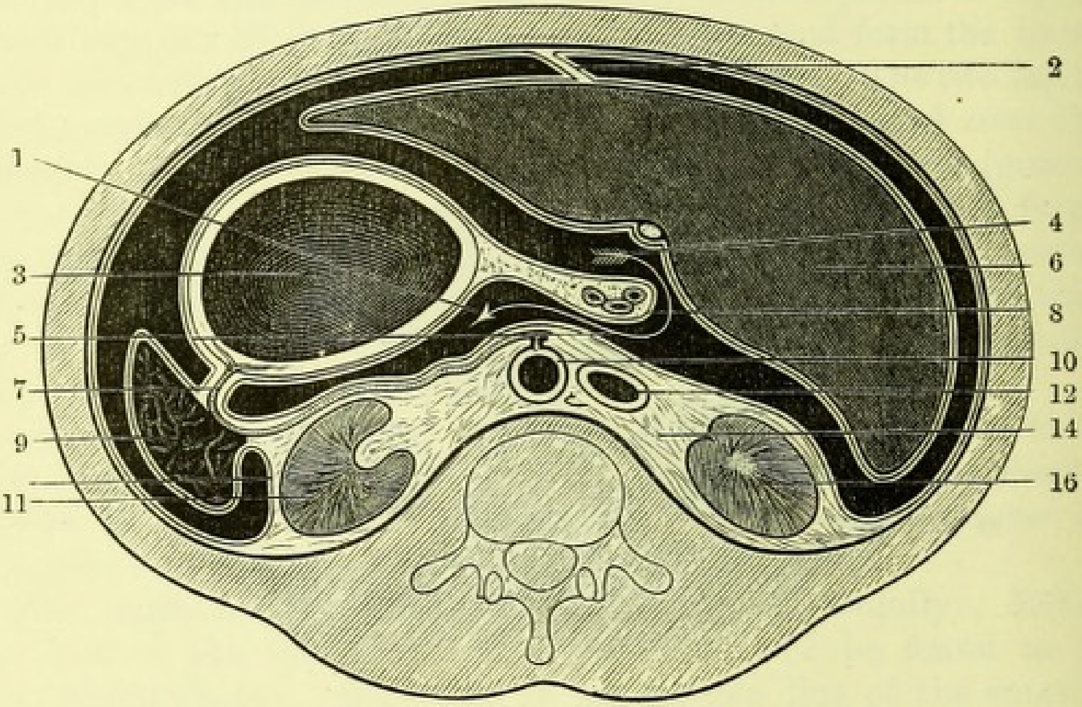
The arrow passes from the greater bag to the lesser bag of the peritoneum through the foramen of Winslow, which is seen in section.

S. Stomach.	Sp. Spleen.	V. Vertebra.
P. Pancreas.	K. Kidney.	A. Aorta.

passes to the diaphragm and left kidney as the left layer of the gastro-phrenic omentum, and so to the left hypochondrium and round the abdominal wall. The continuity of the greater with the lesser bag is thus made evident, and the foramen of Winslow is seen to be merely the narrowed tube of communication between the two cavities.

The *gastro-phrenic omentum*, passing from the back of the cardiac

Fig. 135.



end of the stomach to the diaphragm and kidney, forms the greater part of the septum between the greater and lesser sacs. It is connected above with the fissure for the ductus venosus on the under surface of the liver, and with the œsophagus, and is continuous in front with the left extremity of the lesser omentum. In many subjects the point of reflection of this septal fold, instead of passing from the stomach, runs from the gastro-splenic omentum, or from the spleen,

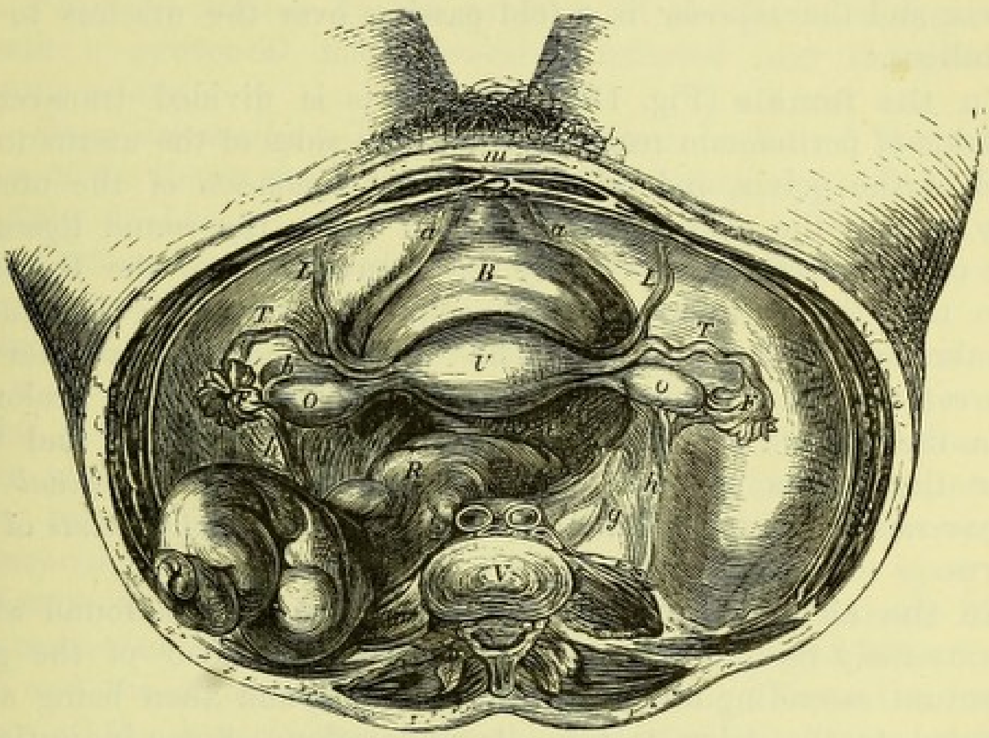
Fig. 135.—Diagram of the reflections of the peritoneum traced horizontally at the level of the foramen of Winslow (W.A.)

1. Point of arrow on lesser sac.
2. Falciform ligament.
3. Cardiac end of stomach.
4. Feather of arrow on greater sac.
5. Foramen of Winslow.
6. Liver.
7. Gastric vasa brevia of splenic artery in gastro-splenic fold.
8. Lesser omentum.
9. Spleen.
10. Aorta.
11. Left kidney.
12. Vena cava.
14. Subperitoneal tissue.
16. Right kidney.

in the latter case receiving the name of *lieno-phrenic* omentum. A small portion of the spleen would then be covered by the peritoneum of the lesser sac (as in the model of His and in Fig. 135).

Besides the folds of peritoneum which have been named in tracing the membrane, there are others which form certain ligaments of the liver and bladder, and of the uterus in the female.

Fig. 136.



Passing from the umbilicus to the liver is seen the obliterated umbilical vein or *round ligament*, and around it is reflected a double fold of peritoneum, the *suspensory* or *falciform ligament* of the liver. This is prolonged on each side over the diaphragm and on to the upper surface of the liver, where it forms the upper layer of the *coronary ligament;* the under layer being formed partly by the lesser sac of the peritoneum, and the triangular surface of the liver between the two being attached by firm areolar tissue to the

Fig. 136.—Female pelvic organs, seen from above (from Savage).

a, *a*. Obliterated hypogastric arteries.
b. Broad ligament of uterus.
e. Posterior ligament of uterus.
g. Ureter.
h. Ovarian vessels.
m. Linea alba and section of urachus.
B. Bladder.
L. Round ligament of uterus.
F. Fimbriated extremity of Fallopian tube.
T. Fallopian tube.
O. Ovary.
R. Rectum.
U. Uterus.
V. Fifth lumbar vertebra.

diaphragm. The duplicatures continuous with the coronary ligament on each side are called the right and left *lateral ligaments.*

The *false ligaments* of the bladder, formed by the peritoneum, are five in number, two posterior, two lateral, and one superior. The *posterior* false ligaments are the margins of the recto-vesical pouch, and are formed by the reflection of the membrane over the ureters. The so-called *lateral* false ligaments are merely the reflections of the peritoneum from the bladder to the sides of the pelvis, and the *superior* is a fold passing over the urachus to the umbilicus.

In the female (Fig. 136), the pelvis is divided transversely by folds of peritoneum reaching from both sides of the uterus to the sides of the pelvis, and called the *broad ligaments* of the uterus; they contain the ovaries, the Fallopian tubes, the round ligament, and other structures. It is by the open mouth of the Fallopian tube that the peritoneum has a communication with the mucous membrane of the uterus. The uterus and vagina intervene between the rectum and bladder, and the peritoneum is prolonged from the rectum to the posterior wall of the vagina, and then over the uterus to the bladder, forming the *recto-vaginal* and *utero-vesical* pouches, and the *anterior* and *posterior ligaments* of the uterus.

In the child an arrangement may occasionally be found which is extremely rare in the adult—the posterior layer of the great omentum ascending directly to the pancreas, and then being again reflected to the colon to form its meso-colon. Some indication of this may be seen in the adult in the transverse meso-colon near its splenic extremity.

Peritoneal Pouches.

An examination of the interior of the greater sac of the peritoneum shows certain pouches and fossæ, some of which are of surgical interest. The principal of these are as follows :—

1. *Fossa phrenico-hepatica.*—On the under surface of the diaphragm, beginning at the left lobe of the liver and extending to the left, parallel to the coronary ligament of the liver. Its diameter is from a sixth of an inch to an inch and a half.

2. *Fossa duodeno-jejunalis.*—Situated at the root of the mesentery, and is exposed by raising the great omentum with the colon and drawing the intestines to the right. It runs from left to right, and is of variable size, generally large enough to admit a finger. The entrance is bounded on the right side by the termination of the

duodenum, on the left side by a semilunar band of peritoneum containing the inferior mesenteric artery above and the colica sinistra below. It sometimes lodges a hernia.

3. *Fossa intersigmoidea.*—Lies at the middle of the root of the sigmoid meso-colon on its left face, and passes upwards on the inner side of the psoas muscle. This fossa is occasionally the seat of a hernia.

5. *Fossa subcæcalis,* behind and internal to the cæcum.

6. *Fossa ileo-colica.*—At the junction of the ileum and cæcum, beneath a peritoneal fold (ileo-colic) reflected over the anterior ileo-colic artery.

7. *Fossa ileo-cæcalis.*—Between the lower border of the termination of the ileum and the root of the vermiform appendix. It is sometimes double.

The *external middle and internal inguinal fossæ* and the *recto-vaginal pouch* have already been described.

The REFLECTIONS OF THE PERITONEUM FROM THE VISCERA TO THE WALL OF THE ABDOMEN may be studied on Fig. 137.

The posterior peritoneal attachment may be divided into an upper portion connected with the liver, stomach and spleen, and a lower belonging to the large and small intestine. The *upper*, commencing with the reflection of the falciform ligament upon the diaphragm, extends backwards somewhat obliquely to join the large area connected with the posterior surface of the right lobe of the liver and the right and left lateral ligaments. From the lower border of the hepatic area runs the posterior attachment of that double layer of peritoneum (gastro-phrenic or lieno-phrenic fold) which forms the septum between the greater and lesser sacs of peritoneum on the left side (Figs. 134, 135), and encloses the œsophagus, the tail of the pancreas, and the splenic vessels; this passes from the point at which the vena cava receives the obliterated ductus venosus, obliquely to the left across the diaphragm to the front of the left kidney, where it joins the attachment of the splenic flexure of the colon.

The *lower* line of attachment commences with the root of the mesentery on the left side of the 2nd lumbar vertebra at the termination of the 3rd stage of the duodenum. From this point it runs obliquely downwards across the spine to the right iliac fossa where it meets the lowest attachment of the ascending colon and of the little appendicular fold. The ascending colic area runs upwards over the iliac crest, the anterior lamella of the transversalis tendon and the front of the right kidney; it is succeeded by the attachment of the transverse meso-colon which extends transversely across the renal vessels and

right sacro-iliac symphysis

Fig. 137.

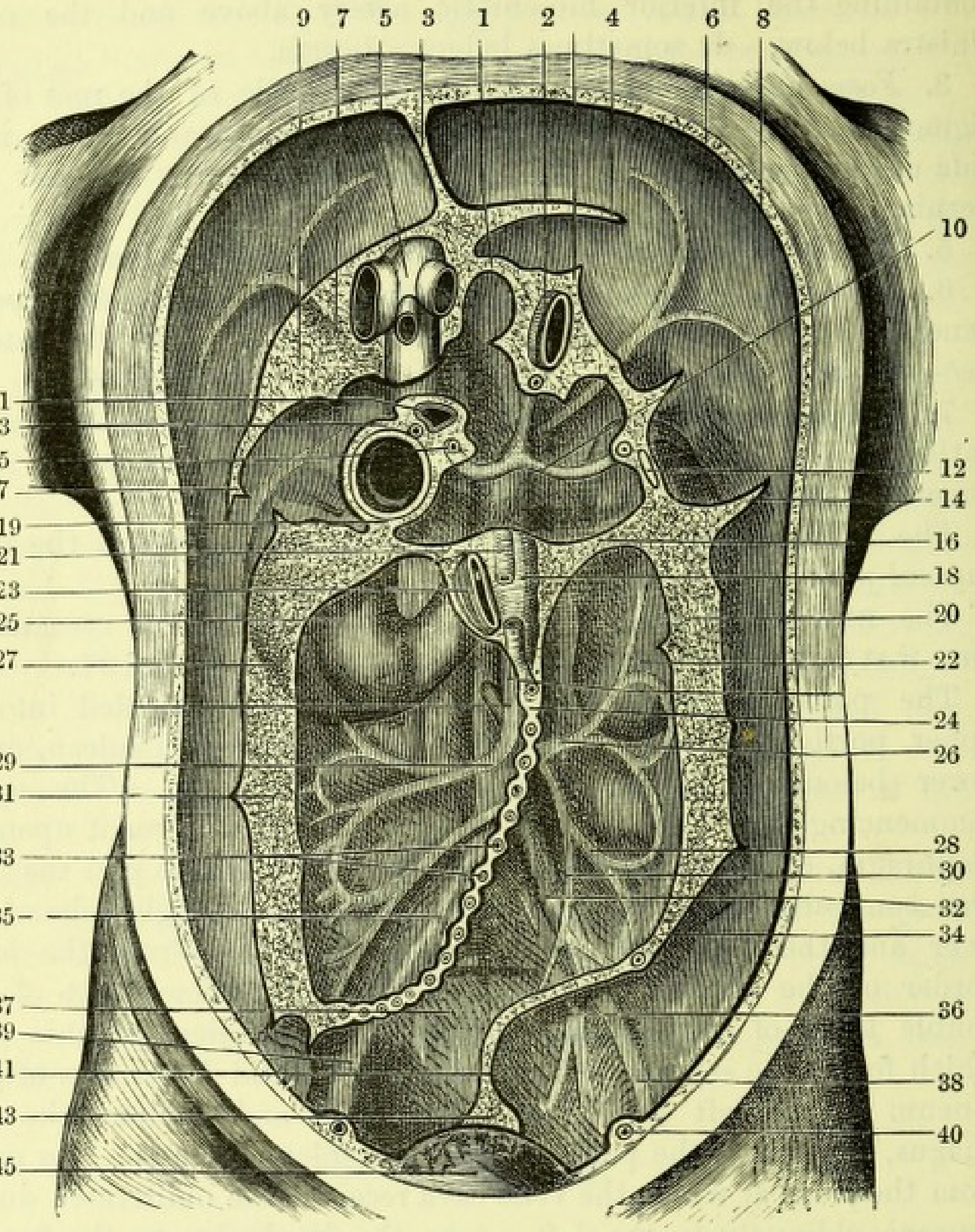


Fig. 137.—Diagram of the parietal attachment of the peritoneum (after Delépine).

1. Upper end of septal fold between greater and lesser sacs.
2. Œsophagus.
3. Falciform ligament.
4. Left lateral ligament.
5. Vena cava inferior.
6. Diaphragm.
7. Phrenic artery.
8. Cut edge of peritoneum.
9. Hepatic area.
10. Splenic artery behind lesser sac.
11. Portal vein below foramen of Winslow.
12. Tail of pancreas in gastro-phrenic omentum.
13. Bile duct.
14. Costo-colic fold.
15. Hepatic artery.
16. Transverse mesocolon.
17. Right lateral ligament.
18. Aorta.
19. Pylorus.

the pancreas, transmitting between its layers the termination of the first stage of the duodenum above and on the right side, and the end of the third stage at the middle line or a little to the left; and receiving at its left extremity the lower end of the septal fold before referred to. At this point it becomes continuous with the descending colic area, which runs downwards over the kidney and transversalis tendon into the left iliac fossa. The descending colic area is succeeded by the attachment of the sigmoid meso-colon and meso-rectum, which crosses obliquely over the sacro-iliac joint to the front of the sacrum.

Mesenteric Vessels.

[In order to dissect the mesenteric arteries, the great omentum and transverse colon must be turned up over the cartilages of the ribs, and the small intestines be drawn down. Beginning at the upper end of the jejunum (*i.e.*, at the point where the small intestine can first be distinctly seen, usually on the left side of the body of the third lumbar vertebra), the dissector should remove the whole of the anterior layer of the mesentery from its root down to the edge of the bowel, where it is to be cut off. This must be continued along the whole length of the small intestine, and the mesentery will be found to pass obliquely downwards from left to right. After the vessels contained in the mesentery are cleaned, the under layer of the ascending and transverse meso-colon must be removed in the same way to expose the vessels going to the large intestine.]

except the 1st part of the duodenum.

Sup. (Inf. Pan. Duo.).

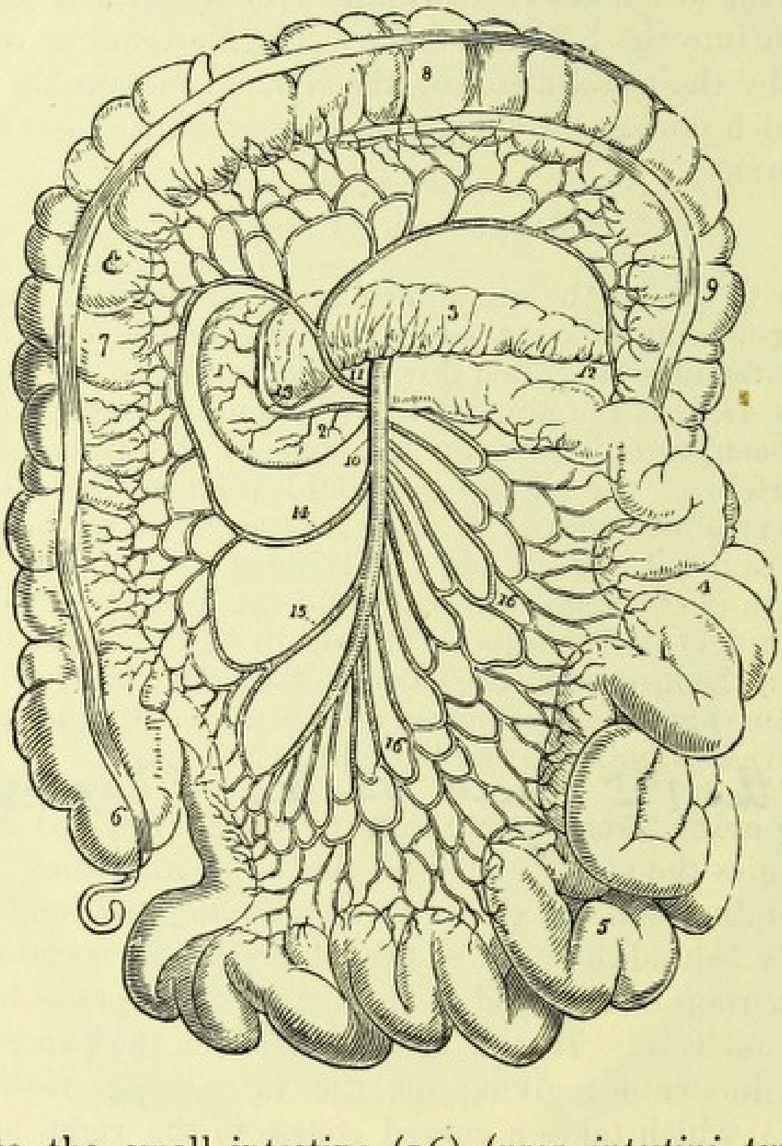
The **Superior Mesenteric Artery** (Fig. 138, 10) is the vessel which supplies the small* and half the large intestines. A branch of the abdominal aorta, it comes off opposite the first lumbar vertebra immediately behind the neck of the pancreas, and is embraced by an inferior extension of the head of the organ, which passes behind both the artery and vein. It runs forward between the pancreas and the transverse duodenum, giving off the *inferior pancreatico-duodenal* branch (13), which takes a curved course to the right between the head of the pancreas and the duodenum, to anastomose with the

---

20. Descending colon.
21. Superior mesenteric artery.
22. Left kidney.
23. Termination of duodenum.
24. Mesentery.
25. Descending duodenum.
26. Colica sinistra.
27. Right kidney.
28. Sigmoidea.
29. Colica dextra.
30. Superior hæmorrhoidal artery.
31. Right colic area.
32. Common iliac artery.
33. Vasa intestini tenuis.
34. Iliac fossa.
35. Left common iliac artery.
36. Internal iliac artery.
37. Pelvis.
38. External iliac artery.
39. External iliac artery.
40. Deep epigastric artery.
41. Meso-rectum.
43. Rectal area.
45. Bladder.

superior pancreatico-duodenal artery. The trunk of the superior mesenteric artery will then be seen to take a slightly curved direction from left to right, and from its convexity or left side are given the

Fig. 138.



branches to the small intestine (16) (*vasa intestini tenuis*), while from its concave right side arise three branches to the large

Fig. 138.—Course and distribution of the superior mesenteric artery (from Wilson).

1. Descending portion of the duodenum.
2. Transverse portion.
3. Pancreas.
4. Jejunum.
5. Ileum.
6. Cæcum and appendix vermiformis.
7. Ascending colon.
8. Transverse colon.
9. Descending colon.
10. Superior mesenteric artery.
11. Colica media.
12. Its anastomosis with the colica sinistra.
13. Pancreatico-duodenalis inferior.
14. Colica dextra.
15. Ileo-colica.
16, 16. Vasa intestini tenuis.

intestine, *ileo-colic* (15), *right colic* (14), and *middle colic* (11) arteries (named in their order from below upwards). The branches to the small intestine form a series of primary, secondary, and sometimes tertiary loops, which inosculate freely with one another, and give off

Fig. 139.

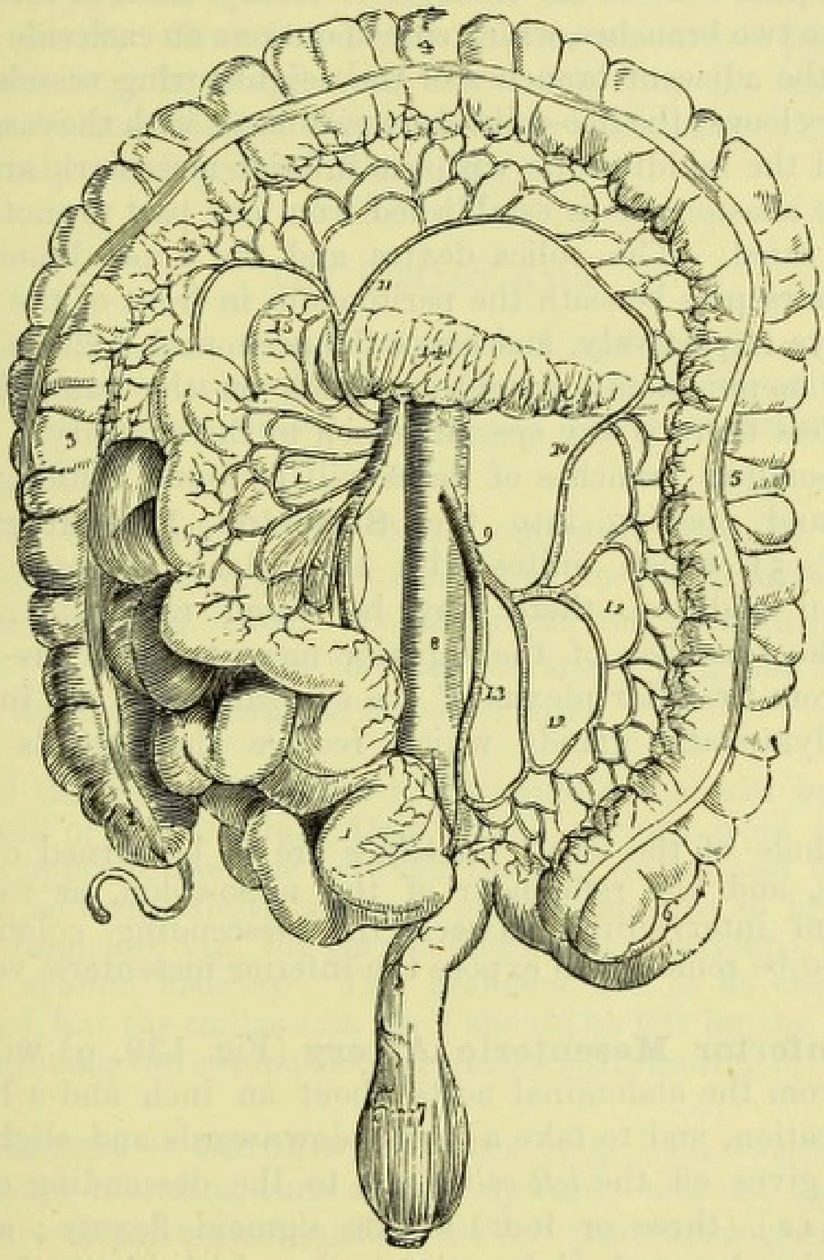


Fig. 139.—Branches of the inferior mesenteric artery (from Wilson).

1, 1. The superior mesenteric and small intestines turned over to the right side.
2. Cæcum and appendix cæci.
3. Ascending colon.
4. Transverse colon turned upwards.
5. Descending colon.
6. Sigmoid flexure.
7. Rectum.
8. Abdominal aorta.
9. Inferior mesenteric artery.
10. Colica sinistra inosculating with—
11. Colica media.
12, 12. Sigmoid branches.
13. Superior hæmorrhoidal artery.
14. Pancreas.
15. Descending portion of the duodenum.

straight branches (longer in the upper than in the lower part of the mesentery) to the intestine, each of which breaks up into two twigs, one for each half of the segment of gut supplied. The branches to the large intestine take the course indicated by their names ; thus the ileo-colic goes to the end of the ileum and commencement of the colon (cæcum), the right colic to the ascending, and the middle colic to the transverse colon. Each of these arteries divides into two branches, which spread out one on each side to inosculate with the adjacent branches of the neighbouring vessels, forming the primary loops; the ileo-colic also anastomose with the vasa intestini tenuis, and the middle colic with the inferior mesenteric artery ; and thus a free anastomosis is established from one part to another of the intestinal canal. The colica dextra and the upper branch of the colica sinistra pass beneath the peritoneum in front of the right and left kidneys respectively, and hence the peritoneal incision for intra-peritoneal nephrectomy should be made on the outer side of the colon, unless there is any special reason to the contrary.

Corresponding branches of veins will be found running with the arteries, and opening into the **Superior Mesenteric Vein** (Fig. 147, 5), which unites with the splenic to form the vena portæ. In addition, there may be found ramifying upon the arteries the branches of the superior mesenteric plexus of nerves derived from the solar plexus of the sympathetic ; and interspersed are the lymphatic glands which receive the lacteals from the intestines.

[The whole of the small intestines are to be turned over to the right side, and the remainder of the meso-colon, as well as the peritoneum intervening between the descending colon and the spine, is to be removed to expose the inferior mesenteric vessels.]

The **Inferior Mesenteric Artery** (Fig. 139, 9) will be seen to arise from the abdominal aorta about an inch and a half above the bifurcation, and to take a course downwards and slightly to the left. It gives off the *left colic* (10) to the descending colon ; the *sigmoid* (12) (three or four) to the sigmoid flexure ; and lastly, the *superior hæmorrhoidal artery* (13), which descends into the pelvis to supply the rectum. These arteries anastomose freely with one another, forming loops, and moreover, the left colic inosculates with the middle colic of the superior mesenteric, and the superior hæmorrhoidal with the middle hæmorrhoidal of the internal iliac artery. The superior hæmorrhoidal artery, at first single, bifurcates on reaching the rectum, and its branches run one on each side of the gut.

The **Inferior Mesenteric Vein** (Fig. 147, 4) will be seen to have tributaries corresponding to the branches of the artery. The lowest of these is the superior hæmorrhoidal, which anastomoses with the middle hæmorrhoidal (6), a tributary of the internal iliac vein, thus forming a communication between the two great venous systems. The inferior mesenteric vein passes upwards beneath the pancreas to join the splenic or superior mesenteric vein, and so into the vena portæ. Branches of the inferior mesenteric plexus of the sympathetic may be traced upon the vessels from the aortic plexus.

It may be noticed that the mesenteric veins have no valves and consequently never present dilatations.

The Cœliac Axis.

[The intestines are now to be replaced, and the liver fastened up to the ribs, either with hooks or, better, by a few stitches; the stomach being then drawn down, the lesser omentum is to be carefully removed.]

Between the layers of the lesser omentum near its free border will be found three important structures, in the following relation to one another (Fig. 143). To the right and most in front is the bile-duct (7), to the left is the hepatic artery (5), and behind and between the two the large vena portæ (9).

Behind the lesser omentum in the middle line will be found the short trunk of the **Cœliac Axis**, which springs from the front of the aorta opposite the disc between the last dorsal and first lumbar vertebræ, and runs above the neck of the pancreas to break up into its three branches, viz., the gastric (coronaria ventriculi), the hepatic, and the splenic arteries. The branches are to be cleaned as far as exposed, but the cœliac axis itself should be left for the present, for fear of injuring the sympathetic plexuses surrounding it.

The **Gastric** or **Coronary Artery** (Fig. 140, 12), the smallest of the three branches, runs at first upwards and to the left in a duplicature of peritoneum, called the left pancreatico-gastric fold; it then passes along the lesser curvature of the stomach from left to right between the layers of the lesser omentum, giving branches to both surfaces of that organ and to the œsophagus. It anastomoses at the pylorus with the pyloric branch of the hepatic artery, and by means of its first or œsophageal branch, with the œsophageal branches of the thoracic aorta. Branches of the sympathetic (gastric plexus) may be traced upon it. Its accompanying *vein* opens into the vena portæ.

The opportunity may be taken to notice the distribution of the pneumogastric nerve to the stomach. The left pneumogastric

Fig. 140.

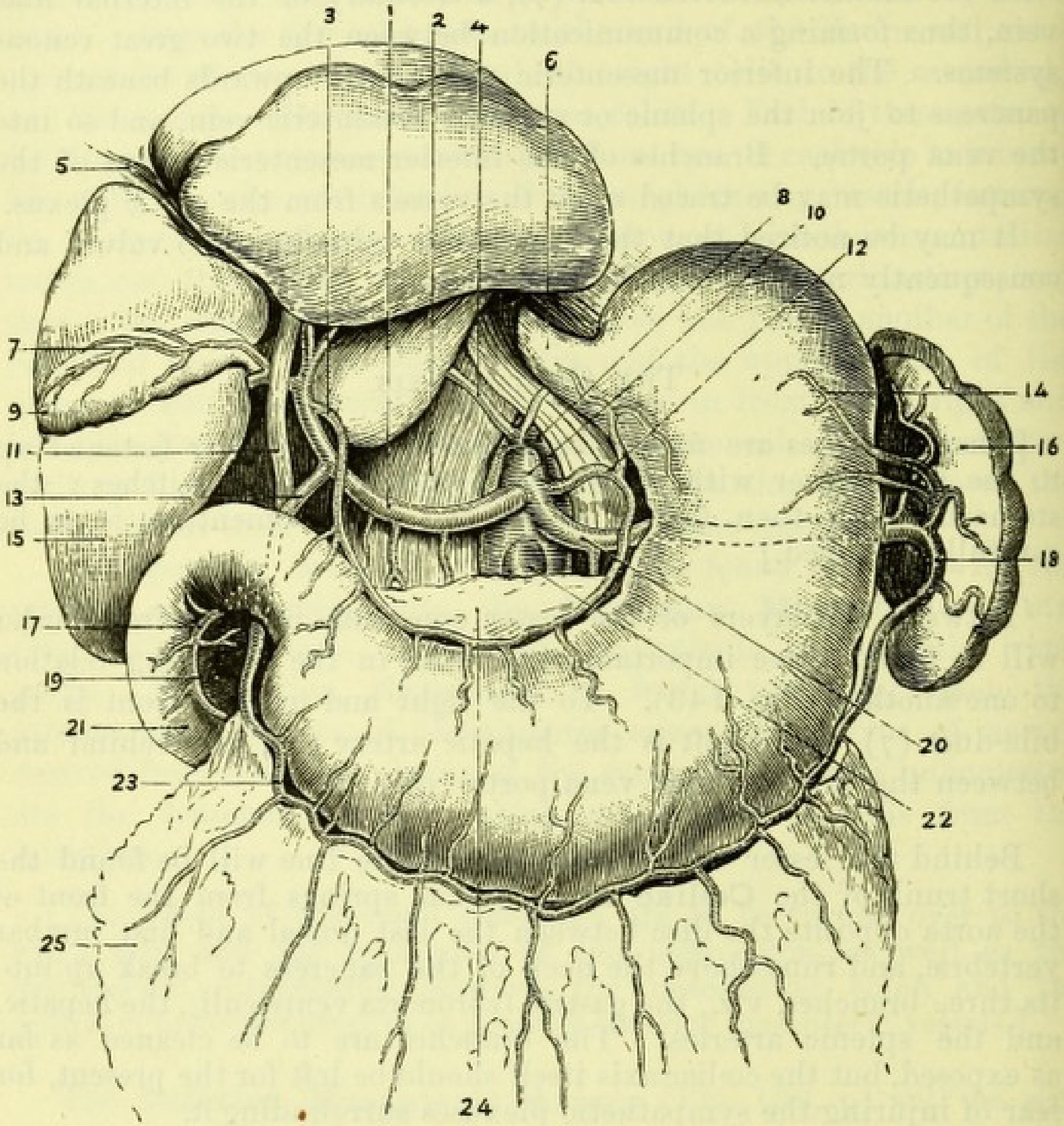


Fig. 140.—Branches of the cœliac axis (after Henle).

1. Hepatic artery.
2. Diaphragm.
3. Superior pyloric artery.
4. Right phrenic artery.
5. Round ligament of liver.
6. Œsophagus.
7. Cystic artery.
8. Abdominal aorta.
9. Gall-bladder.
10. Cœliac axis.
11. Ductus communis choledochus.
12. Gastric artery.
13. Gastro-duodenal artery.
14. Vasa brevia of splenic artery.
15. Liver.
16. Spleen.
17. Pancreatico - duodenalis (-superior).
18. Gastro-epiploica sinistra.
19. Head of pancreas.
20. Splenic artery.
21. Duodenum.
22. Superior mesenteric artery.
23. Gastro-epiploica dextra.
24. Pancreas (drawn down).
25. Great omentum.

gives numerous branches to the front of the stomach, and the right to the back of the viscus, and these can be generally seen through the peritoneal coat without further dissection.

The **Hepatic Artery** (Fig. 140, 1) curves upwards and to the right side, forming the inferior and anterior boundaries of the foramen of Winslow, and ends by dividing into the *right* and *left hepatic branches*, which enter the transverse fissure of the liver. The artery gives off first the *pyloric* branch (3), which has been seen to anastomose at the upper border of the pyloric end of the stomach with the gastric, and secondly a trunk which immediately disappears behind the first portion of the duodenum and is called the *gastro-duodenal* (13). From the right hepatic branch is given off the smaller *cystic* (7) artery, which is distributed to the gall-bladder by two branches, one passing between it and the liver and the other along its free surface.

The **Splenic Artery** (Fig. 140, 20) can be seen only in part, taking a tortuous course behind the stomach and along the upper border of the pancreas to the spleen.

[To continue the dissection it will be necessary to remove the intestines which have been examined, by putting a couple of ligatures upon the upper part of the jejunum, and also upon the upper part of the rectum, and dividing the intestine between the two ligatures at each point. By cutting the superior mesenteric artery the small intestine will be at once set free, but the large intestine must be carefully removed by dividing the meso-colon close to the intestine throughout, and lastly by cutting the inferior mesenteric artery. The gastro-duodenal and splenic arteries and their branches are then to be cleaned.]

The **Gastro-duodenal Artery** (Fig. 140, 13) can be traced out by turning up the stomach. After passing behind the first portion of the duodenum, it divides into the right gastro-epiploic and the superior pancreatico-duodenal arteries.

The *Gastro-epiploica dextra* (23) runs from right to left along the great curvature of the stomach between the folds of the great omentum, supplying branches to both surfaces of the stomach and to the omentum ; it anastomoses with the gastro-epiploica sinistra of the splenic artery.

The *Pancreatico-duodenalis superior* (17) will be found between the duodenum and the head of the pancreas, surrounding the latter, and supplying both ; it anastomoses with a small branch from the commencement of the superior mesenteric artery called the *pancreatico-duodenalis inferior* (Fig. 138, 13), and gives branches to both pancreas and duodenum.

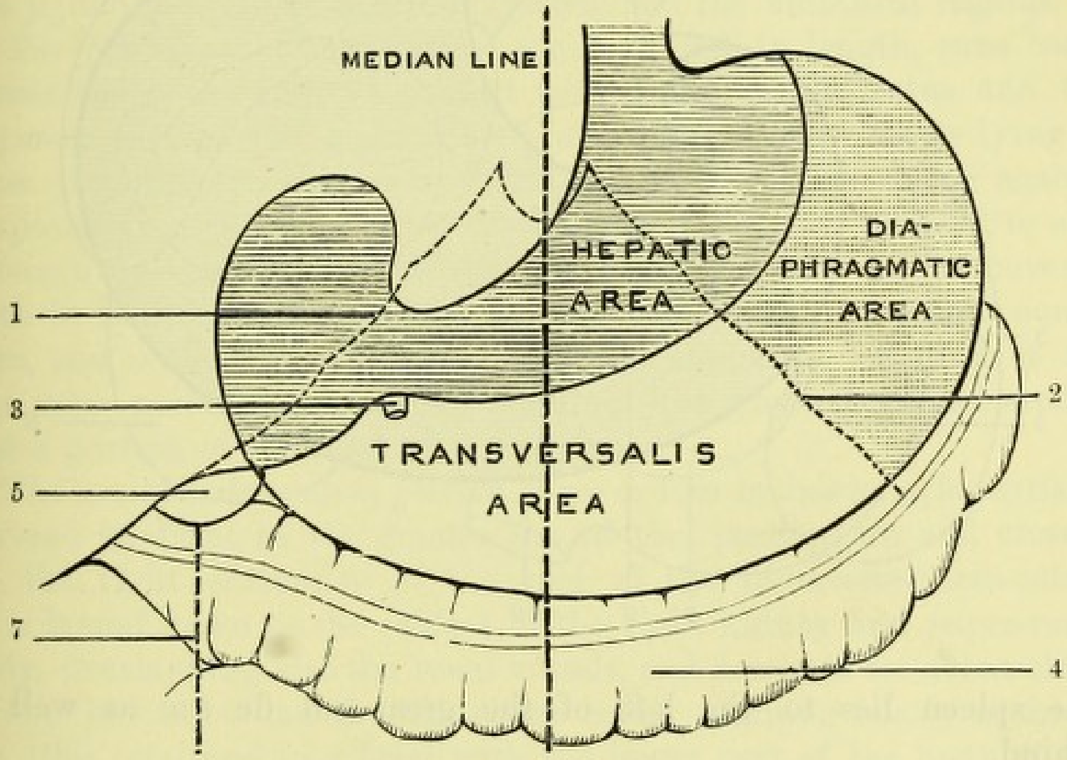
The **Splenic Artery** (Fig. 140, 20) can now be seen in the whole of its course to the spleen, and breaking up into four or five *terminal* branches, which enter the hilum on the concave surface of that organ. It runs behind the posterior layer of the lesser sac of peritoneum, across the left kidney and above the pancreas, and on approaching the spleen it enters the lieno-phrenic omentum with, but above, the tail of the pancreas. As it passes along the upper border of the pancreas it gives off small branches to it (*pancreaticæ parvæ*), and a larger one (*pancreatica magna*) which runs along the whole length of the gland from left to right, with the duct. It also gives branches (*vasa brevia*) (14) to the great end of the stomach, and one of larger size (*gastro-epiploica sinistra*) (18), which runs along the great curvature, between the layers of the greater omentum, to anastomose with the gastro-epiploica dextra of the hepatic, supplying branches to both surfaces of the stomach and to the omentum. Upon the hepatic and splenic arteries are corresponding plexuses of the sympathetic.

The **Splenic Vein** (Fig. 147, 2) is placed below its artery, and lies behind the upper border of the pancreas. It receives tributaries corresponding to the branches of the artery, and usually also the inferior mesenteric vein, but the latter may enter the superior mesenteric vein. It is joined by the superior mesenteric vein behind the upper border of the head of the pancreas, the two forming the vena portæ.

[The pancreas and duodenum should now be thoroughly defined, and the bile duct and the pancreatic duct traced to their entrance into the intestine. If desired, the stomach may be removed by tying and cutting it near the pylorus, and at the œsophagus.]

The **Stomach** is a somewhat pear-shaped viscus, with the greater extremity upwards and on the left, the smaller end at a lower level and on the right side of the median line. It receives at its larger or cardiac end the termination of the œsophagus, and ends at its smaller or pyloric extremity, in the duodenum. The expansion seen on the left side of the œsophageal opening is called the *great cul de sac*, and a small fusiform dilatation near the pylorus is called the *antrum pylori*. It is covered by the peritoneum of the greater sac in front, and by that of the lesser sac behind; and these layers unite above and below at two lines, the *lesser* and *greater curves*, running between the œsophageal and pyloric extremities. The lesser curve gives attachment to the lesser omentum, and is in contact with an anastomotic loop between the coronary and pyloric vessels ; the greater curve is connected with the greater omentum below and with the gastro-splenic omentum on the left, and is traversed by the right and left gastro-epiploic vessels (q. v.). The stomach in the dead subject, unless much distended, is flattened from before backwards, and presents two surfaces and two borders; but during life it is probable that the organ is usually cylindrical in section, and that the inferior border or greater curvature is turned forward towards the abdominal wall. At the antrum pylori

Fig. 141.



the stomach turns somewhat backwards to reach the neck of the gall bladder.

Relations.—The *anterior* surface, belonging to the greater sac of peritoneum, looks forwards and upwards, and is opposed to (1) the left lobe and part of the lobus quadratus of the liver, (2) the diaphragm, and (3) the anterior aponeurosis of the transversalis muscle. The *posterior* surface, belonging to the lesser sac, is related to (1) the spleen, (2) the pancreas, (3) the left kidney and supra-renal capsule, (4) the third stage of the duodenum near its termination, (5) the splenic and left renal vessels, (6) the commencement of the abdominal aorta, (7) the solar plexus and

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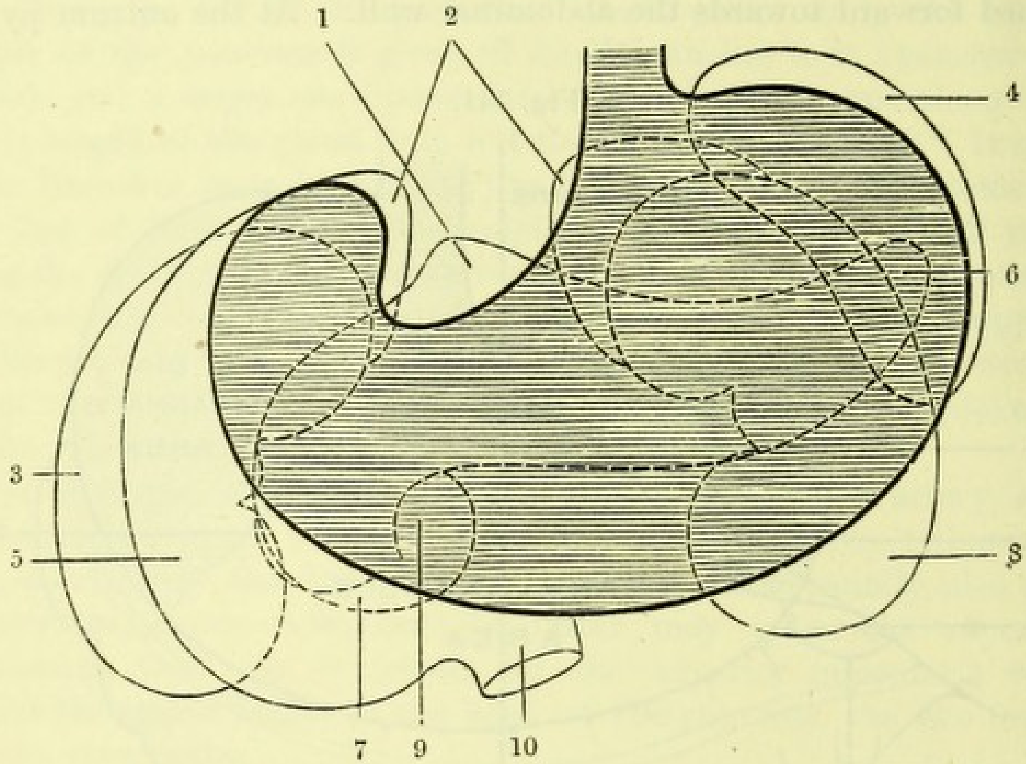
Fig. 141.—Diagram of the anterior relations of the stomach (W. A.).

1. Outline of right costal border.
2. Outline of left costal border.
3. Round ligament.
4. Colon.
5. Gall bladder.
7. Position of right semilunar line.

semilunar ganglia, and (8) the crura of the diaphragm. *Below* it is usually in close relation to the transverse colon, but occasionally the colon appears to carry up the great omentum and pass in front of the stomach. (See plates in Rüdinger and Symington.)

Fig 142.



The spleen lies to the left of the great cul de sac as well as behind.

The *cardiac orifice* lies about an inch to the left of the middle line on a level with the tenth dorsal vertebra, and behind the junction of the seventh costal cartilage with the sternum in front. The *pyloric orifice* is usually found behind the quadrate lobe of the liver, on a level with the first lumbar vertebra and about two inches to the right of the median line; but it extends more to the right when much distended, and is retracted towards the left when empty.

The **Small Intestine** extends from the pylorus to the junction

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Fig. 142.—Diagram of the posterior relations of the stomach (W.A.). Seen from the front, the stomach represented as transparent.

1. Tuber omentale of pancreas.
2. Supra-renal capsules.
3. Right kidney.
4. Spleen.
5. Second portion of duodenum.
6. Tail of pancreas.
7. Head of pancreas (lower process).
8. Left kidney.
9. Head of pancreas.
10. Termination of duodenum.

of the cæcum and colon. It is an unsacculated tube, averaging about 22 feet in length, with a range of variation from ft. 15·6 to ft. 31·10 (Treves), and diminishes in the width of its calibre and the thickness of its walls from its commencement to its termination. It is subdivided into three portions, the duodenum, the jejunum, and the ileum.

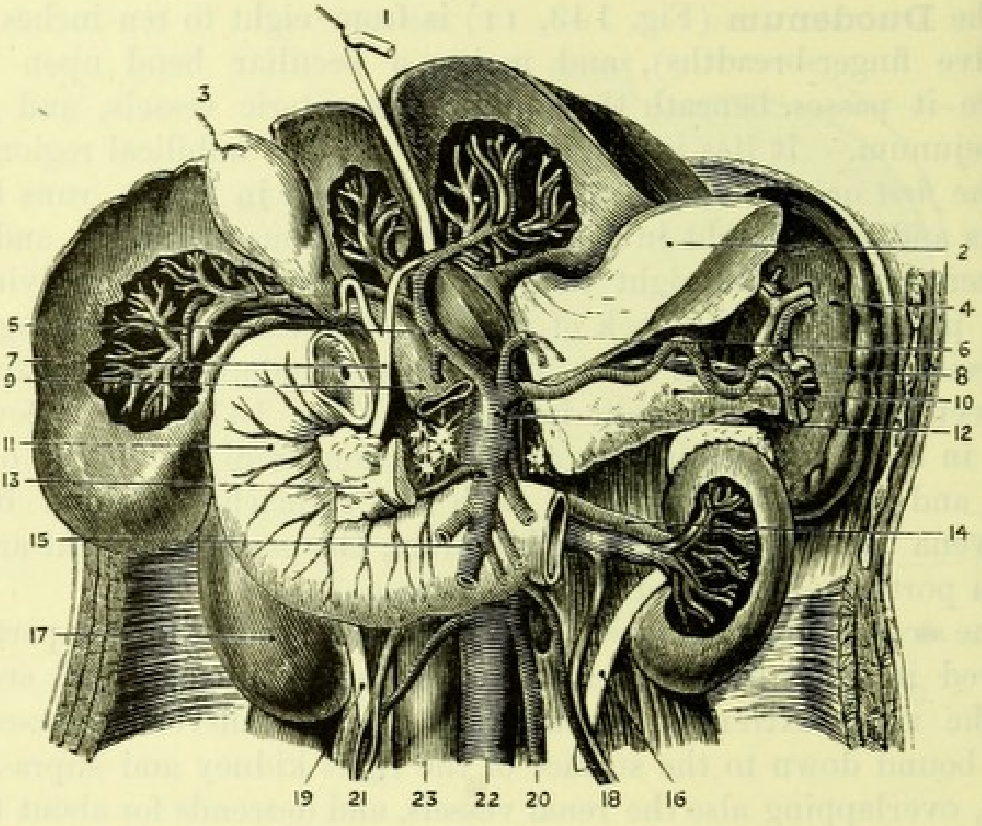
The **Duodenum** (Fig. 143, 11) is from eight to ten inches long (twelve finger-breadths), and makes a peculiar bend upon itself before it passes beneath the superior mesenteric vessels, and joins the jejunum. It lies in the epigastric and the umbilical regions.

The *first* or *ascending portion*, about an inch in length, runs backwards and to the right in contact with the lobus quadratus and the adjacent part of the right lobe proper of the liver, there lying in close proximity to the neck of the gall-bladder, and resting against a special impression in front of the lobus caudatus, internal to and between the renal and colic impressions (Fig. 157). It is covered both in front and behind by a prolongation from the lesser omentum, and is therefore movable with the stomach. Behind it are the vena portæ, the common bile duct, the gastro-duodenal artery, and a portion of the head of the pancreas.

The *second* or *descending portion*, three or four inches long, is partially covered in front by the greater sac of the peritoneum and crossed by the right extremity of the root of the transverse meso-colon. It is bound down to the surface of the right kidney and supra-renal body, overlapping also the renal vessels, and descends for about three or four inches behind the transverse colon, reaching nearly as far as the iliac crest and to a level with the lower part of the body of the third lumbar vertebra. It lies in contact with the outer side of the head of the pancreas, the pancreatico-duodenal vessels intervening, and the biliary and pancreatic ducts pierce it near the middle of its inner surface.

The *third* or *transverse portion*, four or five inches in length, is fixed to the abdominal wall below the line of attachment of the meso-colon, and is covered in front by the peritoneum of the greater sac, except where it is crossed anteriorly by the superior mesenteric vessels. It runs obliquely upwards and to the right across the front of the aorta, vena cava, and thoracic duct, from the level of the third to that of the second lumbar vertebra, at the left side of which the gut receives a complete covering of peritoneum and becomes the jejunum. Immediately above it are the head and the body of the pancreas, with the inferior pancreatico-duodenal and superior mesenteric vessels, the latter afterwards becoming anterior to it. It is surrounded by subperitoneal tissue, and suspended by a band of involuntary muscular fibre (fibro-muscular band of Treitz) to the left crus of the diaphragm. The entrance of the peritoneal *fossa duodeno-jejunalis* (p. 285) lies opposite the junction of the duodenum and jejunum. This is the most fixed portion of the

Fig. 143



small intestine ; and, owing to the weight of the remainder of the bowel, it is at the junction of the duodenum with the jejunum that laceration most commonly occurs in cases of abdominal injury.

The **Jejunum** and **Ileum** are completely covered with peritoneum, except at the interval between the two laminæ of the serous membrane (see p. 280 and Fig. 144), and are fixed to the spine by

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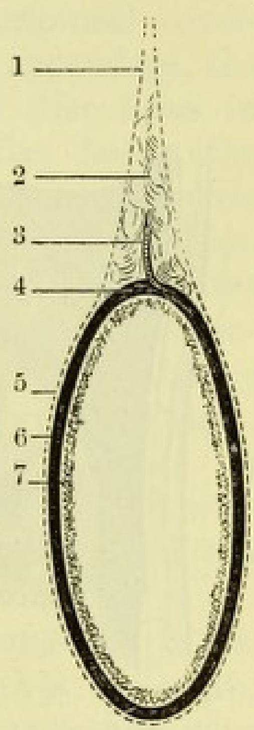
Fig. 143.—The duodenum and its relations (altered from Hirschfeld and Leveillé).

1. Round ligament of liver.
2. Great end of stomach (cut).
3. Gall-bladder.
4. Spleen.
5. Hepatic artery.
6. Coronary artery.
7. Common bile duct.
8. Splenic artery and vein.
9. Vena portæ.
10. Tail of pancreas.
11. Duodenum.
12. Cœliac axis. On each side of the aorta at this point are the semilunar ganglia.
13. Head of pancreas.
14. Left renal vessels.
15. Superior mesenteric artery.
16. Left ureter.
17. Right kidney.
18. Left spermatic vessels.
19. Right ureter.
20. Inferior mesenteric artery.
21. Right spermatic vessels.
22. Aorta.
23. Vena cava.

the mesentery, which extends from the left side of the second lumbar vertebra obliquely across the spine into the right iliac fossa where the ileum joins the cæcum. The commencement of the ileum is arbitrarily fixed at the junction of the second with the third fifth of the length of the conjoint tube.

A fœtal relic, representing the omphalo-mesenteric duct, and known as *Meckel's diverticulum*, is occasionally found as a narrow tube, from half-an-inch to five or six inches in length, opening into the ileum at a distance of eighteen inches to three feet from the ileo-cæcal valve. If long it may run upwards to the umbilicus.

Fig. 144.



The **Pancreas** (Fig. 145) lies transversely in the abdomen, occupying the epigastric and left hypochondriac regions, and is subdivided into a head, body and tail. The *head* is embraced by the duodenum, and sends a process downwards and inwards behind the superior mesenteric vessels; the *body*, which is concave posteriorly, crosses the aorta and left kidney opposite the 1st lumbar vertebra; and the *tail* runs in the gastro-splenic or lieno-splenic omentum, to come in contact with the lower and back part of the visceral surface of the spleen. The median sagittal plane cuts through the neck and the lower process of the head. It is related *in front* with the posterior layer of the lesser sac of peritoneum, and near its lower border with the attachment of the transverse meso-colon; and more anteriorly is covered by the stomach except over a small projection from its upper border, the *tuber omentale*, that rises above the lesser curve of the organ to reach the lesser omentum. *Posteriorly* are the crura of the diaphragm; the vena cava; the commencement of the portal vein and its formative tributaries, the superior mesenteric and splenic veins, with the inferior mesenteric usually joining the latter; the aorta and the origin of its superior mesenteric branch; the thoracic duct; the azygos veins; and the left kidney and renal vessels. The *upper border* is in contact with the cœliac axis and splenic artery, the *lower border* is in close relation with the trans-

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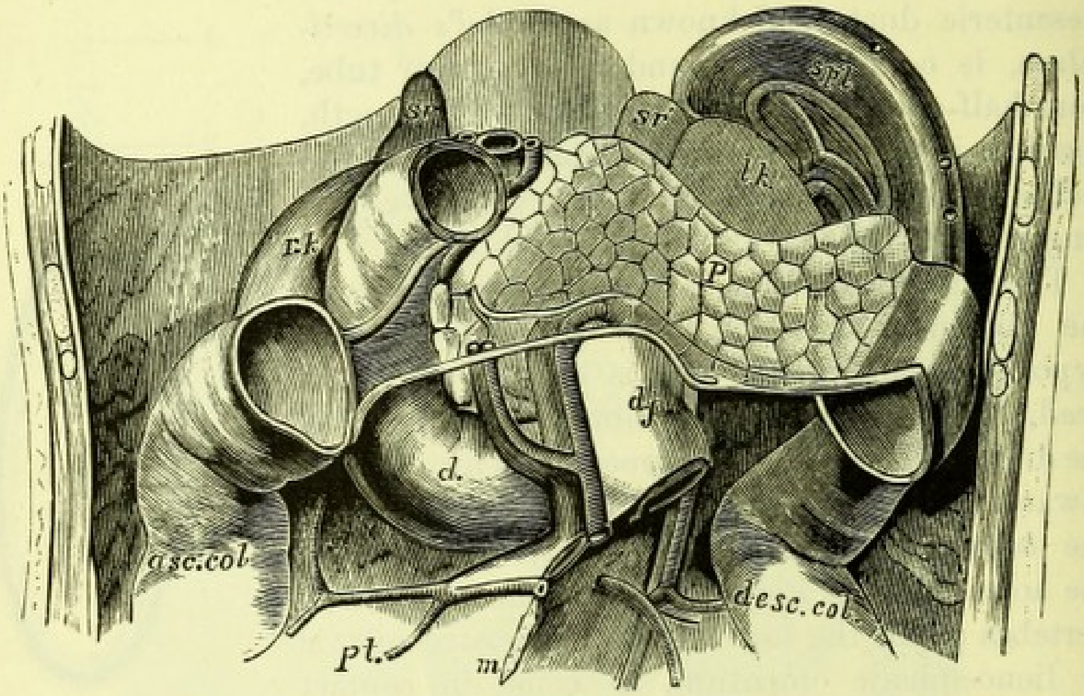
Fig. 144.—The relation of the peritoneum to the wall of the small intestine (W. A.).

1. Mesentery.
2. Fat on interserous triangle.
3. Artery.
4. Portion of muscularis uncovered by peritoneum.
5. Serosa.
6. Muscularis.
7. Mucosa.

verse duodenum, except where it is separated from it by the superior mesenteric vessels.

The duct (canal of Wirsung) begins usually by two branches in the tail and runs from left to right, gathering small tributaries from

Fig. 145.



the body, and receives two larger branches, one from the lower extension of the head, the other from a portion of the upper part of the head, which may be more or less completely separated from the rest by dissection, and is sometimes called the *lesser pancreas*. The main duct then pierces the middle of the second stage of the duodenum and opens into the gut by an aperture common to it and the ductus communis choledochus upon the summit of a small papilla. The duct of the lesser pancreas occasionally opens separately into the duodenum.

The **Large Intestine** is a wide sacculated tube adapted for the retention and final digestion of fæcal matter, and averages about six

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Fig. 145.—The pancreas exposed after removal of the stomach and transverse colon. (From the model of His.)

Over the divided upper end of the duodenum are seen the portal vein, hepatic artery and bile duct. The root of the transverse meso-colon extends across the pancreas between the cut extremities of the colon.

sr. Right supra-renal capsule.
sr'. Left supra-renal capsule.
rk. Right kidney.
spl. Spleen.
asc. col. Ascending colon.
lk. Left kidney.
pt. Colica dextra.
p. Pancreas.
m. Mesentery (cut).
dj. Termination of duodenum.
d. Duodenum.
desc. col. Descending colon.

feet in length. It commences in the right iliac fossa and terminates at the anus, and is subdivided into three segments :—The Cæcum or Caput cæcum coli, the Colon, and the Rectum.

The *Cæcum* is a short but capacious cul de sac, averaging about $2\frac{1}{2}$ inches in length, and lying below the point at which the ileum opens into the large intestine. It has a complete peritoneal covering, and presents at its lower and back part a little appendage, the *appendix vermiformis.* It usually lies in the right iliac fossa in contact *behind* with the psoas and iliacus and iliac fascia, the external cutaneous nerve, and the vermiform appendage ; *anteriorly* it reaches the abdominal wall, and might be exposed by an incision on a level with the anterior superior iliac spine, but it varies greatly in position in different subjects and under different conditions, sometimes extending downwards and inwards along Poupart's ligament, towards or even beyond the median line, at others terminating two or three inches below the iliac crest. It may be overlapped partially or completely by coils of ileum if undistended. On its inner side are the small intestines and the junction with the ileum.

The *Appendix Vermiformis* is a blind tubular prolongation of the diameter of a goose-quill, averaging about four inches in length, but ranging from one to six inches ; and most commonly runs upwards and inwards, but may assume any direction. It is surrounded by peritoneum and provided with a small mesentery. It is not infrequently the seat of ulceration owing to the impaction of intestinal concretions or other foreign bodies.

The *Colon* is subdivided into four parts, ascending, transverse, descending, and sigmoid flexure. Its entire length ranges from $3\frac{1}{4}$ to $6\frac{1}{2}$ feet, and averages about $4\frac{1}{2}$ feet (Treves).

The cæcum and colon are distinguished from the rest of the intestines by the peculiar sacculation caused by the shortness of the longitudinal fibres of the muscular coat and their arrangement in three bands or *tæniæ*, and the colon presents in addition little fatty appendages called *appendices epiploicæ*, attached opposite one of the tæniæ.

The *ascending colon* is usually covered with peritoneum only in front and at the sides. It begins in the right iliac fossa above the level of the anterior superior iliac spine, and runs upwards, crossing the iliac crest a little to the inner side of its mid point, to reach the internal lamella of the posterior tendon of the transversalis (over the quadratus lumborum). Continuing its course, it passes in front of the right kidney external to the second part of the duodenum, reaches the inner surface of the right lobe of the liver, forming the *hepatic flexure*, and is succeeded by the transverse colon.

The *transverse colon* is invested by peritoneum derived from both sacs, and runs in a curved direction inwards, forwards, and slightly downwards to the anterior abdominal wall (but is separated from it by the anterior double layer of the great omentum) opposite the umbilicus, thence outwards, backwards and upwards to the lower end of the spleen, where it bends to form the *splenic flexure.*

The *descending colon* begins below the splenic flexure, and like the ascending colon is usually bound down to the posterior abdominal wall without the intervention of a mesentery ; it passes downwards over the front of the left kidney, the transversalis tendon, and the crest of the ilium, about an inch to the inner side of its mid point, to enter the iliac fossa. The gut then developes a mesentery and becomes known as the sigmoid flexure.

The *sigmoid flexure* resembles the rest of the colon in its general characters, but is invested by peritoneum along its whole length, and is fixed to the abdominal wall by a meso-colon. It first runs downwards and forwards, reaching the anterior abdominal wall on the inner side of the anterior superior spine of the ilium (where it may be exposed in inguinal colotomy) thence passes backwards into the true pelvis, turning upon itself in an S-like form, at length loses its mesentery opposite the third sacral vertebra, and becomes continuous with the rectum at a point arbitrarily but somewhat indefinitely fixed at the left sacro-iliac joint.

Surgery.—It will be seen that the cæcum and sigmoid flexure are accessible to operation intra-peritoneally through the anterior abdominal wall, each at a point internal to and a little above the anterior superior iliac spine (Fig. 54), while the ascending and descending portions of the colon may be reached retro-peritoneally by a transverse or oblique incision in the space between the thorax and pelvis, with its centre opposite to a point an inch behind the middle of the iliac crest (Fig. 146). In an uncertain proportion of cases, however, a true mesentery may be present for these portions of the large intestine, but it is probable that this is far less common than examination of the empty or partially empty gut in the dead subject would lead us to imagine. A mesentery that does not disappear when the intestine is fully distended is perhaps not present in more than one case in twelve.

The *Rectum* is 8 or 9 inches in length and extends from the left sacro-iliac joint to the anus. It is divided into three portions, the first, 4 or 5 inches in length, reaching as far as the third piece of the sacrum ; the second, 3 inches long, passing to the tip of the coccyx ; and the third, about an inch in length, ending at the anal aperture. The *first portion* is continuous with the sigmoid flexure

Fig. 146.

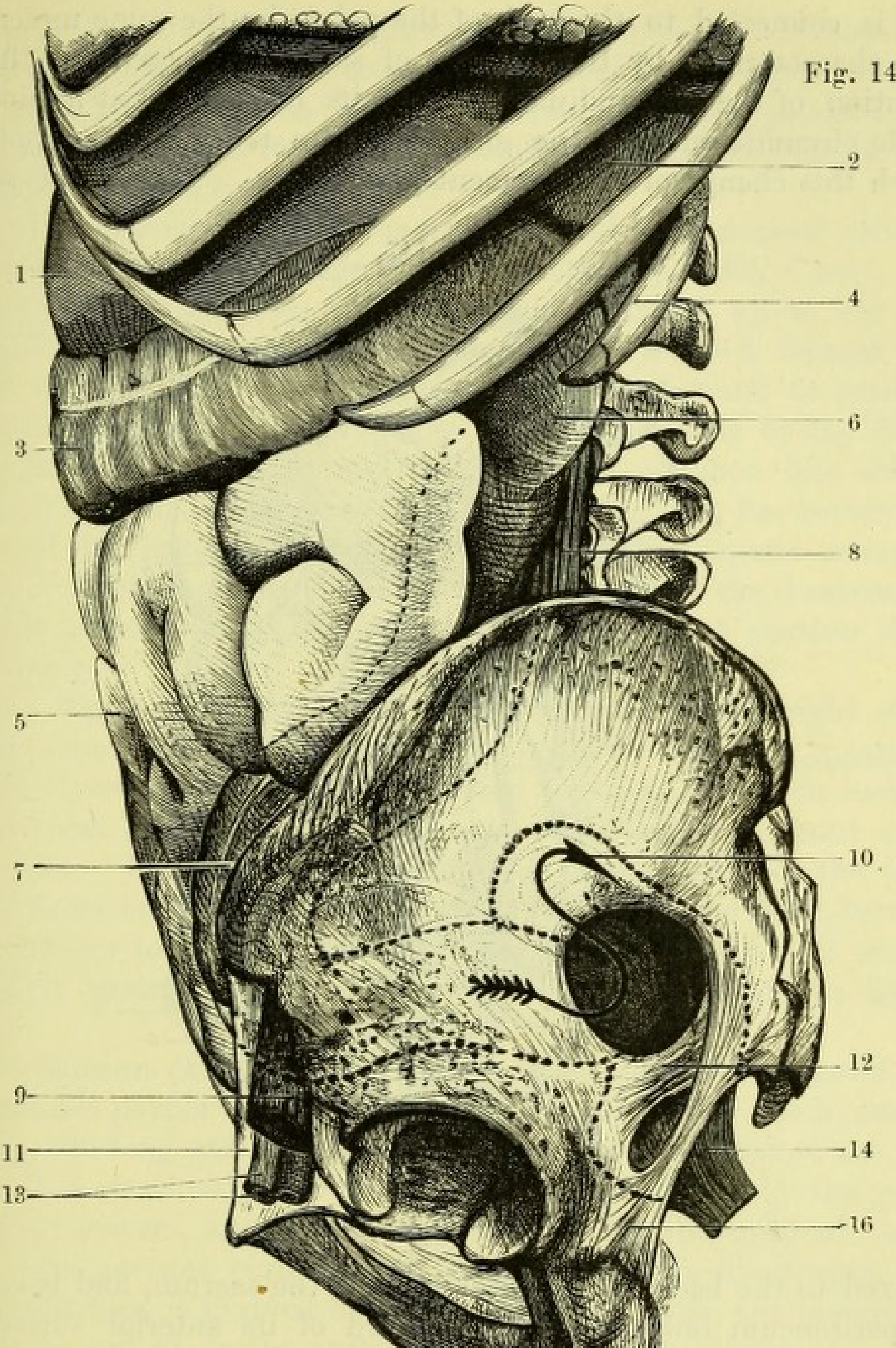
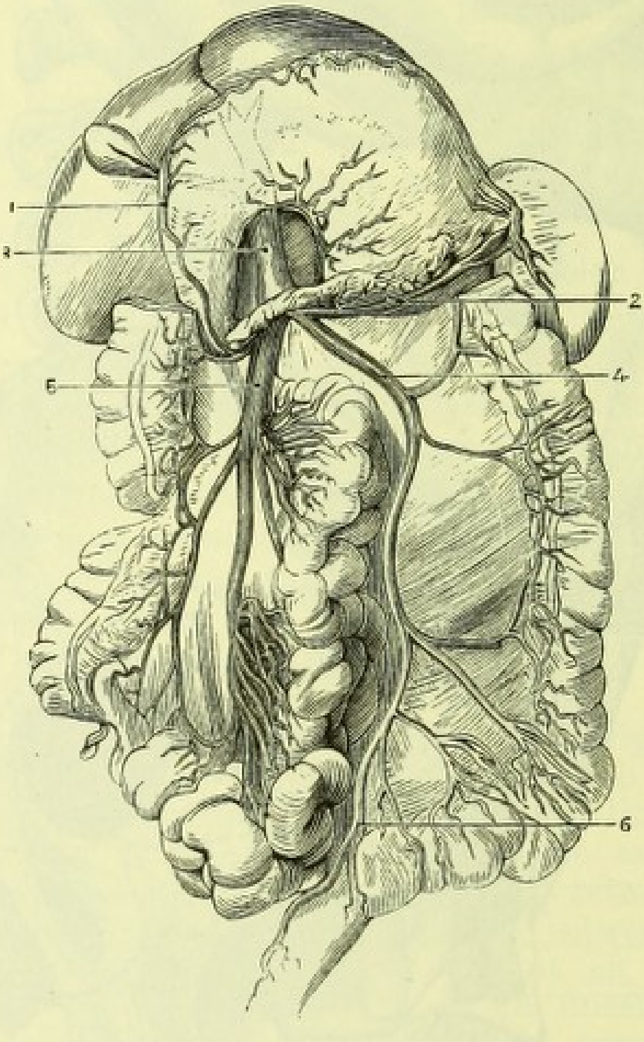


Fig. 146.—The abdominal viscera seen from the left side (adapted from the model of His).

1. Stomach.
2. Spleen.
3. Transverse colon.
4. Twelfth rib.
5. Small intestine.
6. Descending colon.
7. Sigmoid flexure (seat of operation).
8. Quadratus lumborum.
9. Iliacus.
10. Pelvic portion of sigmoid flexure in continuation with first portion of rectum.
11. Poupart's ligament.
12. Lesser sacro-sciatic ligament.
13. Femoral vessels.
14. Rectum.
16. Great sacro-sciatic ligament.

and is connected to the back of the pelvis by the same mesentery. It is characterised by the absence of sacculation, owing to the distribution of the longitudinal fibres of its muscular coat around the whole circumference of the gut, but there is no definite point at which this change of arrangement takes place. The *second portion*

Fig. 147.



is fixed to the back of the lower half of the sacrum, and is covered by peritoneum only in the upper third of its anterior surface, the lower two-thirds of this surface being intimately connected with the back of the bladder, the vasa deferentia, and the prostate,* and invested by a sheath of recto-vesical fascia. The *third portion* passes

Fig. 147.—The portal vein and its tributaries (from Henle).

1. Gastro-duodenal vein.
2. Splenic vein.
3. Portal vein.
4. Inferior mesenteric vein.
5. Superior mesenteric vein.
6. Superior hæmorrhoidal vein.

* The prostate is sometimes regarded as a relation of the third portion, which would in this case have a length of over two inches along its posterior wall.

downwards and somewhat backwards between the two levatores ani, which are intimately connected with it, and has no peritoneal relation. It is surrounded by the external sphincter just above the anus, and above this its circular muscular fibres, here greatly thickened, form the *internal sphincter.*

The *mucous membrane* of the intestine and the *ileo-cœcal valve* will be examined at a later stage of the dissection (p. 330, *et seq.*).

The **Bile Duct** (Fig. 143, 7) should be traced up to the liver, where it will be found to commence in right and left *hepatic ducts*, which emerge from the transverse fissure and unite to form the *common hepatic duct;* this is joined at an acute angle by the duct of the gall-bladder (*cystic*), and becomes the common bile duct or *ductus communis choledochus.* The bile duct at first lies between the layers of the lesser omentum to the right of the hepatic artery and portal vein, then passes behind the first portion of the duodenum to join the pancreatic duct, and open into the second portion of the duodenum.

The **Vena Portæ** (Fig. 147, 3) is formed to the right of the median line by the junction of the splenic and superior mesenteric veins, behind the upper border of the pancreas, about an inch and a half from its right extremity, and immediately in front of the vena cava. It is four inches long, and ascends between the layers of the lesser omentum to the transverse fissure of the liver, between, but posterior to, the bile duct and the hepatic artery. It receives the small gastric and cystic veins, and like its tributaries has no valves.

The **Spleen** (Fig. 143, 4) is a somewhat flattened organ of oval outline and purple colour, occupying the back of the left hypochondrium. Its long axis is oblique and corresponds to that of the 10th rib. It is attached to the greater end of the stomach by the gastro-splenic omentum, and to the diaphragm by the lieno-phrenic omentum. Its *parietal* surface is in contact with the diaphragm. Its *visceral* surface is divided by a ridge into two parts, the posterior of which is applied to the outer border of the left kidney and supra-renal capsule; while the anterior and larger lies in contact with the stomach, the tail of the pancreas, and the splenic flexure of the colon, and presents a *hilum* pierced by the splenic vessels. Its *anterior border* is usually notched, the *posterior* entire, but this is not invariable. Its *upper extremity* approaches the spinal column and touches the left supra-renal capsule, its *lower extremity* reaches the posterior axillary line and is supported by the costo-colic fold of peritoneum. Its weight averages six ounces, but varies greatly.

It is completely invested by the greater sac of peritoneum, except at the hilum, where the serous membrane is reflected upon the splenic vessels, and where a small portion of the lesser sac may separate the two layers of the greater sac and come into contact with the inner surface of the organ (Fig. 135).

Deep Dissection of the Abdomen.

[The stomach, duodenum, pancreas, and spleen should now be taken away by dividing the œsophagus, bile duct, and vessels, and the liver should then be carefully removed in order to see the arrangement of the coronary ligament. The round and falciform ligaments should first be cut and the liver pulled down ; by carrying the knife along the attachment to the diaphragm, the upper layer of the coronary ligament will then be divided, as well as the right and left lateral ligaments, which are formed from it. The vena cava and a part of the liver uncovered by peritoneum will now be exposed, the latter being attached to the diaphragm by areolar tissue ; and when this is carefully divided, the right suprarenal capsule and the top of the right kidney will be brought into view. The vena cava must be cut through at the upper and again at the lower margin of the posterior surface of the liver, when it will only be necessary to divide the under layer of the coronary ligament (derived chiefly from the lesser sac of the peritoneum) to remove the organ.

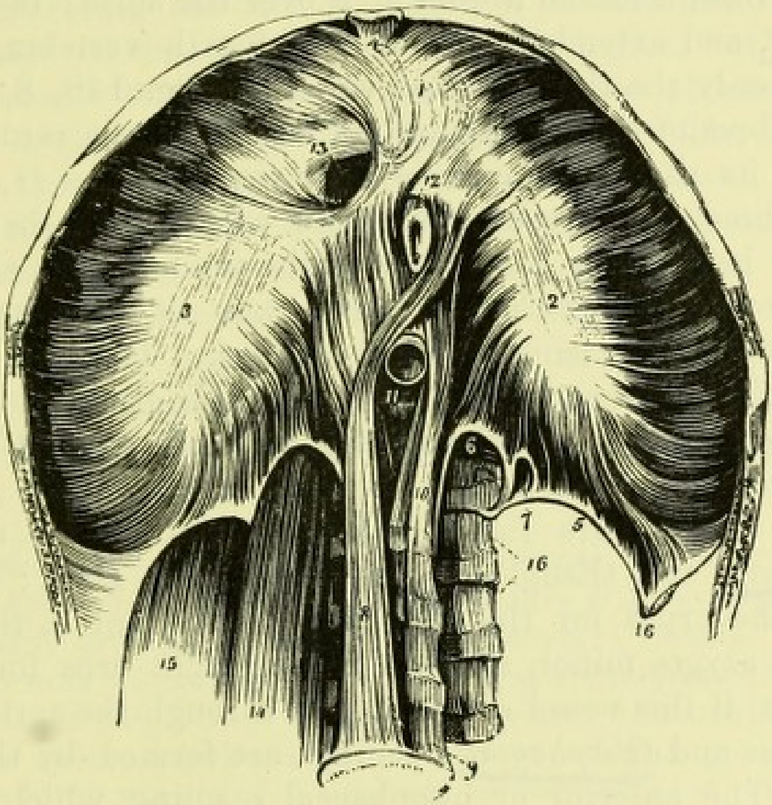
The viscera should all be placed in a covered pan, for examination during the time that the subject is turned.

The diaphragm is to be cleaned by stripping off the peritoneum, as far as possible in the direction of the muscular fibres ; and at the same time the inner surface of the flap of abdominal muscles still attached should be cleaned, in order to follow out the fibres of the transversalis. Care must be taken to avoid puncturing the diaphragm, and to preserve the branches of artery and nerve ramifying on its surface. The crura or muscular slips on each side of the aorta must be cleaned, and two tendinous arches over the psoas and quadratus lumborum muscles defined, for which purpose it will be well to detach one kidney and turn it over to the opposite side temporarily.]

The **Diaphragm** (Fig. 148) is an arched muscle, concave towards the abdomen ; this concavity is exaggerated after death, owing to the fact that *expiration* is the last act of life. It rises to the level of the fifth costal cartilage at its junction with the sternum on the right side, and to that of the sixth on the left. It *arises* from the back of the ensiform cartilage ; from the inner surfaces of the cartilages of the six lower ribs, where it interdigitates with the transversalis abdominis; from the internal and external arcuate ligaments, which cross the psoas and quadratus lumborum muscles respectively; and by its crura from the lumbar vertebræ and intervertebral discs.

The *ligamentum arcuatum externum* is a fibrous arch extending from the transverse process of the first (occasionally the second) lumbar vertebra to the tip of the last rib. It crosses the upper part

Fig. 148.



of the quadratus lumborum; giving attachment above to the muscular fibres of the diaphragm, and below to the anterior lamella of the posterior tendon of the transversalis and to the fascia transversalis (Fig. 148, 5).

Fig. 148.—Under or abdominal surface of the diaphragm (from Wilson).

1. The central leaflet of the tendinous centre.
2. The left or smallest leaflet.
3. The right leaflet.
4. Fasciculus from the ensiform cartilage.
5. Ligamentum arcuatum externum of the left side.
6. Ligamentum arcuatum internum.
7. A small arched opening for the least splanchnic nerve (occasional).
8. Right crus.
9. Fourth lumbar vertebra.
10. Left crus.
11. Aortic opening.
12. Œsophageal opening.
13. Opening for the inferior vena cava.
14. Psoas magnus passing beneath the ligamentum arcuatum internum.
15. Quadratus lumborum passing beneath the ligamentum arcuatum externum.
16. Tip of last rib.

The *ligamentum arcuatum internum* is a similar arch running from the outer border of the crus over the psoas, to become attached to the tip of the first or occasionally the second lumbar transverse process. It gives attachment to muscular fibres above and to the fascia iliaca below (Fig. 148, 6).

The *crura* or pillars of the diaphragm *arise* from the front of the bodies and intervertebral discs of the four upper lumbar vertebræ, and usually from a mesial fibrous arch over the aorta; the right crus is the larger, and extends as low as the fourth vertebra, while the left reaches only the third lumbar vertebra (Fig. 148, 8, 10).

All the fibres of the diaphragm are *inserted* into a central tendon, called from its shape the *cordiform* or *trefoil tendon* (1, 2, 3), but the inner fibres of the crura decussate with one another and form a figure-of-8 before they can pass into the tendon, thus almost completely surrounding first the aorta and then the œsophagus. The right leaflet of the tendon is the largest. The pericardium is attached to the upper surface of the diaphragm, partly to the tendon and partly to the muscular fibres connected with the left leaflet, and aids in the upward fixation of the summit of the dome.

D. 12. (at 1st Lumbar Vert.) *Openings.*—There are three large openings in the diaphragm, for the Aorta, the Œsophagus, and the Vena Cava; and small orifices in the crura for the splanchnic nerves, one in the left crus for the vena azygos minor, and one in the right crus for the vena azygos major, if this vessel does not pass through the aortic opening.

D. 10. The *Aortic* and *Œsophageal* openings are formed by the fibres of the crura. The anterior or œsophageal opening, which is slightly to the left side, is entirely muscular; but that for the aorta will be found upon dissection to be bounded by the internal tendinous fibres of the two crura, and usually by a fibrous arch between these. The aortic opening is strictly speaking *behind* the diaphragm, as it is completed posteriorly by the vertebral column.

D. 8 or 9. The opening for the *Vena Cava* is entirely tendinous. It is more or less quadrilateral (*foramen quadratum*), and is situated in the right division of the cordiform tendon.

Through the *aortic* orifice pass the aorta, the vena azygos major, and the thoracic duct: through the *œsophageal* opening, the œsophagus with the two pneumogastric nerves; through the *caval* opening, the vena cava inferior (which is firmly attached to the margins of the aperture), and also a branch of the phrenic nerve. The greater and lesser splanchnic nerves pierce the crus on each side, and the lower hemi-azygos vein passes through the left crus. The gangliated cord of the sympathetic is continued into the abdomen from the thorax beneath the ligamentum arcuatum internum. The *costo-xiphoid space* on each side, between the sternal and costal origins of the muscle, transmits the superior epigastric vessels and some cellular tissue. It is sometimes the seat of a hernia.

Action.—The diaphragm is essentially a muscle of inspiration. It acts partly by the straightening of its curved fibres, so augmenting the space between it and the lower part of the chest wall; and partly by elevating the ribs to which it is attached. Its tendon probably does not descend to any material degree, but it opposes a passive resistance to the upward pressure of the abdominal viscera during the contraction of the abdominal muscles. The diaphragm is *supplied* by the phrenic nerves from the cervical plexus, which, after traversing the thorax, pierce the fibres of the muscle and are distributed principally on its under surface. Its arteries, the *phrenic*, from the abdominal aorta, on the under surface, and the *musculo-phrenic* and *comes nervi phrenici* from the internal mammary, anastomose with some of the intercostal arteries. The branches of the internal mammary will be seen when the upper surface of the diaphragm is dissected with the Thorax.

[The vessels and muscles of the abdominal cavity are now to be cleaned. Around the aorta and its branches will be found the sympathetic nerve giving off plexuses to the several vessels. The greater part of this may be removed, but the great splanchnic nerves should be traced from the points where they pierce the crura of the diaphragm to their terminations in the semilunar ganglia. These ganglia are large masses of a pinkish colour, situated on each side of the aorta close to the diaphragm; the right lies beneath the vena cava, and it will therefore be necessary to turn down this vessel for a short distance in order to expose it; they closely resemble lymphatic glands in appearance, and are connected by numerous nerves surrounding the cœliac axis and constituting the solar plexus. The gangliated cord of the sympathetic on each side of the vertebræ is to be preserved. The vena cava inferior (a piece of which it will be remembered has been removed with the liver) is to be cleaned, and care must be taken not to cut off the right spermatic vein on its anterior surface. The vein may be secured in its proper position with a pin if necessary. The kidneys and supra-renal capsules are to be dissected and the vessels going to each defined; and the spermatic vessels should be traced out.]

Sympathetic Nerve.—On each side of the aorta and close to the crura of the diaphragm will be seen a pinkish body of a somewhat crescentic form, called the semilunar ganglion (Fig. 143, 12), and into it may be traced the great splanchnic nerve from the thoracic ganglia.

The *Solar plexus* is formed by fibres crossing from one semilunar ganglion to the other, around the cœliac axis and superior mesenteric artery and between the supra-renal capsules, and receives a branch from the right pneumogastric. Its continuation, the *aortic plexus*, will have been more or less seen in cleaning the aorta, and so also the secondary plexuses derived from it and distributed upon the several branches, viz., the phrenic, gastric, hepatic, splenic, superior mesenteric, supra-renal, renal, spermatic, and inferior mesenteric plexuses. In addition to the great splanchnic nerve, the lesser splanchnic nerve may, in a favourable subject, be traced into the solar plexus, and the third or renal splanchnic nerve into the renal plexus.

The **Abdominal Aorta** (Fig. 149) is the direct continuation of the thoracic aorta, and reaches from the lower border of the last dorsal to the fourth lumbar vertebra, where it divides into the two common iliacs. It is ensheathed by sub-peritoneal connective tissue, in which are lymphatic glands and more or less fat; and is closely invested by the solar and aortic sympathetic plexuses. It is covered *in front* by the liver, stomach, transverse colon, intestines, and peritoneum, and, in more immediate contact by (1) the pancreas, with the splenic vein near its upper border, (2) the left renal vein, (3) the transverse duodenum, and (4) the branches which spring from its anterior aspect. *Behind* are the bodies of the lumbar vertebræ and their ligaments, and the left lumbar veins. To its *right* is the right crus of the diaphragm, and the vena cava lies in close contact below, but is separated from it above by an angular interspace: and deeply placed between the upper part of the aorta and the right crus are the receptaculum chyli and thoracic duct, and the vena azygos major: the great splanchnic nerve may either run through the aortic opening or pierce the right crus. To the *left* are the left gangliated cord of the sympathetic, the left crus of the diaphragm, the splanchnic nerves, and, perhaps, the commencement of the vena azygos minor. Its point of bifurcation, though often in the middle line, and occasionally a little to the right side, is usually a little below and to the left of the umbilicus, above which point it may be readily compressed.

Surgery.—The abdominal aorta has been tied immediately above the bifurcation for iliac aneurism, but without success. It may be reached either by a median incision prolonged above and below the umbilicus, as in the original operation of Sir Astley Cooper, the peritoneum being necessarily opened in front, and again at the point of ligature; or by an incision at the side, similar to that for ligature of the common iliac artery but larger, followed by partial

Fig. 149.

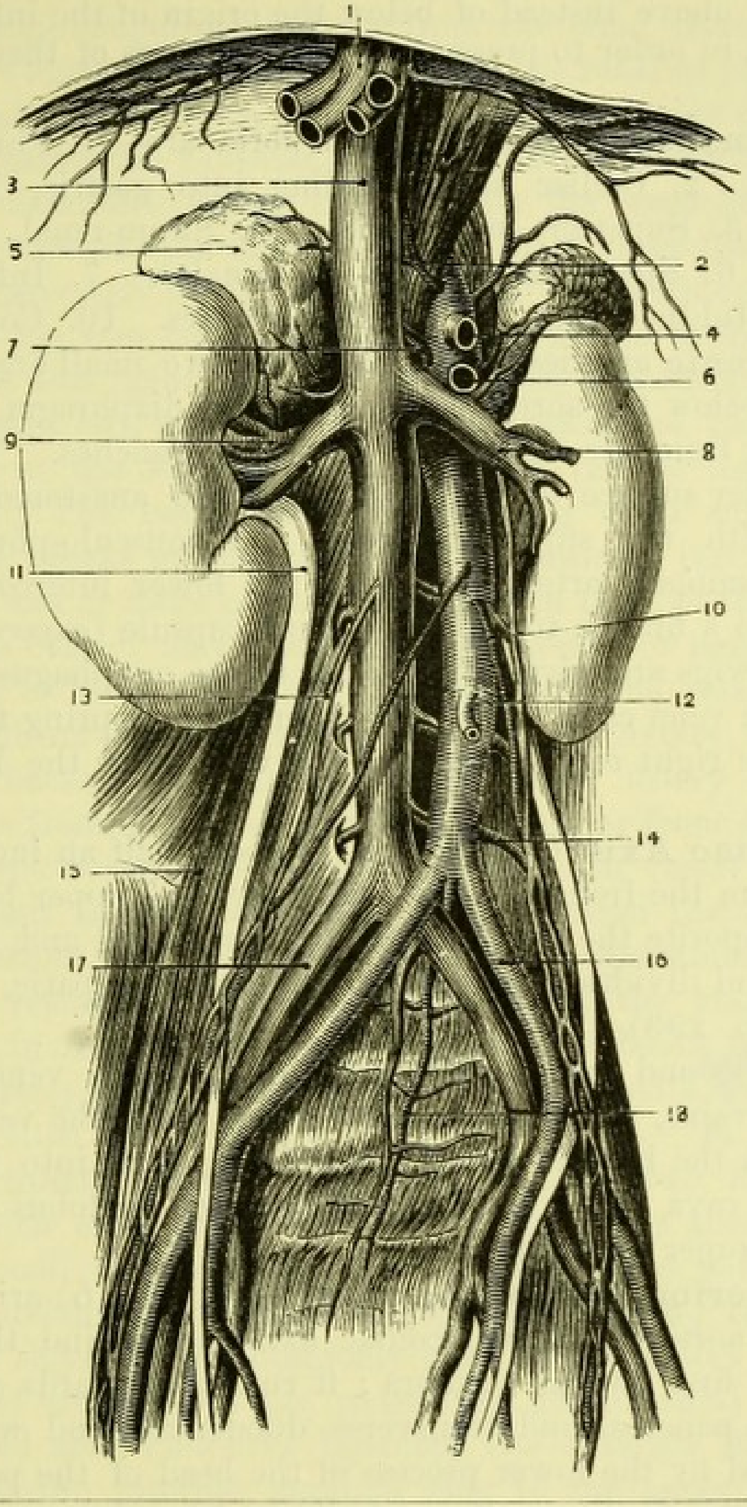


Fig. 149.—Abdominal aorta and vena cava (from Henle).

1. Hepatic vein (cut).
2. Phrenic arteries.
3. Vena cava.
4. Cœliac axis (cut).
5. Supra-renal capsule.
6. Superior mesenteric artery (cut).
7. Supra-renal artery.
8. Renal vein.
9. Renal artery.
10. Left spermatic vessels.
11. Right ureter.
12. Inferior mesenteric artery.
13. Right spermatic vein.
14. A lumbar artery.
15. Psoas magnus.
16. Common iliac artery.
17. Common iliac vein.
18. Middle sacral artery.

detachment of the unopened peritoneum. Mr. Lane proposed to apply the ligature above instead of below the origin of the inferior mesenteric artery, in order to preserve the anastomoses of that vessel.

The **Branches** of the abdominal aorta are—1. Phrenic or diaphragmatic. 2. Cœliac axis (dividing into gastric, hepatic, and splenic). 3. Superior mesenteric. 4. Supra-renal or capsular. 5. Renal. 6. Spermatic (ovarian in female). 7. Inferior mesenteric. 8. Middle sacral. 9. Lumbar arteries. 10. Common iliacs.

The **Phrenic** arteries (Fig. 149, 2) are two small branches, which arise close below the aortic opening in the diaphragm, either from the aorta or from the cœliac axis or other branches. They ramify on the under surface of the diaphragm and anastomose with one another, with the superior phrenic and musculo-phrenic of the internal mammary artery, and with the lower intercostals. Each supplies also a branch to the supra-renal capsule (*superior capsular*), and small twigs are given by the left to the œsophagus, and by the right to the vena cava. The two arteries may spring from a single trunk. The right *vein* opens into the vena cava, the left into the left renal.

The **Cœliac Axis** (Fig. 149, 4) is about half an inch in length. It arises from the front of the vessel above the upper border of the pancreas, opposite the disc between the last dorsal and first lumbar vertebræ, and divides at once into the gastric, hepatic, and splenic arteries (*v.* p. 293).

The gastric and splenic *veins* terminate in the vena portæ, but the hepatic veins, which receive the blood from the vena portæ as well as from the hepatic artery in the liver, open into that portion of the vena cava which is embedded between the lobus Spigelii and right lobe proper of the liver.

The **Superior Mesenteric** artery (Fig. 149, 6) arises from the front of the aorta below the cœliac axis and behind the pancreas, opposite the first lumbar vertebra; it runs downwards and forwards between the pancreas and transverse duodenum, and with its vein is surrounded by the lower process of the head of the pancreas. It supplies nearly all the small and half the large intestines by means of its inferior pancreatico-duodenal branch, vasa intestini tenuis, and the ileo-colic, colica dextra, and colica media arteries (Fig. 138). Its *vein* opens into the vena portæ.

The **Supra-renal** arteries (Fig. 149, 7) arise opposite the first lumbar vertebra and pass, one on each side, transversely to the supra-renal capsules, the right going beneath the vena cava. In the fœtus they are as large as the renal arteries. In addition to this artery (*middle capsular*), the capsule is supplied by a branch from the phrenic (superior) and one from the renal artery (inferior). The right *vein* enters the vena cava, the left the renal or phrenic vein.

. The **Renal** arteries (Fig. 149, 9) arise on each side of the aorta immediately below the capsular arteries, about half an inch below the superior mesenteric artery, and opposite the lower border of the first lumbar vertebra (the right usually a little lower than the left). They run transversely to the concave border of the kidney, the right going behind the vena cava. The aorta being a little to the left of the middle line at this point, the right renal artery is necessarily slightly longer than the left, while, owing to the position of the vena cava on the right of the column, the right renal vein is much shorter than the left. The renal artery, after giving off a small *inferior capsular* twig, breaks up into three or four branches just as it enters the kidney: one or more of these may pass in front of the vein, and occasionally a branch may run behind the ureter, or may pierce the kidney above or below the hilum, but as a rule the relation of the parts at the hilum of the kidney is (1) Vein, (2) Artery, (3) Ureter, from before backwards. An additional renal artery not unfrequently arises from the lower part of the aorta, or from the common iliac artery, and occasionally more than one such vessel is present. It is important for the surgeon to bear in mind these and other possible variations in the arterial supply in operations upon the organ. The renal or emulgent *veins* open into the vena cava, the left crossing in front of the aorta immediately below the superior mesenteric artery, and receiving the left spermatic, left phrenic, and supra-renal veins.

The **Spermatic** arteries (Fig. 149, 10) are two long slender branches, which arise from the front of the aorta about an inch below the renal, and pass downwards behind the peritoneum to the internal abdominal ring and through the inguinal canal to the testes. The right courses obliquely over the vena cava (sometimes behind it) and each crosses the psoas, the genito-crural nerve, and the ureter, and near Poupart's ligament the external iliac vessels; then entering the internal inguinal ring to the outer side of the deep epigastric vessels, traverses the inguinal canal, to emerge at the external ring and enter the scrotum. *In the female* the spermatic arteries become the *ovarian*, and pass into the pelvis to ramify in the broad ligament of the uterus (Fig. 166, 1). One small twig accompanies the round ligament to the inguinal canal, another runs along the Fallopian tube, and a third supplies part of the uterus, anastomosing with the uterine branch of the internal iliac. (Ovary).

The spermatic *veins* form a plexus around the arteries (*pampini-*

form plexus). They take a different course on the two sides, the left opening at a right angle into the left renal vein, and the right running obliquely into the vena cava. This arrangement is said to account in part for the more frequent occurrence of 'varicocele' on the left side, but Dr. J. H. Brinton, of Philadelphia, furnishes a better explanation by demonstrating the existence of a valve at the caval orifice of the right vein, while there is none at the entrance of that of the left side into the renal. The left vein, moreover, is liable to compression by accumulated fæces in the sigmoid flexure, which lies in front of it.

The great length of the spermatic arteries is explained by the fact that the testicles were originally in the abdomen, opposite the point where the arteries arise, and that as they descended the vessels necessarily became elongated.

The **Inferior Mesenteric** artery (Fig. 149, 12) arises opposite the third lumbar vertebra, a little to the left of the middle of the front of the aorta, and supplies the lower half of the large intestine (*v.* p. 292) by its left colic, sigmoid, and superior hæmorrhoidal branches. Its *vein* opens into the splenic vein.

The **Middle Sacral** (*sacral aorta*) (Fig. 149, 18) is a small branch arising at the bifurcation of the aorta, and passing down into the pelvis along the middle of the sacrum. It anastomoses with the lateral sacral branches of the internal iliac arteries. The corresponding *vein* opens into the left common iliac vein.

The **Lumbar** arteries (Fig. 149, 14), usually four in number on each side, arise in a double row from the back of the aorta, and pass transversely, close upon the vertebræ, beneath the psoas and the gangliated cords of the sympathetic, and on the right side beneath the vena cava. The upper arteries also pass under the crura of the diaphragm, where these bridge over the narrower portions of the bodies of the vertebræ. Only small portions of these arteries can be seen at present, but when followed out each will be found to divide into an anterior and a posterior branch. The *anterior* branch runs between the abdominal muscles, to supply them, and to anastomose with the lower intercostal, epigastric, and circumflex iliac arteries. The first anterior branch usually passes in front of the quadratus lumborum, the others behind it. The *posterior* branch passes between the transverse processes, subdividing into *muscular* to the erector spinæ, and *spinal* to the vertebral canal through the intervertebral foramen, the latter vessel supplying the bony and ligamentous walls of the canal, the membranes of the cord, and the cord itself by means of a long twig which runs along the nerve root. The lumbar *veins*, three or four for each side, open into the vena cava. They are connected opposite the transverse processes of the vertebræ by a vertical vessel, the *ascending lumbar vein*, which forms the radicle of the azygos veins.

The **Common Iliac Arteries** (Fig. 149, 16) are the direct continuations of the abdominal aorta, and extend from the bifurcation at the fourth lumbar vertebra to the lumbo-sacral articulation, where each divides into the external and internal iliac arteries. The right common iliac is usually a little longer than the left; and the relations differ on the two sides, owing, principally, to the fact that the two common iliac *veins* unite to form the vena cava on the right side of the vertebral column. Both arteries rest on the vertebral column, covered in front by the peritoneum, and are usually crossed near their termination by the ureters, but the *left* is crossed in addition by the rectum and superior hæmorrhoidal vessels, and the *right* by the termination of the ileum and the lowest branch of the superior mesenteric artery. The *left* artery rests against the psoas magnus, while the *right* artery lies upon its own vein below and crosses the vein of the opposite side above. The only *branches* from the trunks are small twigs to the iliacus muscles and to the ureter.

COMMON ILIAC VEINS.—The *left* common iliac vein will be seen to lie to the inner side of its own artery, and then to pass beneath the right artery to reach the vena cava, whilst the *right* vein is at first behind and then to the outer side of the right artery until it unites with the left. Thus both the veins lie to the right of their respective arteries, and the commencement of the vena cava is immediately to the right of, or sometimes even slightly behind, the right common iliac. They receive the lateral sacral and ilio-lumbar veins, and the middle sacral vein enters the left common iliac.

The **Vena Cava Inferior** (Fig. 149, 3) lies ensheathed in subperitoneal tissue to the right of the aorta. It is in close relation to it below, but is separated from it by an angular interval above, and there lies in a more anterior plane. It is formed by the junction of the two common iliac veins on the right of the fifth lumbar vertebra, and keeps to the right of the vertebral column as high as the liver; where it passes somewhat forward, entering a deep groove (occasionally converted into a canal by a bridge of hepatic substance) between the lobus Spigelii and the right lobe proper, and receives the hepatic veins; finally it reaches the quadrilateral opening in the diaphragm. In *front* of it are the peritoneum (with the foramen of Winslow), the duodenum, the pancreas, the liver, the portal vein, and the right spermatic vein. *Behind* lie the vertebral column, the right crus of the diaphragm, a portion of the right supra-renal capsule, the right capsular, phrenic, renal, supra-renal, and lumbar arteries, and the sympathetic chain of ganglia, besides occasionally the bridge of hepatic substance (*ponticulus*) mentioned above. To the *right*, and in close contiguity, lie the right kidney and ureter and the greater part of the supra-renal capsule ; to the *left*, the aorta, the thoracic duct, the commencement of the vena azygos major, and the solar plexus and right semilunar ganglion. It receives the lumbar, right spermatic, renal, right supra-renal, and right phrenic veins, and as it passes through the liver the large hepatic veins open into it : thus it returns the whole of the blood of the abdomen and lower extremities to the heart.

The **External Iliac Artery** (Fig. 166, 3) reaches from the point of bifurcation of the common iliac to Poupart's ligament, where it becomes the femoral, its direction corresponding with a line drawn from the umbilicus to a point midway between the symphysis pubis and the anterior superior iliac spine. It passes along the brim of the true pelvis, and upon the psoas muscle, invested by a process of subperitoneal tissue, which includes both it and the vein, and must be removed in order to expose them. The crural branch of the genito-crural nerve lies close to the *outer side* of the artery, and the genital branch of the same nerve, as well as the spermatic vessels and deep circumflex iliac vein cross in *front* of it near Poupart's ligament. Occasionally the ureter crosses the upper part of the artery. The *vein* lies to the *inner* side of the artery in the whole of its course upon the left side, but is beneath its upper part on the right side ; and, close to Poupart's ligament, the *vas deferens* or *round ligament* hooks around the epigastric artery, and descends into the pelvis to the inner side of the external iliac trunk.

Like the aorta and common iliac arteries it is ensheathed by subperitoneal connective tissue, and three compartments may be demonstrated in the sheath as well as in that of the femoral artery, with which it is in continuity :—an external compartment for the artery, a middle for the vein, and an internal, less well defined, for a chain of lymphatic glands and vessels.

Branches.—The deep epigastric and the deep circumflex iliac arteries are usually given off just above Poupart's ligament, but occasionally are found on a level with the ligament, or even springing from the common femoral below it.

The *Epigastric* artery passes inwards and upwards immediately outside the peritoneum, and pierces the fascia transversalis to enter the rectus muscle at its posterior aspect, to which it has been already traced (p. 272). Its relation to the vas deferens and round ligament is mentioned above.

The branches of the epigastric are *pubic* to the back of the pubic bone, *cremasteric* to the cord, and *muscular*. An abnormal branch of large size is frequently found coming off from the epigastric close to its origin, and descending into the pelvis; this is the obturator artery, and its important relations to the neck of a femoral hernia have been already described (p. 125). The *epigastric vein* joins the external iliac vein.

The *Circumflex Iliac* artery takes a course outwards along Poupart's ligament, and lies at first immediately outside the peritoneum. It soon, however, pierces the transversalis fascia and muscle, and runs along the crest of the ilium between the muscles, to anastomose with the ilio-lumbar branch of the internal iliac, with the last lumbar, and with the superficial circumflex iliac arteries. The *vein* has been seen to cross the external iliac artery an inch above Poupart's ligament, to open into the external iliac vein.

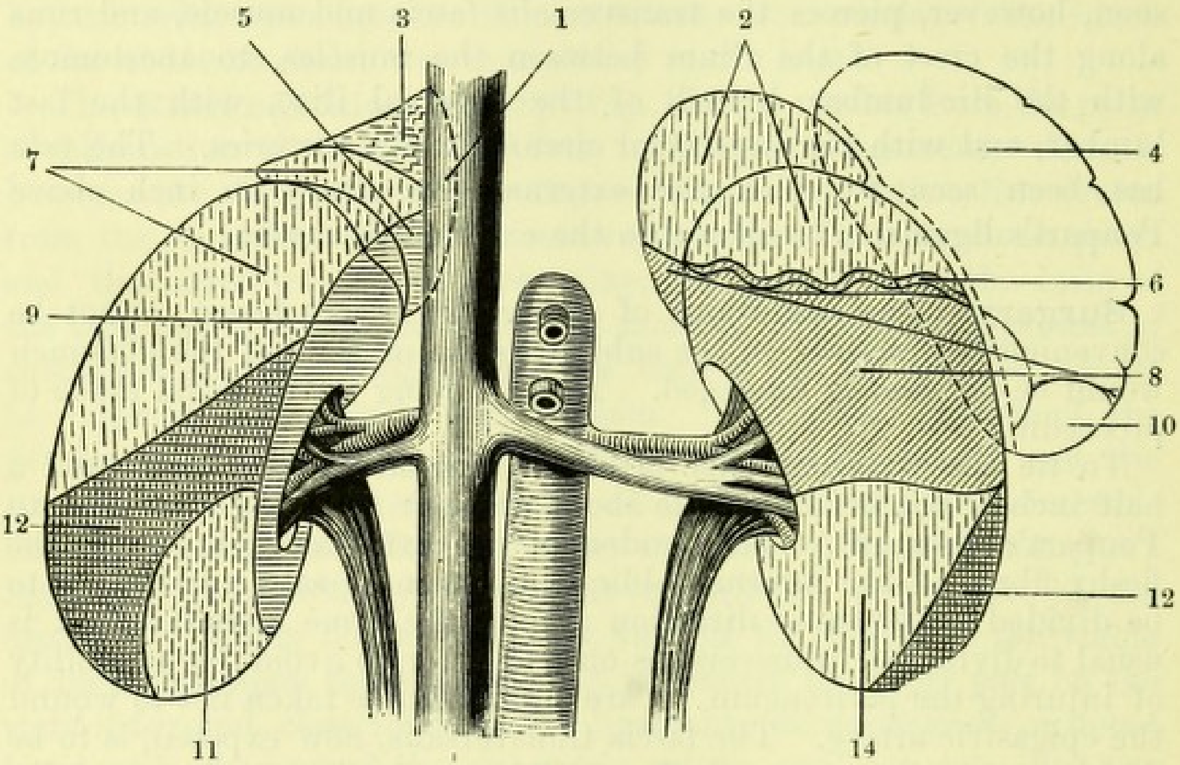
Surgery.—The operations of tying the iliac arteries cannot be conveniently practised on the subject, as the muscles of the abdomen would be necessarily damaged. The following is the usual mode of proceeding:—

To tie the External Iliac artery, a lunated incision three and a half inches long is to be made about an inch above and parallel to Poupart's ligament. The tendon of the external oblique and the fleshy fibres of the internal oblique and transversalis muscles are to be divided in the same direction and to the same extent, and it is usual to divide the transversalis on a director, to avoid the possibility of injuring the peritoneum. Care must also be taken not to wound the epigastric artery. The fascia transversalis, now exposed, is to be divided on a director and the peritoneum is then to be carefully stripped up from the iliac fossa and turned forward with the viscera, the ureter and spermatic vessels generally adhering to the membrane and being therefore drawn out of the way. The finger can now reach the inner border of the psoas, at which the artery can be felt, but the subperitoneal sheath must be carefully opened before the needle can be passed between the vein and the artery. The vessel should be tied as nearly as possible midway between the origins of the internal iliac and epigastric arteries.

The Internal and Common Iliac arteries may be tied through a similar incision prolonged to a length of about five inches, or by one of similar length placed so that its centre is opposite the anterior superior iliac spine. The steps of the proceeding are the same as those for tying the external iliac, but the operations are more arduous, owing to the greater depth of the arteries and the consequent difficulty in reaching them. A direct transperitoneal operation is easier and safer, and is often preferred even for the ligature of the external iliac artery.

When the *external iliac* artery is tied, the circulation in the lower limb is carried on principally by the internal iliac, the branches of which (gluteal, sciatic, and obturator) anastomose freely with branches of the profunda femoris. In addition, the anastomoses between the epigastric and the internal mammary branch of the subclavian, and between the circumflex iliac and the lumbar arteries, become greatly developed. Were the *internal iliac* tied, a return current would be established from the profunda femoris to the branches before mentioned, whilst the visceral branches would receive their blood through

Fig. 150.



anastomoses with the vessels of the opposite side. When the *common iliac* is tied, the circulation in the limb depends mainly upon the internal mammary and epigastric, aided by blood brought circuitously from the opposite internal iliac to that of the same side, and thence to the profunda femoris. The middle sacral artery would also form a direct communication between the aorta and the lateral sacral branch of the internal iliac.

The **Kidneys** are a pair of bean-shaped organs, each measuring about

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Fig. 150.—Diagram showing relation of kidneys, supra-renal bodies, and spleen (W. A.). (From Morris's System of Anatomy.)

1. Caval area.
2. Gastric area (peritoneal).
3. Hepatic area (non-peritoneal).
4. Gastric area of spleen.
5. Duodenal area (non-peritoneal).
6. Splenic artery.
7. Hepatic area (peritoneal).
8. Pancreatic area (non-peritoneal).
9. Duodenal area (non-peritoneal).
10. Colic area of spleen.
11. Meso-colic area.
12. Colic area (non-peritoneal).
14. Meso-colic area.
16. Ureter.
18. Aorta.
20. Vena cava.

$4\frac{1}{2}$ inches in length, $2\frac{1}{2}$ inches in breadth, and an inch and a quarter in thickness, and weighing about $4\frac{1}{2}$ ounces. They lie in the hypochondriac, epigastric, lumbar and umbilical regions (see p. 278) and are placed behind the peritoneum in a kind of lymph space in the fat bearing subperitoneal tissue (Fig. 135), opposite the last dorsal and three upper lumbar vertebræ, the right usually lying about half an inch lower than the left. The long axis of each is directed downwards and outwards. Its *antero-external* or *visceral surface* is directed

Fig. 151.

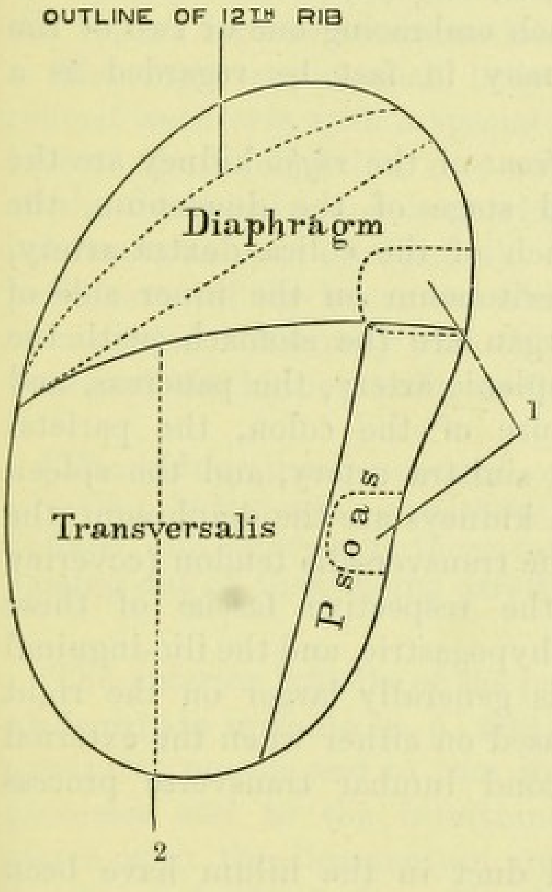
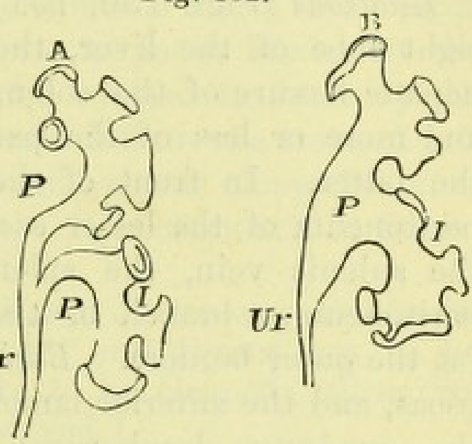


Fig. 152.



outwards and forwards, its *postero-internal* or *parietal surface* looks backwards and inwards. Its *outer border*, representing the angle of junction of its two surfaces, is narrow and convex. Its *inner border*, looking obliquely inwards, forwards, and a little downwards,

Fig. 151.—Diagram of relations of the posterior surface of the kidney (W. A.). (From "Morris' System of Anatomy.")

1. Transverse processes of the first and second lumbar vertebræ.
2. Line indicating outer border of quadratus lumborum.

Fig. 152.—Two forms of the renal duct (from Wilson).

A. Calyx.
P. Pelvis.
Ur. Ureter.
I. Infundibulum.

is convex above and below, but slightly concave in its middle third, and fissured by the *hilum*. The *upper extremity* is rounded, and supports the supra-renal body, which encroaches also upon its anterior surface and internal border. The *lower extremity*, also rounded, lies farther from the median plane than the upper.

The *hilum* is a slit-like aperture in the middle of the inner border of the kidney, bounded in front and behind by two prominent lips. It forms the entrance into a deep depression or cavity, the *sinus*, at the bottom of which lie (1) the renal papillæ perforated by the openings of the secreting tubes, (2) the apertures transmitting vessels and nerves to the organ, and (3) the attachments of the 'calices' of the main duct, each embracing one or two of the papillæ (Fig. 160). The kidney may in fact be regarded as a hollow organ.

Relations (Figs. 150, 151).—*In front* of the *right* kidney are the right lobe of the liver, the second stage of the duodenum, the hepatic flexure of the colon, a branch of the colica dextra artery, and more or less of the parietal peritoneum on the inner side of the latter. In front of the *left* organ are the stomach (with the peritoneum of the lesser sac), the splenic artery, the pancreas, and the splenic vein, the splenic flexure of the colon, the parietal peritoneum, a branch of the colica sinistra artery, and the spleen (at the outer border). *Behind* both kidneys are the diaphragm, the psoas, and the anterior lamella of the transversalis tendon (covering the quadratus lumborum), with the respective fasciæ of these muscles, and the last dorsal, the ilio-hypogastric, and the ilio-inguinal nerves. The diaphragmatic area is generally larger on the right side, and may be considerably increased on either when the external arcuate ligament passes to the second lumbar transverse process instead of the first.

The relations of the vessels and duct in the hilum have been already given (p. 315).

The **Ureters** (Fig. 149, 11) should be traced out. They are about a foot long, and will be seen to lie in a sheath of subperitoneal tissue over the psoas muscles, passing behind the spermatic vessels, and, after crossing the common or external iliac artery, to disappear into the pelvis, where they will be afterwards traced to the bladder. The right ureter runs behind the second stage of the duodenum, and lies close to the inferior vena cava. In the female both tubes approach the sides of the cervix uteri, and lie in contact with the upper part of the vagina, crossing it obliquely to reach the base of the bladder. The proximal extremity of each ureter begins with eight or nine short tubes called *calices*, which surround the renal papillæ at the bottom of the sinus. These join with each other, with or without the intervention of short passages called *infundibula*, to form usually two tubes, the *upper* and *lower pelves*, and the union of the two pelves constitutes the *common pelvis renalis*, which generally narrows to the size of a goose-quill, and becomes the ureter proper (Fig. 152).

The **Supra-renal Body** or **Capsule** (Fig. 149, 5) is a small yellow body, somewhat resembling a cocked-hat, resting upon the upper end and inner border of each kidney, and lying against the crus of the diaphragm. The vessels to it should be traced out, and one kidney and capsule are then to be removed and put aside with the viscera for after-examination.

The *right* supra-renal body is triangular in outline, and in contact *anteriorly* with a special impression at the back of the right lobe of the liver, below this with the peritoneum and a small piece of the duodenum, and is overlapped along its inner border by the inferior vena cava (Rolleston). The *left* is covered in front by the peritoneum of the lesser sac, which separates it from the stomach ; it is in contact externally with the spleen, and extends along the inner border of the kidney as far as the hilum. It is crescentic in form.

[The kidney being removed or turned out of the way, the fasciæ covering the psoas, quadratus lumborum, and iliacus are to be defined, and afterwards those muscles are to be cleaned ; all nerves passing out of them being carefully preserved.]

The anterior lamella of the posterior tendon of the **transversalis abdominis muscle** (*v.* p. 262) will be found to lie in front of the quadratus muscle and to pass inwards to the tips of the transverse processes and to the intertransverse ligaments ; it is connected above with the ligamentum arcuatum externum of the diaphragm, and below is attached to the iliac crest and ilio-lumbar ligament. It is covered in front by the *fascia transversalis.*

The *fascia iliaca,* or ilio-psoas fascia, ensheaths the psoas and iliacus. The *fascia over the psoas* is attached to the lower edge of the ligamentum arcuatum internum of the diaphragm, and to the vertebræ from which the muscle takes its origin, and joins the fascia over the iliacus below. It is owing to this fascial sheath that "psoas abscess," the result of spinal caries, is conducted along the psoas muscle to the inner side of the thigh.

The *fascia covering the iliacus internus* muscle is attached above to the inner lip of the iliac crest, and is continuous below with the fascia over the psoas magnus. The conjoint sheath should be traced beneath Poupart's ligament, where it passes behind the sheath of the femoral vessels to reach the insertion of the muscle (*v.* p. 139).

The **Psoas Magnus** muscle (Fig. 153, 6) *arises* by five slips from the sides of the intervertebral discs between the last dorsal and all the lumbar vertebræ, and from the adjacent parts of the bodies and roots of the transverse processes of these vertebræ; and between these slips from a series of tendinous arches crossing the constricted portion of the bodies of the four upper lumbar vertebræ. The muscle passes along the border of the true pelvis in close relation to the iliac vessels, and disappears beneath Poupart's ligament to be *inserted* by a tendon into the apex of the lesser trochanter of the femur.

The **Psoas Parvus** (Fig. 153, 4) is a small muscle occasionally found upon the front of the psoas magnus. It *arises* in front of the upper slip of the psoas magnus, from the bodies of the last dorsal and first lumbar vertebræ, and from the intervening disc, and ends in a long tendon which is *inserted* into the ilio-pectineal eminence and part of the ilio-pectineal line, and gives an expansion to the iliac fascia.

The **Iliacus Internus** (Fig. 153, 8) *arises* from the upper half of the iliac fossa, reaching the margins of the crest, iliac notch, and anterior inferior iliac spine; from the sacro-iliac and ilio-lumbar ligaments; and, frequently, from the capsular ligament of the hip-joint. Its fleshy fibres unite with the tendon of the psoas, and are *inserted* with it into the lesser trochanter, and into the shaft for about an inch below. A bursa lies beneath the conjoined muscle between it and the capsule of the hip, and may communicate with the joint cavity by a round aperture between the ilio-femoral and ilio-pubic bands. This is a channel by which pus may enter the iliac fossa in hip disease.

The psoas and the iliacus are flexors and external rotators of the thigh, and taking their fixed point below are flexors and rotators of the trunk upon the thigh. This is seen in dislocation of the femur downwards into the thyroid foramen, when the body is always bowed forwards owing to the tension of these muscles. The psoas is *supplied* by the lumbar nerves, the iliacus by intra-pelvic branches of the anterior crural nerve.

The **Quadratus Lumborum** (Fig 153, 5) is the short muscle filling the space between the last rib and the crista ilii. It has its origin below, from the posterior portion of the inner lip of the crest of the ilium and from the adjacent ilio-lumbar ligament; and ascends to be *inserted* into the lower border of the last rib, and by three or four slips into the tips of the transverse processes of the lumbar vertebræ. It is sometimes described as consisting of two distinct parts. The quadratus draws down and fixes the last rib, and causes a slight lateral inclination of the trunk towards the iliac crest ; it is *supplied* by the posterior branches of the lumbar nerves.

Twelfth dorsal or thoracic nerve (Fig. 153, 3).—Crossing the quad-

Fig. 153.

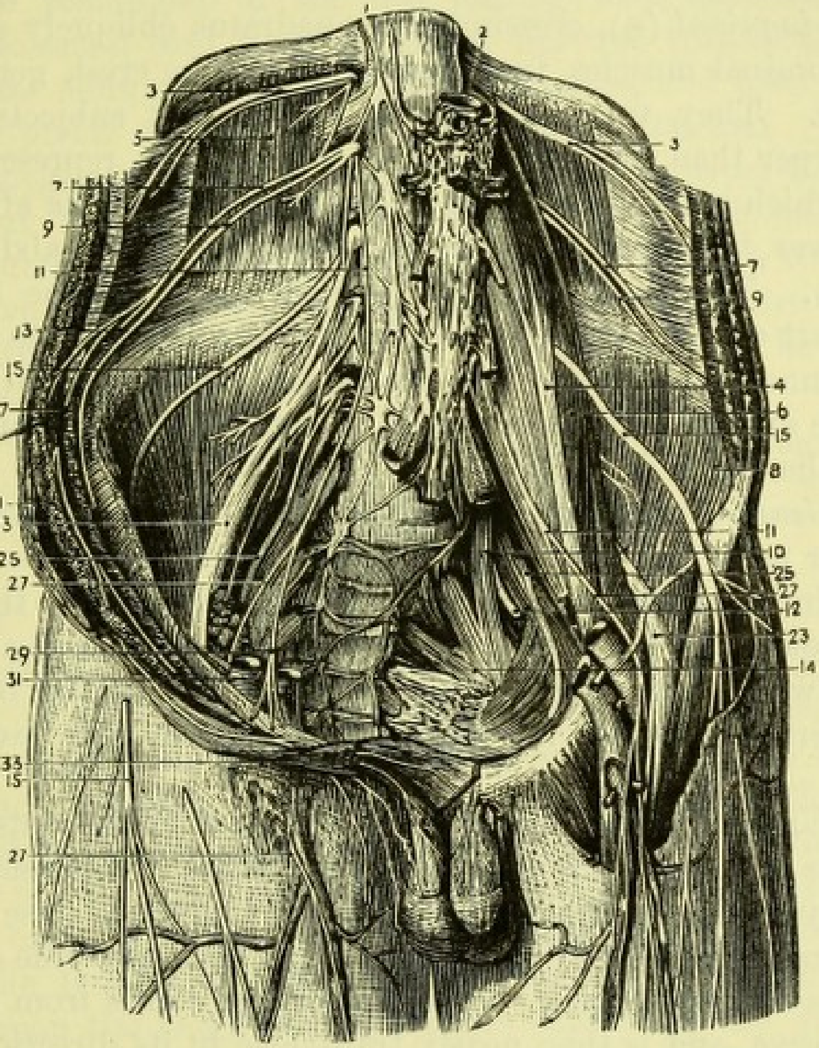


Fig. 153.—Lumbar plexus (from Hirschfeld and Leveillé).

1. Right gangliated cord of sympathetic.
2. Abdominal aorta.
3, 3. Last dorsal nerves.
4. Psoas parvus.
5. Quadratus lumborum.
6. Psoas magnus.
7, 7. Ilio-hypogastric nerves.
8. Iliacus internus.
9, 9. Ilio-inguinal nerves.
10. Lumbo-sacral nerves.
11, 11. Genito-crural nerves.
12. Gluteal nerve.
13. Iliac branch of ilio-hypogastric [nerve.
14. Sacral plexus.
15, 15, 15. External cutaneous nerves.
17. Transversalis abdominis.
19. Obliquus internus.
21. Obliquus externus.
23, 23. Anterior crural nerves.
25, 25. Obturator nerves.
27, 27. Crural branch of genito-crural nerve.
29. Genital branch of genito-crural nerve.
31. External iliac artery.
33. External abdominal ring.

ratus, and immediately below the ligamentum arcuatum externum, will be found a large nerve, the twelfth dorsal, which will be seen to disappear through the transversalis muscle to reach the buttock, and must not be confounded with the branches of the lumbar plexus.

The **Lumbar Plexus** (Fig. 153).—Emerging from the outer border of the psoas, about midway between the last rib and the crest of the ilium, will be found two small nerves, the *ilio-hypogastric* (7) and *ilio-inguinal* (9), crossing the quadratus obliquely and piercing the abdominal muscles immediately above the crest, generally close together. They vary considerably in different subjects, one being often larger than the other, or the two may be represented by one trunk which subdivides in the abdominal wall. The after-course of the nerves has been given in the dissection of the abdominal wall (p. 257). The ilio-hypogastric is distributed to the skin of the lower part of the abdomen, and by its dorsal branch to the buttock on the inner side of the last dorsal, and the ilio-inguinal emerges from the external abdominal ring to supply the scrotum and inner side of the thigh.

The *Genito-crural nerve* (11) appears on the front of the psoas at its upper part, and is of small size. It descends on the muscle, and divides into a *genital* (29) branch, which accompanies the spermatic cord through the inguinal canal to the cremaster, and a *crural* (27) branch, which runs under Poupart's ligament to the outer side of the external iliac artery, and is lost in the skin over Scarpa's triangle.

The *External Cutaneous nerve* (15) appears at the outer border of the psoas just below the level of the crista ilii. It crosses the iliacus obliquely to the anterior superior spinous process, close to which it passes under Poupart's ligament to supply the outer side of the thigh nearly as low as the knee. (This sometimes comes from the anterior crural nerve, and is then nearly transverse in its direction.)

The *Anterior Crural* (23) is a large nerve close to the outer border of the psoas at its lower part, and lies between that muscle and the iliacus, giving branches to the latter and usually also to the femoral artery. It passes under Poupart's ligament into the thigh.

The *Obturator nerve* (25) will be better dissected with the pelvis, but may be seen passing below the brim of the true pelvis upon the upper fibres of the obturator internus above the obturator vessels, to disappear through the upper part of the thyroid foramen.

A small *Accessory Obturator* nerve is occasionally found arising with the obturator nerve. It passes over the body of the os pubis, joining the obturator nerve on the inner side of the thigh, and supplying twigs to the pectineus and the hip joint.

[The psoas should be carefully removed piecemeal on one side, in order to dissect the lumbar nerves to their origins, and to trace out the plexus completely. The gangliated cord of the sympathetic can now be fully seen, and should be cleaned.]

The *Lumbar plexus* will now be seen to be formed by the 1st, 2nd, 3rd, and part of the 4th lumbar nerves, with a branch from the 12th dorsal; the remainder of the 4th joining with the 5th to form the "lumbo-sacral cord." The several nervous trunks are united more or less definitely by connecting branches, and from them the nerves are given off, thus:—from the last dorsal and 1st lumbar the ilio-hypogastric and the ilio-inguinal nerves; from the 1st and 2nd lumbar the genito-crural nerve; from the 2nd and 3rd the external cutaneous nerve; from the 2nd, 3rd, and 4th the anterior crural nerve; from the anterior fibres of the same trunks (2nd, 3rd and 4th) the obturator nerve. The origins may be tabulated as follows:—

Lumbar nerves	12 and 1 . . .	Ilio-hypogastric and ilio-inguinal.
	1 2 . .	Genito-crural.
	2 3 .	External cutaneous.
	2 3 4	Anterior crural.
	2 3 4	Obturator.

Sympathetic Nerve.—The *Gangliated Cords of the Sympathetic* (Fig. 153, 1) will be found on each side of the spinal column, and behind the vena cava upon the right side. A ganglion is situated opposite each vertebra, and gives off a number of branches, which may be divided into (1) those communicating with the ganglia above and below; (2) those communicating with the spinal nerves, which are often two in number, and accompany the lumbar arteries beneath the tendinous arches of the psoas; (3) branches to the plexuses upon the neighbouring arteries supplying the viscera and the vertebræ and ligaments.

Some *lymphatic glands* (*lumbar*) may also be found surrounding the great vessels. They receive the lymphatics from the testis in the male, from the ovary and Fallopian tube in the female, from the iliac and sacral glands, and from the ascending or descending colon. A few *renal* lymphatic glands are found above the renal vessels.

The **Vena Azygos Major** may be seen lying close to the right side of the aorta, and communicating with two or more of the lumbar veins, and sometimes with the vena cava or right renal. It passes through the aortic opening.

The **Left Lower Vena Azygos** may be seen to commence in the left lumbar veins or from the left renal, and to pass through the left crus of the diaphragm.

Receptaculum Chyli.—By detaching the right crus of the diaphragm from the vertebræ, and if necessary, removing a piece of the aorta opposite the upper lumbar vertebræ, the *receptaculum chyli*, the dilated origin of the thoracic duct, will be seen lying between and behind the aorta and vena cava, opposite the second and third lumbar vertebræ. It receives all the lymphatics and lacteals of the abdomen, and is continued upwards as the thoracic duct.

The subject will now be turned for the dissection of the back, and the dissectors of the abdomen should occupy the time with the examination of the viscera.

The Structure of the Viscera of the Abdomen.

[The stomach and intestines should be cleaned by allowing a stream of water to pass through them ; and the stomach, and portions of the small and large intestine, should be distended with air by means of a blow-pipe, so as to permit of dissection of their coats.]

The **Stomach** (Fig. 154) has been described (p. 296) as to form and relations.

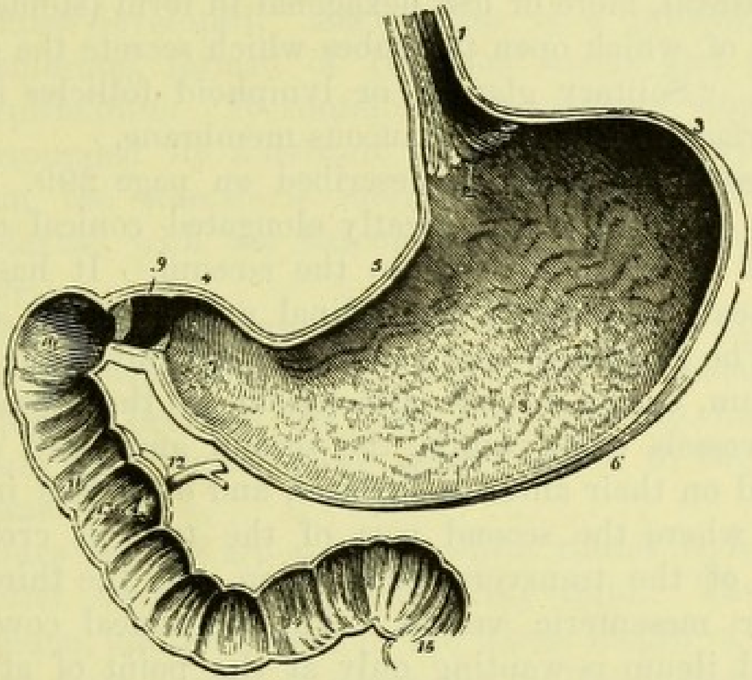
Its coats are four in number—serous, muscular, areolar, and mucous.

The *serous coat* is continuous with the lesser omentum above, with the great omentum below, and with the gastro-splenic omentum on the left side; the layer in front of the stomach is derived from the greater sac, and that behind from the lesser sac of the peritoneum. Along the lesser curvature the two layers of peritoneum are separated by the gastric and pyloric vessels, and along the greater curvature by the gastro-epiploic and splenic vessels.

The *muscular coat* consists of three sets of unstriped fibres, external longitudinal, middle circular, and internal oblique. The longitudinal fibres, running principally along the lesser curvature, are continuous with those of the œsophagus, and are continued into the duodenum. The circular fibres, which are next in order, enclose the entire viscus, and are collected together at the small end to form the pylorus. The oblique fibres, continuous with the circular fibres of the œsophagus, may be exposed by everting the viscus and dissecting away the mucous membrane ; they are distributed principally over the great end of the stomach, and are so arranged around the cardiac orifice as to form a "button-hole" sphincter, one set of fibres crossing the right side of the opening to spread out on either surface towards the left extremity of the viscus, the other in like manner crossing the left border of the opening to reach the more central portion of the greater curve.

The *areolar* or *sub-mucous coat* consists of areolar tissue, in which

Fig. 154.



ramify the blood-vessels and a rich lymphatic plexus, and between this and the mucous coat is a thin layer of involuntary muscle, the *muscularis mucosæ.*

On laying open the stomach along its lesser curvature, the *mucous membrane* will be seen to be arranged in longitudinal folds or ridges called *rugæ*, which disappear when the viscus is distended, and are more evident in the child than in the adult. By in-

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Fig. 154.—Section of the stomach and duodenum (from Wilson).

1. Œsophagus.
2. Cardiac orifice of the stomach.
3. Great end of the stomach.
4. Lessor or pyloric end.
5. Lesser curve.
6. Greater curve.
7. The antrum of the pylorus.
8. Longitudinal rugæ of the mucous membrane.
9. Pylorus.
10. Ascending portion of the duodenum.
11. Descending portion.
12. Pancreatic duct and ductus communis choledochus close to their termination.
13. Papilla upon which the ducts open.
14. Transverse portion of duodenum.
15. Commencement of jejunum. In the interior of the duodenum and jejunum the valvulæ conniventes are seen.

verting the pyloric end the *pyloric sphincter* will be seen as a prominent ring of strong circular fibres, surrounding the intestine beneath the mucous membrane, and acting as a sphincter muscle.

The mucous membrane is thick and soft, and of a pink colour when recent; it is thickest near the pylorus and thinnest at the greater end, where perforation from post-mortem digestion usually takes place. The surface of the membrane is divided into a series of shallow *alveoli*, more or less hexagonal in form (stomach cells), at the bottom of which open the tubes which secrete the gastric juice and mucus. 'Solitary glands' or lymphoid follicles are scattered over the surface of the gastric mucous membrane.

The **Small Intestine** is described on page 299. It may be regarded as a tortuous and greatly elongated conical cylinder, the smaller end of which opens into the cœcum. It has four coats, viz. peritoneal, muscular (longitudinal and circular), areolar, and mucous. The peritoneal coat completely surrounds the first part of the duodenum, except at the attachment of the lesser omentum, where the vessels enter, while the second and third portions are only covered on their anterior surfaces, and even this investment is incomplete where the second part of the tube is crossed by the attachment of the transverse meso-colon, and the third portion by the superior mesenteric vessels. The peritoneal covering of the jejunum and ileum is wanting only at the point of attachment of the mesentery, where the muscularis of about a fifth or a sixth of the gut forms the base of the interserous triangle (Fig. 144). The muscular coat consists of an external layer of longitudinal fibres and an internal thicker layer of circular fibres, both complete and continuous. The mucous membrane is amplified in extent of surface by plications called valvulæ conniventes, by papillary projections called villi, and by follicular involutions known as tubes of Lieberkühn; and its thickness diminishes progressively, together with the calibre of the gut, as it becomes more remote from the stomach and approaches the cœcum. Racemose glands (Brunner's) are found in the upper part of the duodenum, and aggregations of lymphoid follicles chiefly in the ileum, while solitary lymphoid follicles are scattered throughout the intestine. A *muscularis mucosæ* is present in the submucous tissue, as in the stomach, and enters into the formation of both the villi and valvulæ conniventes.

The *valvulæ conniventes* (or valves of Kerkring) are transverse folds of mucous membrane and submucous tissue, which will be seen to commence about the middle of the second stage of the duodenum, and to increase in size as they approach the middle of the jejunum; below this point they become smaller, disappearing in the lower fourth of the ileum. They extend around about two-thirds of the circumference of the gut.

The *Villi* are minute projections from the surface of the mucous membrane, and give it a velvety appearance, which may be best seen by floating a piece of intestine in water. They begin at the pyloric sphincter and end at the ileo-cœcal valve, and attain their greatest length (about $\frac{1}{50}$th of an inch) where the valvulæ conniventes are most developed. Each villus is a prolongation of the mucous membrane, formed of lymphoid tissue and covered with columnar epithelium. It contains in its centre a single or double lacteal, surrounded by a delicate layer of involuntary muscle prolonged from the *muscularis mucosæ;* externally to which is a capillary plexus, with the basement-membrane on which the epithelium rests.

Lieberkühn's follicles are minute tubes lined with columnar epithelium, and common to the whole of the small intestines. They are placed between the villi, and dip into the submucous areolar tissue, their depth being proportionate to the thickness of the membrane.

The *Solitary follicles* are seen as white round bodies about the size of millet seed, containing a milky fluid. They consist of lymphoid tissue, and are found in the whole length of the digestive tract, but are most numerous where the multiplication of surface is least.

Brunner's glands, peculiar to the upper part of the duodenum, are small racemose glands situated in the submucous areolar tissue and opening into the intestine by minute ducts. To see these it is necessary to pin out a piece of duodenum with the mucous membrane downwards, and then carefully to dissect away the muscular coat.

The **Duodenum** (Fig. 154) should be laid open along its free border, in order to see the common opening of the bile and pancreatic ducts, which is marked by a papilla situated at the back of the second portion of the intestine, and about or below its middle (13) A second opening, the *accessory duct of Santorini*, connected with the lesser pancreas, may sometimes be found above this part. A probe should be passed through the papilla into the common bile duct and along the pancreatic duct. The duodenum is the widest and thickest portion of the small intestine, and is characterised structurally by the presence of Brunner's glands in the sub-mucous membrane of its upper segment. It contains also valvulæ conniventes, villi, Lieberkühnian tubes, and solitary follicles.

Vater's Ampulla

[The jejunum and ileum (except a few inches to be left attached to the cœcum) should be laid open along the line of attachment of the mesentery, in order to avoid damaging Peyer's patches, which are at the opposite side of the gut.]

The **Jejunum**, including about two-fifths of the remaining small intestine, is remarkable for the large size of the valvulæ conniventes, the great development of the villi, and the number of solitary follicles, but has no special characteristic. Its nominal separation from the ileum is arbitrary and useless.

In the **Ileum** the valvulæ conniventes will be found to diminish rapidly in size, and to be absent altogether at the lower part. A small tube or cord may sometimes be found in connection with the gut, about three feet from the ileo-cœcal valve, extending towards the umbilicus. This is called *Meckel's diverticulum,* and is a relic of the vitelline duct of the fœtus. It is occasionally the cause of internal strangulations, and of umbilical fæcal fistula in newly born children.

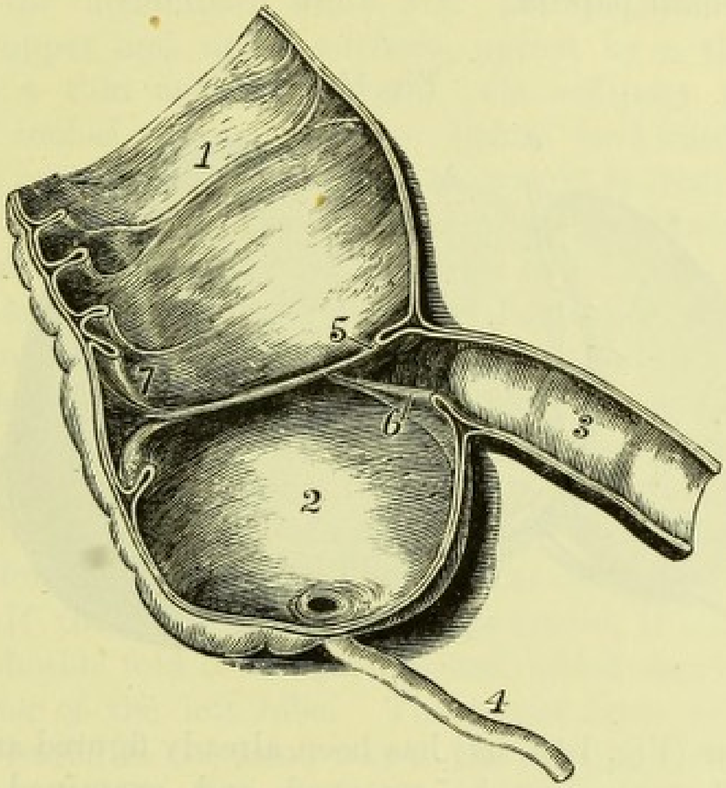
Peyer's patches (*glandulæ agminatæ*) are the special characteristic of this part of the intestine, but are occasionally found in the jejunum; they are from twenty to thirty in number, but vary much in size and are sometimes invisible. They will be recognised as shallow oval or rounded depressions, dotted on their surface, and of a lighter colour than the rest of the intestine, and are always found on the part of the intestine farthest from the attachment of the mesentery. Each patch consists of a collection of lymphoid follicles. Peyer's glands will be found inflamed, and sometimes ulcerated, in subjects which have died of typhoid fever.

The **Large Intestine** is remarkable in nearly the whole of its length for a pouched appearance, consequent upon the longitudinal muscular fibres being shorter than the intestine itself. Typically these longitudinal fibres are arranged in three distinct bands or *tæniæ*, two of which can be seen through the peritoneum, and the third between the layers of the meso-colon; but in the rectum, which is not pouched, and the vermiform appendix, the fibres spread over the whole gut, as in the small intestine. The *appendices epiploicæ* are small processes containing fat, attached along the free border of the intestine, and will be found to vary considerably in size in different subjects.

[The cœcum with a few inches of small and large intestine should be detached, and the large intestine turned inside out to see the ileo-cœcal valve. After this has been done and the intestine re-inverted, the cut ends may be tied and the piece inflated and dried, that the valve may be again examined.]

The *Ileo-cœcal valve* (Fig. 155, 5) is formed by a prolongation of the mucous membrane and circular fibres of the muscular coat of ileum into the cavity of the cœcum, and appears as two folds bounding a horizontal slit-like aperture of communication. The upper fold or flap, which is horizontal in direction, is sometimes known as the *ileo-colic*, and the lower or more vertical one as the *ileo-cœcal* fold. Two ridges, one on each side, extend from the angles of union of the two folds, and are called the *frœna* or *retinacula.* The valve permits the ready passage of fluid from the small into the large intestine, but opposes regurgitation.

Fig. 155.



The mucous membrane of the large intestine has *no* villi, these ceasing abruptly at the free margin of the ileo-cœcal valve, but resembles that of the small intestine in having columnar epithelium, tubular glands resembling the follicles of Lieberkühn, and solitary follicles, embedded in the submucous tissue.

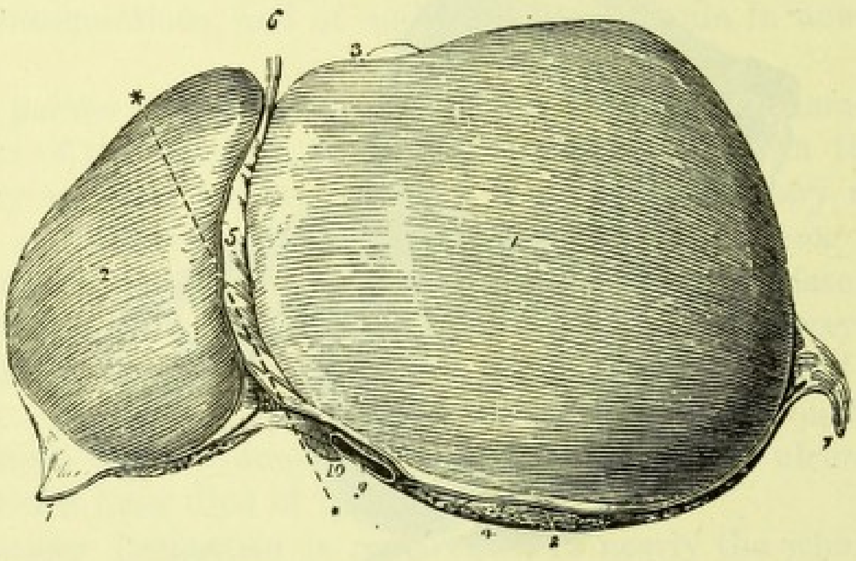
Fig. 155.—The cœcum laid open, showing the termination of the ileum and the ileo-cœcal valve (from Wilson).

1. Ascending colon.
2. Cœcum.
3. Ileum.
4. Vermiform appendix.
5. Upper fold of ileo-cœcal valve.
6. Lower fold of ileo-cœcal valve meeting the upper fold to form a retinaculum.
7. Fold of colon.

The **Pancreas** (Fig. 145, and p. 301), should be cleaned, but left attached to the duodenum. It is a compound racemose gland, and consists of lobules of a yellowish colour held together by loose fibrous tissue, a small duct passing from each lobule into the main trunk. A probe should be passed from the duodenum into the duct (canal of Wirsung), and when dissected out, will be found to pass along the whole length of the gland, nearer the posterior than the anterior surface. A large accessory duct passes from the upper part of the head and occasionally opens separately into the duodenum.

The pancreatic duct lies close to the bile duct, and the two pierce the duodenal wall, opening usually by a common orifice upon the summit of a small papilla.

Fig. 156.



The **Spleen** (Fig. 145, *spl*) has been already figured and described (p. 307), and may now be removed and examined in section. Beneath the peritoneal coat which invests the organ, will be found a fibrous coat containing an abundance of unstriped muscular tissue, which is continued into the splenic substance, to form the

Fig. 156.—Upper surface of the liver (from Wilson).

1. Right lobe.
2. Left lobe.
3. Fundus of the gall-bladder seen projecting beyond the anterior border of the right lobe.
4. Posterior or rounded border.
5. Falciform or suspensory ligament.
6. Round ligament.

7, 7. The two lateral ligaments.
8. The space left uncovered by the peritoneum and surrounded by the coronary ligament.
9. Inferior vena cava.
10. Point of the lobus Spigelii.

* * Position and direction of mesial sagittal plane.

trabeculæ or meshes in which the splenic *pulp* is contained. In this pulp, which consists of a reticulum of branched connective-tissue corpuscles (Quain), are found the *Malpighian corpuscles*, small round or oval bodies attached to the minute divisions of the splenic artery. They are composed of lymphoid tissue derived from a transformation of the external or areolar coat of the small arteries, and average $\frac{1}{70}$ inch in diameter. The arteries end in capillaries, which lose themselves in the connective tissue of the pulp, in the interstices of which the blood flows. The veins anastomose freely in and upon the trabeculæ, and open into the splenic vein.

The **Liver** (Figs. 156, 157) when removed from the body loses to a very large extent the form which is impressed upon it by the contact of the abdominal walls and the neighbouring viscera. It presents upper and under surfaces, united by a thick posterior surface and a thin anterior margin. Its ordinary measurements are, twelve inches across, six from before backwards, and three inches in its greatest thickness; and its weight is from three to four pounds. It is fixed to the diaphragm by peritoneal reflections, which are called respectively the superior or falciform, the posterior or coronary, and the right and left lateral ligaments, and by a fibrous cord resulting from the obliteration of the umbilical vein of the fœtus, which runs to its lower surface and is known as the 'round ligament.' The upper surface is divided into two unequal parts, of which the right is the larger, by the attachment of the *falciform* ligament, the two layers of which will be found to diverge posteriorly, forming the upper layer of the *coronary* and the *lateral ligaments.* If the *left lateral ligament* be traced, it will be found to consist of a double fold of the peritoneum, which may be followed to the left border of the left lobe. The upper layer of the coronary ligament, if traced in the same way to the right, will be found to be reflected upon itself to form the *right lateral ligament*, which is much shorter than the left, and then will be followed to the under surface of the right lobe of the liver, to form the under layer of the coronary ligament. A more or less triangular interval is thus left between the two layers of the coronary ligament, where the liver is attached to the diaphragm by cellular tissue and is in relation with the right suprarenal capsule.

The **upper surface** of the liver is dome-shaped, and moulded to the inner surface of the diaphragm and to a small portion of the anterior abdominal wall at the subcostal angle, and may be regarded as having superior anterior and right lateral faces. It is slightly depressed at its summit, where it is separated by the diaphragm from the heart (impressio cardica).

The **under surface** (Fig. 157) presents three *fissures* and four *lobes* for examination.

Fissures.—The *longitudinal fissure* divides the under surface into right and left lobes, and is directed obliquely from a point two or three inches to the right of the sagittal plane in front, to end about an inch to the left of the plane behind. It is occupied anteriorly by the obliterated umbilical vein, and behind the transverse fissure by the cord-like relic of the ductus venosus, which lies between the two layers of the upper attached border of the septal fold of

Fig. 157.

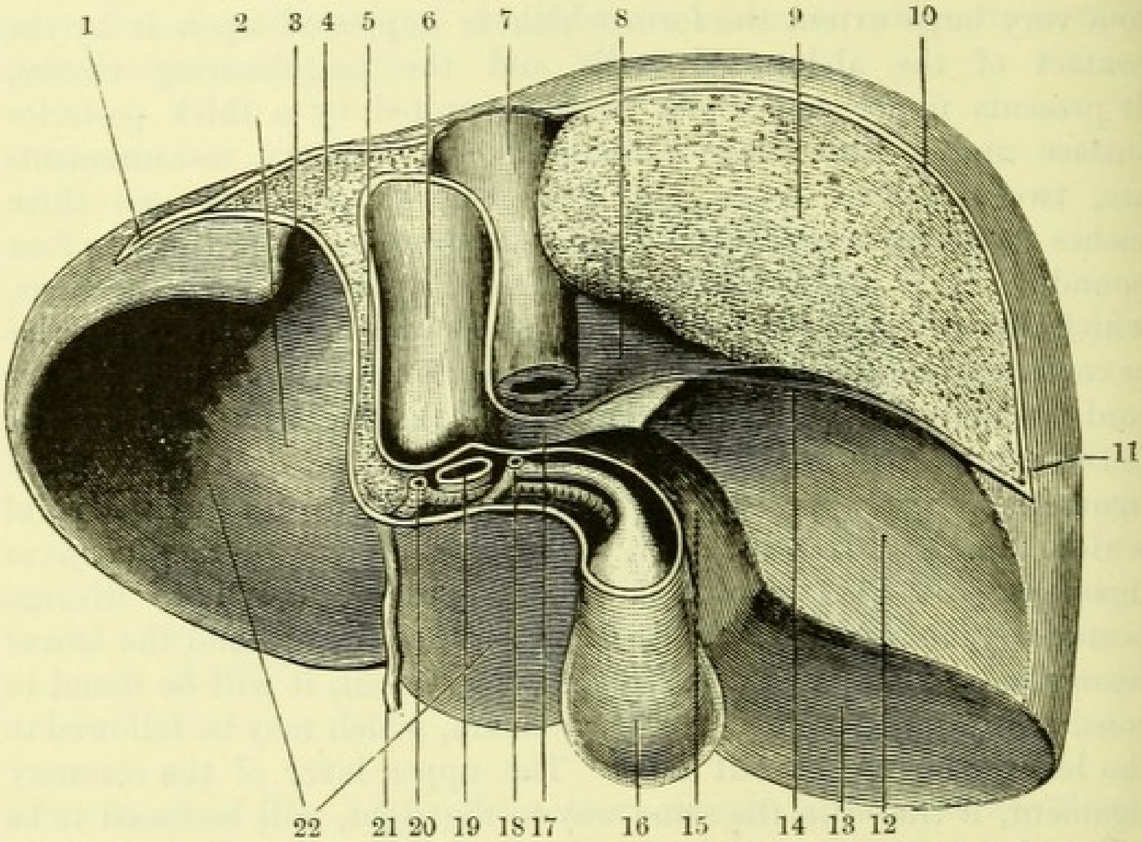


Fig. 157.—Under surface of the liver (W. A.).

1. Cut edge of left lateral ligament.
2. Tuber omentale of left lobe.
3. Œsophageal notch.
4. Surface of liver uncovered by peritoneum.
5. Fissure of ductus venosus.
6. Spigelian lobe with cut edge of peritoneum of lesser sac.
7. Vena cava.
8. Impression for supra-renal capsule.
9. Portion of liver between layers of coronary ligament.
10. Cut surface of upper layer of coronary ligament.
11. Cut edge of right lateral ligament.
12. Renal impression.
13. Colic impression.
14. Cut edge of coronary ligament-inferior layer.
15. Duodenal impression.
16. Gall bladder.
17. Lobus caudatus.
18. Common bile duct.
19. Portal vein.
20. Hepatic artery.
21. Round ligament.
22. Gastric impression on left and quadrate lobes.

peritoneum, continuous with the left extremity of the lesser omentum (see p. 284). In the fœtus at term the longitudinal fissure is nearly mesial and sagittal, but as growth proceeds its anterior extremity shifts gradually towards the right. The *transverse* or *portal fissure* which is also obliquely directed lies at right angles to the longitudinal; the small omentum is attached to its borders, and it gives passage to the hepatic duct, hepatic artery, portal vein, lymphatics, and nerves, and to a connective tissue sheath for these structures derived from the capsule of Glisson. Parallel to the longitudinal fissure but more to the right is the fossa or *fissure for the gall-bladder*, a shallow depression usually uncovered by peritoneum and in direct contact with the opposed wall of the gall-bladder.

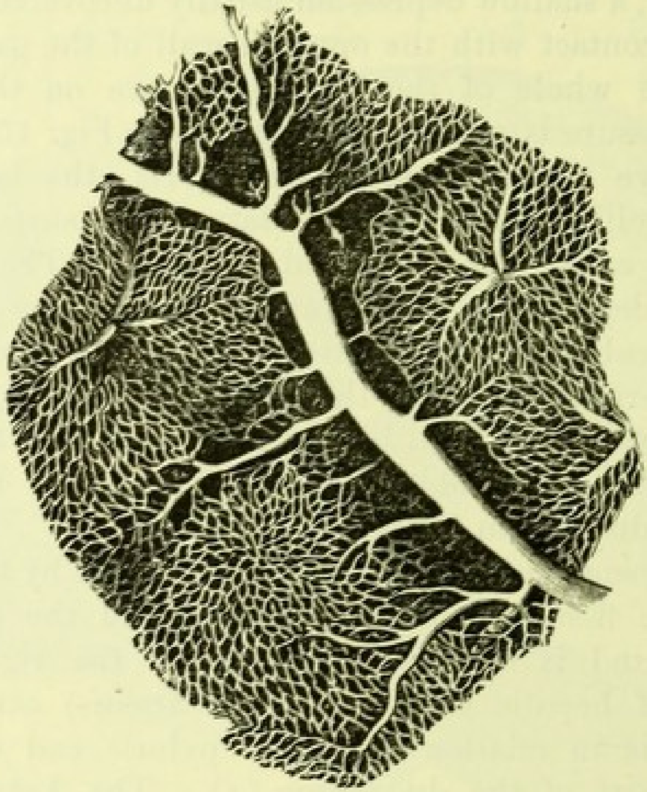
Lobes.—The whole of the liver substance on the right of the longitudinal fissure is strictly the *right lobe* (Fig. 157), but certain parts of it have received special names, viz., the lobus quadratus, the lobus Spigelii and the lobus caudatus: the surface to the right of these being called the 'right lobe proper.' The right lobe has three shallow depressions on its under surface, one anterior, where the ascending colon touches the liver (19), one posterior, corresponding to the anterior surface of the right kidney (21), over which it lies in the erect posture, and between and to the left of these near the neck of the gall-bladder a small impression for the hepatic flexure of the duodenum (15).

The *Lobus quadratus* is a square lobe bounded by the longitudinal and transverse fissures, the gall-bladder, and the anterior border of the liver, and is often connected with the right lobe proper by a bridge of hepatic substance (*pons hepatis*) across the round ligament; it is in relation with the pyloric end of the stomach and the first part of the duodenum (1). The *Lobus Spigelii* (12) lies behind the transverse fissure, and between the fissures for the vena cava and the ductus venosus. It will be described with the posterior surface. The *Lobus caudatus* (11) is a small 'tail' of liver substance which connects the lobus Spigelii with the right lobe proper, and lies behind the transverse fissure. It forms the upper boundary of the foramen of Winslow and is covered by the peritoneum connecting the greater with the lesser sac. The *left lobe* is on the opposite side of the longitudinal fissure. It presents a rounded prominence corresponding to the lesser omentum, the *tuber omentale* (4), and around this, nearer the marginal border, a concavity, the *gastric impression* (1) which is continuous with the gastric area upon the under surface of the lobus quadratus, and with a rounded *œsophageal notch* (6), on the posterior border for the abdominal portion of the œsophagus.

The vessels entering the transverse fissure should be defined, and the fibrous tissue around them (capsule of Glisson) removed. The *right* and *left hepatic ducts* will be found to emerge from the corresponding lobes and to unite in the *common hepatic duct*, which is about two inches long; this is afterwards joined by the *cystic duct* from the gall-bladder, and forms the *common bile duct* (ductus communis choledochus), a tube nearly three inches long, which should be traced into the duodenum.

The **posterior surface** consists of (1) a small portion of the left

Fig. 158.



lobe, together with its *œsophageal notch* near the termination of the longitudinal fissure; (2) the greater part of the *fissure for the ductus venosus;* (3) nearly the whole of the lobus Spigelii; (4) the *fissure for the vena cava,* with, perhaps, a *ponticulus* or little bridge of hepatic substance crossing the fissure behind the vessel; (5) the portion *of the right lobe proper* which lies between the layers of the coronary ligament and in direct contact with the diaphragm. It is here that an important anastomosis occurs between the phrenic and hepatic vessels. The *Lobus Spigelii* * is an oblong lobe

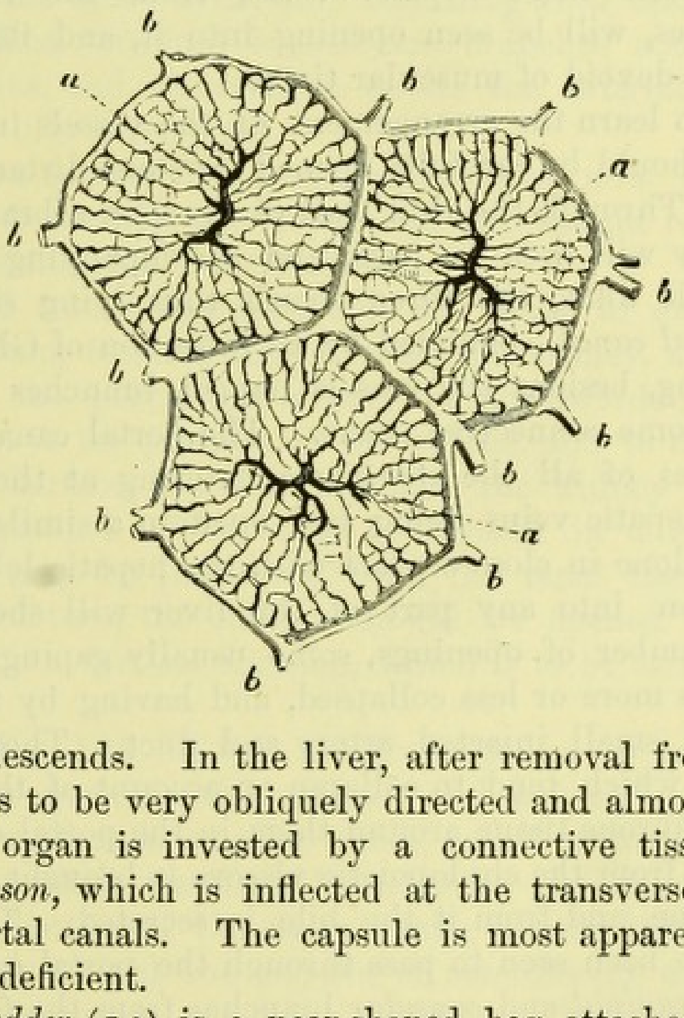
Fig. 158.—Rabbit's liver injected, showing a portal vein, with interlobular branches and plexus. Intralobular vein commencing in the centre of a lobule (from Frey).

* In a liver removed from the body the lobus Spigelii appears to form a part of the under surface of the organ and the aortic impression upon its surface is lost.

bounded below and in front by the transverse fissure, on the left by the fissure for the ductus venosus, and on the right by the fissure for the vena cava; and is connected inferiorly with the right lobe proper by the *lobus caudatus.* Only its lower border belongs to the inferior surface; the rest, looking directly backwards, presents a vertical aortic impression, and is separated from the bodies of the 10th and 11th dorsal vertebræ by the diaphragm and the thoracic aorta. It is the only part of the liver that is covered by the peritoneum of the lesser sac.

The *fissure for the vena cava* is almost vertical, but inclines slightly

Fig. 159.



inwards as it descends. In the liver, after removal from the body, it often appears to be very obliquely directed and almost horizontal.

The entire organ is invested by a connective tissue coat, the *capsule of Glisson,* which is inflected at the transverse fissure and follows the portal canals. The capsule is most apparent where the peritoneum is deficient.

The *gall-bladder* (13) is a pear-shaped bag attached by cellular tissue to the under surface of the liver, and covered superficially by the peritoneum. When distended, its large end or *fundus* projects beyond the anterior border of the liver, and approaches the parietes opposite the point at which the linea semilunaris joins the right

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Fig. 159.—Diagram of the circulation in the lobules of the liver (after Kiernan).

a, *a*, Intralobular veins. *b*, *b*. Interlobular veins.

costal border; the neck is curved upon itself twice and ends in the cystic duct, which is about an inch and a half long and joins the hepatic duct. A fold of peritoneum continuous with the right extremity of the lesser omentum is often attached to its under surface. The mucous membrane in the fundus presents numerous alveoli of irregular shape with intervening ridges, and in the neck a somewhat spiral fold. The epithelium is columnar.

The hepatic artery and the portal vein each divides into right and left branches, and the cystic branch should be traced to the gall-bladder from the right artery.

The piece of the vena cava removed with the liver is to be laid open, when the large hepatic veins, from the right, left and Spigelian lobes, will be seen opening into it, and its coats will be found almost devoid of muscular tissue.

In order to learn the arrangement of the vessels in the liver, the vena portæ should be carefully opened for some distance with a pair of scissors. Through the thin wall of the vein a branch of injected hepatic artery will then be seen, and accompanying it is a branch of the hepatic duct, the three vessels thus lying side by side in a canal (*portal canal*), bounded by an inflection of Glisson's capsule, and containing, besides the vessels named, branches of lymphatics, nerves, and some connective tissue. The portal canal thus encloses representatives of all the structures entering at the portal fissure. One of the hepatic veins being laid open in a similar way, will be seen to run alone in close contact with the hepatic lobules.

An incision into any part of the liver will show on its cut surfaces a number of openings, some usually gaping,—the hepatic veins; others more or less collapsed, and having by their sides the sections of a small injected artery and duct. These last are the portal veins, which tend to collapse on account of the loose attachment of the fibrous tissue around them in the portal canals.

The blood from the chylopoietic viscera is brought to the liver by the vena portæ, and from it the bile is secreted. The divisions of the vein have been seen to pass through the portal canals, in which they receive *vaginal* and *capsular* branches from the fibrous tissue of the organ, and subsequently divide until their branches run *between* the minute lobules or acini, whence they are called *interlobular veins* (*b*). From these interlobular veins is derived the *lobular capillary plexus*, which converges towards the centre of each lobule and pours its blood into the *intralobular vein* (*a*). Each intralobular vein passes out of the lobule at right angles to the portal vessels, and unites with other intralobular veins to form the *sublobular* veins; these open into the *hepatic veins*, which have been traced into the vena cava. The appearance of a piece of minutely injected liver is shown in Figs. 158, 159.

Each primary *hepatic duct* originates from a plexus of intercellular passages or biliary capillaries, which run towards the circumference of the lobule, and unite with radicles of adjacent lobules ; the resulting ducts running along the portal canals by the side of the portal vein to emerge eventually at the transverse fissure.

The *Hepatic artery* is destined principally for the nourishment of the tissue of the organ, and has little if anything to do with its secreting function. It gives off *vaginal* branches which run in the portal canals, and *capsular* branches which supply the fibrous tissue on the surface, the blood eventually returning into branches of the portal vein. The terminal *interlobular* branches accompany the interlobular veins, and their blood enters the interlobular plexus from which the bile is secreted.

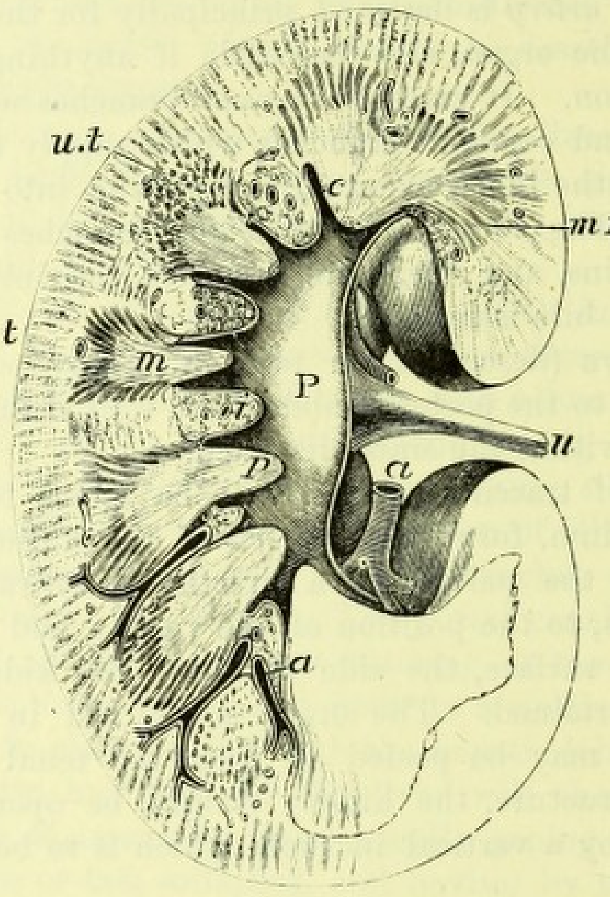
The **Kidneys** (described on page 320) may now be removed. Their relations to the posterior abdominal wall should be noted, and the structures within the sinus dissected.

The ureter, if traced upwards, will be found to expand before reaching the hilum, forming the *pelvis* of the kidney, and it should be noticed that the pelvis has a direction downwards ; so that by referring to this, to the position of the vessels, and to the flattening of the posterior surface, the side to which the kidney belongs can be readily ascertained. The organ is enclosed in a tough fibrous capsule, which may be peeled off from the renal tissue. To see the internal structure, the kidney should be opened through the convex border by a vertical incision, which is to be carried into the pelvis.

The *Pelvis* (Fig. 160, P) will usually be found to be subdivided into two tubular portions, the *superior* and *inferior pelves*, each of which may branch into smaller tubes, called *Infundibula*, before breaking up into their terminal branches or *Calices.* The calices are fixed to the bottom of the sinus *renalis*, around little nodules of kidney substance termed the *papillæ* or *mamillæ* (*c*), which are the apices of the *pyramids of Malpighi* (*m*). These pyramids are conical in form (triangular in the section), and darker in colour than the rest of the tissue, and are arranged more or less regularly side by side. They constitute what is called the *tubular* or *medullary* substance of the kidney ; the lighter granular portion or *cortex* lies at the margin of the section, forming a layer over the bases of the pyramids and sending processes called *Columns of Bertini* (*i*) between them.

The renal artery breaks up into four or five branches, which again subdivide and pass into the columnæ Bertini between the pyramids to the cortical substance, forming *cortico-medullary arches* between the cortex and bases of the Malpighian pyramids. From these arise the *interlobular* arteries, which pass between segments of the cortical substance called *pyramids of Ferrein* (Fig. 160, *c. t*),

Fig. 160.



and give off *afferent* arteries to the *Malpighian bodies* or *glomeruli* (Fig. 161, *g*). Each Malpighian body is enclosed in a *capsule* at the extremity of a minute *uriniferous tube* (1), and consists of a capillary plexus with an arterial twig (or afferent vessel) entering, and a venous radicle (or efferent vessel) leaving it, and these bodies are arranged along the arteries like bunches of currants upon a stalk. The *uriniferous tube* (3) connected with the capsule is convoluted in

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Fig. 160.—Section of kidney (after Henle).

u. t. Uriniferous tubes.
c. t. Cortex with pyramids of Ferrein.
m. Pyramids of Malpighi.
i. Column of Bertini.
p. Papilla.
c. Calyx embracing papilla.
m. r. Medullary rays.
P. Pelvis.
u. Ureter.
a, a. Artery.

the cortical substance, and a secondary *intertubular plexus* is formed around it by the venous radicle which emerges from the Malpighian

Fig. 161.

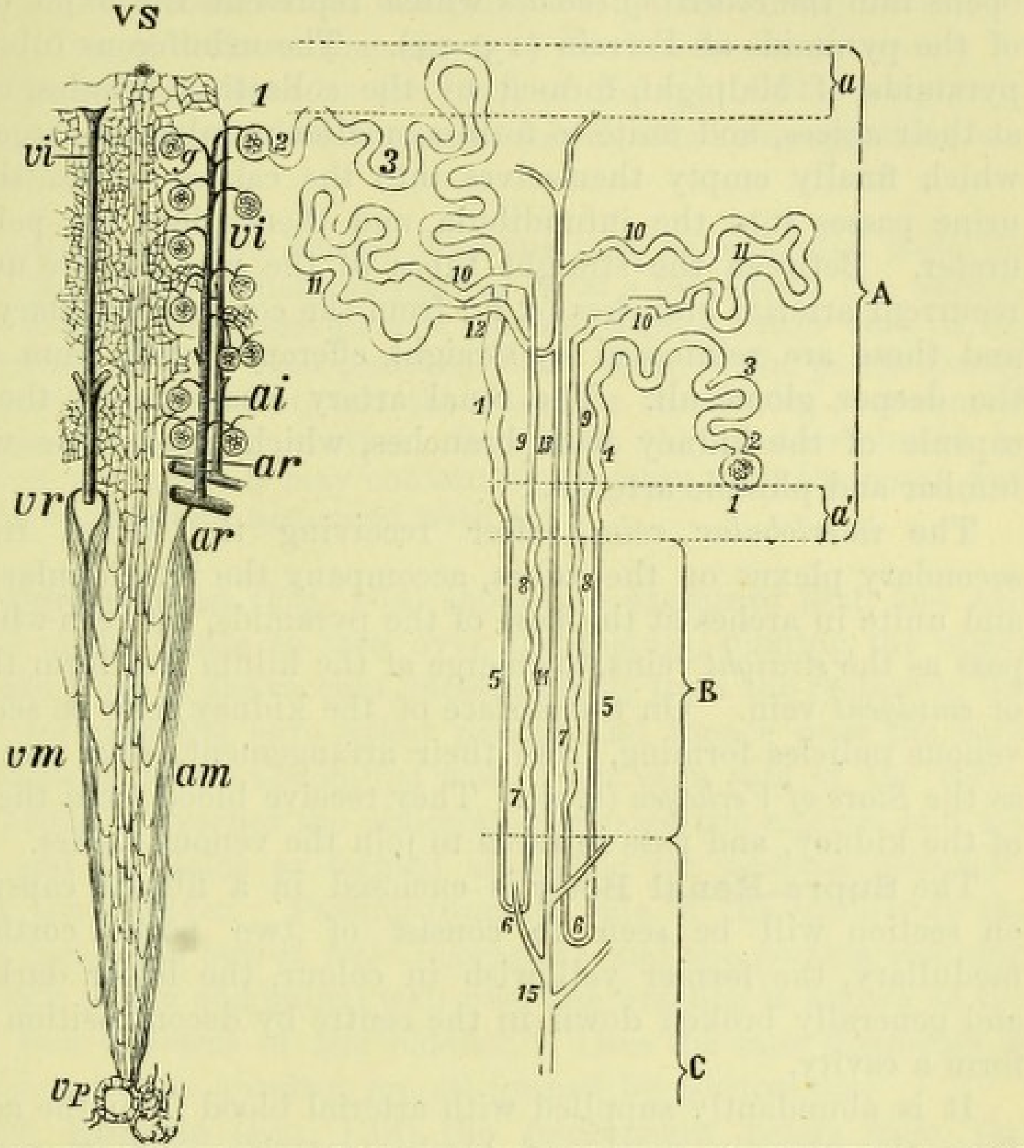


Fig. 161.—Scheme of the renal tubes and blood-vessels (from Wilson : modified from Klein).

On the left of the figure the arrangement of the blood-vessels of the kidney is shown, on the right the course of the uriniferous tubules.

v. s. Venæ stellatæ of Verheyen.
v. i. Interlobular veins.
v. r. Venæ rectæ.
m. v. Veins of medullary part.
v. p. Veins of papillæ.
a. i. Interlobular artery.
g. Glomerulus.
a. r. Arteriæ rectæ.
a. m. Arteries of medullary part.
A. Cortex.
B. Boundary zone.
C. Papillary zone of medulla.
a. a'. Superficial and deep layers of cortex, free of glomeruli.

1. Malpighian capsule.
2. Neck.
3. First convoluted tubule.
4. Spiral tubule of Schachowa.
5. Descending limb of looped tubule of Henle.
6. Bend.
7, 8, 9. Ascending limb.
10. Irregular tubule.
11. Second convoluted tubule.
12. Junctional tubule.
13, 14. Collecting tubule.
15. Excretory tubule.

tuft. The tube then becomes suddenly smaller, and passes for a variable distance into the pyramid as the *looped tube of Henle* (5—9); again curving upon itself it reaches the cortex, increases in size, and opens into the *collecting tubules* which represent the axial elements of the pyramids of Ferrein (13, 14). The uriniferous tubes of the pyramids of Malpighi, formed by the collecting tubules, converge at their apices, and unite to form a smaller number of larger tubes, which finally empty themselves into the calices ; from these the urine passes into the infundibula, and thence into the pelvis and ureter. Between the straight tubes of the medulla are numerous recurrent arterial branches (*a. r.*) from the cortico-medullary arches, and these are reinforced by straight efferent vessels from some of the deeper glomeruli. The renal artery also supplies the fibrous capsule of the kidney with branches, which anastomose with the lumbar and phrenic arteries.

The *interlobular veins*, after receiving the blood from the secondary plexus on the tubes, accompany the interlobular arteries and unite in arches at the base of the pyramids, between which they pass as the *straight* veins, to emerge at the hilum and form the renal or *emulgent* vein. On the surface of the kidney may be seen small venous radicles forming, from their arrangement, what are known as the *Stars of Verheyen* (*v. s.*). They receive blood from the capsule of the kidney, and pass inwards to join the venous arches.

The **Supra-Renal Body** is enclosed in a fibrous capsule, and on section will be seen to consist of two parts, cortical and medullary, the former yellowish in colour, the latter dark brown and generally broken down in the centre by decomposition so as to form a cavity.

It is abundantly supplied with arterial blood from the aorta and from the phrenic, renal, and lumbar arteries ; and its nerves are derived from the solar plexus. The form and relations have been described on p. 322.

THE PELVIS.

The subject being replaced on its back, the dissectors should proceed with the examination of the pelvis, unless they were unable to finish the aorta, lumbar plexus, and iliac arteries before the body was turned, in which case they must revert to the dissection of them at once (*v.* p. 311). In any case the dissectors are strongly advised to read through the dissection of the deep parts of the abdomen again, before proceeding any further.

They should, moreover, observe that the pelvic cavity bends backwards at an angle of about 110° with that of the abdomen ;

that the plane of its inlet looks forwards rather than upwards, forming an angle of 150° to 155° with a vertical line striking the promontory of the sacrum; and that the symphysis and sacrum are more nearly horizontal than vertical. From this strong inclination of the pelvis it follows that most of the viscera in its cavity lie above a horizontal plane at the level of the top of the symphysis, and are hence more or less accessible to palpation through the abdominal wall.

[The pelvis with two lumbar vertebræ is to be separated from the trunk with the saw, when, by placing it on a table with the sacrum towards himself, the dissector will be able to get a better view of the contents than has yet been possible. The cavity of the pelvis should be carefully sponged out, and the dissector should let a stream of water run through the rectum, after which the bladder should be emptied of any urine it may contain by pressure with the hand, and should be moderately distended with air.]

The **Peritoneum** (Fig. 164) should be examined first, and will be found in the **Male** to pass over the rectum, binding the upper part to the front of the sacrum (*meso-rectum*); from the rectum to the bladder, forming the *recto-vesical pouch;* and thence over the back of the bladder to the abdominal wall. On each side of the recto-vesical pouch it overlies the obliterated hypogastric arteries and the ureters, and the folds so formed are called the *posterior false ligaments* of the bladder. Passing from the side of the bladder to the pelvis it forms the *lateral false ligaments;* and the portion reaching to the back of the abdominal wall over the urachus is known as the *superior false ligament* of the bladder. Thus the false ligaments of the bladder, five in number, are all formed by peritoneum.

In the **Female** (Fig. 133) the peritoneum passes from the rectum to the posterior wall of the vagina, about an inch below its attachment to the cervix uteri, forming the *recto-vaginal pouch of Douglas* and *posterior ligaments of the uterus* (Fig. 136), thence over the body of the uterus, and from the front of the cervix to the bladder, forming the *utero-vesical pouch.* On each side of the uterus it is stretched across the pelvis, forming the *broad ligament* of the uterus, which contains the round ligament in front, the ovary and its ligament behind, the Fallopian tube above, and a quantity of vessels, connective tissue, and unstriped muscular fibre. The false ligaments of the bladder are the same as in the male, but are less distinctly marked; and the reflections of peritoneum from the bladder to the uterus in front has been named the *anterior* ligaments of the uterus.

[The peritoneum is to be stripped off the upper part and sides of the bladder, but the recto-vesical pouch is not to be interfered with at present. By scraping away a little fat with the handle of the knife the pelvic fascia will be brought into view, but to examine it from the outside thoroughly the following dissection must be made. One dissector holding the pelvis firmly, the other is to clear away the remains of the adductor muscles on the left side of the pubes so as to expose the obturator externus muscle, which must then be carefully removed. Beneath the muscle will be found the branches of the *obturator artery*, forming a circle around the foramen and lying upon the obturator membrane, which gives passage to both obturator artery and nerve at its upper part. On removing the obturator membrane, the fibres of the obturator internus muscle will be brought into view. With the saw a horizontal cut is now to be made from the upper margin of the obturator foramen into the cotyloid cavity, and a similar one at the lower margin of the obturator foramen, the extremities of the two cuts being about an inch apart in the bottom of the cavity. These are to be joined by a vertical cut with the chisel, and the piece of bone having been loosened with that instrument, can be removed with the bone-forceps. With the chisel and bone-forceps the margins of the obturator foramen may then be cut away so as to leave only a ring of bone. The obturator internus being now fully exposed, should be carefully detached from the adjacent structures, and may then be readily removed by grasping the tendon with the bone-forceps and drawing the whole muscle out through the lesser sacro-sciatic foramen. The outer surface of the pelvic fascia will then be exposed.]

The **Pelvic Fascia** (Figs. 162, 163) consists of several more or less distinct planes, which are however in many places continuous with one another.

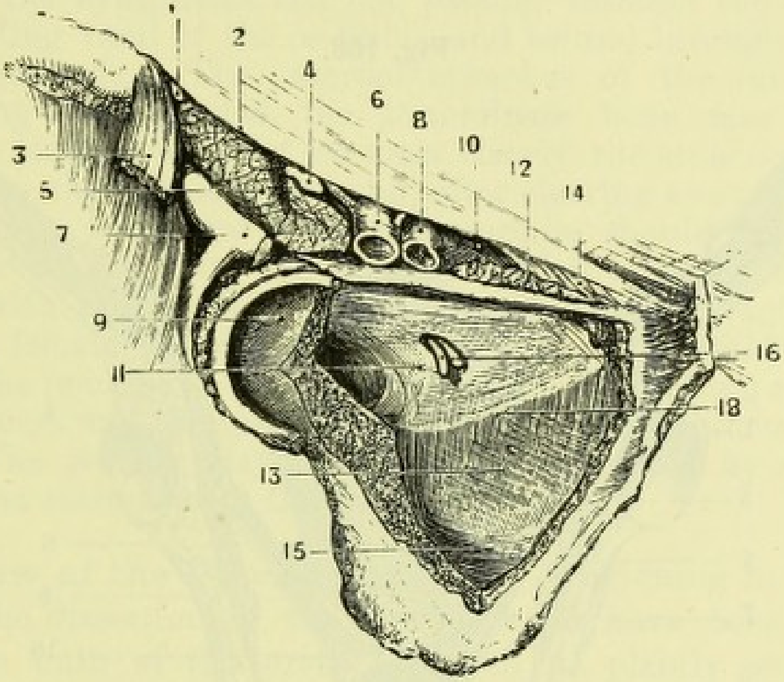
1. The *obturator fascia* (*pelvic fascia proper*), the outer surface of which has been exposed in the dissection described above, is the special fascia of the obturator internus muscle, to the inner surface of which it is applied. It is fixed round the margins of the attachment of the muscle, viz., to the back of the symphysis in front, to the upper border of the true pelvis above, to the margin of the great sciatic notch behind, and to the ischial tuberosity and the great sacro-sciatic ligament and pubic arch below. It forms a channel (*canal of Alcock*) for the pudic vessels and nerves in the outer wall of the ischio-rectal fossa, and, marginally, it is closely related to the deep layer of the triangular ligament which bridges across the subpubic arch (Fig. 163, 4).

2. The *fascia over the pyriformis* covers the muscle of that name. It is continuous with the posterior part of the recto-vesical fascia.

3. The *recto-vesical fascia* (Fig. 163, 8) has a parietal layer

covering the levatores ani and coccygei, and a visceral layer investing and binding down the pelvic viscera. It is fixed in front to the back of the pubic bones above the origin of the levatores ani, and dips down between these muscles as far as the apex of the prostate, forming two rounded folds, the *anterior true (pubo-prostatic) ligaments of the bladder*, beneath which lie the dorsal vein

Fig. 162



of the penis, opening into the prostatic plexus, and the vesico-pubic muscles derived from the anterior wall of the bladder. Laterally it blends with the obturator fascia along a curved fibrous band known as the *white line*, which extends from the back of the pubic bone to the ischial spine, and gives origin to the greater part of the levator ani. It covers the upper surface of the levator ani and coccygeus, and is reflected from these upon the prostate, bladder and rectum, and upon the vagina in the female; while posteriorly it is connected to the pyriformis fascia, and in front is

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Fig. 162.—Pelvic fascia seen from the outside (drawn by J. T. Gray).

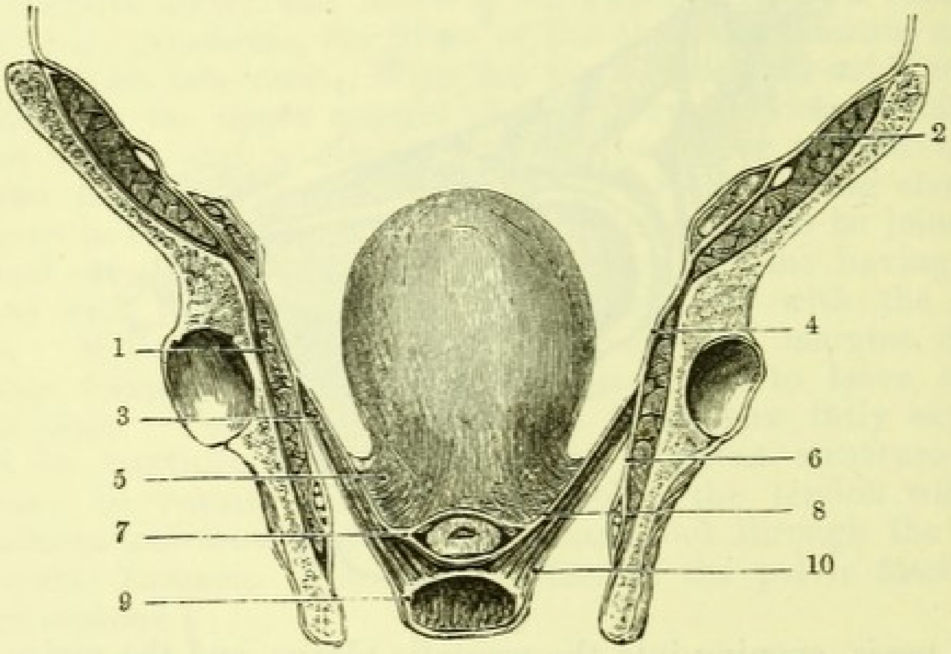
1. External cutaneous nerve.
2. Poupart's ligament.
3. Sartorius.
4. Anterior crural nerve.
5. Psoas and iliacus muscles.
6. Femoral artery.
7. Origins of rectus femoris.
8. Femoral vein.
9. Acetabulum, partly removed.
10. Crural ring.
11. Pelvic fascia.
12. Pectineus muscle.
13. Obturator fascia.
14. Gimbernat's ligament.
15. Pudic vessels and nerve in sheath of fascia.
16. Obturator vessels and nerve.
18. Fascial origin of levator ani (white line).

in contact with the deep layer of the triangular ligament (Fig. 114, 12).

4. The *ischio-rectal* or *anal fascia* is a thin membrane covering the outer or perinæal surface of the levator ani, and is derived from the obturator fascia (Fig. 163, 10).

The *deep triangular ligament*, which has been previously described, might be included amongst this system of fasciæ; for it stretches across the pubic arch, and blends at its attachment to the

Fig. 163.



bones with the obturator fascia, of which it may be regarded as a continuation (Fig. 114, 20).

The *ischio-rectal fossa* is an interspace between the ischio-rectal fascia and that part of the obturator fascia which lies below the white line. It is bounded above by the angle of divergence of the two fasciæ, and sends a forward extension above the perineal ledge nearly as far as the pubic bone, and a posterior extension over the great sciatic ligaments (*v.* p. 232).

Thus, the levator ani muscle is seen to be enclosed between the

Fig. 163.—Section of pelvis to show the pelvic fascia from the front (drawn by J. T. Gray).

1. Obturator internus.
2. Iliac fascia attached above to inner lip of iliac crest.
3. Levator ani.
4. Obturator fascia.
5. Lateral ligament of bladder.
6. Obturator fascia, splitting below to enclose pudic vessels and dorsal nerve of the penis.
7. Capsule of prostate.
8. Recto-vesical fascia.
9. Rectum (cut).
10. Anal fascia.

recto-vesical and ischio-rectal layers of fascia ; the ischio-rectal fossa is lined by the obturator and ischio-rectal layers ; and four of the true ligaments of the bladder are formed by the recto-vesical layer,—the fifth being the obliterated urachus.

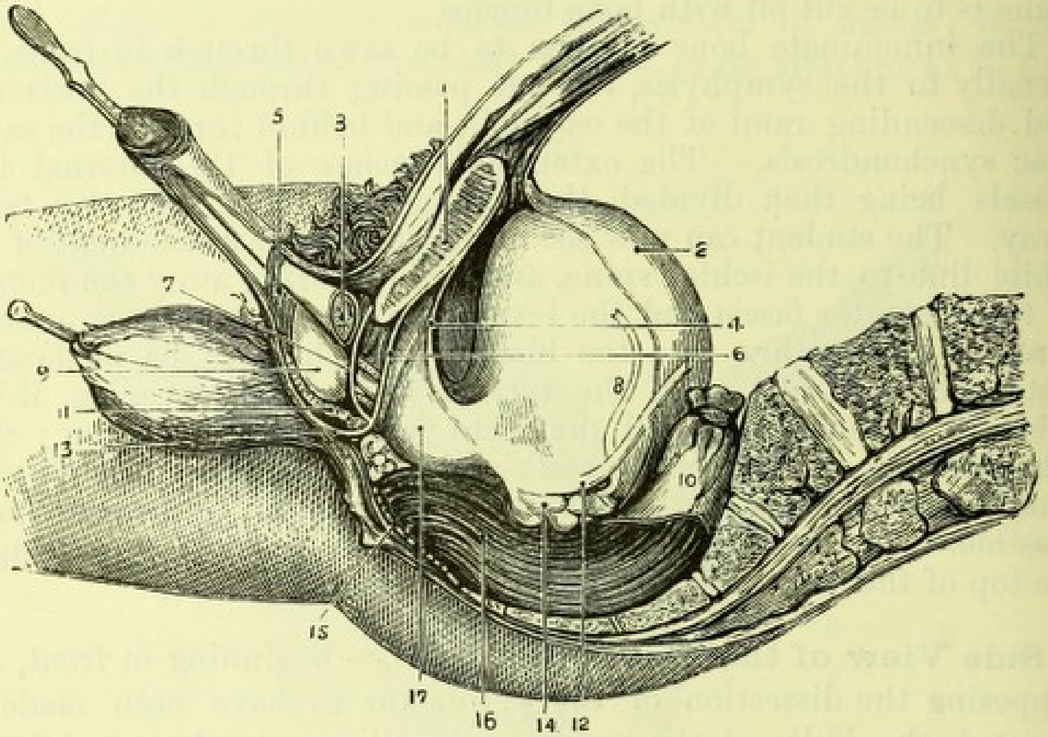
[On the left side, the obturator fascia and the triangular ligament are to be separated from their bony attachments, and the ischial spine is to be cut off with bone forceps.

The innominate bone is then to be sawn through in front, externally to the symphysis, the cut passing through the horizontal and descending rami of the os pubis, and behind through the sacro-iliac synchondrosis. The external branches of the internal iliac vessels being then divided, the innominate bone may be taken away. The student can now see more clearly the attachment of the white line to the ischial spine, and, after clearing away the remains of the obturator fascia and the levator ani, he should pass a sound through the urethra into the bladder (which is to be moderately distended with air), stuff the rectum and also the vagina, if the subject be a female, and fill the recto-vesical pouch with tow ; then take away the remains of the recto-vesical fascia, cleaning at the same time the viscera and the branches of vessels going to them as far as possible. The rectum may conveniently be secured by a string to the top of the sacrum or to the lumbar vertebra.]

Side View of the Pelvis (Fig. 164).—Beginning in front, and supposing the dissection of the perinæum to have been made as directed, the bulb of the urethra (9) will be plainly seen lying in contact with the inferior surface of the superficial triangular ligament (7), which has been purposely left untouched on the left side. The two triangular ligaments will be recognised, and between them will be seen the cut edge of some pale muscular fibres, the *compressor urethræ* or *deep transversus perinæi* (Henle). The staff may be felt through this as it lies in the membranous portion of the urethra, which by a little dissection will be exposed, and may be seen in a favourable subject to be surrounded by a circular sphincter of unstriped muscular fibres. One of Cowper's glands, resembling a pea in size and appearance, may be found immediately below the urethra, and its duct pierces the superficial triangular ligament. Behind the membranous portion of the urethra will be found the remains of the lateral true ligament of the bladder and the sheath of the prostate (6), both derived from the recto-vesical fascia.

The **Membranous portion of the Urethra** is a very important part, and should be specially noticed in the present view. It is seen to extend from the deep to the superficial layer of the triangular ligament. It is one half an inch in length, and is inclined downwards and slightly forwards, the lower end lying about one inch from the lower border of the pubic symphysis. This is the portion of the urethra opened by the deep incision in lithotomy, and it should be noticed how much its position will vary according to the movements of the staff,—whether that instrument be hooked under the pubic arch or depressed towards the rectum.

Fig 164.



The sheaths derived from the recto-vesical fascia should be traced on to the prostate, bladder, and rectum, and these organs are to be cleaned, and their relations to one another noticed.

Fig. 164.—Section of pelvis to the left of the median line at the pubes, and through the middle line of the sacrum (drawn by J. T. Gray).

1. Section of left pubic bone.
2. Peritoneum on bladder.
3. Left crus penis (cut).
4. Recto-vesical fascia forming anterior ligaments of bladder.
5. Part of accelerator urinæ.
6. Superior layer of triangular ligament, or pelvic fascia, continuous with the capsule of the prostate.
7. Inferior layer of triangular ligament, or deep perinæal fascia.

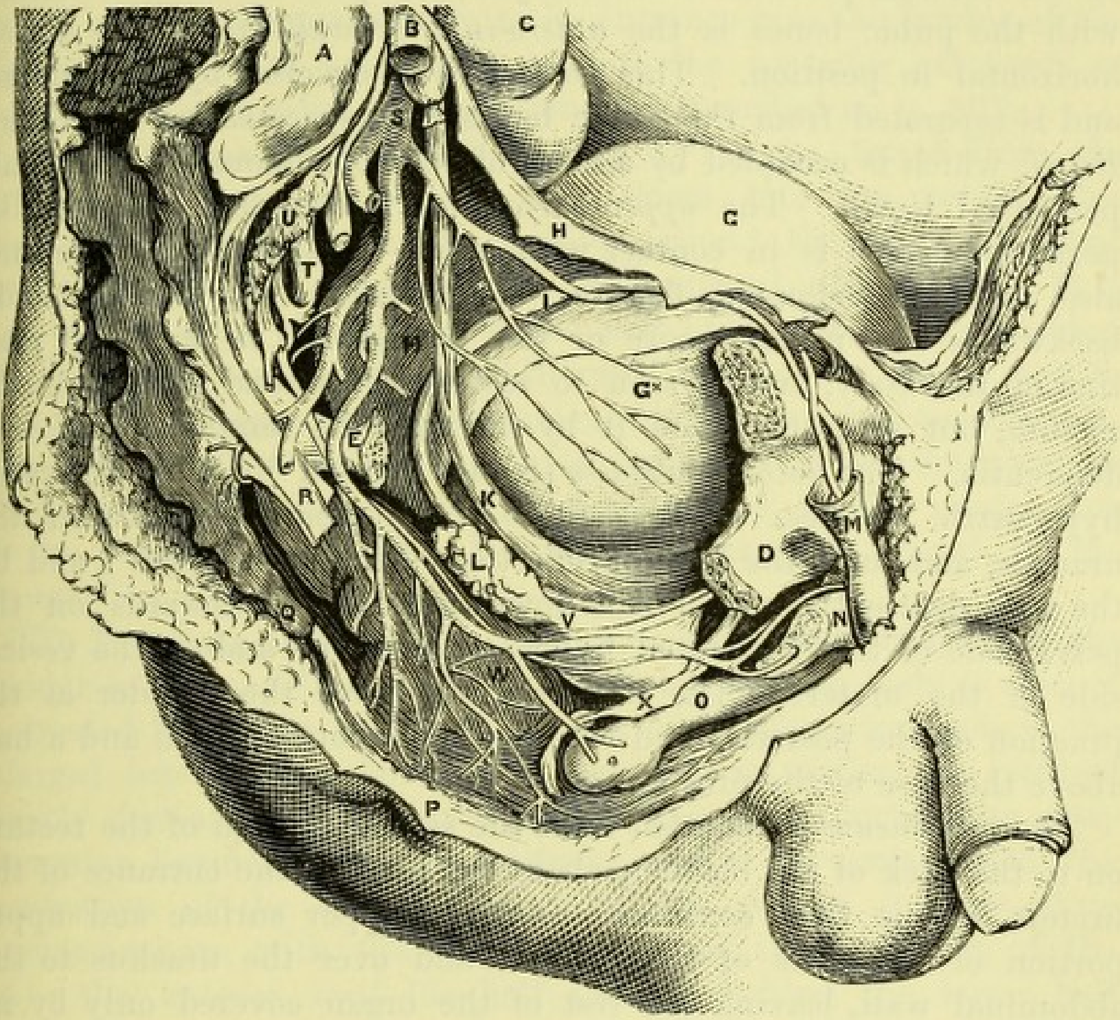
Between 6 and 7 are seen the following: — membranous urethra, deep muscles of urethra (insertion), and Cowper's gland of the left side.

8. Vas deferens.
9. Bulb of urethra.
10. Rectum.
11. Cut edges of accelerator urinæ and transversus perinæi.
12. Left ureter.
13. Reflection of deep layer of superficial fascia round transversus perinæi.
14. Left vesicula seminalis.
15. Cut edge of levator ani.
16. Rectum.
17. Prostate.

The **Rectum** (Fig. 164, 10) has been described on page 304.

[The left vesicula seminalis should be dissected and its position noted, and the vas deferens and ureter of the left side are also

Fig. 165.



to be traced out; the recto-vesical pouch of peritoneum is to be laid open along the side, so that its extent may be fully appreciated.]

Fig. 165.—Side view of male pelvis (from Maclise's Surgical Anatomy).

A. Sacrum.
B. External iliac artery.
C. Upper end of rectum.
D. Ramus of pubes.
E. Spine of ischium (cut off).
G. Bladder covered by peritoneum.
H. Bladder uncovered by peritoneum.
I. Vas deferens.
K. Ureter.
L. Vesicula seminalis.
M. Spermatic cord.
N. Crus penis.
O. Urethra. o. Bulb.
P. Sphincter ani.
Q. Coccyx.
R. Sacro-sciatic ligament.
S. Internal iliac artery.
T. Sacral nerves.
U. Pyriformis.
W. Pudic artery and nerve.
X. Triangular ligament (cut).

The **Bladder** (Fig. 164, 2) varies in position according to its state of distension, lying behind the pubic bones when empty, but rising from the pelvis into the abdomen when distended. The so called *neck* of the bladder is the commencement of the prostatic urethra, and its "*apex*" is represented by the attachment of the urachus. In the vertical position of the subject, the part which is in contact with the pubic bones is the *antero-inferior wall* (3), and is almost horizontal in position. This surface is uncovered by peritoneum, and is separated from the pubic bones by a space called the *cavum Retzii*, which is occupied by a mass of fat continuous with the sub-peritoneal tissue. The *upper surface* (2) is completely covered by peritoneum, and is in contact with small intestine and sometimes also with the sigmoid flexure. The *posterior surface* (4) looks backwards and usually more or less downwards in the erect position of the body, and is seen to rest on the second portion of the rectum, but separated from it by the vesiculæ seminales and vasa deferentia. The *lateral surfaces* (8) are crossed by the obliterated hypogastric arteries, which pass to the abdominal wall near the urachus, and limit the line of reflection of the peritoneum ; and by the vasa deferentia, which run downwards and backwards on the pelvic side of the obliterated hypogastric arteries and on the vesical side of the ureters. The ureters (12) pierce the bladder at the junction of the posterior and lateral walls, about an inch and a half above the base of the prostate.

The *peritoneum* is reflected from the second portion of the rectum on to the back of the bladder, about the level of the entrance of the ureters, and is then continued over the upper surface and upper portion of the sides of the bladder and over the urachus to the abdominal wall, leaving the rest of the organ covered only by its investment of ischio-rectal fascia (Fig. 164, 2).

It should be noticed how much the extent of bladder uncovered by peritoneum, both above and below, depends upon the distension of the viscus ; since, in the contracted state the antero-inferior surface is in contact with the pubic bones, whilst in the distended condition it rises above the bone usually for a distance of two inches or more, and lies against the posterior surface of the anterior abdominal muscles. Thus tapping above the symphysis may generally be effected without injury to the serous membrane, but as the peritoneal fold occasionally fails to rise the operation is not free from danger. The depth of the recto-vesical pouch will similarly be found to vary, the peritoneum reaching nearer to the prostate when the bladder is empty than when it is full ; consequently the operation of tapping by the rectum can be only safely undertaken when the bladder is distended. The average distance of the recto-vesical pouch from the anus is $2\frac{1}{2}$ inches when both rectum and bladder are empty, and $3\frac{1}{2}$ inches when the bladder is distended (Cripps).

The left **Ureter** (Fig. 164, 12), descending from the kidney, is contained in the root of the posterior false ligament of the bladder (or in the root of the broad ligament in the female), and now can be traced beneath the peritoneum to its entrance into the fundus of the bladder, at a point below and beneath the posterior extremity of the vesicula seminalis. Its relations are described on p. 322.

The left **Vas Deferens** (Fig. 164, 8) can be traced from the testicle, and has been seen to turn down into the pelvis after leaving the inguinal canal, hooking around the deep epigastric artery, and to the inner side of the external iliac artery. It is now seen to wind over the posterior part of the side of the bladder, crossing the outer side of the obliterated hypogastric artery, and to be continued beneath the peritoneum to the base of the bladder, where it passes to the inner side of the ureter above the point at which the latter pierces the bladder wall, and to the mesial side of the vesicula seminalis. It will be afterwards traced to the prostate.

The **Prostate Gland** (Fig. 164, 17) is now seen in front of the bladder as the part lies on the table; but when the body is erect it is situated below the bladder, the neck of which corresponds to the enlarged *base* of the gland. Its long axis is vertical or inclined slightly forwards at its lower end. The *apex* touches the deep triangular ligament (6); the *posterior wall* is in contact with the termination of the second portion of the rectum (or, according to some authors, with the commencement of the third part of the gut); the *anterior wall* lies half an inch behind the lower half of the pubic symphysis, but is separated from it by a portion of its capsule, a plexus of veins, the pubo-prostatic ligaments, and the vesico-pubic muscular fibres; the *sides* are in contact with the anterior borders of the levatores ani. It is enclosed by a process of recto-vesical fascia which forms the *capsule*, between the layers of which lies the large prostatic plexus of veins. Structurally it is composed partly of glandular, partly of muscular tissue. The urethra passes through its substance nearer the anterior than the posterior surface (see also p. 368).

[A transverse cut is now to be made at the bottom of the recto-vesical pouch, which will allow the bladder to be drawn forward, when a little dissection will expose that part of the surface of the viscus uncovered by peritoneum which lies over the rectum.]

The portion of the base of the bladder uncovered by peritoneum is triangular in shape. It is bounded at the sides by the *vasa deferentia* and *vesiculæ seminales*, the latter being external to the former; above by the reflection of peritoneum at the line of the entrance of the ureters, and the apex is at the back of the prostate. It is here that the bladder is opened when punctured from the rectum.

The recto-vesical layer of pelvic fascia can now be traced between the rectum and bladder (p. 347), giving a covering to those organs, to the prostate, and to the vesiculæ seminales.

The **Vesiculæ Seminales** (Fig. 164, 14) are two branched and convoluted sacs, placed between the fundus of the bladder and the rectum, lying externally to the vesiculæ seminales, and converging to enter the base of the prostate close to the median line. When *in situ* they are about three inches in length, somewhat expanded at their posterior extremities, and are broad above and narrow where they approach the vasa deferentia at the base of the prostate. The superior extremities, which overlap the ureters, are about two inches and a half apart, and are covered by the anterior layer of the peritoneum of the recto-vesical pouch. The branching is not visible until the bodies are dissected.

The **Vasa Deferentia** become somewhat enlarged, sacculated and present short diverticula on dissection where they pass beneath the bladder between the vesiculæ seminales, but are very narrow where they join with the ducts of the latter to form the common ejaculatory ducts (Fig. 172, 12).

In the Female (Fig. 178), the short urethra will be seen to pass obliquely downwards and slightly forwards from the bladder, piercing the triangular ligaments; and immediately below and behind it is the vagina passing up to the uterus [which must be held in position by a string passed through its fundus]. The rectum occupies the same position as in the male, but is rather larger; the peritoneum will be seen to pass from it to the posterior surface of the upper part of the vagina, to form the recto-vaginal pouch, and is then reflected over the body of the uterus to form the utero-vesical pouch.

The recto-vesical fascia gives coverings to the rectum and vagina. This should be defined, and the latter canal may be laid open along the side to study the position of the *os uteri*.

The bladder, urethra, and other pelvic organs in the female are described on p. 376, *et seq*.

The viscera of the pelvis being drawn down to the left, the internal iliac vessels and sacral plexus of the right side can be examined; the position of many of them on the left side having been previously, as far as possible, ascertained. Opportunity may be taken to trace branches of the sympathetic nerve to the sides of the pelvic organs.]

The **Internal Iliac Artery** (Fig. 166, 4) is a branch of the common iliac, arising opposite the lumbo-sacral articulation, and immediately passing into the pelvis. It is usually about an inch to an inch and a half long, and is smaller than the external iliac. In the fœtus it is proportionally much larger, as the *hypogastric artery*, the direct continuation of the common iliac in size and direction, passed forwards over the bladder to the umbilicus; but this is now converted into a fibrous cord, which however is pervious for a short distance, and thus gives branches to the bladder. The internal iliac is crossed at its origin by the ureter, and closely covered by the peritoneum in front; behind it are the internal iliac vein, the sacrum and the lumbo-sacral cord, and in the female the ovary rests in a depression (fossa ovarica) between the artery and the vein. At the upper border of the great sacro-sciatic notch it divides into *anterior* and *posterior* trunks, which give branches to the viscera and to the inside and outside of the pelvis.

Branches (Fig. 166).—From the anterior division are given off three visceral and three parietal branches; from the posterior division three parietal branches.

Anterior Division.

Visceral branches.	Superior vesical. Inferior vesical. Middle hæmorrhoidal.	Parietal branches.	Obturator Pudic. Sciatic.

Uterine / Vaginal — additional in female. The vaginal corresponding to the inferior vesical in the male.

Posterior Division.

Parietal branches.	Gluteal. Ilio-lumbar. Lateral sacral.

1. The *Superior Vesical* (7) arteries are small branches from the unobliterated portion of the hypogastric artery, which are distributed to the upper part of the bladder. A *middle vesical* branch is sometimes derived from one of these, and from another or from the inferior vesical is derived the *artery of the vas deferens*, which accompanies the duct to the testicle and anastomoses with the

spermatic artery. In the female this vessel is represented by the *funicular artery* to the round ligament.

Fig. 166.

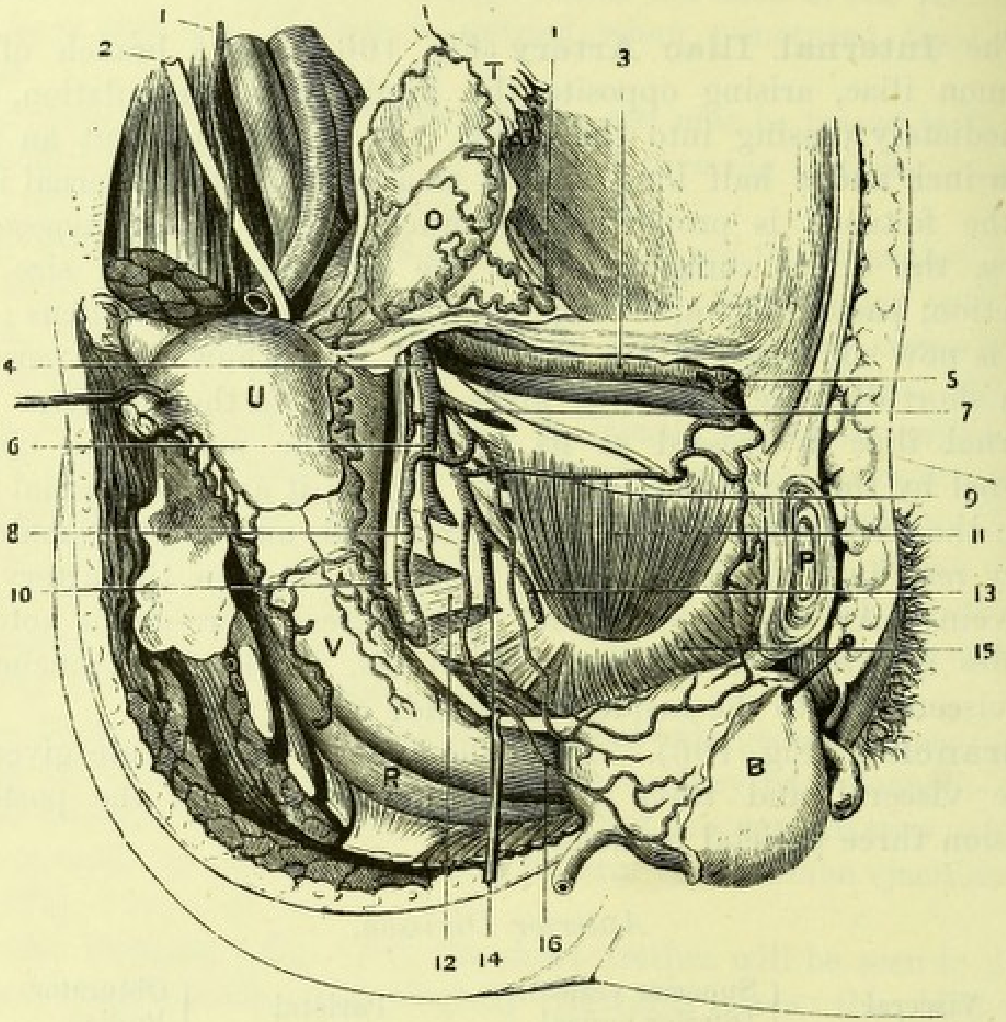


Fig. 166.—Side view of female pelvis with internal iliac artery (altered from Savage).

1. 1. Spermatic or ovarian artery.
2. Right ureter (cut).
3. External iliac vessels.
4. Internal iliac artery.
5. Epigastric artery giving off an obturator branch.
6. Posterior trunk of internal iliac dividing into gluteal, ilio-lumbar, and lateral sacral branches.
7. Anterior trunk of internal iliac artery giving off superior vesical and uterine arteries, and ending in the obliterated hypogastric (cut).
8. Uterine artery anastomosing with the ovarian in the broad ligament, and giving off a vaginal branch.
9. Obturator artery.
10. Left ureter.
11. Obturator internus.
12. Sacral plexus.
13. Pudic artery.
14. Sciatic artery.
15. Levator ani.
16. Inferior vesical and middle hæmorrhoidal arteries.

B. Bladder.
U. Uterus.
O. Ovary.
T. Fallopian Tube.
R. Rectum.
V. Vagina.
P. Pubes

2. The *Inferior vesical* and 3, *Middle hæmorrhoidal* (16) arteries generally come off together, and are distributed to the posterior surface of the bladder, the prostate, the vesiculæ seminales, and the adjacent portion of the rectum. The middle hæmorrhoidal artery anastomoses with the superior hæmorrhoidal branch of the inferior mesenteric above, and with the inferior hæmorrhoidal branch of the pudic artery below. The arteries of the bladder anastomose freely with one another, and with those on the opposite side.

4. The *Uterine* (8) and *Vaginal* arteries supply those organs, the uterine passing in the base of the broad ligament as far as the cervix, and then running up close to the side of the body of the organ and giving branches to its anterior and posterior surfaces. It anastomoses at the superior angle of the uterus with the ovarian and funicular arteries, and inferiorly with the vaginal.

5. The *Obturator* (9) artery passes directly forwards, below the level of the nerve and above that of the vein, to the obturator foramen, through which it disappears with the nerve, after giving off a small *pubic* branch to the back of the bone, and an *iliac* branch to the iliacus internus and ilium. The pubic branch anastomoses with a pubic branch of the deep epigastric. The distribution of the obturator artery outside the pelvis has been already seen on the right side, but may now be followed out on the left side.

When the obturator arises from the epigastric artery, there is generally a small branch running in the proper position with the obturator nerve (*v.* p. 125).

6. The *Pudic* (13) and 7, the *Sciatic* (14) arteries can only be seen for a short distance within the pelvis, as they lie on the pyriformis and sacral plexus before passing through the lower part of the greater sacro-sciatic foramen below that muscle. The pudic is generally smaller than the sciatic, and a little in front of it, but the size and relative positions of the vessels vary. If the perinæum and the buttock have been dissected, the opportunity may be taken to trace the sciatic artery through the great sacro-sciatic foramen to its distribution outside the pelvis, and to follow the pudic in its course around the spine of the ischium, and through the lesser foramen to the perinæum, where it will be seen running close to the margin of the os pubis (Fig. 115, 9).

The three parietal branches from the *Posterior Division* of the internal iliac artery (Fig. 168) are, the gluteal, the ilio-lumbar, and the lateral sacral arteries.

1. The *Gluteal* artery is a thick trunk, disappearing at once through the upper part of the great sacro-sciatic foramen, between the lumbo-sacral cord and the first sacral nerve, and above the

Fig. 167.

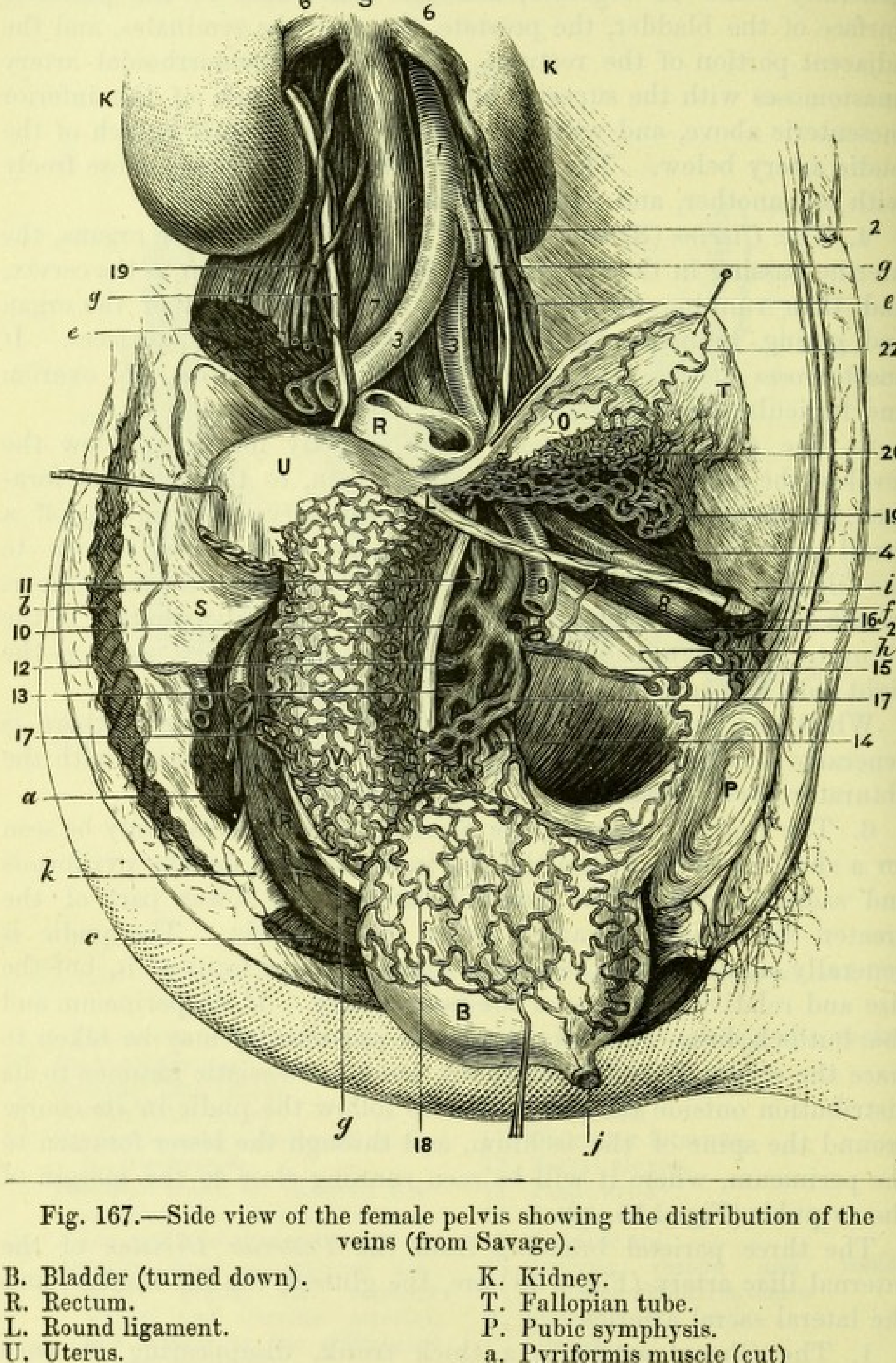


Fig. 167.—Side view of the female pelvis showing the distribution of the veins (from Savage).

B. Bladder (turned down).
R. Rectum.
L. Round ligament.
U. Uterus.
O. Ovary.
V. Vagina.
S. Sacro-iliac synchondrosis.
K. Kidney.
T. Fallopian tube.
P. Pubic symphysis.
a. Pyriformis muscle (cut)
b. Gluteal muscles.
c. Coccygeus muscle.
d. Obturator internus.

pyriformis. It supplies *muscular* branches and a *nutritious* artery to the innominate bone, and is distributed to the buttock.

2. The *Ilio-lumbar* artery (10) passes into the iliac fossa beneath the psoas and iliacus muscles along the lumbo-sacral cord ; and then divides into 1, a *lumbar* branch which anastomoses with the last lumbar artery, supplies the psoas and gives off a spinal branch, and 2, an *iliac* branch which supplies the iliacus and the bone, anastomosing with the obturator, circumflex iliac, and lumbar arteries.

3. The *Lateral sacral* artery (13, 15) (often double) descends on the front of the sacrum, internally to the sacral foramina, to the coccyx, where it anastomoses with the artery of the opposite side and with the sacra media from the aorta. In its course it gives branches which enter the sacral foramina, and reach the muscles and skin on the back of the sacrum, while others supply the pyriformis muscles and coccygeus, as well as the sacral nerves.

The *Veins* corresponding to the branches of the internal iliac artery open into the internal iliac vein, with the exception of the ilio-lumbar and occasionally the lateral sacral veins, which join the common iliac veins. The internal iliac vein passes beneath its artery to the common iliac vein, which on the left side also receives the middle sacral vein (Fig. 167).

[The bladder and rectum are now to be drawn out of the pelvis as much as possible, to do which it will be necessary to divide the ligaments of the bladder and the recto-vesical layer of pelvic fascia ; this will bring into view the structures which close the lower aperture or outlet of the pelvis.]

The **Floor of the Pelvis** (Fig. 169), which is directed forwards and upwards, is formed by the following structures. In front, the levatores ani of the two sides blend in the middle line, supporting

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e. Psoas magnus.
f. Linea alba.
g.g. Ureters.
h. Obturator nerve.
i. Internal abdominal ring.
1. Abdominal aorta.
2. Inferior mesenteric artery.
3.3. Common iliac arteries.
4. Left external iliac artery.
5. Vena cava inferior.
6.6. Renal veins.
7.7. Common iliac veins.
8. External iliac vein.
9. Internal iliac artery (cut).
10. Gluteal vein.
11. Ilio-lumbar vein.
12. Lateral sacral vein.
13. Sciatic vein.
14. Pudic vein.
15. Obturator vein.
16. Epigastric vein.
17. Uterine veins.
18. Vesico-vaginal veins.
19. Ovarian veins.
20. Bulb of the ovary.
21. Vein to round ligament.
22. Fallopian veins.

and closely connected with the pelvic viscera. Immediately behind these, and separated from them only by a very narrow space of cellular tissue, are the two coccygei muscles, supported by

Fig. 168

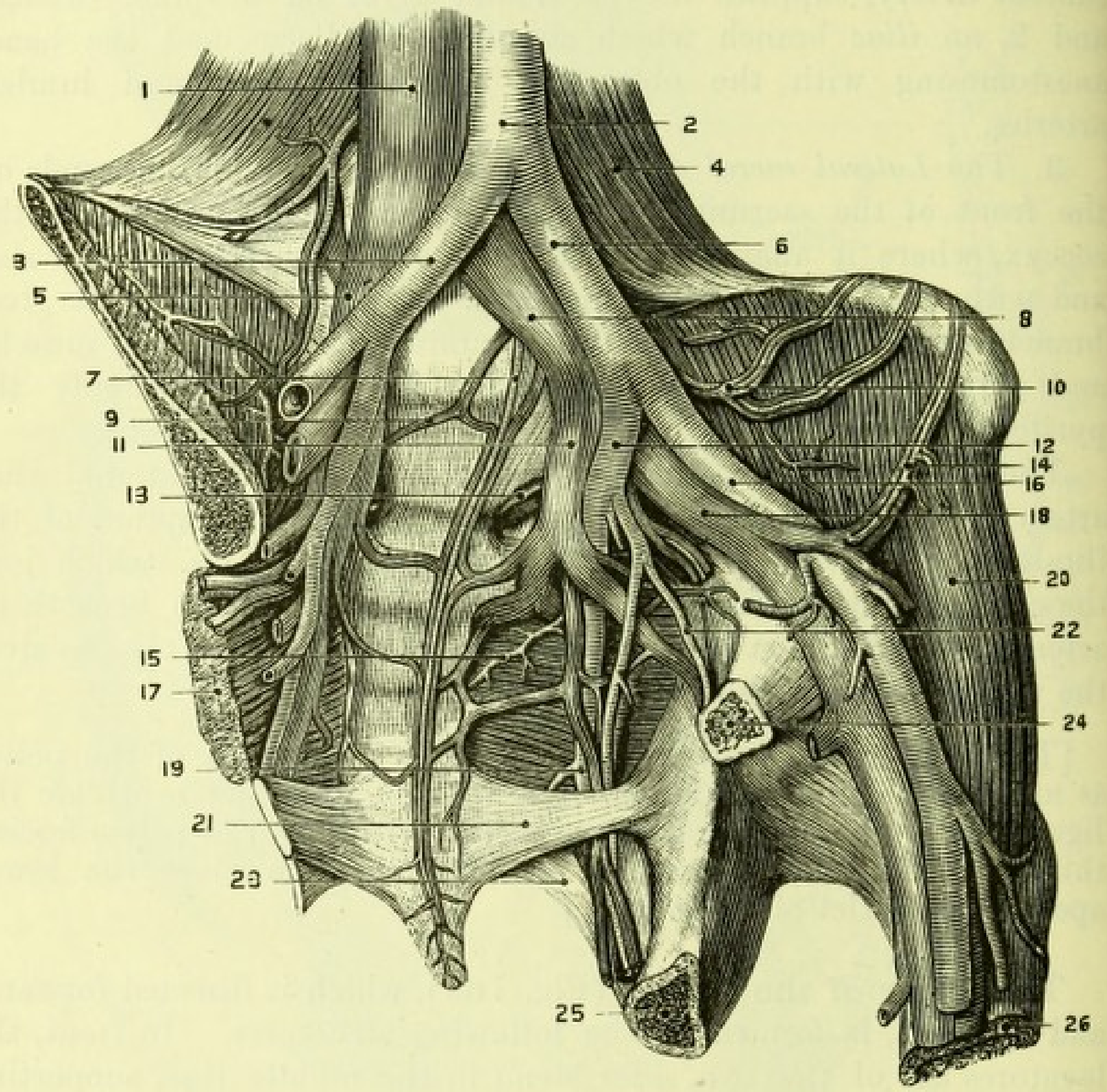


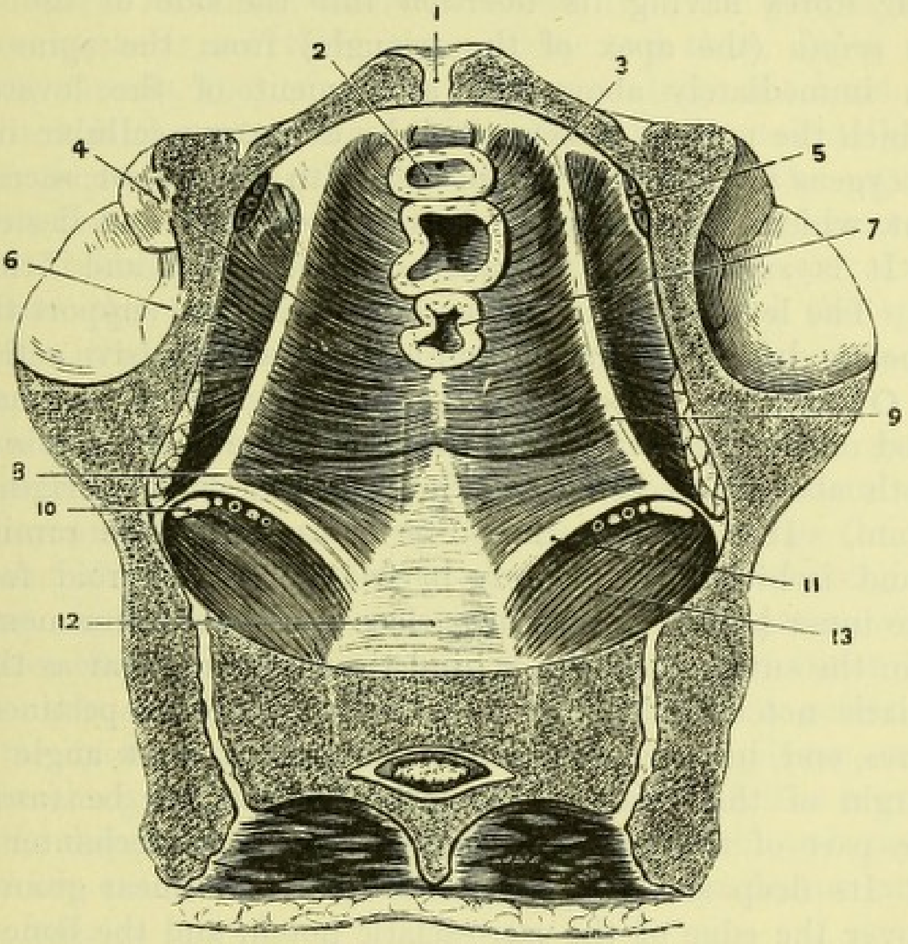
Fig. 168.—The iliac arteries and veins (from Bonamy and Beau).

1. Vena cava
2. Aorta.
3. Right common iliac artery.
4. Quadratus lumborum.
5. Right common iliac vein.
6. Left common iliac artery.
7. Middle sacral artery.
8. Left common iliac vein.
9. Middle sacral vein.
10. Ilio-lumbar artery.
11. Left internal iliac vein.
12. Left internal iliac artery.
13. Lateral sacral artery.
14. Circumflex iliac artery.
15. Lateral sacral artery.
16. Left external iliac artery.
17. Pyriformis.
18. Left external iliac vein.
19. Pudic vessels.
20. Ilio-psoas.
21. Small sacro-sciatic ligament.
22. Obturator artery.
23. Great sacro-sciatic ligament.
24. Horizontal ramus of pubes.
25. Ischium.
26. Femur.

the two smaller sacro-sciatic ligaments. The great sacro-sciatic foramina, which lie above the coccygei, are occupied by the pyriformis muscles, and the gluteal vessels and nerves leave the pelvis at the upper border of these muscles, and the sciatic and pudic below.

The **Levator Ani Muscle** (Fig. 169, 4) takes its *origin* from the back of the os pubis, from the front of the spine of the

Fig. 169.



ischium, and between these points its fibres are usually attached to the *white line* of the obturator fascia, seen in the dissection of the fascia from without (Fig. 162), but occasionally the fibres arise from the pelvic fascia some distance above the white line. The

Fig. 169.—Floor of female pelvis (from Savage).

1. Symphysis pubis.
2. Section of bladder.
3. Section of vagina.
4. Levator ani muscle.
5. Obturator vessels.
6. Obturator internus muscle.
7. Section of rectum.
8. Coccygeus muscle.
9. ' White line' of pelvic fascia.
10. Sciatic and pudic vessels and nerves.
11. Lesser sacro-sciatic ligament.
12. Front of sacrum.
13. Pyriformis muscle.

anterior fibres pass by the side of the prostate in the male, and of the vagina in the female; the middle fibres blend with the longitudinal fibres of the rectum and the external sphincter; and the posterior fibres partly unite with those of the opposite side in the median raphé behind the anus, and partly are attached to the apex of the coccyx. It is *supplied* by branches from the 4th sacral nerve, and by a branch from the anterior perinæal nerve.

The **Coccygeus** (Fig. 169, 8) is a little triangle of pale muscular fibres having its *insertion* into the side of the coccyx, and its *origin* (the apex of the triangle) from the spine of the ischium immediately above the attachment of the levator ani, from which the muscle is separated by a narrow cellular interval. The coccygeus is intimately connected with the lesser sacro-sciatic ligament, which has nearly the same attachments and lies external to it. It is *supplied* by a branch from the 4th and 5th sacral nerves. The levatores ani and coccygei raise and support the floor of the pelvis during expiration and abdominal expulsive actions.

The **Obturator Internus Muscle** (Fig. 170, 19) has been destroyed on the right side, but on the left side of the pelvis may be seen both above and below the level of the fascial origin of the levator ani. It *arises* from the posterior aspect of the rami of the pubes and ischium immediately in front of the thyroid foramen; from the inner half of the pelvic surface of the obturator membrane; and from the surface of bone behind the foramen as far as the great sacro-sciatic notch, and above it as high as the ilio-pectineal line. The fibres end in a tendon, which turns at a right angle around the margin of the lesser sacro-sciatic foramen, to be *inserted* on the fore part of the upper border of the great trochanter of the femur. Its deep surface presents three or four linear grooves as it winds over the edge of the sacro-sciatic notch, and the bone is here encrusted with cartilage and lubricated by a bursa. It is *supplied* by a special nerve derived from the junction of the lumbo-sacral with the first sacral nerve. It is an external rotator of the femur, and a feeble abductor when the thigh is flexed.

[The pelvic viscera are now to be removed by carefully detaching the urethra and bladder from the pubic bones, dividing the levator ani, and severing the slight connections between the rectum and coccyx. The whole of the urinary and genital organs should be carefully preserved for after-examination. The sacral nerves can now be dissected on the right side of the pelvis, and in order to see them clearly it will be well to remove the remaining branches of the internal iliac artery. All the branches of the sacral nerves should be preserved, and care should be taken not to remove the gangliated cord and hypogastric plexus of the sympathetic. The upper sacral nerves will be readily seen emerging from the foramina, but the fifth sacral and the coccygeal nerves will be found piercing the coccygeus muscle close to the side of the coccyx.]

The **Sacral Plexus** (Fig. 170) is formed by the union of the upper three and part of the fourth sacral nerves, with the lumbo-sacral cord derived from the fourth and fifth lumbar nerves, which is seen descending into the pelvis. The several nerves, as they leave the sacral foramina, receive branches from the gangliated cord of the sympathetic on their inner side, and then, lying on the pyriformis muscle, they unite to form one large flat band. This passes through the great sacro-sciatic foramen immediately above the lesser sacro-sciatic ligament, and, by looking at the outside of the pelvis, the dissector will be able to see the three nerves into which it divides, viz., Great Sciatic, Small Sciatic, and Internal Pudic ; and the pudic nerve may be traced around the spine of the ischium and through the lesser sacro-sciatic foramen to the perinæum.

Branches within the Pelvis.—A couple of branches are given to the *pyriformis*, either from the plexus or from the sacral nerves before they unite. The *nerve to the obturator internus* (26) arises at the point of union of the lumbo-sacral with the first sacral nerve, and, lying on the anterior surface of the plexus, passes with the pudic nerve through the sacro-sciatic foramina to the inner surface of the muscle, supplying in its course the gemellus superior. The *nerve to the quadratus* from the lower part of the plexus, or sometimes from the great sciatic nerve, passes out beneath that nerve close behind the hip-joint, and supplies the articulation and muscular twigs which enter the deep surfaces of the quadratus and the gemellus inferior.

At the upper margin of the great sacro-sciatic foramen will be seen the *superior gluteal nerve* (15), derived from the lumbo-sacral cord and one or two of the upper sacral nerves ; it passes out above the pyriformis with the gluteal artery, supplying the glutei medius and minimus, but unlike the vessel does not give any superficial branch to the gluteus maximus. The *inferior gluteal* nerve to the gluteus maximus may arise either from the plexus or from the lesser sciatic nerve.

Below the plexus are the branches of the other sacral nerves. These last can seldom be made out well, since the nerves themselves are very small, and are surrounded by a quantity of fibrous tissue.

From the 4*th Sacral nerve* a branch may be traced to its junction with the 5th nerve, and from the 4th also are derived *visceral* *branches* to the bladder and rectum, which communicate with the sympathetic, and *muscular branches* to the levator ani and coccygeus; as well as a *hæmorrhoidal branch* which passes through the levator

Fig. 170.

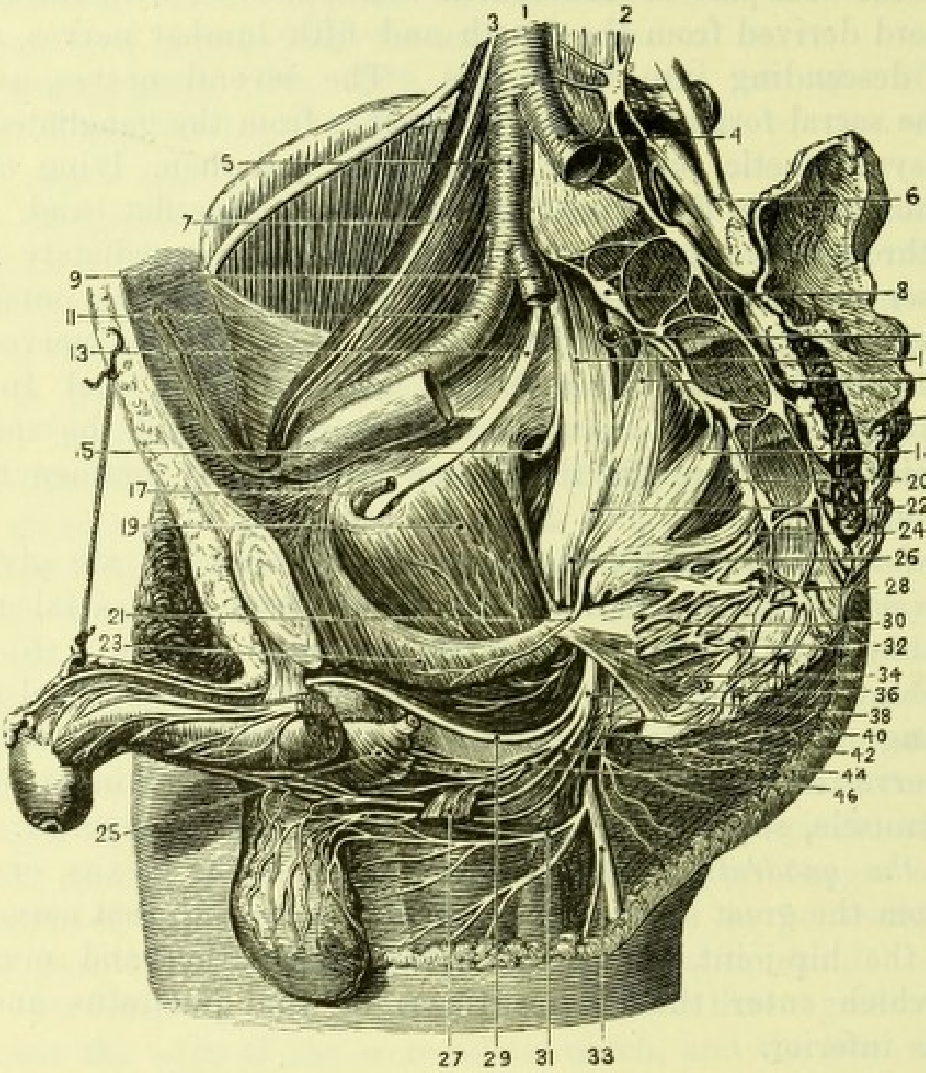


Fig. 170.—Side view of the nerves of the pelvis, the viscera having been removed (from Hirschfeld and Leveillé).

1. Abdominal aorta.
2. Gangliated cord of sympathetic (left side).
3. Genito-crural nerve.
4. Left common iliac artery.
5. Right common iliac artery.
6. Left lumbo-sacral cord.
7. Psoas muscle.
8. Gangliated cord of sympathetic (right side).
9. Internal iliac artery (cut).
10. Gluteal artery (cut).
11. Right external iliac artery.
12. Right lumbo-sacral nerve.
13. Obturator nerve.
14. First sacral nerve.
15. Gluteal nerve.
16. Pyriformis of left side (cut).
17. Obturator artery.
18. Second sacral nerve.
19. Obturator internus.
20. Pyriformis of right side.
21. Nerve to levator ani.
22. Sacral plexus.
23. Levator ani (cut).
24. Third sacral nerve.
25. Bulb of urethra covered by accelerator urinæ.

ani, or between this muscle and the coccygeus, to the perinæum, to supply the external sphincter.

The *5th Sacral nerve* communicates with the 4th and the coccygeal nerve, and terminates by piercing the coccygeus muscle, which it supplies, to reach the skin over the back of the coccyx.

The *Coccygeal nerve* (6th) also emerges from the lower end of the sacral canal, and pierces the coccygeus muscle to end on the back of the coccyx.

The **Gangliated Cord of the Sympathetic** (Fig. 170, 8) may be traced on each side of the sacrum internally to the foramina, and has upon it four or five ganglia: the two cords unite on the coccyx in the *ganglion impar.* Communicating branches are given to the sacral nerves and to the hypogastric plexus.

The *Hypogastric plexus* is placed on the front of the sacrum, and is continuous with the sympathetic plexus upon the aorta. It is continued forward upon the two internal iliac arteries to form the *pelvic plexuses,* which are placed on each side of the bladder and rectum.

In addition, there are upon the several hollow viscera plexuses from the sympathetic, parts of which are visible in the various stages of the dissection. They are derived from the pelvic plexuses, and are distributed over the branches of arteries supplied to the several viscera, receiving corresponding names.

The **Pyriformis Muscle** (Fig. 170, 20), if not sufficiently well seen, may be more fully exposed by drawing the sacral plexus out of the sacro-sciatic foramen. It *arises* from the front of the sacrum between the 1st, 2nd, 3rd, and 4th sacral foramina, from the grooves external to these foramina, from the great sacro-sciatic ligament, and from the margin of the great sacro-sciatic foramen; and leaves the pelvis through the great sacro-sciatic foramen, having the gluteal vessels and superior nerve at its upper, and the sciatic and pudic vessels and nerves at its lower border. It is *inserted* into the upper border of the great trochanter of the femur, behind the insertion of the obturator internus and gemelli. Its *action* is to rotate outwards and

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26. Nerve to obturator internus.
27. Transversus perinæi.
28. Fourth sacral nerve.
29. Dorsal nerve of penis.
30. Visceral branches (cut).
31. Inferior pudendal nerve.
32. Fifth sacral nerve.
33. Small sciatic nerve.
34. Coccygeus muscle.
36. Sixth or coccygeal nerve.
38. Internal pudic nerve.
40. Inferior hæmorrhoidal nerve.
42. Posterior superficial perinæal nerve.
44. Anterior superficial perinæal nerve.
46. Deep perinæal nerves to bulb and muscles.

abduct the femur, and it is *supplied* by branches from the upper sacral nerves.

The Rectum and External Organs of Generation in the Male.

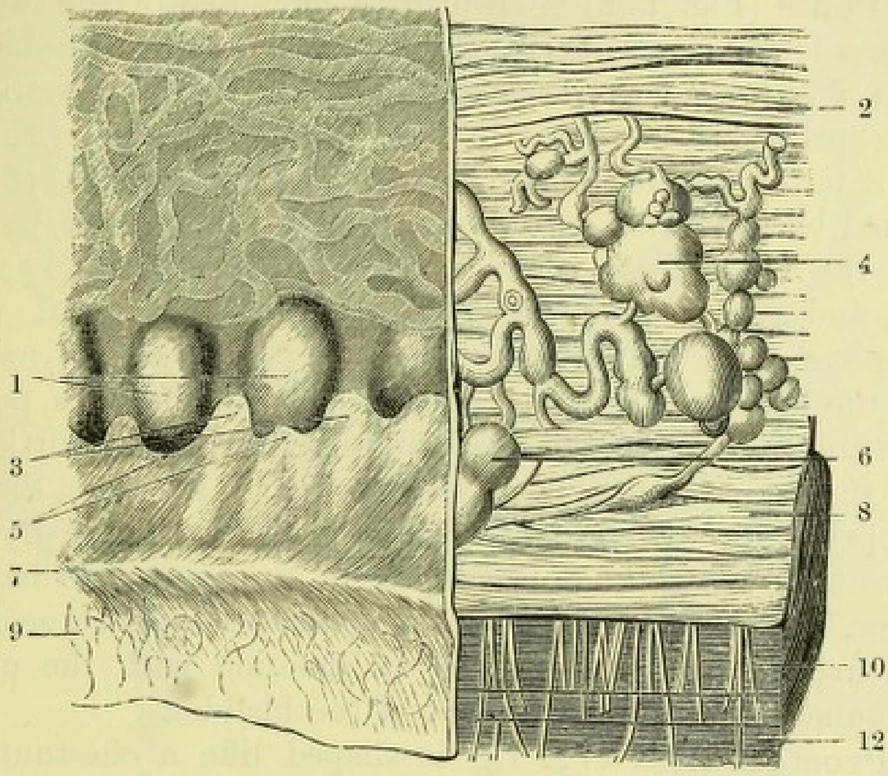
[The bladder with the urethra and the rectum having been removed as directed, should be laid on the table with the rectum uppermost, and that viscus should be filled with cotton-wool and cleaned, and its muscular fibres exposed.]

The **Rectum** (Fig. 164, 16). The arrangement of the peritoneum upon the rectum has been already described (p. 304), and the longitudinal muscular fibres will be now seen to differ from those of the rest of the large intestine, in being spread all around it instead of being collected in three bands; they are, however, thickened in front and behind, the anterior fibres (*prærectalis*) being formed by the fusion of the omental and free tæniæ of the colon. The internal or circular muscular fibres become thickened near the anus to form the internal sphincter muscle, as will be seen when the bowel is opened. The numerous arteries are derived from three sources—the superior hæmorrhoidal artery, from the inferior mesenteric, which bifurcates on reaching the rectum, its two branches running to within three inches of the anus; the middle hæmorrhoidal from the internal iliac; and the inferior hæmorrhoidal from the internal pudic. The veins terminate above in the portal system and below in the internal iliac veins.

The intestine being opened along its unattached border, the mucous membrane will be seen to be smooth, except near the anus, where it is thrown into longitudinal folds by the sphincter. Here also it frequently happens that hæmorrhoids exist. Three or four transverse ridges of mucous membrane (valves or *folds of Houston*) will be found from three to six inches above the anus. These are effaceable by distension, except one plication, *the fold of Kohlrausch*, which is permanent and involves the circular muscular fibres as well as the mucous membrane. This is of considerable surgical importance, as it projects as a kind of ledge from the right side of the gut, about three inches above the anus and might be perforated by the careless introduction of a bougie or rectal tube.

The mucous membrane above the anus for half or three quarters of an inch has the characters of skin, and is separated from the true mucous structure by a more or less well defined line (Fig. 171, 3) which indicates the position of the septum that originally existed between the blind extremity of the fœtal gut and the anal dimple in the integument. It is interesting to remember that the structural difference shows itself in pathological changes, that an ordinary squamous epithelioma occurs in the lowest part of the rectum, while the part above is attacked by a malignant growth of different character and tendencies—a columnar epithelioma. Immediately

Fig. 171.



above the septum the rectal wall presents a number of little pouches (*lacunæ semilunares*) in which sharp foreign bodies may lodge (1).

The cavity of the bowel is ampullated between the fold of Kohlrausch and the upper margin of the internal sphincter, and

Fig. 171.—Inner surface of lower end of rectum (after Luschka).

1. Rectal portion of the mucous membrane with lacunæ semilunares.
2. Circular muscular fibres.
3. Demarcation between anal and rectal portions of the mucous membrane.
4. 6. Varicose hæmorrhoidal veins.
5. Anal portion of mucous membrane with columns of Morgagni.
7. White line of Hilton, at junction of internal and external sphincters.
8. Internal sphincter.
9. Cutaneous zone above anal aperture.
10. Tendinous fibres of longitudinal muscular coat.
12. External sphincter.

opposite the sphincter the wall presents a number of longitudinal plications called the *columnæ recti* of Morgagni (5). The line of junction between the two sphincters is indicated by a *white line* (7) in the mucous membrane (Hilton).

[The rectum is now to be carefully dissected from the bladder, which is to be moderately distended with air, and the under surface of the penis and bladder being then placed before the student, he is to dissect out thoroughly the whole of the parts exposed.]

The **Penis** (Fig. 172) is seen to be composed of the two *corpora cavernosa*, forming its dorsal segment, and the mesial *corpus spongiosum urethræ* (21), situated between them ventrally. The latter is prolonged in front to form the *glans penis* (20), while behind it terminates in the dilated part called the *bulb* (18), which is covered by the bulbo-cavernosus muscle and should be cleaned. Behind the bulb is the slender *membranous portion* (15) of the urethra, and the *prostate* (13), the posterior surface of which is now exposed with the *vesiculæ seminales* (10), *vasa deferentia*, and base of the bladder. On each side of the membranous portion of the urethra may be found, by careful dissection, a little yellow body of the size of a pea, *Cowper's gland* (Fig. 173, 11), the duct of which opens into the bulbous portion of the urethra. By turning the preparation over, the dorsal aspect of the penis will be brought into view, and the dorsal vessels and nerves will be seen. The dorsal vein may now be traced to its junction with the plexus of veins around the prostate and neck of the bladder.

The **Prostate** (Fig. 172, 14) is shaped like a chestnut, having the small end or apex downwards and the base at the 'neck' of the bladder. Its weight in the adult is about six drams, the same as that of the testicle; its length from base to apex is in health from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch, and the greatest transverse diameter is about $1\frac{3}{4}$ inch, but these measurements undergo great variation in old persons, the subjects of 'enlarged prostate.' The prostate presents two indistinct lateral lobes, the division between which is marked by a slight groove on the posterior surface, and an occasional projection in the floor of the urethra is described by some authors as a third or middle lobe, but is the result of morbid changes in that portion of the body which lies above the prostatic fissure and in front of the ejaculatory ducts. The *prostatic fissure* (12) is a little cleft in the centre of the posterior aspect, or base, which transmits the common ejaculatory ducts and sinus pocularis. The *structure* of the prostate is partly glandular and partly muscular. A powerful sphincter of unstriped muscle

(Fig. 172) is formed above the orifices of the ejaculatory ducts, and serves to prevent reflux of the semen into the bladder during congress; and a quantity of muscular fibre in front of this point,

Fig. 172.

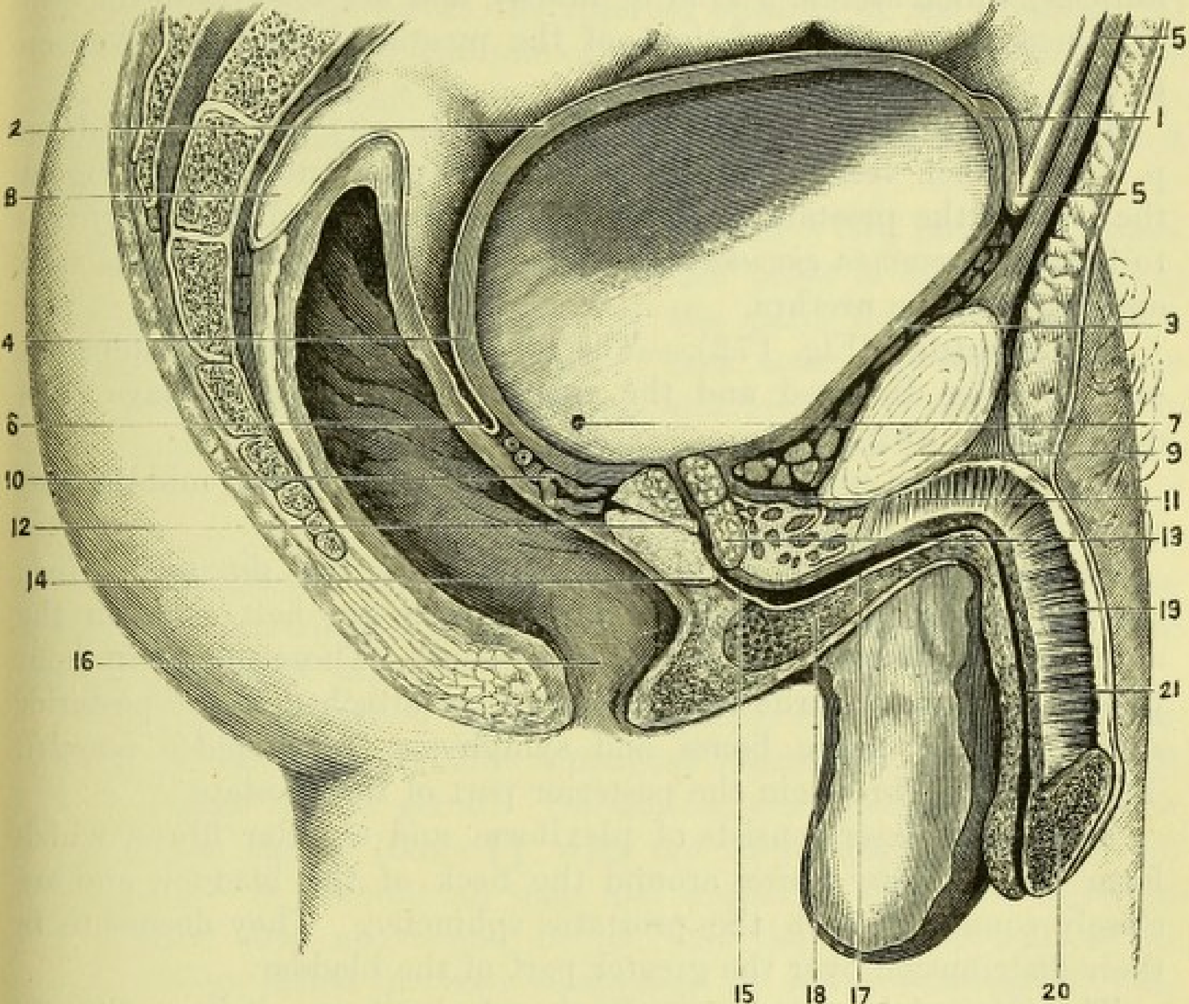


Fig. 172.—Sagittal section through the middle line of the pelvis and the pelvic viscera (from Sappey).

1. Apex of the bladder.
2. Upper surface of the bladder.
3. Lower surface of the bladder.
4. Fundus of the bladder.
5. Urachus making a turn upon itself.
6. End of recto-vesical pouch.
7. Entrance of ureter.
8. Rectum, points to the lower limit of the meso-rectum.
9. Symphysis pubis. Behind this is the space known as the cavum Retzii, filled with loose fat.
10. End of vas deferens and inner part of left vesicula seminalis, indicating the base of the prostate.
11. Anterior true ligament of bladder.
12. Prostatic fissure. Above this is the portion of the prostatic sphincter forming the so-called 'middle lobe.'
13. Prostatic part of the urethra.
14. Apex of the prostate.
15. Membranous part of the urethra.
16. Anus.
17. Bulbous part of the urethra.
18. Bulb.
19. Septum pectiniforme.
20. Glans penis.
21. Spongy part of urethra.

partly striped (near the apex) and partly unstriped, serves to expel the prostatic secretion into the urethra and aid in ejaculating the mixed seminal and prostatic fluids. The glandular structure is situated mainly in the posterior and lateral portions of the body, below the openings of the ejaculatory ducts, and consists of branched follicles, which secrete a kind of mucus, and are sometimes the seat of concretions. The relations of the prostate have been given on p. 353.

The **Vesiculæ Seminales** (Fig. 164, 14) are described on p. 354. Each vesicle consists of a convoluted tube, narrowing at the base of the prostate, and joining the corresponding *vas deferens* to form the *common ejaculatory duct*, which will be afterwards seen opening into the urethra.

The **Bladder** (Fig. 172).—The *peritoneal coat* of the bladder has been already dissected and the relations of the viscus have been described (p. 352).

The *muscular coat* consists of three layers, external, middle, and internal.

The *external layer*, sometimes known as the *detrusor urinæ*, consists chiefly of longitudinal fibres which are best seen on the anterior and posterior surfaces of the viscus. Those placed in front pass in the anterior true ligaments, and are attached to the posterior surface of the pubic bones and symphysis (*vesico pubic muscle*). The posterior fibres join the posterior part of the prostate.

The *middle layer* consists of plexiform and circular fibres, which form the *sphincter vesicæ* around the neck of the bladder, and are closely connected with the prostatic sphincter. They decussate in their distribution over the greater part of the bladder.

The *internal layer* is longitudinal and plexiform : it is continuous with the longitudinal fibres of the urethra, and is joined by the fibres of the ureters, which meet in the middle line and are spread over the trigonum (Ellis).

Beneath the muscular coat is a quantity of loose submucous connective tissue.

[The bladder is to be opened along its anterior inferior wall by a longitudinal cut, which is to be continued with a strong pair of scissors through the upper surface of the prostate and the whole length of the urethra, in the latter portion being a little to one side of the middle line.]

Interior of Bladder and Urethra (Fig. 173).—The mucous membrane of the bladder, if healthy, will be pale, and is more or less plicated throughout, except near the urethra, at the triangular space called the *trigonum vesicæ* (1). The three sides of this triangle are each about an inch long, and the three angles correspond to the orifices of the two ureters above, and the internal urinary meatus below. A horizontal ridge of mucous membrane extends between the two ureters, and from the middle of this runs a vertical fold, the *uvula vesicæ*, as far as the internal opening of the urethra. If a probe be introduced into one of the ureters, it will be seen to pass very obliquely through the coats of the bladder, and can sometimes be felt through the wall of the rectum when the finger is introduced into the bowel.

The **Urethra** (Fig. 172) is about six and a half inches in length when the parts are at rest, but when the penis is stretched during catheterism or after the removal of the parts from the body, the length is increased to eight inches or even more. It is divided into the prostatic, membranous, bulbous, and spongy portions, and the tube, as a whole, presents *three dilatations*, one in the prostatic portion, one in the bulbous portion, and one in the anterior part of the spongy portion (fossa navicularis); and *three constrictions*, one at each extremity (internal and external meatus), and one at the membranous portion. The external meatus is the least dilatatable part of the entire passage.

The *Prostatic portion* (Fig. 173) piercing the prostate, is nearly vertical in direction, and lies somewhat nearer the pubic than the rectal surface of the gland. On section, near its middle, it is seen as a fissure, shaped like a U, with the curve directed towards the symphysis. It is about an inch and a quarter long, and wider in the middle than above and below. At the posterior wall is an erectile ridge called the *veru montanum* or *caput gallinaginis* (6), dividing the canal into two hollows (represented by the free extremities of the U on section) called the *prostatic sinuses* (8), into which the prostatic ducts open. On the veru montanum will be found the orifice of the *sinus pocularis* (5), a little blind pouch directed backwards; and on each side near its margin open the common ejaculatory ducts.* The anterior wall shows the apertures of numerous simple follicles.

The *Membranous portion* (9) is the shortest and narrowest division of the urethra, and being placed between the two layers of the triangular ligament which meet below, its upper or anterior wall

* The position of the sinus pocularis is given differently by various authors; thus Quain, Gray and Wilson place it on the anterior, and Cruveilhier and Ellis on the posterior, part of the veru montanum. The discrepancy arises from slight variations in the shape and extent of the ridge.

is somewhat longer than its posterior wall or floor, the former measuring about $\frac{3}{4}$ inch and the latter $\frac{1}{2}$ inch. It is enclosed by a

Fig. 173.

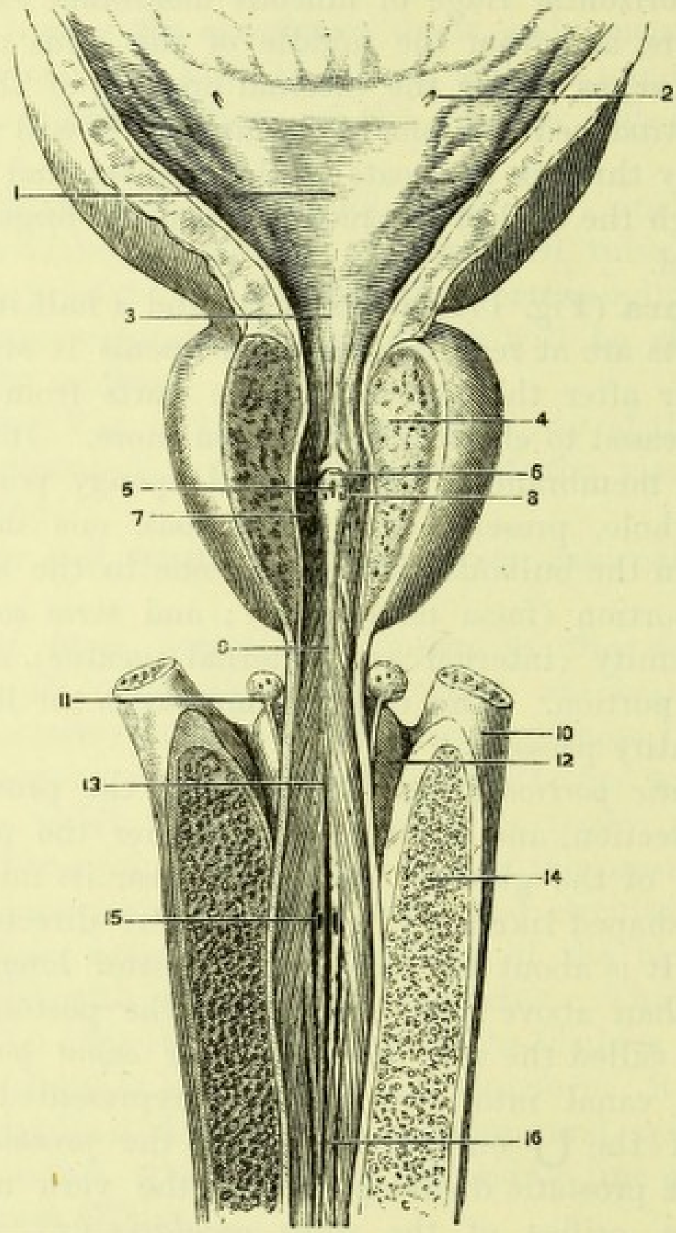


Fig. 173.—The bulbous, membranous and prostatic urethra, with part of the bladder, laid open from above (modified from Wilson).

1. Trigonum vesicæ.
2. Opening of ureter.
3. Uvula vesicæ, indicating the apex of the trigone.
4. Ventral wall of prostate laid open.
5. Opening of sinus pocularis. The orifices of the ejaculatory ducts lie one on either side of this.
6. Veru montanum.
7. Mucous membrane.
8. Prostatic sinus and openings of prostatic ducts.
9. Membranous part of the urethra.
10. Crus penis (cut).
11. Cowper's gland and commencement of its duct.
12. Upper surface of the bulb.
13. Commencement of bulbous portion of urethra.
14. Section of crus penis.
15. Entrance of duct of Cowper's gland.
16. Spongy part of the urethra.

sphincter of circular involuntary fibres continuous with the circular fibres of the bladder and prostate, and is invested by the fibres of the deep transversus perinæi muscle. The mucous membrane is smooth, and presents no orifices ; it is frequently stained of a red colour.

The *Bulbous portion* (13), the part corresponding to the bulb externally, is about an inch long, but there is no line of demarcation between it and the spongy portion. The canal is dilated at this spot, and in its floor are the two minute orifices of the ducts of Cowper's glands (15), which run obliquely through the wall of the urethra for some distance. The bulb will be seen to be continuous with the corpus spongiosum, which surrounds the spongy or anterior portion of the urethra, and expands again to form the *glans penis.*

The *Spongy portion* (16) is the longest part of the canal. Its calibre is somewhat smaller than that of the bulbous portion, but it expands in the glans penis to form the *fossa navicularis,* again becoming contracted at the *meatus* or orifice, the least dilatable portion of the urethra. Along the floor of the spongy portion are numerous mucous follicles or *lacunæ,* the orifices of which are directed towards the meatus ; a few similar follicles are situated on the upper surface of the urethra, one of which, opposite the fossa navicularis, is called the *lacuna magna.* This can seldom be made out when the urethra is opened from above, as here directed.

The mucous membrane is smooth and pale in health, but assumes the characters of skin in the last eighth of an inch of its length. The student should notice carefully any traces of stricture, which will probably be found, if present, in the bulbous portion.

Beneath the mucous membrane of the urethra there is a thin layer of erectile tissue, and outside this a tunic of longitudinal involuntary muscular fibre, continuous with the submucous layer of the bladder muscle (Ellis), and intermixed with fibrous tissue.

The **Corpora Cavernosa Penis** may now be seen as two vascular bodies enclosed in fibrous sheaths, which unite to form an imperfect median septum between them, known as the *septum pectiniforme* (Fig. 172, 19, Fig. 174, 5) from its comb-like appearance. The elastic sheath or *tunica albuginea* consists of two layers of fibres, external longitudinal and internal circular. It is the latter that forms the septum, and from its inner surface *trabeculæ* or thread-like processes are distributed through the vascular tissue of the organ. The attachments of the corpora cavernosa, by their crura, to the ischio-pubic rami have been seen in the dissection of the perinæum.

A transverse section of the body of the penis (Fig. 174) shows the reticulated structure of the corpora cavernosa, and that of the corpus spongiosum, around the urethra. The dorsal vein (1), with a dorsal artery (2) and nerve (3) on each side of it, lies along the upper surface of the corpora cavernosa. The artery of the corpus cavernosum (4) is in the substance of the corpus cavernosum. A transverse section through the posterior part of the glans

Fig. 174.

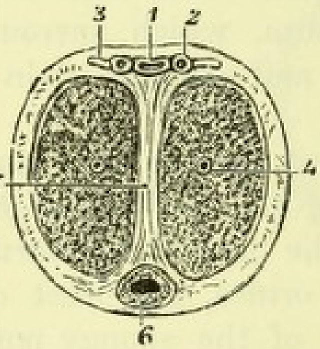
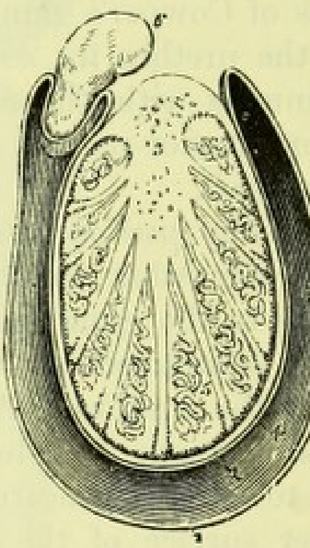


Fig. 175.



presents a different aspect. It shows the anterior extremities of the corpora cavernosa, now separated from each other, surrounded by the coarse erectile tissue of the corpus spongiosum, the whole being invested by the integument of the glans. On section, the urethra in the prostate has the ∪ form already described, in the membranous portion it is stellate, in the body of the penis it

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Fig. 174.—Transverse section of the penis (from Wilson).

1. Dorsal vein.
2. Dorsal artery.
3. Dorsal nerve.
4. Artery of corpus cavernosum.
5. Septum pectiniforme.
6. Urethra, surrounded by corpus spongiosum.

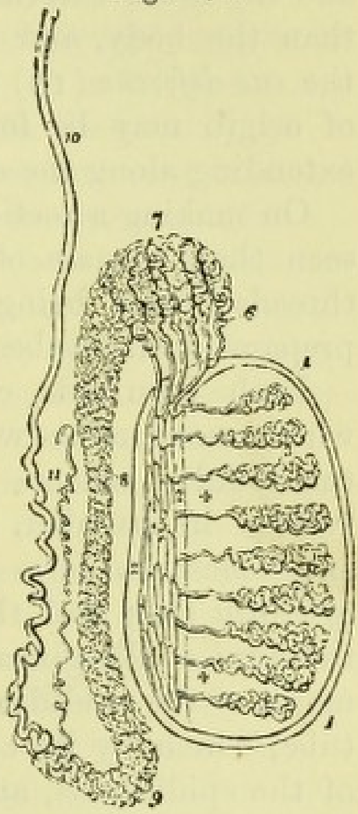
Fig. 175.—Transverse section of the testicle (from Wilson).

1. Cavity of the tunica vaginalis.
2. Tunica albuginea.
3. Mediastinum testis giving off numerous septa. The cut extremities of the vessels below the figure belong to the rete testis; and those above to the arteries and veins of the organ.
4. Tunica vasculosa, or pia mater testis.
5. One of the lobules, consisting of the convolutions of the tubuli seminiferi, and terminating by a single duct, the vas rectum.
6. Section of the epididymis.

assumes the form of a horizontal fissure, in the glans the fissure is vertical, and about the neck it has the transitional shape of an inverted ⊤.

The **Testicle** (Fig. 175) has already been seen in its position in the scrotum, and its structure should now be investigated as far as possible.

Fig. 176.



The testis consists of two parts, an anterior or larger portion, the *body*; and an accessory part, the *epididymis*, which lies on the outer side of the posterior border of the body, and is continuous below with the *vas deferens* or duct.

The testicle has three tunics. The *tunica vaginalis* (1) is a serous covering derived originally from the peritoneum, and may be described as consisting of two portions, the *tunica vaginalis propria*, which is adherent to the organ, and the *tunica vaginalis reflexa* lining the scrotal sac. The *tunica vaginalis propria* invests both sides of the body of the gland, the outer side of the middle and nearly the whole of the upper portion (globus major) of the epididymis, and the lower half inch of the spermatic cord. It is deeply inflected between the middle of the epididymis and body of the testicle on the outer side, there forming a deep pouch, known as the *digital fossa*, by which the external aspect of the gland may be recognised. The *tunica albuginea* (2) is a strong fibrous capsule enclosing the body of the testis, and sending into it from behind a vertical process called the *mediastinum* (3) or corpus Highmorianum. From this, secondary processes or *septa* radiate to the inner surface of the tunica albuginea and separate the *lobules* of the testicle. The tunica albuginea is inseparably connected with the tunica vaginalis propria. The *tunica vasculosa* (4), beneath the tunica albuginea, is a delicate membrane containing the

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Fig. 176.—Anatomy of the testis (from Wilson).

1, 1. Tunica albuginea.
2, 2. Mediastinum testis.
3, 3. Lobuli testis composed of tubuli seminiferi.
4, 4. Vasa recta.
5. Rete testis.
6. Vasa efferentia, of which six only are represented in this diagram.
7. Coni vasculosi, constituting the globus major epididymis.
8. Body of the epididymis.
9. Globus minor epididymis.
10. Vas deferens.
11. Vas aberrans.

ramifications of the blood-vessels, but these cannot be seen except when finely injected.

The *Epididymis* (Fig. 176) is divided into three parts. The upper extremity is the *head* or *globus major* (7), which is divisible into a number of *coni vasculosi;* the central portion is the *body* (8), and the lower extremity the *tail* or *globus minor* (9), which is larger than the body, and often as large as the head. From this arises the *vas deferens* (10) or duct of the testicle, and close to its point of origin may be found a minute blind tube of variable length, extending along the cord and called the *vas aberrans* (11).

On making a section of the uninjected testis, little more can be seen than a mass of a drab colour, which may be drawn out in threads; these being the minute seminal tubes. In an injected preparation the tubes may be traced as follows (Fig. 176):—

Each lobule is composed of convoluted *tubuli seminiferi* (3), which anastomose with one another: these as they emerge from the lobules become straight, and form the *vasa recta* (4), about twenty in number. Entering the mediastinum, the vasa recta anastomose to form the *rete testis* (5), from which arise the *vasa efferentia* (6); and these, from twelve to fifteen in number, pierce the tunica albuginea to form the *coni vasculosi* (7) of the globus major of the epididymis. The ducts are then all collected into one tube, which by its convolutions forms the body and globus minor of the epididymis, and ends in the vas deferens. The latter enters the abdomen through the inguinal canal, and has been traced to its opening, upon the margin of the sinus pocularis of the prostate.

Attached to the top of the testis, immediately in front of the globus major of the epididymis, may generally be found one or two little vesicles called the *hydatids of Morgagni,* the remains of Müller's duct; and in the cellular tissue of the cord, immediately above the epididymis and beneath the funicular tunica vaginalis, is seen a small white branching structure, the *Organ of Giraldès,* which is probably part of the remains of the Wolffian body of the fœtus.

Pelvic Viscera in the Female.

[The organs removed from the pelvis are to be laid out upon the table with the rectum upwards; this is to be cleaned, and, after it has been examined, is to be dissected from the uterus.]

The **Rectum** (Fig. 178, 4) corresponds to that of the male, but is related anteriorly to the pouch of Douglas and vagina, instead of to the bladder and recto-vesical pouch. The description of the rectum will be found at page 354.

[The preparation being reversed, the bladder and urethra are next to be dissected and examined. The peritoneum is to be dissected up from the bladder and left attached to the uterus.]

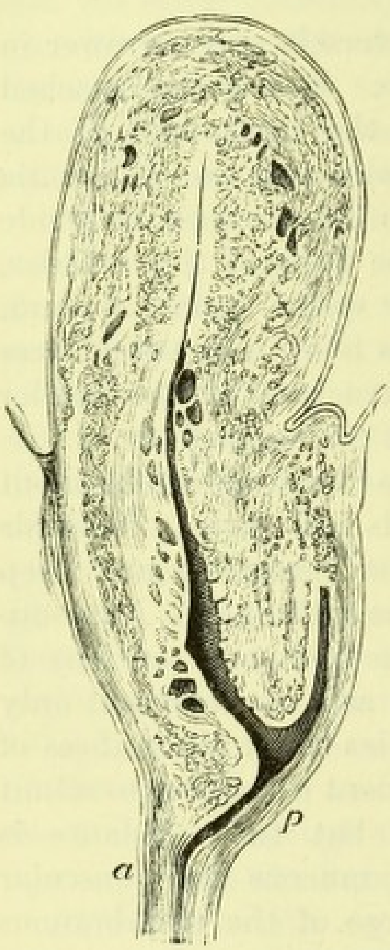
The **Bladder** (Fig. 178, 7) is wider transversely and narrower in its antero-posterior diameter than in the male. It is firmly attached behind to the neck of the uterus and to the front wall of the vagina; the relation to the vesiculæ seminales and vasa deferentia being of course wanting. The ureters turn forwards on each side of the upper part of the vagina to gain the base of the bladder, running obliquely for a short distance in the vesico-vaginal septum, then forwards, piercing the coats of the viscus to open by two orifices about an inch apart, as in the male. The structure of the bladder in the female corresponds to that of the male (see page 370).

The **Urethra** (Fig. 178, 21) of the female is a simple tube about an inch and a half long, and runs downwards and slightly forwards in front of the vagina, piercing the triangular ligaments and deep transversus perinæi muscle to open into the vestibule. Anatomically it corresponds to the prostatic and membranous portions of the male urethra, but morphologically it is said to represent only that portion of the prostatic urethra which lies above the orifices of the ejaculatory ducts. It is capable of sufficient dilatation to admit the finger for exploration of the bladder, but the resistance is considerable at the external meatus. The mucous and muscular coats (circular and longitudinal) resemble those of the membranous urethra of the male, and the upper part of the tube is invested by unstriped muscular fibres which probably correspond to those of the prostate in the male.

[The bladder and urethra are to be carefully removed, and the vagina and uterus exposed. The broad ligament of the uterus should be pinned out for the examination of the Fallopian tube and round ligament, and the preparation must afterwards be reversed for the dissection of the ovary, which is placed posteriorly.]

The **Vagina** (Fig. 178, 14) has been seen in its position in the pelvis (p. 354). It is composed of longitudinal muscular fibres enclosing erectile tissue, and lined by a mucous membrane, which, when the tube is open, will be seen to form transverse *rugæ*, starting from longitudinal ridges, the *columnæ rugarum*, on the anterior and posterior walls. Its anterior wall is about $3\frac{1}{2}$ inches long, the posterior wall an inch more. In its ordinary condition it forms a fissure, shaped in cross section like the letter ⊢⊣ with a long transverse and short lateral limbs, and runs upwards and backwards in a slightly curved course which differs according to the degree of distension of the rectum. The lower end of the uterus will be felt projecting into its cavity, but the point of reflection of the mucous membrane on to the os uteri (*fornix*), is much higher behind than in front, and hence the greater length of the posterior wall, which lies in contact with both lips of the os. At its lower end are the remains of the *hymen* (*carunculæ myrtiformes*), and below these may be seen the orifices of the two small *glands of Bartholin*, above two folds of vulvar mucous membrane called the *nymphæ*.

Fig. 177.



The **Uterus** (Fig. 179, 1) is more or less pyriform in shape; the upper part or body being broad and somewhat flattened from before backwards, and larger above than below, the lower part or *cervix* being cylindrical. It opens below into the vagina.

[The anterior wall is to be divided vertically with scissors, and the cut prolonged on each side towards the Fallopian tube.]

The direction of the long axis of the uterus is doubtful, but in all probability it varies considerably with the changing conditions of the bladder and intestines. Under ordinary circumstances its summit never rises above the plane of the pelvic inlet.

It is about three inches long, and its maximum transverse and antero-posterior diameters are two inches and one inch respectively. Its anterior surface is flattened, and is covered with peritoneum as far as the junction of body and cervix; its posterior surface is convex, and is invested by peritoneum over its whole length as far as the attachment of the vagina. Its narrow lateral borders give attach-

Fig. 177.—Longitudinal section of uterus and upper part of vagina. *a*, Anterior, *p*, Posterior vaginal wall.

Fig 178.

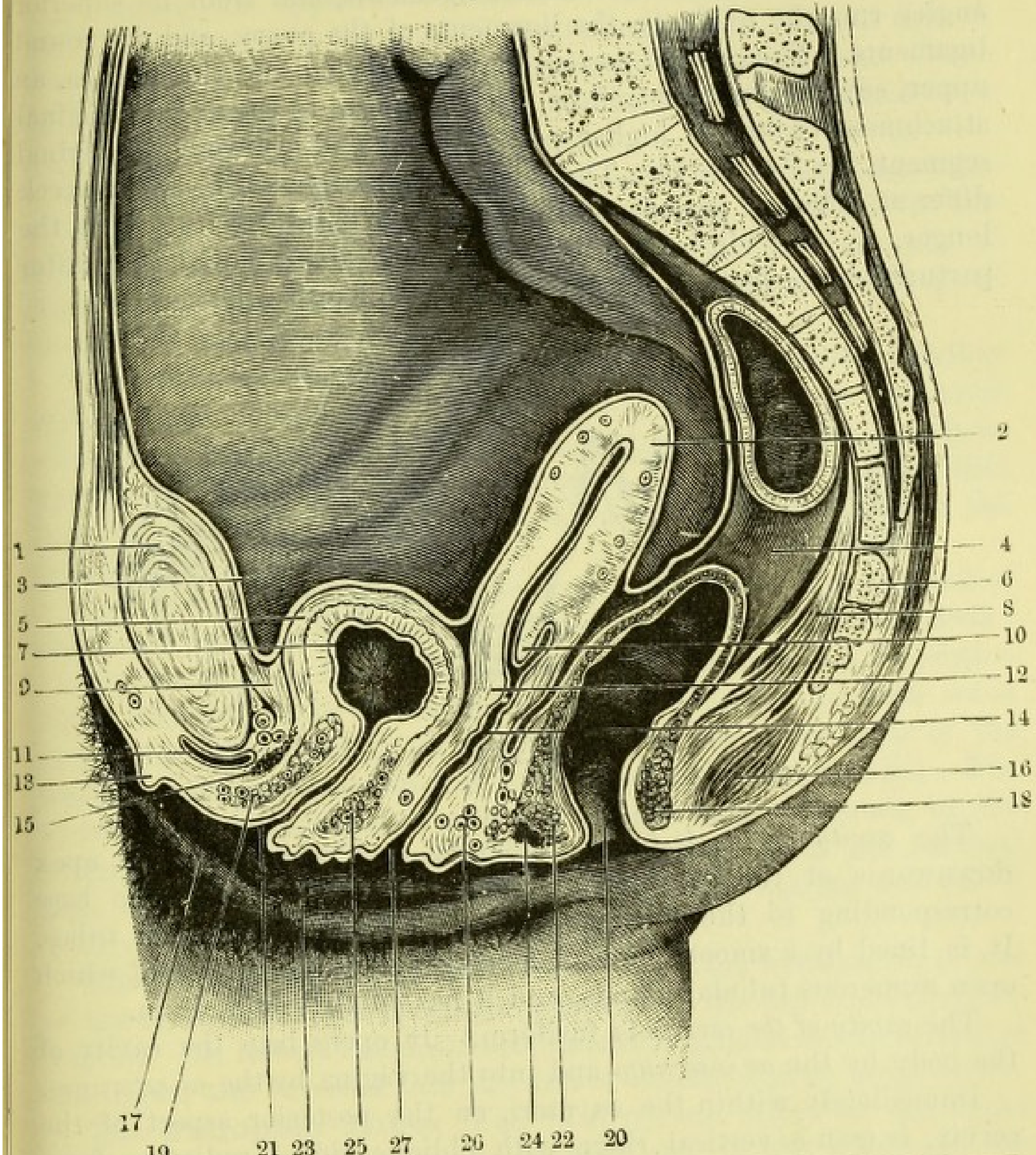
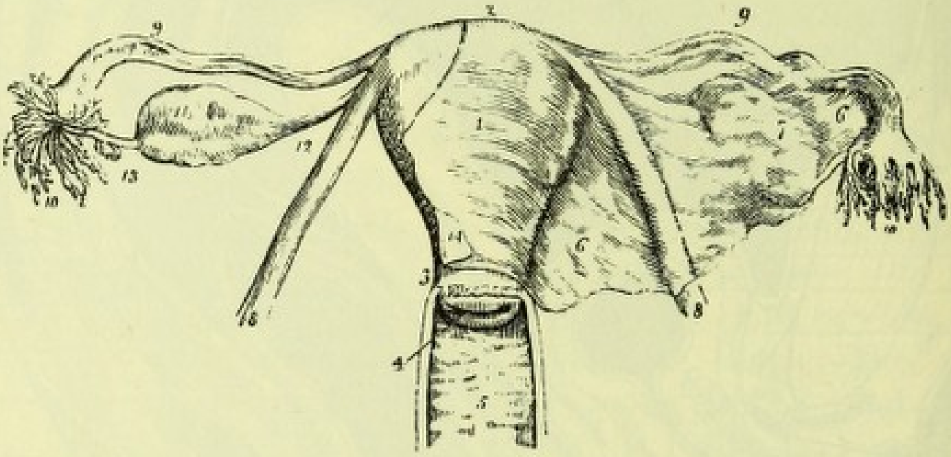


Fig. 178.—Section of female pelvis (after Henle).

1. Symphysis.
2. Uterus (the recto-vaginal pouch behind this is too shallow).
3. Peritoneum.
4. Rectum.
5. Vesical wall.
6. Coccyx.
7. Cavity of bladder.
8. Recto-coccygeal muscle.
9. Prevesical fat.
10. Posterior lip of os uteri.
11. Dorsal vein.
12. Anterior lip of os uteri.
13. Clitoris.
14. Vagina.
15. Deep transversus perinæi.
16. External sphincter ani.
17. Labium majus.
18. Internal sphincter ani.
19. Unstriped muscular fibre.
20. Anus.
21. Urethra.
22. Internal sphincter ani.
23. Labium minus.
24. Part of external sphincter.
25. Unstriped muscular fibre.
26. Vessels.
27. Vaginal orifice.

ment to the broad and utero-sacral ligaments, and from its superior angles run the oviducts, the ligaments of the ovary, and the round ligaments. The *cervical portion* may be divided into three zones, an upper, supravaginal; a middle, corresponding to the area of vaginal attachment (which is higher posteriorly); and a lower intravaginal segment, the "*os uteri.*" The relative dimensions of body and neck differ at different periods of life. In the child the cervix is the longer, in the virgin the two parts are about equal, but after parturition the body is left nearly twice as long as the cervix.

Fig. 179.



The *cavity of the body* is triangular in shape, with the apex downwards at the os internum, and the extremities of the base corresponding to the orifices of the oviducts or Fallopian tubes. It is lined by a smooth mucous membrane, on the surface of which open numerous tubular glands, and it has ciliated epithelium.

The *cavity of the cervix* is fusiform. It opens into the cavity of the body by the *os internum* and into the vagina by the *os externum.*

Immediately within the os uteri, on the posterior aspect of the cervix, is seen a vertical ridge with oblique ridges radiating from

Fig. 179.—Diagram of Uterus with its appendages viewed from the front (from Wilson).

1. Body of the uterus.
2. Fundus.
3. Cervix.
4. Os uteri.
5. Vagina.
6, 6. Broad ligament of the uterus.
7. Convexity of the broad ligament formed by the ovary.
8, 8. Round ligaments of the uterus.
9, 9. Fallopian tubes.
10, 10. Fimbriated extremities of the Fallopian tubes; on the right side the mouth of the tube is turned forwards in order to show its *ostium abdominale.*
11. Ovary.
12. Utero-ovarian ligament.
13. Tubo-ovarian ligament.
14. Peritoneum of anterior surface of uterus, continuous with the anterior layer of the broad ligament.

it, producing the appearance known as the *arbor vitæ uterina.* A similar appearance in the mucous membrane of the anterior surface of the cervix has been necessarily destroyed by the incision. These markings correspond to muscular fasciculi, and are hence of a different nature from those in the vagina.

The *utero-sacral ligaments* are two flat bands of smooth muscular fibre, which run from the sides of the uterus backwards in the utero-rectal peritoneal folds (which form the lateral boundaries of the pouch of Douglas), on either side of the rectum, to the front of the sacrum near the sacro-iliac synchondroses.

The uterus is composed of pale unstriped muscular fibre together with a large quantity of areolar tissue. In pregnancy the muscular fibres become much developed, and are divisible into three layers: an external, chiefly transverse in direction; a middle, irregular; and an internal layer, forming sphincters around the tubal orifices and cervix.

The *uterine artery,* a branch of the internal iliac, enters the root of the broad ligament to reach the organ at the level of the cervix: crossing in front of the ureter, it then runs upwards in a serpentine course along the side of the uterus, giving branches to both walls and to the upper part of the vagina, and at the upper angle of the uterus it anastomoses with the ovarian and funicular arteries. The *uterine veins* form a plexus with the ovarian and terminate in the internal iliac veins. The *vaginal arteries* come from the internal iliac and vesical, anastomosing above with the uterine and below with vestibular twigs of the external pudic.

The *nerves* of the uterus are derived from the hypogastric plexus of the sympathetic, the spermatic plexus, and the 3rd and 4th sacral nerves. Dr. Robert Lee described numerous ganglia on the surface of the organ, and believed that the nerves enlarge during pregnancy.

The **Fallopian Tubes** (Fig. 179, 9), are found at the upper part of the broad ligament, one on each side of the uterus, to the angles of which they are attached. Each tube is about four inches long, and of very small calibre at the uterus, but gradually expands to form an *ampulla* and terminates in a trumpet-shaped expansion furnished with a number of marginal processes (*fimbriæ*), which radiate from the external openings of the canal. One of the fimbriæ (*fimbria ovarica* or *tubo-ovarian ligament,* 13) is attached to the ovary, and serves to direct the ostium in grasping the ovum as it emerges from that organ. The tube is muscular in structure, and is lined by a longitudinally plicated mucous membrane with ciliated epithelium. Its external orifice (*ostium abdominale*) opens into the peritoneal cavity.

The **Round Ligament** (Fig. 179, 8) placed in the anterior part of the broad ligament is composed of unstriped muscular fibre and areolar tissue, and is covered by peritoneum. It extends from the angle of the uterus to the inguinal canal through which it passes to become lost in the fat of the labium. In the child and occasionally in the adult it is accompanied for a short distance into the inguinal canal by a funicular process of peritoneum called the *canal of Nuck.*

It is supplied by a small artery which anastomoses at the superior angle of the uterus with the ovarian and uterine. Its lymphatics open into the inguinal glands.

The **Ovary** (Fig. 179, 11) is an almond-shaped body projecting from the posterior part of the broad ligament and attached to the superior angle of the uterus by a muscular band, the *utero-ovarian ligament* (12), and by its opposite extremity to the *fimbria ovarica* of the Fallopian tube. It rests in a shallow peritoneal sulcus (*fossa ovarica*) at the side of the true pelvis, between the internal iliac artery and vein, a little below a point midway between the anterior superior iliac spine and the median line. It presents for description a free and an attached border ; two extremities, the uterine and tubal ; and two surfaces. Its true position is doubtful. It is generally represented as lying horizontally with its surfaces looking upwards and downwards, and its extremities pointing inwards and outwards, but there is reason to believe that its long axis is vertical, the surfaces looking inwards and outwards (Symington).

It is composed of a fibro-muscular stroma condensed peripherally into a cortex (*tunica albuginea*), which is covered with epithelium, and contains innumerable *ovisacs* or *Graafian vesicles.* From time to time certain of these ovisacs enlarge, approach the surface and burst, discharging each an ovum, which is received by the mouth of the oviduct and conveyed to the uterus. This process causes a scarring of the originally smooth tunica albuginea, and certain changes in the ruptured ovisac which lead to the formation of a yellowish mass called the *corpus luteum.* Should impregnation occur, the increased determination of blood to the ovary gives a much larger development to the corpus luteum than under ordinary circumstances, and hence we hear of a "corpus luteum of pregnancy" in medico-legal investigations.

The *broad ligaments* are duplications of peritoneum extending from the lateral borders of the uterus to the sides of the true pelvis, and present each an anterior and a posterior surface, a smooth or free border, an internal or uterine border, an external or obturator border attached to the obturator fascia, and an inferior border or base, attached to the levator ani. Between the two laminæ are the following structures:—(1) The oviduct at the superior border. (2) The ovary and its ligament, projecting from the posterior surface. (3) The round ligament, projecting from the anterior surface. (4) The parovarium, paroophoron, or organ of Rosenmüller, relics of the Wolffian body lying above the attached border of the ovary. (5) Bands of unstriped muscular fibre (utero-pelvic ligaments). (6) Connective tissue continuous with the subperitoneal tissue. (7) The uterine, ovarian and funicular vessels, all meeting at the superior angle of the uterus. (8) The uterine and ovarian nerves.

Ligaments of the Pelvis.

[The remaining soft tissues are to be removed from the halves of the pelvis, and the several ligaments to be dissected out.]

Articulation of the Vertebral Column with the Pelvis (Fig. 180).—The last lumbar vertebra is connected with the sacrum by a continuation of the several ligaments common to the vertebral column, and by an intervertebral substance, which, like the last

Fig. 180.

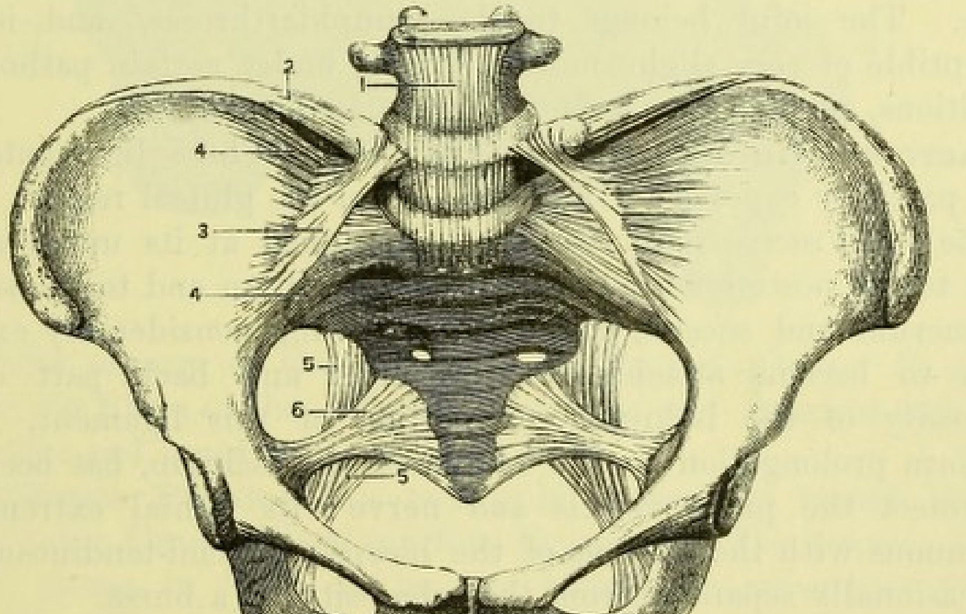


Fig. 180.—Ligaments of the pelvis (from Sappey).

1. Lower part of anterior common ligament of vertebræ.
2. Ilio-lumbar ligament.
3. Sacro-vertebral ligament.
4, 4. Anterior sacro-iliac ligament.
5, 5. Great sacro-sciatic ligament.
6. Small sacro-sciatic ligament.
7. Fibro-cartilage of symphysis.

lumbar vertebra, is of much greater thickness in front than behind. There are also two special ligaments, the sacro-lumbar and ilio-lumbar.

The *sacro-lumbar ligament* (3) is short, thick, and triangular; and is attached to the transverse process of the last lumbar vertebra above, and the upper border of the sacrum below.

The *ilio-lumbar ligament* (2) is triangular, and passes horizontally from the tip of the transverse process of the last lumbar vertebra, to the crest of the ilium close above the sacro-iliac articulation.

Sacro-iliac Articulation.—The *anterior sacro-iliac ligament* (Fig. 180, 4) consists of short fibres passing between the anterior surfaces of the two bones.

The *posterior sacro-iliac ligament* (Fig. 181, 1) is composed of strong ligamentous bands, connecting the rough portion of the ilium behind the auricular surface of articulation with the posterior surface of the sacrum external to the posterior foramina. The *oblique sacro-iliac ligament* (3), is merely a superficial portion of the posterior ligament, which reaches from the posterior superior spine of the ilium to the third lateral tubercle on the sacrum.

When the ilium and sacrum are separated after the dissection of the other ligaments of the pelvis, a distinct layer of cartilage will be found between the two bones, with occasionally an intervening space. The joint belongs to the 'amphiarthroses,' and is only susceptible of very slight motion except under certain pathological conditions, such as ankylosis of the hip.

Sacro-sciatic Ligaments (Fig. 181).—These ligaments have been partially exposed in the dissection of the gluteal region.

The *Great sacro-sciatic ligament* (2) is broad at its upper attachment to the posterior inferior spine of the ilium and to the sides of the sacrum and coccyx, and after narrowing considerably expands again to become attached to the inner and back part of the tuberosity of the ischium. A portion of this ligament, by its falciform prolongation to the ramus of the ischium, has been seen to protect the pudic vessels and nerve: its ischial extremity is continuous with the tendons of the biceps and semi-tendinosus, and is occasionally separated from the tuberosity by a bursa.

The *Small sacro-sciatic ligament* (4, 5) is a strong triangular band attached by its base to the side of the sacrum and coccyx close to, but in front of, the great ligament, and by its apex to the spine of the ischium. It separates the greater from the lesser sacro-sciatic foramen, and is closely incorporated anteriorly with the coccygeus muscle.

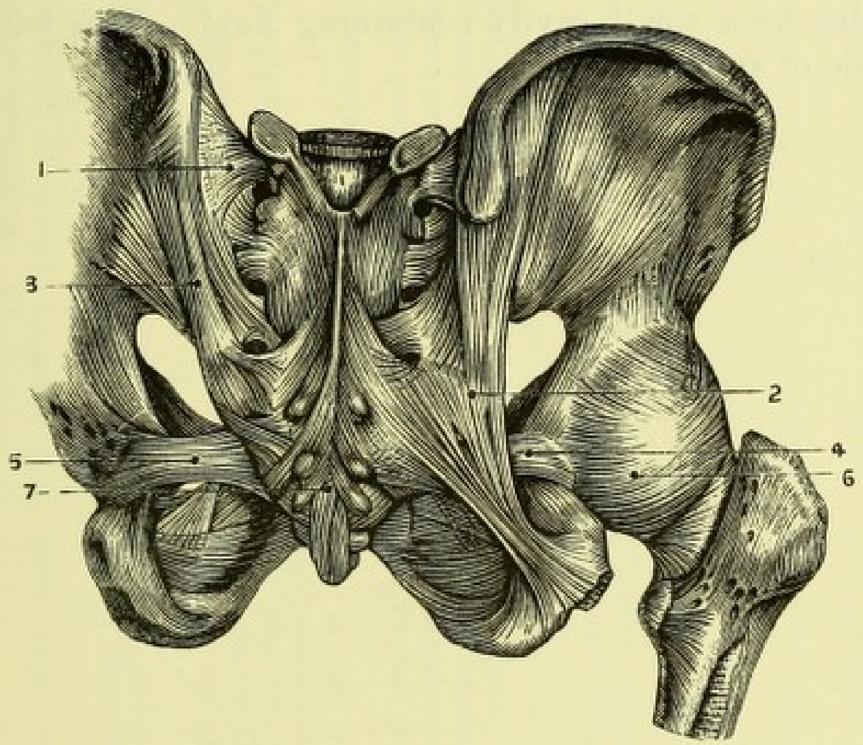
Articulation of the Sacrum and Coccyx.—The *anterior* *sacro-coccygeal ligament* is a thin fasciculus, passing from the anterior surface of the sacrum to the front of the coccyx.

The *posterior sacro-coccygeal ligament* is attached to the lower opening of the sacral canal, and passes along the whole length of the posterior surface of the coccyx.

A small *inter-articular cartilage* intervenes between the sacrum and coccyx; and the cornua of the latter are connected to the former by short *lateral* ligamentous bands.

The *Obturator Membrane* is a fibrous structure filling up the obturator foramen except at its upper part, where an opening is

Fig. 181.



left for the passage of the obturator vessels and nerve. It gives origin to the fibres of the obturator externus and internus muscles by its outer and inner surfaces.

Symphysis Pubis.—The two pubic bones are united by an inter-articular fibro-cartilage and four ligaments. The *anterior pubic ligament* passes in front of the two bones, the superficial fibres interlacing obliquely, and the deeper ones running transversely.

Fig. 181.—Posterior ligaments of the pelvis and hip-joint (Bonamy and Beau).

1. Posterior sacro-iliac ligament.
2. Great sacro-sciatic ligament.
3. Oblique sacro-iliac ligament.
4. Small sacro-sciatic ligament.
5. The same fully exposed by removal of the great ligament.
6. Capsule of hip-joint.
7. Posterior sacro-coccygeal ligament.

The *posterior pubic ligament* consists merely of a few scattered fibres.

The *superior pubic ligament* connects the pubic crests.

The *sub-pubic ligament* is a strong band passing from one pubic bone to the other, and arching beneath the symphysis. It is closely related to the dorsal vein of the penis.

[To see the arrangement of the inter-articular cartilages, a vertical transverse section of the symphysis near its posterior part should be made with the saw.]

The *inter-articular fibro-cartilage* intervenes between the roughly-grooved surface of each pubic bone, and is sometimes divided into two lamellæ by a small cavity containing fluid. This joint also is an example of amphiarthrosis.

MUSCLE.	ORIGIN.	INSERTION.	NERVE.
Obliquus externus	Bony parts Lower ribs 8, intercostal fascia	Iliac crest ½, Poupart's ligament, pubic crest and spine, symphysis, opposite crest and ilio-pectineal line, median line	
Obliquus internus	Fascia lumborum, iliac crest ⅔, Poupart's ligament ⅓	Costal cartilages lower 4, median line, pubic crests and ilio-pectineal line	Lower six intercostals; ilio-hypogastric and ilio-inguinal nerves (1st lumbar).
Transversalis	Lower costal cartilages 6, fascia lumborum, iliac crest ¾, Poupart's ligament ⅓ 3/4	Median line, pubic crest, and ilio-pectineal line with obliquus internus	
Pyramidalis	Pubic crest	Median line	
Rectus abdominis	Pubic crest, symphysis	Costal cartilages, 5, 6, 7 ant. surface.	
Diaphragm	Ensiform cartilage, lower costal cartilages 6, ligamenta arcuata ext. and int., 3 or 4 lumbar vertebræ; intervertebral discs	Central cordiform tendon	Phrenics (3rd, 4th and 5th cervical).
Psoas magnus	12th dorsal and all lumbar vertebræ and intervertebral discs	Lesser trochanter of femur	Lumbar nerves.
Psoas parvus	12th dorsal and 1st lumbar vertebræ and disc	Ilio-pectineal eminence and line	Lumbar nerves.
Iliacus internus	Iliac fossa and ilio-lumbar ligament	Below lesser trochanter of femur	Anterior crural. (Pelvic branch).
Quadratus lumborum	Iliac crest, ilio-lumbar ligament	Last rib, lumbar transverse processes	Lumbar nerves.
Levator ani	Back of os pubis, "white line" of fascia, ischial spine	Rectum, perinæum median raphé, coccyx	4th sacral.
Coccygeus	Spine of ischium	Side of coccyx	4th and 5th sacral.
Obturator internus	Inner wall of pelvis around obturator membrane. Membrane inner ⅔	Top of great trochanter, with Gemelli	From sacral plexus.
Pyriformis	Front of sacrum, great sciatic notch	Top of great trochanter behind obturator internus	Upper sacral nerves.
Sphincter ani	Tip of coccyx	Central point of perinæum	From 4th sacral.
Bulbo-cavernosus	Central fibrous raphé	Triangular ligament, raphé on upper surface of corpus spongiosum, corpus cavernosum	Superficial perinæal.
Ischio-cavernosus	Ramus and tuber ischii and crus	Corpus cavernosum and crus	
Superficial transversus perinæi	Tuber ischii (inner side)	Central point of perinæum	
Deeptransversus perinæi	Back of ischio-pubic rami	Urethra	Dorsal nerve of penis.
Sphincter vaginæ	Central point of perinæum	Upper surface of clitoris and triangular ligament	Superficial perinæal.
Erector clitoridis	Tuber ischii (front)	Crus clitoridis (sides)	

TABLE VIII.—ARTERIES OF ABDOMEN AND PELVIS.

Abdominal Aorta.

- α. Branches to digestive viscera (single).
  - *Cœliac axis*, arises opposite upper border of 1st lumbar vertebra.
    - *Gastric.*
      - Œsophageal.
      - Coronary.
      - Cardiac.
    - *Hepatic.*
      - Pyloric.
      - Gastro-duodenalis
        - Gastro-epiploica dextra.
        - Pancreatico-duodenalis superior.
      - Left hepatic.
      - Right hepatic—Branch : cystic.
    - *Splenic.*
      - Pancreaticæ parvæ et magna.
      - Gastric vasa brevia.
      - Gastro-epiploica sinistra.
      - Splenic.
  - *Superior mesenteric*, arises opposite 1st lumbar vertebra.
    - Branches to small intestine:
      - *Pancreatico-duodenalis inferior.*
      - *Vasa intestini tenuis.*
    - Branches to large intestine:
      - *Ileo-colic.*
      - *Colica dextra.*
      - *Colica media.*
  - *Inferior mesenteric*, arises opposite 3rd lumbar vertebra.
    - *Colica sinistra.*
    - *Sigmoideæ.*
    - *Superior hæmorrhoidal.*
- β. Branches to non-digestive viscera (paired)
  - *Supra-renal*, arises opposite upper part of 1st lumbar vertebra.
  - *Renal*, arises opposite lower part of 1st lumbar vertebra.
  - *Spermatic*, arises opposite 2nd lumbar vertebra.
- γ. Parietal branches
  - *Phrenic*, arises opposite upper border of 1st lumbar vertebra (sometimes one or both from cœliac axis or other branches).
  - *Lumbar*, usually 5 on each side.
    - *Anterior division* to abdominal walls.
    - *Posterior division*
      - *Muscular branch* to erector spinæ.
      - *Spinal branch* to spinal column, membranes and cord.
        - Ramus canalis anterior.
        - Ramus canalis posterior.
        - Ramus medullæ spinalis.
  - *Sacra media* (sacral aorta).
- δ. *Terminal* ..
  - *Common Iliacs.* Small twigs to peritoneum, sub-peritoneal tissue, and ureters.
    - A. *Internal iliac, anterior trunk.*
      - Superior vesical.
      - Inferior vesical—Branch: deferential.
      - Obturator. Branches: iliac and pubic.
      - Middle hæmorrhoidal.
      - Sciatic.
      - Internal pudic. Branches: muscular, vesical, inferior hæmorrhoidal, transverse anterior and posterior perinæal, artery to bulb, artery to corpus cavernosum, and dorsal artery of the penis.
    - *posterior trunk*
      - Ilio-lumbar.
      - Lateral sacral.
      - Gluteal, superficial and deep branches.
    - B. *External iliac.* Becomes femoral below Poupart's ligament.
      - *Deep epigastric.* Branches: pubic and deferential.
      - *Deep circumflex iliac.*

The veins correspond to the arteries, but the visceral veins from the tomach, intestine, spleen and pancreas form the portal vein, which reaks up into a venous plexus within the liver. From this plexus rise the hepatic veins, the trunks of which open into the inferior vena ava where it is imbedded in the caval fissure of the liver. The immeliate tributaries of the portal vein are the gastric, the splenic (which usually receives the inferior mesenteric in addition to those corresponding o the branches of the splenic artery) and the superior mesenteric.

The veins of the non-digestive viscera and abdominal parietes terminate in the inferior vena cava, except the left spermatic vein, which usually ends in the left renal.

TABLE IX.—THE SPINAL NERVES IN THE ABDOMEN AND PELVIS.

LUMBAR NERVES:

- *Posterior branches* ..
  - Internal. Muscular to erector spinæ.
  - External. Muscular and cutaneous.
- *Anterior branches* .. 1st, 2nd, 3rd and 4th, with communicating branch from 12th dorsal, form lumbar plexus, and give off small twigs to quadratus lumborum.
  - (12 D. 1 L.) *Ilio-hypogastric* ....
    - Muscular to transversalis and obliqui abdominis.
    - Cutaneous iliac and hypogastric branches.
  - (12 D. 1 L.) *Ilio-inguinal* ....
    - Muscular to transversalis and obliqui abdominis.
    - Cutaneous to thigh and scrotum or labium.
  - (1 D. 2 L.) *Genito-crural* ....
    - Genital or muscular to cremaster.
    - Crural or cutaneous to thigh.
  - (2 & 3 L.) *External cutaneous* (see lower extremity).
  - (2, 3 & 4 L.) *Anterior crural* (see lower extremity).
    - Within pelvis
      - Muscular to iliacus.
      - Arterial to external iliac.
  - (2, 3 & 4 L.) *Obturator* (see lower extremity).
  - (4th) *Communicating* to lumbo-sacral cord.
  - *Lumbo-sacral cord* = 5th lumbar.

SACRAL NERVES (see lower extremity).

- *Posterior branches.* Muscular and cutaneous.
- *Anterior branches.* With lumbo-sacral cord form sacral plexus.
  - *Superior gluteal.* (5 L. 1 S.)
  - *Small sciatic.* (5 L. 1 & 2 S.)
  - *Inferior gluteal* (sometimes from small sciatic) 5 L. 1 & 2 S.
  - *Perforating cutaneous* to buttock (3 & 4 S.).
  - *Visceral,* joining sympathetic.
  - *Muscular to*
    - Pyriformis (2 S.).
    - Obturator internus and gemellus superior (5 L. 1 S.).
    - Quadratus femoris and gemellus inferior (twig to hip joint).
    - Levator ani.
    - Coccygeus.
    - External sphincter.
  - *Great sciatic* (4 & 5 L. 1, 2, 3 & 4 S.).
  - *Pudic* (3 & 4 S.)
    - Inferior hæmorrhoidal.
    - Perinæal
      - Muscular to levator ani, ischio-cavernosus, bulbo-cavernosus, and superficial transversus perinæi.
      - Cutaneous to perinæum.
    - Dorsal nerve of penis
      - Muscular to deep transversus perinæi.
      - Cutaneous to skin of penis.

PART IV.

DISSECTION OF THE HEAD AND NECK.

[*The Student is requested to read the 'Introduction' before commencing the dissection, unless he has done so on a previous occasion.*]

Before beginning the dissection the student should make himself fully acquainted with the external configuration of the part, and the relation of surface-markings to deeper structures. If he has already dissected this region, he should make the incisions necessary for exposing the common carotid artery and the third part of the subclavian artery, and may also advantageously perform the operations of laryngotomy and tracheotomy, and practice extraction of the teeth and the operation for plugging the posterior nares, which last can be done with a flexible catheter. Various portions of the cranium can be recognised through the integuments, and should be noted, as they may be used later in cerebral localisation. They are the *glabella* or *nasal eminence*, the *bregma*, the *lambda*, and the *external occipital protuberance* or *inion* in the middle line ; and the *external angular process*, the *frontal eminence*, the *zygomatic arch*, the *parietal eminence*, the *mastoid process*, the *temporal ridge*, and the *superior curved line* on either side.

The superficial appearances on the face will be described more particularly under that head, and reference may be made to the section now, if time allows.

In the neck, the median line is the boundary of the dissection, and presents the following prominences and depressions, from above downwards. The symphysis of the lower jaw ; a depression corresponding to the interval between the anterior bellies of the two digastric muscles ; the projection of the hyoid bone, the greater cornua of which can be felt running out almost horizontally on each side in some subjects ; the depression corresponding to the thyro-hyoid membrane (obliterated by the ascent of the thyroid cartilage during deglutition) ; the prominent *pomum Adami* of the thyroid cartilage, the well defined pit corresponding to the crico-thyroid membrane; and the prominent ring of the cricoid cartilage. Below this may occasionally be felt the isthmus of the thyroid body, and even the trachea above and below it in a thin subject, and, lastly, the supra-sternal fossa. On each side (particularly in women) there is the slight projection of the lateral lobe of the thyroid body.

The crico-thyroid membrane and the trachea should be especially noticed, as the positions in which laryngotomy and tracheotomy are performed.

The clavicle and sternum and the sterno-clavicular joints bound the dissection below, and across the side of the neck the prominence of the sterno-mastoid marks the division into anterior and posterior triangles; in an injected body the carotid artery may be felt near the middle of the anterior border of this muscle. The external jugular vein, if full of blood, will probably be seen crossing the sterno-mastoid obliquely, and may be opened *secundum artem* by an incision parallel to the muscle.

After the dissection of the neck is commenced, and sometimes before in thin subjects, two important bony landmarks may be distinguished, the prominent transverse process of the atlas below the mastoid process, and the anterior tubercle of the transverse process of the 6th cervical vertebra (*carotid tubercle* of Chassaignac) nearly opposite the lower border of the cricoid cartilage.

It will be found to be impossible to dissect both sides of the head and neck simultaneously, and the students should therefore arrange to work together, and to take turns at dissecting and reading.

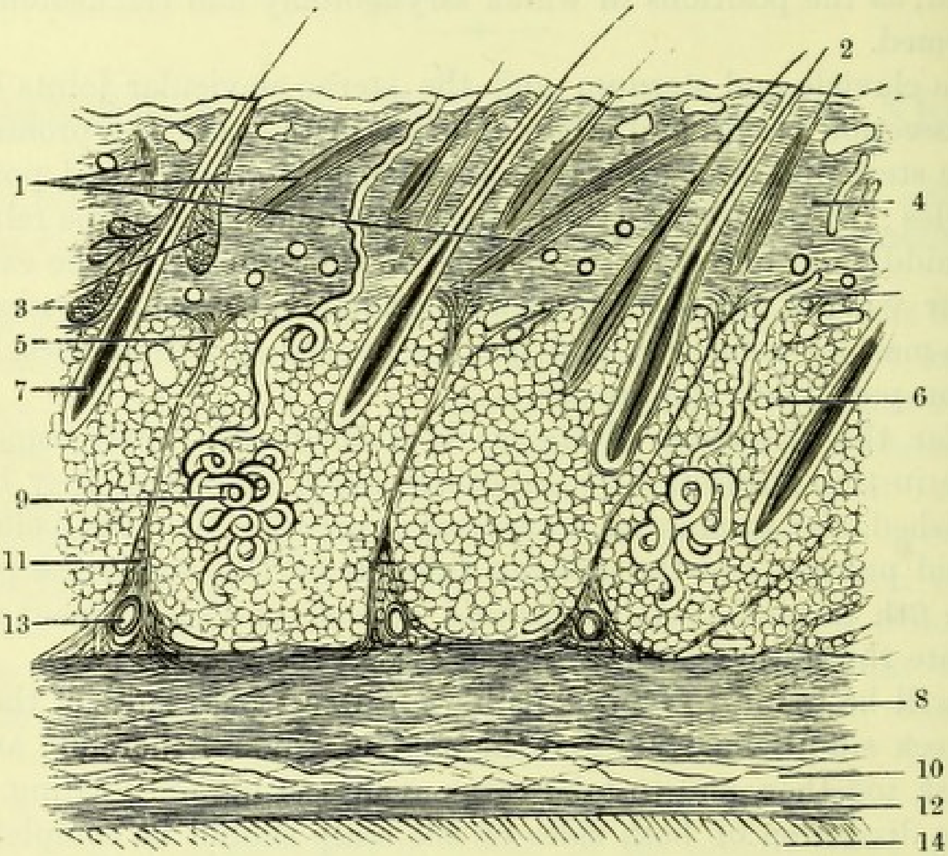
The dissection of both sides of the scalp should be completed on the first day, in order that the brain may be removed on the second morning.

The Scalp.

[The head being shaved and raised on a block, one incision is to be carried from the root of the nose to the occiput, and another at right angles to it from the front of the ear across the head to the corresponding point on the opposite side, and the flaps thus marked out are to be dissected, beginning at the top of the head. Great care must be taken to remove only the skin and not the subcutaneous tissues, which are very thin; the best guides are the roots of the hair, which should be exposed on the under surface of the flaps. The flaps having been turned down to the level of the brow in front, and the occipital protuberance behind, the dissector may, if he choose, attempt to define the small muscles of the external ear, which are seldom well developed. A portion of the scalp may be excised and its structure examined.]

The **Scalp** consists of many structures (Fig. 182). In the portion covering the vertex these are as follows, from without inwards. 1. *Epidermis,* covering the papillæ, prolonged into the hair follicles

Fig. 182.



and continuous with the linings of the sudoriparous and sebaceous
S. ducts. 2. *Cutis vera,* containing sebaceous follicles and *arrectores*
C. *pilorum* muscles. 3. *Panniculus adiposus,* consisting of ovoid lobules of fat arranged side by side, with their long axes at right angles to the surface. The hair bulbs and sudoriparous coils lie in the upper part of

Fig. 182.—Section of the scalp (after Poirier).

1. Arrectores pilorum.
2. Epidermis.
3. Sebaceous glands.
4. Cutis vera.
5. Interlobular process.
6. Panniculus adiposus.
7. Hair bulb.
8. Galea aponeurotica.
9. Sudoriparous gland.
10. Tela conjunctiva.
11. Interlobular process of fibrous tissue.
12. Pericranium.
13. Branch of temporal artery.
14. Bone.

Skin.
Cutaneous Fat. 3 Muscles of Ear.
Aponeurosis.
Loose Areolar Tissue
Pericranium.

this layer, and the temporal and other vessels in the lower. 4. *Galea aponeurotica*—the tendon of the occipito frontalis—covering the vertex and prolonged laterally over the temporal fascia and zygoma to be lost upon the face. It is connected with the deep surface of the derm by fibrous processes, which pass between the fat lobules of the panniculus adiposus.

The scalp so constituted is connected with the pericranium by a loose connective tissue, the *tela conjunctiva*, with large intercommunicating spaces. Any blood or pus effused in this subaponeurotic space tends to spread over the whole cranium while like collections in the scalp itself are sharply circumscribed. from muscle to muscle at front & back.

In the *frontal* and *occipital regions* the galea aponeurotica is partially replaced by the muscular fibres of the occipito-frontalis ; and in the temporal region the aponeurosis gives attachment to the anterior and superior auricular muscles.

The **Muscles of the Pinna** (Fig. 183), are the *auricularis superior*, the *auricularis anterior*, and the *auricularis posterior* (*attollens, attrahens* and *retrahens auriculam*). The names sufficiently indicate their positions, and they are all inserted into the pinna, the anterior *arising* from the anterior part of the aponeurosis of the occipito-frontalis, and being *inserted* into the helix ; the superior *from* the middle part of the same aponeurosis, and *inserted* into the fossa of the antihelix ; and the posterior, which consists of two or three stronger bundles of fibres, arising *from* the mastoid process and passing *to* the back of the concha. They rarely have any power of moving the pinna, but may slightly modify its shape, and the anterior and superior muscles may act with the occipito-frontalis as tensors of the galea aponeurotica. Minute intrinsic muscles are also present, but these will not repay dissection.

[The muscular fibres of the occipito-frontalis are to be cleaned both on the forehead and on the occiput, care being taken not to damage the intervening aponeurosis, or the nerves which pierce the muscle at several points and communicate on its substance.]

The **Occipito-frontalis** (Fig. 183).—The *anterior belly* (2) has no bony attachment, but blends at its *origin* with the fibres of the orbicularis palpebrarum, pyramidalis nasi, and corrugator supercilii. The *posterior belly arises* from the outer half or two-thirds of the superior curved line of the occipital bone, and very slightly from the mastoid process of the temporal bone, and is separated from its fellow by a triangular interspace which is occupied by a prolongation of the galea aponeurotica. Both bellies are *inserted* into the galea.

The muscle wrinkles the forehead transversely, elevates the eyebrows, and slightly aids in raising the upper lid : in some persons it may also be made to move the entire scalp backwards and forwards by the alternating contractions of its two bellies; and in association with the auricular muscles it probably aids the circulation of lymph in the spaces of the tela conjunctiva by tensing the galea aponeurotica. It is *supplied* by the facial nerve.

Cutaneous Vessels and Nerves (Figs. 183, 184).—In front of the ear will be found branches of the three divisions of the 5th nerve and branches of the facial nerve, together with ramifications of the ophthalmic and temporal vessels. Behind the ear are, the posterior auricular branch of the facial nerve, the auricular branch of the vagus, the great auricular and small occipital of the cervical plexus, the great occipital from the posterior branch of the second cervical nerve, and sometimes the third occipital from the third cervical nerve, together with the posterior auricular and occipital arteries. It must be borne in mind that the sensory branches of the 5th nerve, although chiefly important to the dissector in their relation to the skin, give branches to the muscles with which they are in contact, and these unite with the motor filaments derived from the facial nerve. In the limbs, both sensory and motor nerves are supplied to the muscles from a single nerve trunk.

1. The *Supra-orbital nerve* (8) [first div. of 5th] will be most readily found by feeling for the supra-orbital notch, and then cutting through the occipito-frontalis at that spot. It divides into two branches within the orbit, the larger passing through the notch or foramen, the smaller through a shallow groove internal to the notch. The twigs pierce the occipito-frontalis, and supply the skin nearly as far as the lambdoid suture.

2. The *Supra-trochlear nerve* (6) [first div. of 5th] is a small nerve which leaves the orbit at its inner angle, and supplies the skin of the forehead after piercing the occipito-frontalis.

The *Supra-orbital artery* (Fig. 184, 2) [ophthalmic] accompanies the supra-orbital nerve, and also gives superficial branches to the occipito-frontalis muscle and integument.

The *Frontal artery* (1) [ophthalmic] is of small size, and accompanies the supra-trochlear nerve.

The *Supra-orbital* and *Frontal veins* unite to form the angular vein, which is the commencement of the facial vein ; they communicate freely with the ophthalmic vein.

3. The *Temporal branch of the Temporo-malar nerve* (Fig. 183, 10) [second div. of 5th] will be found with difficulty, as it is of small size.

Fig. 183.

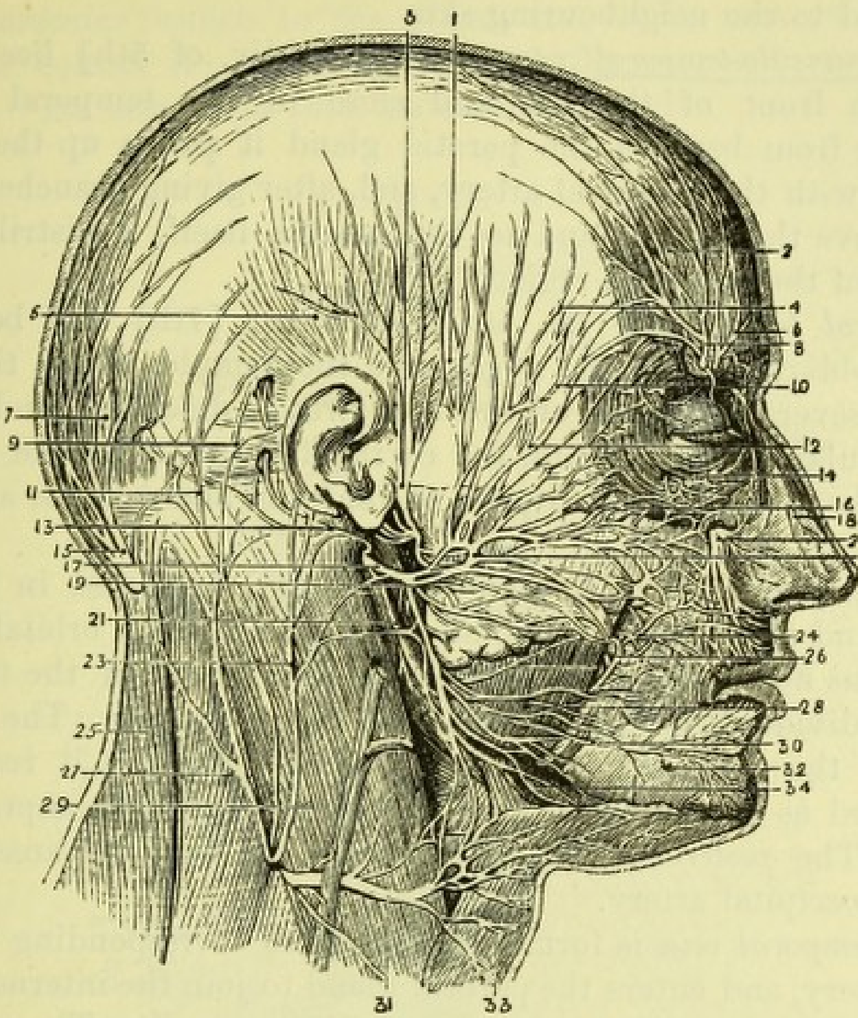


Fig. 183.—Nerves of the scalp and face (from Hirschfeld and Leveillé).

1. Anterior auricular muscle.
2. Anterior belly of occipito-frontalis.
3. Auriculo-temporal nerve.
4. Temporal branches of facial nerve (7th).
5. Supra-auricular muscle.
6. Supra-trochlear nerve (5th).
7. Posterior belly of occipito-frontalis.
8. Supra-orbital nerve.
9. Posterior auricular muscle.
10. Temporal branch of temporo-malar.
11. Small occipital nerve.
12. Malar branches of facial nerve.
13. Posterior auricular nerve (7th).
14. Malar branch of temporo-malar nerve (5th) (ramus subcutaneus malæ).
15. Great occipital nerve.
16. Infra-orbital branches of facial nerve (7th).
17. Facial nerve.
18. Nasal nerve (5th).
19. Cervico-facial division of facial.
20. Infra-orbital nerve (5th).
21. Branches to digastric and stylo-hyoid (facial).
22. Temporo-facial division of 7th.
23. Great auricular nerve.
24. Buccal branches of facial neive.
25. Trapezius.
26. Buccal nerve (5th).
27. Splenius capitis.
28. Masseter.
29. Sterno-mastoid.
30. Supra-maxillary branches of facial nerve (7th).
31. Superficial cervical nerve.
32. Mental nerve (5th).
33. Platysma.
34. Infra-maxillary branches of facial nerve (7th).

It pierces the temporal fascia immediately above the zygoma, and is distributed to the neighbouring skin.

4. The Auriculo-temporal nerve (3) [third div. of 5th] lies immediately in front of the ear and close to the temporal artery. Emerging from beneath the parotid gland it passes up the side of the head with the temporal artery, and, after giving branches to the pinna above the meatus and to the meatus itself, is distributed to the skin of the temporal region.

5. *Temporal branches of the facial nerve* (4) [7th] will be found running obliquely over the zygoma to the temple, where they join with the several branches of the 5th already described, and supply the orbicularis palpebrarum, the corrugator supercilii, the anterior belly of the occipito-frontalis, and the anterior and superior auricular muscles.

The *Temporal artery* (6) [external carotid] is found in front of the ear, and after giving off some facial branches, an orbital branch which runs above the zygoma between the layers of the temporal fascia, it divides into anterior and posterior branches. The *anterior* lies upon the temporal fascia, and is subcutaneous ; it reaches as far forward as the forehead, and anastomoses with the supra-orbital artery. The *posterior* turns back above the ear and anastomoses with the occipital artery.

The *Temporal vein* is formed by branches corresponding to those of the artery, and enters the parotid gland to join the internal maxillary vein and form the temporo-maxillary trunk. The veins do not accompany the arteries in the scalp. Both run in the deep portion of the panniculus adiposus, but the arteries retract in their fibrous canals when cut, while the veins, more firmly attached to the surrounding connective tissue tend to gape if divided.

Surgery.—It is on the anterior branch of the temporal artery that the operation of arteriotomy is performed, when it is desired to abstract blood from the head. In the operation it is necessary to make only a puncture in the artery, and, when sufficient blood has flowed, to divide the vessel, in order that the ends may be able to retract and prevent the formation of a false aneurism.

6. The *Posterior Auricular nerve* (13) [facial] will be found immediately behind the ear, and running over the mastoid process with an accompanying artery. It is distributed to the posterior belly of the occipito-frontalis, to the posterior auricular muscles, and to the superior if this be not supplied by the temporal branch ; as well as to the minute muscles of the posterior part of the auricle.

The *Posterior Auricular artery* (Fig. 184, 8) [external carotid] accompanies the nerve in this part of its course, and is distributed by its *auricular* branch to the pinna, and by its *mastoid* branch to the skin behind it; anastomosing with the temporal and occipital arteries. Its *vein* opens into the external jugular.

Fig. 184.

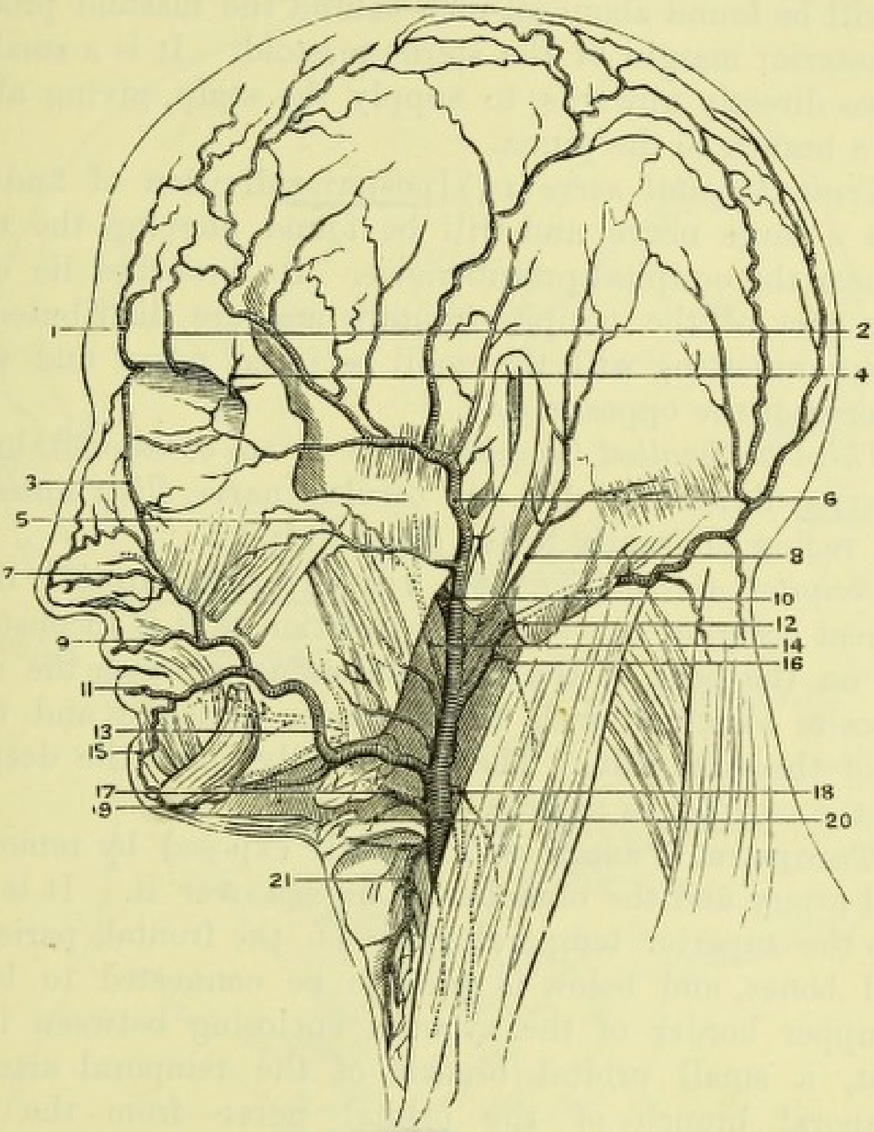


Fig. 184.—Arteries of the scalp and face (after Henle).

1. Frontal artery.
2. Supra-orbital artery.
3. Angular artery.
4. Branch of lachrymal artery.
5. Transverse facial artery.
6. Superficial temporal artery.
7. Lateral nasal artery.
8. Posterior auricular artery.
9. Superior coronary artery and artery to septum.
10. Internal maxillary artery.
11. Inferior coronary artery.
12. Occipital artery.
13. Facial artery.
14. Ascending pharyngeal artery.
15. Inferior labial artery.
16. Sterno-mastoid branch of occipital artery.
17. Lingual artery.
18. Sterno-mastoid branch of carotid artery.
19. Submental artery.
20. Hyoid branch of lingual artery.
21. Superior thyroid artery.

7. The *Great Auricular nerve* (Fig. 183, 23) [2nd and 3rd cervical nerves] ascends to the pinna, to which it gives numerous *auricular* branches, principally on its posterior surface, forming a junction with the posterior auricular nerve. It supplies also a small *mastoid* branch to the skin over the mastoid process.

8. Cervical Plexus). The *Small Occipital nerve* (11) [2nd, ~~or 2nd and 3rd~~ cervical nerve] will be found about an inch behind the mastoid process and at the posterior margin of the sterno-mastoid. It is a small nerve, and passes directly upwards to supply the scalp, giving also occasionally a branch to the pinna.

9. The *Great Occipital nerve* (15) [posterior division of 2nd cervical nerve] is a large nerve, and will be found piercing the trapezius muscle near the occipital protuberance. Its branches lie over the posterior part of the occipito-frontalis and are distributed to the scalp, communicating with the small occipital nerve and with the fellow nerve of the opposite side.

10. The *Third* or *Smallest Occipital nerve* is an occasional branch of the posterior division of the 3rd cervical nerve, distributed to the occipital region internally to the great occipital.

The *Occipital Artery* (Fig. 184, 12) [external carotid] lies close to the great occipital nerve, but its relation to it is inconstant. It ramifies on the back of the scalp, anastomosing with the artery of the opposite side, and with the posterior auricular and temporal arteries of the same side. The *vein* usually joins the deep plexus beneath the complexus muscle.

The **Temporal Fascia** will be fully exposed by removing the temporal artery and the branches of nerves over it. It is *attached* above to the superior temporal ridge on the frontal, parietal, and temporal bones, and below it splits to be connected to both lips of the upper border of the zygoma, enclosing between its layers some fat, a small orbital branch of the temporal artery, and the temporal branch of the orbital nerve from the superior maxillary. It is *pierced* by the middle temporal artery and the temporal branch of the orbital nerve, and gives origin by its deep surface to fibres of the temporal muscle. It is *related* externally to the temporal portion of the galea aponeurotica which passes downwards over the zygoma to the face; and internally is separated from the temporal muscle by a quantity of fat.

Temp. Mal. 2 & V

The **Temporal Muscle** will be exposed in part by removing the fascia covering it. It *arises* from the frontal sphenoid parietal and temporal bones, between the superior temporal ridge and the pterygoid ridge of the sphenoid, and from the under surface of the temporal fascia. Its fibres are seen to converge to a tendon, which will be found in a subsequent dissection to be *inserted* into the tip and inner aspect of the coronoid process of the lower jaw.

The **Lymphatics** of the scalp (Fig. 185), are closely associated with the veins. The mid-frontal region, together with the face, is

Fig. 185.

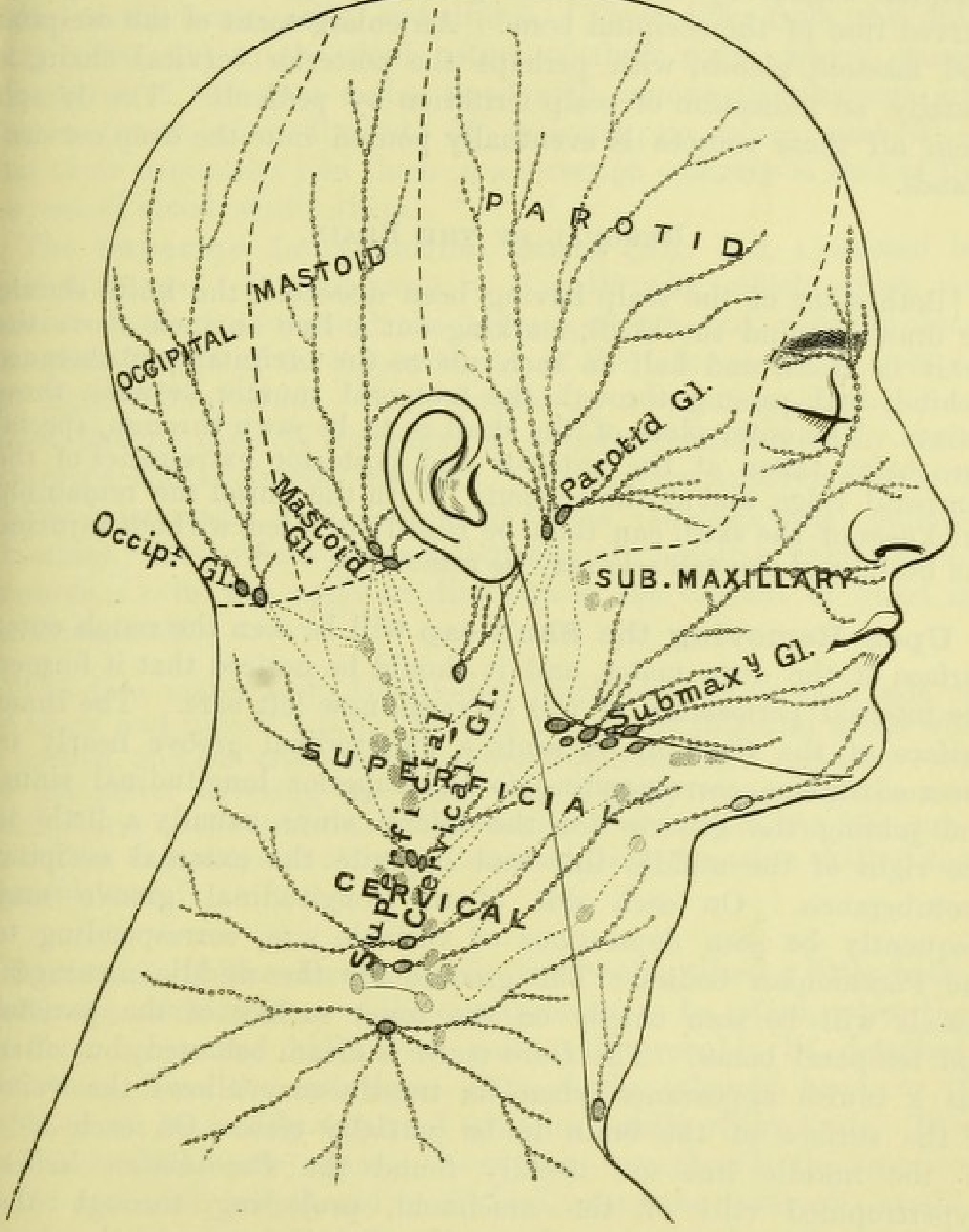


Fig. 185.—Diagram showing the superficial lymphatic regions of the head and neck. (W. A.)

(The deep cervical glands are indicated by lighter shading).

drained by the *submaxillary* glands; the lateral frontal and the anterior temporo-parietal regions (in front of a line drawn vertically upwards from the pinna), by the *pre-auricular* or *parotid* glands which overlie the parotid salivary gland, and partly by the submaxillary gland; the posterior parieto-temporal region by the *mastoid* or *retro-auricular* glands upon the mastoid process; the occipital region by the *occipital* glands lying below the superior curved line of the occipital bone. An enlargement of the occipital and mastoid glands, with perhaps the posterior cervical chain, is usually an indication of scalp irritation by pediculi. The lymph from all these sources is eventually poured into the deep cervical glands.

Removal of the Brain.

[Both sides of the scalp having been dissected, the knife should be drawn around the skull, marking out a line an inch above the orbit in front, and half an inch above the occipital protuberance behind, and passing through the temporal muscle between those points. The outer plate of the skull is to be sawn through, special care being taken at the anterior and posterior extremities of the temporal ridge, and at the occiput. With the chisel the remaining thickness of the skull can then be readily divided without injuring the brain, and the calvaria may be removed.].

Upon Removing the Skull-cap will be seen the rough outer surface of the dura mater, and it should be noticed that it formed the internal periosteum of the calvaria, now left bare. The inner surface of the *Skull-cap* presents a longitudinal groove nearly in the median line, corresponding to the superior longitudinal sinus, and joining the grooves for the lateral sinus, usually a little to the right of the middle line and opposite the external occipital protuberance. On each side of the longitudinal groove may frequently be seen depressions of variable size, corresponding to the Pacchionian bodies. The grooves for the middle meningeal vessels will be seen chiefly on the inner surface of the parietal and temporal bones. The *Dura mater* is cream coloured, but often has a bluish appearance when its translucency allows the veins of the surface of the brain to be partially seen. On each side of the middle line are usually found the *Pacchionian bodies*, hypertrophied villi of the arachnoid, projecting through the dura mater and indenting the skull. Ramifying upon the dura mater is the large *middle meningeal artery* [internal maxillary], and in a well-injected body the *anterior meningeal* [ethmoidal] and *posterior meningeal* (ascending pharyngeal) may sometimes be seen.

the meningeal arteries are the principal nutrient vessels of the bones as well as of the membranes.

The *Meningeal Veins* (venæ comites) accompany the arteries, and terminate chiefly in the internal maxillary, ethmoidal, vertebral, ascending pharyngeal, and occipital veins, and in the sinuses of the dura mater.

The **Sinuses** are the intracranial canals in which terminate the veins of the brain, orbit, and diploë. They differ from the ordinary veins, (1) in the rigid nature of their walls, which consist of a layer of the dura mater lined with venous endothelium, and remain patent when divided; (2) in having no valves; and (3) in that their tributaries join them in a direction contrary to that of the current of blood within them.

The **Superior Longitudinal Sinus** (Fig. 186, 1) should be opened at once. It commences in a small vein, which enters the skull from the nose through the foramen cæcum, and, running along the whole length of the upper border of the falx cerebri, it ends in the right lateral sinus. It is formed by a splitting of the dura mater, and its canal is triangular in section, and traversed by small tendinous cords (*chordæ Willisii*). It receives superior cerebral, diploic, meningeal, and pericranial veins (through the parietal foramina); the orifices of its tributaries all pointing from behind forwards, *i.e.* in the opposite direction to the current of blood in the sinus itself.

[The dura mater is to be divided longitudinally on each side of the sinus and turned down. By this means the subdural space will be opened, and the arachnoid membrane will be seen reflected over the pia mater covering the brain. By slightly separating the two hemispheres of the brain with the handle of the knife, the falx cerebri will be exposed, and must be detached from the crista galli of the ethmoid bone.]

Removal of the Brain.—The head being tilted a little backwards, the anterior lobes of the cerebrum are to be raised, when the *Olfactory nerves* and bulbs (1st pair) will probably be detached with them from the cribriform plate of the ethmoid bone, or if not, they can be readily displaced with the handle of the knife. The *Optic Nerves* (2nd pair) of large size, will be seen close to the anterior clinoid processes, and should be divided, when the Internal Carotid Arteries will be brought into view, and must also be cut, together with the *infundibulum* attached to the *pituitary body* in the middle line. The 3rd pair (*motores oculorum*) will be seen piercing the dura mater behind and a little external to the carotid arteries, and behind the anterior clinoid process, and after dividing these, the *tentorium cerebelli* will be brought into view, with the slender 4th nerve (*patheticus vel trochlearis*) on each side, at the point of the decussation between its free and attached borders, a little behind and external to the posterior clinoid process. The tentorium is to be divided on each side by carrying the knife backwards and outwards, parallel to the margin of the petrous bone, and the 4th pair will be cut at the same time. The tentorium having been turned aside, the remaining cranial nerves will be exposed, and must be cut, in their numerical order. The 5th pair (*trifacial*) will be found to be composed each of two roots, the larger and superior one being chiefly sensory, and the deeper, which is anterior at its origin, chiefly motor in function. The 6th pair (*abducentes*) lie nearer the median line below the posterior clinoid processes. The 7th or *facial*, and the 8th or *auditory*, the latter behind and below the former and connected with it by a band of fibres called the pars intermedia, are seen on each side entering the internal auditory meatus with the auditory vessels. The 9th nerve or *glosso-pharyngeal* runs with the 10th or *vagus*, and the 11th or *spinal accessory*, to pierce the dura mater at a point external to the jugular eminence of the occipital bone, and appear in the angle between the lateral and inferior petrosal sinuses, where these are about to pierce the jugular foramen before uniting to form the jugular vein. The 9th is the highest of the three, and has a separate dural aperture, while the 11th is joined by spinal filaments which pass upwards from the spinal canal. The three nerves disappear through the *foramen lacerum posterius* or jugular foramen with the sinuses named. The 12th (*hypoglossal*) nerve consists of two bundles placed near the median line, which pierce the dura mater separately between the jugular eminence and foramen magnum and then pass together through the *anterior condyloid foramen*. At the point of junction between the falx cerebri and the tentorium will be found the *straight sinus*, joining the lateral and superior longitudinal sinuses at the torcular Herophili : it receives anteriorly the *inferior longitudinal sinus*, which runs in the free border of the falx cerebri, and the *veins of Galen*, passing from the velum interpositum ; and in its course it is joined by the *superior cerebellar veins*.

The knife is now to be pushed through the foramen magnum so as to divide all the parts passing into the skull, viz., the spinal cord and its membranes, the two vertebral arteries, the small spinal vessels, and the two spinal-accessory nerves ; and it should be noticed that the cord can be cut considerably lower than the point at which the vertebral arteries enter the spinal canal. The brain can now be lifted out of the skull, by slipping the fingers beneath the cerebellum and allowing the head to fall back.

[Before placing the brain in methylated spirit, the dissectors should pick off the arachnoid and the pia mater from the base, and carefully lay out the nerves in their proper positions, taking care not to interfere with the arteries. The brain should be placed in a pan with the base upwards, and with a piece of calico bandage beneath it, so that it may be easily lifted out; but if it is too decomposed to be worth preserving, the vessels at its base should be dissected at once. After removal of the brain the points of exit of the various nerves should be carefully examined at the base of the skull.]

The Dura Mater and Sinuses of the Skull.

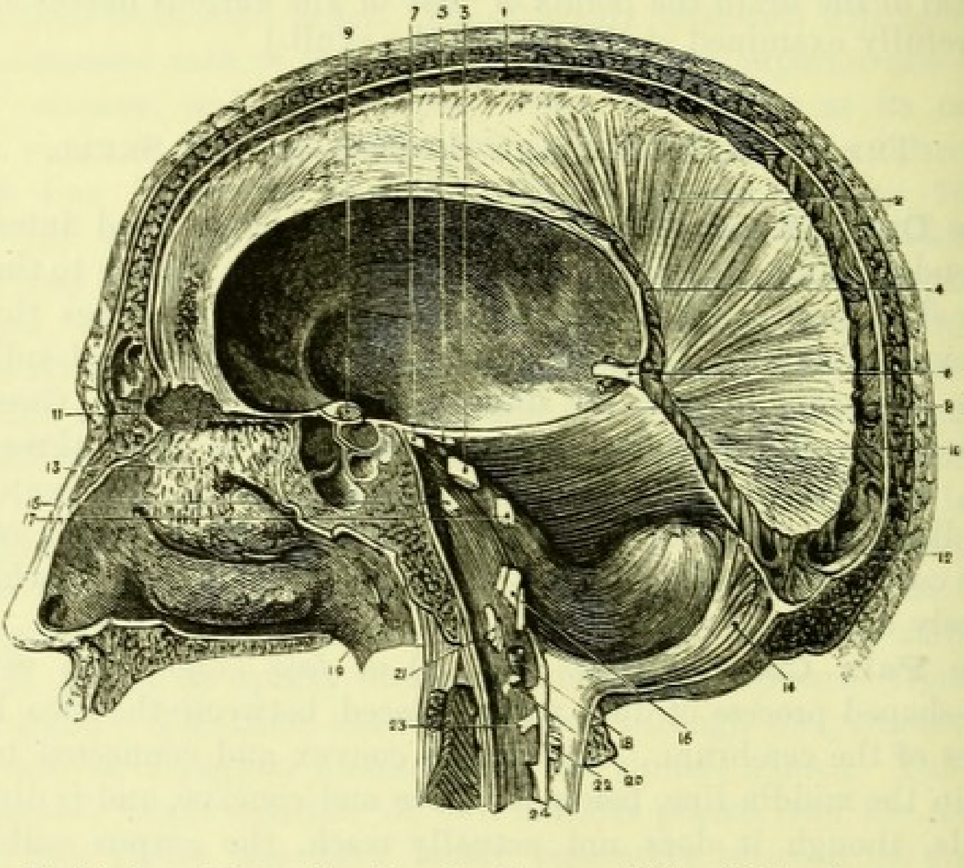
The **Dura Mater** is a strong fibrous membrane lined internally with endothelium, and firmly attached by its outer surface to the base of the skull, especially at the sutures. It sends processes through the several foramina to form sheaths for the nerves, and splits in certain situations to form the sinuses, and to enclose the Gasserian ganglion and pituitary body. It is inflected to form three processes, the falx cerebri, the falx cerebelli, and the tentorium cerebelli; and below is continuous with the dura mater of the spinal cord through the foramen magnum, to the margin of which it is closely attached.

The **Falx Cerebri** (Fig. 186, 2) or *falx major* is a vertical sickle-shaped process of dura mater, placed between the two hemispheres of the cerebrum. Above it is convex and connected to the skull in the middle line, below it is free and concave, and is directed towards, though it does not actually reach, the corpus callosum. It is attached in front to the crista galli of the ethmoid bone; and behind, where it is much deeper, to the internal occipital protuberance and to the mid-line of the tentorium cerebelli. The superior and inferior longitudinal sinuses run along its upper and lower borders, and the straight sinus lies between it and the tentorium.

The **Tentorium Cerebelli** (Fig. 186, 8) is the process of dura mater placed between the cerebrum and cerebellum. When perfect its free margin bounds an oval opening, through which pass the crura cerebri with the corpora quadrigemina, the superior peduncles of the cerebellum, and the posterior cerebral arteries. It is attached in front to the anterior and posterior clinoid processes of the sphenoid bone, and to the superior border of the petrous bone, there splitting to form the superior petrosal sinus; and behind, to the margins of the groove for the lateral sinus on the occipital, parietal, and temporal bones.

The **Falx Cerebelli** (Fig. 186, 14), or *falx minor* lies below the tentorium in the median line, and is attached to the median ridge of the occipital bone nearly as far as the foramen magnum. It is of small prominence and generally divides below, sending a slip to each side of the foramen magnum.

Fig. 186.



The **Inferior Longitudinal Sinus** (Fig. 186, 4) runs along the lower border of the falx major. It is much smaller than the

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Fig. 186.—Sinuses of the skull (side view) (from Hirschfeld and Leveillé).

1. Superior longitudinal sinus.
2. Falx cerebri.
3. 5th nerve.
4. Inferior longitudinal sinus.
5. 4th nerve.
6. Venæ Galeni.
7. 3rd nerve.
8. Tentorium cerebelli.
9. 2nd nerve.
10. Straight sinus.
11. Crista galli of ethmoid.
12. Torcular Herophili.
13. 1st nerve.
14. Falx cerebelli.
15. 6th nerve.
16. 9th, 10th and 11th nerves.
17. 7th and 8th nerves.
18. Vertebral artery.
19. Eustachian tube.
20. 1st cervical nerve.
21. 12th nerve.
22. Posterior root of 2nd cervical nerve.
23. Anterior root of 2nd cervical nerve.
24. Ligamentum denticulatum.

uperior longitudinal sinus (1), and bears more resemblance to a true ein. It begins about the middle of the falx and opens into the traight sinus.

The **Straight Sinus** (Fig. 186, 10) must be opened along the ine of attachment of the falx to the tentorium. It is formed by he union of the *venæ Galeni* of the brain with the inferior longi-udinal sinus, and receives the superior cerebellar veins. It opens nto the *torcular Herophili*, and thus connects the two longitudinal sinuses.

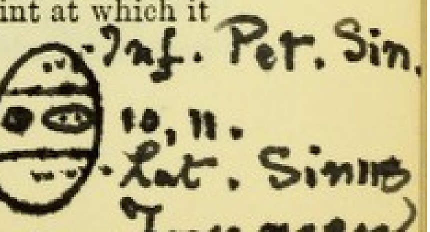
The **Occipital Sinus** (Fig. 187, 18) is formed by a splitting of the falx cerebelli. It communicates above with the torcular Herophili, and bifurcates below to join the posterior spinal veins, its branches reaching on each side as far as the lower end of the lateral sinus.

The **Torcular Herophili** (Fig. 187, 21) is the meeting point of the superior longitudinal, straight, occipital and two lateral sinuses. It is usually situated on the right of the internal occipital protuberance, but sometimes to its left.* The occipital diploic veins commonly open into it.

The **Lateral Sinuses** (Fig. 187, 20), the largest, commence at the torcular Herophili, and take a curved course to the foramen jugulare on each side. It is necessary to cut through the tentorium in order to expose the cavity of the sinus, which will be found to groove the occipital, parietal, and temporal bones, and the occipital bone again close to the jugular process. It *receives* the superior petrosal sinus, the posterior temporal and sometimes the occipital diploic veins, and the inferior cerebral and cerebellar veins; and communicates with the veins of the exterior through the mastoid and posterior condyloid foramina. Finally, after passing through the foramen lacerum posterius, it is joined by the inferior petrosal sinus, and forms the internal jugular vein, returning nearly the whole of the blood from the brain; the interval between the two sinuses at the foramen lacerum posterius being occupied by the 9th, 10th, and 11th nerves. The lateral sinus which receives the superior longitudinal is usually larger than its fellow.

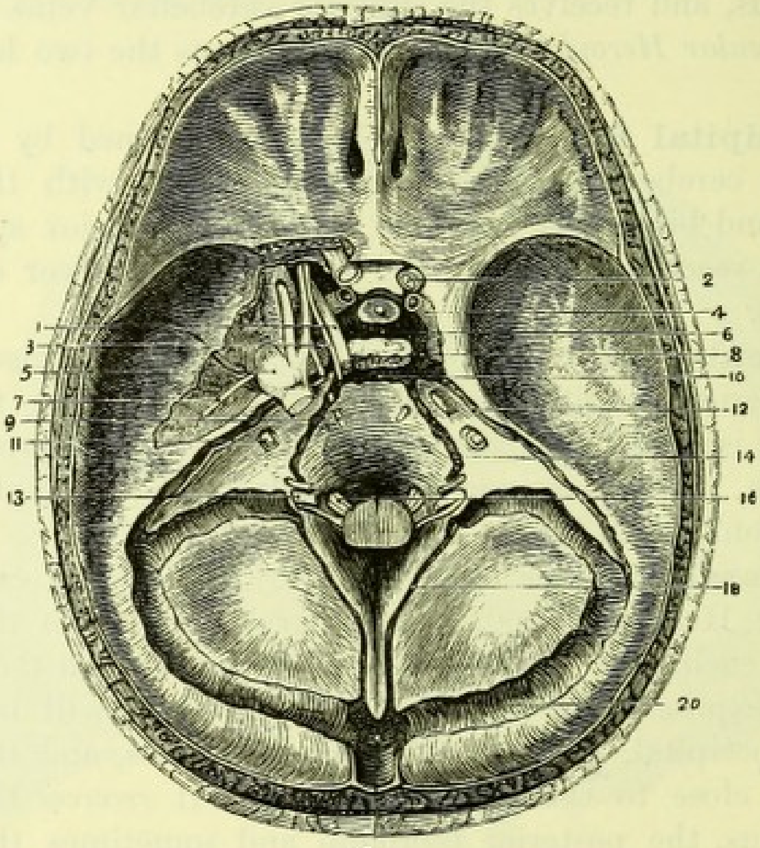
The portion of the vessel below the tentorium, grooving the mastoid portion of the temporal and the jugular process of the occipital bone, is sometimes known as the *sigmoid sinus*.

* Usually the longitudinal sinus becomes dilated a little to one side of the internal occipital protuberance, oftener the right side, forming the torcular Herophili, and then is continued into the corresponding lateral sinus. The straight sinus is continued into the lateral sinus of the opposite side, and a cross branch of larger or smaller size passes from the torcular to the point at which it makes the bend to the left or right as the case may be.



The **Superior Petrosal Sinus** (Fig. 187, 12) will be exposed by running the knife along the upper border of the petrous bone, from which the tentorium was detached. It of small size, and runs from the cavernous sinus back to the lateral sinus, just where

Fig. 187.



the latter turns downwards in the temporal bone. It receives tributaries from the cerebrum, cerebellum, and internal ear.

The **Inferior Petrosal Sinus** (Fig. 187, 14) will be opened by carrying the knife from the foramen jugulare, directly forwards

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Fig. 187.—Dissection of the sinuses of the skull and cranial nerves; the cavernous sinus dissected on the left side (drawn by J. T. Gray).

1. 3rd nerve.
2. Optic nerve.
3. 4th nerve.
4. Internal carotid artery.
5. Gasserian ganglion of 5th nerve, with its three divisions.
6. Circular sinus.
7. Superficial petrosal nerve.
8. Cavernous sinus.*
9. 6th nerve.
10. Transverse or basilar sinus.
11. 7th and 8th nerves.
12. Superior petrosal sinus.
13. 9th, 10th and 11th nerves.
14. Inferior petrosal sinus.
16. 12th nerve of left side.
18. Occipital sinus.
20. Lateral sinus.
21. Torcular Herophili.

* The spheno-parietal sinus should be represented as extending along the posterior border of the lesser wing of the sphenoid to open into this.

along the lower border of the petrous bone to the posterior clinoid process. It communicates in front with the cavernous sinus, and behind with the internal jugular vein, after passing through the foramen jugulare in front of the 9th, 10th, and 11th nerves; and is brought into connection with its fellow by the **transverse** or **basilar sinus** (10), which crosses the basilar process of the occipital bone.

The **Cavernous Sinus** (Fig. 187, 8) is placed by the side of the pituitary body, and requires careful dissection on account of the nerves in relation with it. These are the 3rd, 4th, ophthalmic division of the 5th, and 6th, and their positions should be at once ascertained. The 3rd, of good size (1), will be recognized close behind the anterior clinoid process; the 4th, very small (3), at the point of decussation of the free and attached borders of the tentorium; the entire 5th nerve, larger than the others and somewhat flattened out (5), is seen immediately beneath the tentorium; and the 6th, piercing the dura mater nearer the median line, upon the basilar process, about half an inch below the posterior clinoid process (9). The sinus receives the circular, the superior petrosal, and the spheno-parietal sinuses, the ophthalmic vein, and a communicating vein from the pterygoid plexus through the foramen lacerum medium.

[The left sinus will be found the most convenient for dissection, and should therefore be taken first. The 4th nerve is to be followed out carefully to the sphenoidal fissure by dividing the dura mater with a sharp knife, and the 3rd should be taken next. The dura mater over the 5th, having been freely divided, should be torn up from the bone, by which means and a very little dissection, the Gasserian ganglion and middle meningeal artery will be brought fully into view.]

The **Circular Sinus** surrounds the pituitary body, and brings into communication the two cavernous sinuses.

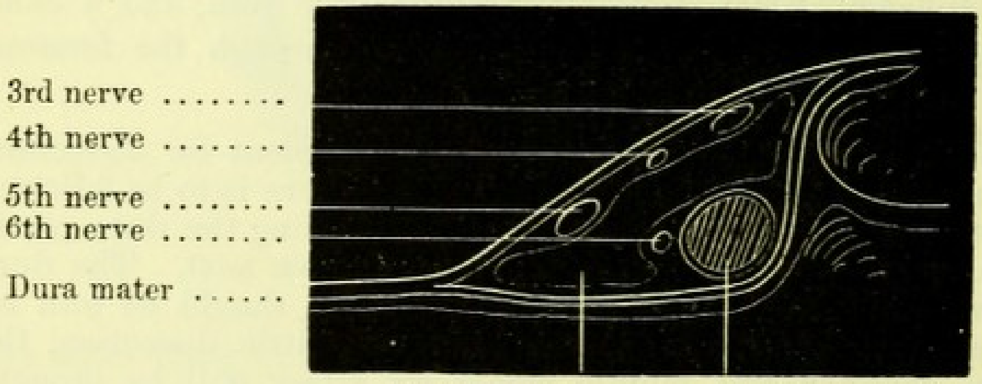
The **Spheno-parietal Sinus** is a small vessel running in the fold of dura mater over the posterior border of the lesser wing of sphenoid. It receives some anterior temporal diploic veins and ends in the cavernous sinus.

The **Gasserian Ganglion** (Fig. 187, 5), the largest of the cranial ganglia, is of a pinkish colour, and is placed in a shallow fossa upon the tip of the superior surface of the petrous portion of the temporal bone, enclosed in a kind of pouch of dura mater known as the *space of Meckel*. It is formed upon the larger or sensory portion of the 5th, and the smaller or motor portion passes beneath it. From the ganglion the three great divisions of the 5th are to be traced as follows :—The first or ophthalmic division to the sphenoidal fissure ; the second or superior maxillary division to the foramen rotundum ; and the third or inferior maxillary division to the foramen ovale. The motor trunk of the nerve joins this last division outside the skull, after passing through the foramen ovale. The ophthalmic division is seen to pass along the outer side of the cavernous sinus, and to give off its *nasal* branch and a minute recurrent branch (Arnold) to the tentorium cerebelli before it enters the sphenoidal fissure.

A small *recurrent* twig given off outside the skull from the 3rd division of the 5th enters the cranium through the foramen spinosum, and divides into two branches, one of which supplies the great wing of the sphenoid, the other pierces the petro-squamous suture to end in the mucous membrane of the mastoid cells.

[The 6th nerve is to be followed by dividing the dura mater over it, and will be found to lie against the outer side of the carotid artery, where this makes its sigmoid turn at the side of the sella

Fig. 188.



turcica. The vessel should be fully defined, and an attempt made to see the carotid plexus of the sympathetic upon it, from which a branch goes to join the 6th. It will render the dissection more useful, if a small piece of the lesser wing of the sphenoid is clipped off with the bone forceps so as to open up the sphenoidal fissure, and the nerves can then be carefully followed to their entry into the orbit.]

The 3rd and 4th nerves, and the first division of the 5th nerve, have been seen to lie in the outer wall of the *cavernous sinus* immediately beneath the dura mater ; and between them and the 6th nerve, which is placed against the carotid artery, is the

Fig. 188.—Diagram of left cavernous sinus seen in section from behind (drawn by J. T. Gray).

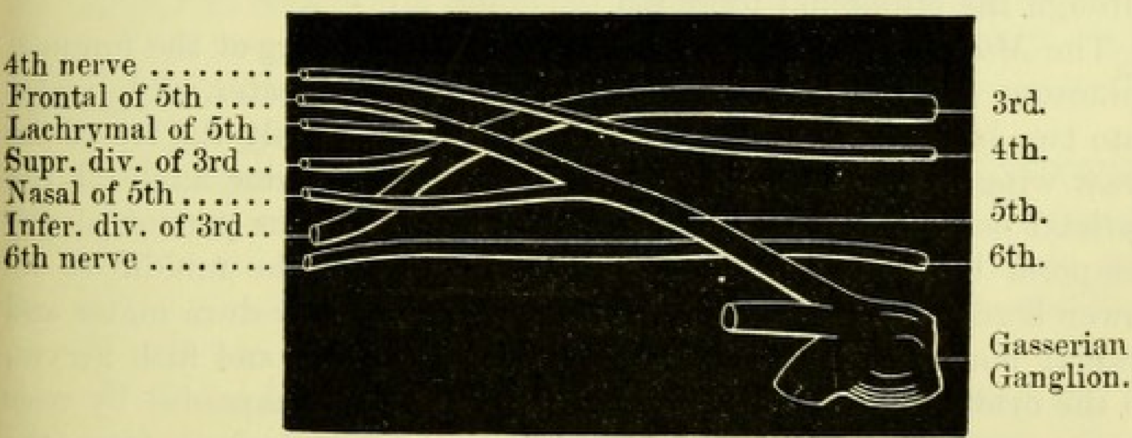
venous canal through which the blood is returned from the orbit. The wall of this is very delicate, and can seldom be defined; it receives the ophthalmic vein, the spheno-parietal sinus, the circular sinus, and a vein from the pterygoid plexus through the foramen lacerum medium, and opens into the two petrosal sinuses (Fig. 188).

The relation which the nerves hold to one another in the cavernous sinus is at first from above downwards according to their *numerical* order—*i.e.* 3, 4, 5, 6. Before they reach the orbit, however, they change their relative positions, and at the sphenoidal fissure are placed roughly as follows, from above downward—4, 5, 3, 6.

If the fissure has been opened up as advised, and the dissection be carefully made, the 3rd nerve before entering the orbit will be found to divide into two parts (between which the nasal branch of the 5th takes its course), and the 5th, after giving off the nasal nerve, to divide into the *frontal* and *lachrymal* branches. The order therefore of parts passing through the sphenoidal fissure, from above downwards, would strictly be as follows (Fig. 189) :—

Above the muscles.	Fourth nerve. Frontal and lachrymal nerves [5th].
Between the heads of external rectus.	Upper division of 3rd nerve. Nasal branch of 5th nerve. Lower division of 3rd nerve. Sixth nerve. Ophthalmic vein (most internally).

Sphenoidal fissure. Fig. 189. Cavernous Sinus.



The **Internal Carotid Artery** (Fig. 187, 4) should be traced to the upper opening of the carotid canal at the apex of the petrous

Fig. 189.—Diagram of the nerves passing through the cavernous sinus (drawn by J. T. Gray).

bone. It makes a sigmoid turn by the side of the sella turcica, and then winds close behind the anterior clinoid process, where it was cut in removing the brain. In a well-injected body, a few small branches (*arteriæ receptaculi*) appear in the cavernous sinus going to the dura mater ; and the ophthalmic artery will be seen entering the optic foramen to the outer side of the optic nerve.

Sympathetic Nerve.—A network of filaments may be traced upon the outer side of the carotid artery in the carotid canal, forming the *carotid plexus* ; this receives an ascending branch from the superior cervical ganglion and gives branches of communication to the sixth nerve, the Gasserian ganglion, Meckel's ganglion (by the *deep petrosal*), and Jacobson's nerve. The *cavernous plexus* may be found on the inner side of the artery close to the anterior clinoid process ; from it pass twigs of communication to the 3rd, 4th, 5th and 6th cranial nerves and the lenticular ganglion.

Sphen. Pal.

By displacing the Gasserian ganglion will be seen a little groove in the upper surface of the petrous bone, conducting a small nerve and artery to the hiatus Fallopii, through which they disappear. They are the *greater superficial petrosal* nerve and artery, the nerve, the continuation of the Vidian, going to join the facial, and the artery a branch of the middle meningeal. Two other nerves may be found entering the temporal bone, on the outer side of the hiatus Fallopii ; one, the *small superficial petrosal*, is the communication between the facial nerve and the otic ganglion ; the other, the *external superficial petrosal*, also passing to the facial nerve, is derived from the sympathetic on the middle meningeal artery.

X

Meningeal Arteries.—The *Anterior Meningeal Arteries* from the ethmoidal arteries, if injected, will be seen to enter the cranium through the ethmoidal foramina.

Int. Max.

The *Middle Meningeal Artery* can be seen entering at the foramen spinosum. It ramifies on the outside of the dura mater, and divides into two branches, an anterior, which grooves deeply the tip of the great wing of the sphenoid and the anterior inferior angle of the parietal bone, and a posterior crossing the squamous portion of the temporal bone to reach the parietal bone near the middle of its lower border. It supplies nearly the whole of the dura mater and cranial bones, and gives small twigs to the facial and fifth nerves, to the orbit, and to the temporal fossa. It is accompanied by *venæ comites*, and by a plexus of sympathetic nerves derived from the superior cervical ganglion. The middle meningeal *plexus* gives filaments to the otic ganglion and to the intumescentia gangliform of the facial nerve (*external petrosal*).

The *Small Meningeal Artery* is a branch of the internal maxillary or middle meningeal, and enters the skull through the foramen ovale.

The *Meningeal Branch of the Ascending Pharyngeal* artery may be found perforating the foramen lacerum medium.

The *Posterior Meningeal Arteries* are small branches of the occipital and vertebral, which enter by the foramen jugulare and foramen magnum respectively.

The *Meningeal Nerves* are derived from the fourth, the fifth (Gasserian ganglion, and first and third divisions), the twelfth, and the carotid plexus of the sympathetic.

The Posterior Triangle of the Neck.

[In order to dissect the posterior triangle, the blocks beneath the head should be removed, and the head drawn downwards and to the opposite side and secured with hooks. The shoulders are to be raised to a convenient height by blocks beneath the scapulæ, and the arm drawn down, and if possible secured in that position. The side of the neck is thus put fully on the stretch, and probably the external jugular vein distended with blood will be seen beneath the skin.

One incision is to be carried from the back of the pinna to the clavicle near its inner end, and another from this point along the whole length of that bone ; a third incision is to be made (if necessary) transversely from the pinna to the occiput, and the flap of skin is then to be reflected backwards. The dissection should be begun at the inferior angle, the dissector of the *right* side standing by the shoulder, and the dissector of the *left* side at the head, of the subject.]

Beneath the skin is the *superficial fascia*, between the layers of which will be found the platysma. The fibres of this muscle may be cleaned at once while removing the skin, and care must be taken, as soon as its upper border is reached, to keep close to the skin, or the superficial nerves may be injured. The superficial veins are beneath the platysma.

The **Platysma Myoides** (Fig. 190, *6*) is only seen in its lower part, the rest will be found in the dissection of the anterior triangle and face. It is a subcutaneous muscle *arising* from the fascia over the pectoral and deltoid muscles, and very slightly from the front of the clavicle ; it passes obliquely across the neck to be *inserted* into the lower border of the mandible, and into the lower lip, the fibres of opposite sides interlacing below the symphysis. It is *supplied* by the facial nerve. Its action is to depress the lower jaw, and it appears to aid in producing the expressions of grief and terror.

Through the platysma will generally be seen the **External Jugular Vein** (Fig. 190, 13), which runs parallel or nearly so to the fibres of the muscle ; if, therefore, in bleeding from the jugular, an incision were made in the direction of the vein, the blood would escape with difficulty, and hence the rule in practice, viz., to cut parallel to the sterno-mastoid, *i.e.*, across the fibres of the platysma, so that they may retract.

[The platysma is to be detached from the clavicle and turned forward, and the cutaneous nerves are to be sought, some passing upwards to the scalp and cheek, some forwards over the neck, and others downwards to the shoulder and chest. They will be found to diverge from a point about half-way down the posterior border of the sterno-mastoid.]

The Superficial Branches of the Cervical Plexus are arranged in two sets,—an upper comprising the Superficial Cervical, Great Auricular, and Small Occipital nerves ; and a lower or descending set, the Sternal, Clavicular, and Acromial branches.

a. The **Superficial Cervical Nerve** (Fig. 190, 17) [from the second and third nerves] will be found turning round the posterior border of the sterno-mastoid, and crossing it transversely beneath the platysma to ramify over the anterior triangle, where it communicates with the infra-maxillary branches of the facial nerve, and supplies the integument of the front and side of the neck.

b. The **Great Auricular Nerve** (Fig. 190, 11) [from the second and third nerves] is the largest branch of the set, and turning round the posterior border of the sterno-mastoid, passes obliquely to the pinna and ends in three sets of branches, *facial* to the parotid gland and skin covering it, communicating deeply with the facial nerve ; *auricular* to the back of the pinna ; and *mastoid* to the skin over the mastoid process.

This last is often of large size, and may be mistaken for the following :

c. The **Small Occipital Nerve** (Fig. 190, 3), [from the second ~~or second and third nerves]~~, which is sometimes double, is always to be found at the posterior margin of the sterno-mastoid muscle, and runs directly upwards to the scalp, where it has been already seen.

The **Descending Branches** (Fig. 190, 21), sternal, clavicular, and acromial [from the loop between the 3rd and 4th nerves], take the directions indicated by their names, and passing over the clavicle are distributed to the skin upon the upper part of the pectoral muscle and shoulder, where they are seen by the dissector of the arm.

Fig. 190.

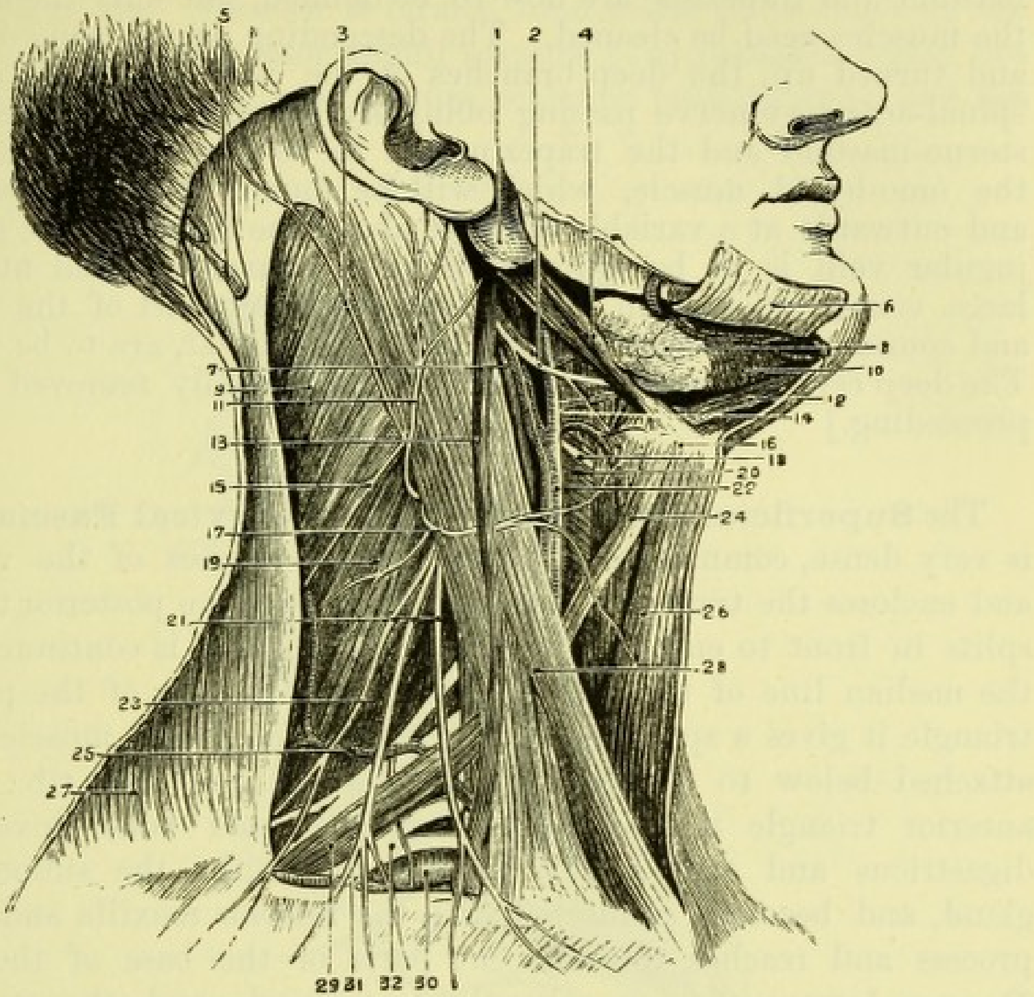


Fig. 190.—Superficial dissection of the triangles of the neck (drawn by J. T. Gray).

(In order to see the relations of the posterior triangle properly, the figure should be placed in the recumbent position, since it is impossible to see the subclavian artery as represented when the body is upright.)

1. Parotid gland.
2. Hypoglossal nerve (12th).
3. Small occipital nerve.
4. Posterior belly of digastric and stylo-hyoid.
5. Occipital artery and great occipital nerve.
6. Platysma (turned up).
7. Internal jugular vein.
8. Submaxillary gland.
9. Splenius capitis.
10. Mylo-hyoid.
11. Great auricular nerve.
12. Anterior belly of digastric.
13. External jugular vein.
14. External carotid artery.
15. Spinal-accessory nerve.
16. Hyoid bone.
17. Superficial cervical nerve.
18. Superior laryngeal nerve.
19. Levator anguli scapulæ.
20. Inferior constrictor of the pharynx.
21. Descending branches of the superficial cervical plexus.
22. Common carotid artery with descendens hypoglossi nerve.
23. Scalenus posticus and medius.
24. Anterior belly of omo-hyoid.
25. Transverse cervical artery.
26. Sterno-hyoid.
27. Trapezius.
28. Sterno-mastoid.
29. Posterior belly of omo-hyoid.
30 Subclavian artery.
31. Supra-scapular artery (transversalis humeri).
32. Brachial plexus partly covered by omo-hyoid.

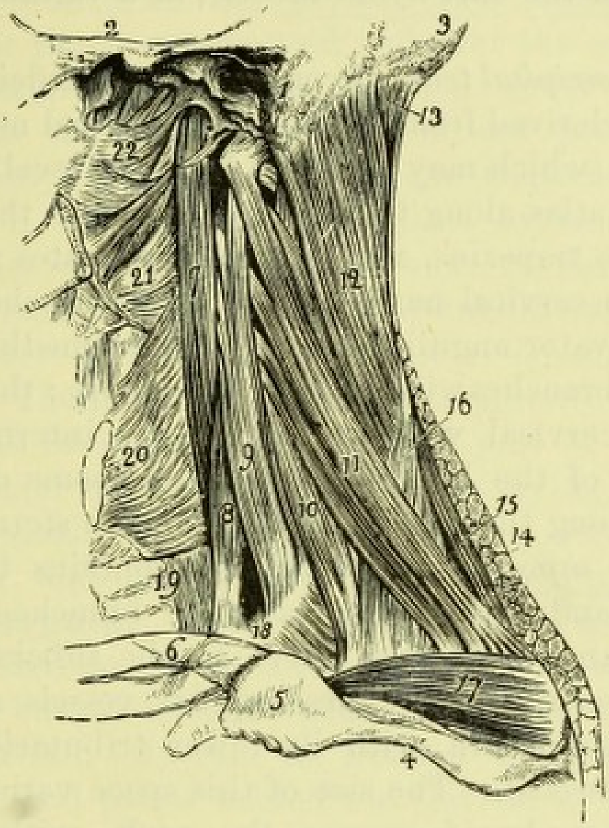
[The anterior and posterior boundaries of the triangle (the sterno-mastoid and trapezius) are now to be defined, but only the edges of the muscles need be cleaned. The descending nerves being detached and turned up, the deep branches of the cervical plexus and the spinal-accessory nerve passing obliquely between the borders of the sterno-mastoid and the trapezius are to be dissected out, and also the omo-hyoid muscle, which will be found running downwards and outwards at a variable distance above the clavicle ; the external jugular vein is to be followed as far as convenient, and numerous large veins, which form a plexus at the lower part of the triangle and communicate freely with the external jugular, are to be noticed. The deep cervical fascia will be seen and partially removed in this proceeding.]

The **Superficial Portion of the Deep Cervical Fascia,** which is very dense, commences at the spinous processes of the vertebræ and encloses the trapezius muscle, then crosses the posterior triangle, splits in front to enclose the sterno-mastoid, and is continued on to the median line of the neck. At the lower part of the posterior triangle it gives a special covering to the omo-hyoid muscle, and is attached below to the back of the clavicle and first rib : in the anterior triangle it is attached to the hyoid bone, invests the digastricus and stylo-hyoid muscles, ensheaths the submaxillary gland, and becomes connected with the inferior maxilla and styloid process and reaches the adjacent parts of the base of the skull. **Deeper layers** of fascia cover the deep muscles and other structures of the neck, form a kind of capsule for the thyroid body, and are prolonged into the thorax and axillæ. These, with the carotid sheath, and certain areolar interspaces (pre-visceral, retro-visceral, and sterno-mastoid fissures) between the laminæ of the deep fascia, are described on p. 436.

[To see the floor of the triangle the rest of this part of the deep fascia is to be removed ; it will be most readily detached by beginning above at the junction of the sterno-mastoid and trapezius, and carrying the knife obliquely downwards and backwards so as to be parallel to the fibres of the muscles beneath. It should be removed only as low as the omo-hyoid at present, and all branches of nerve and artery should be carefully preserved.]

The **Posterior Triangle** (Fig. 190) is the space bounded *in front* by the sterno-mastoid, *behind* by the trapezius, and *below* by the middle third of the clavicle, its *apex* being represented by the meeting of the anterior and posterior boundaries at the occiput. It is covered in by skin, superficial and deep fasciæ, superficial branches of vessels and of the cervical plexus, and at the lower part by the platysma. Its *floor* is formed from above downwards by the splenius capitis (9), levator anguli scapulæ (19) (beneath which lies the splenius colli), scalenus medius, scalenus posticus (23), and the

Fig. 191.



upper digitation of the serratus magnus. The last cannot be seen at present.

The splenius colli does not form part of the floor, because it is covered in by the levator anguli scapulæ. In some subjects, where

Fig. 191.—Lateral view of the muscles of the prevertebral region and side of the neck (from Wilson).

1. The mastoid process of the temporal bone.
2. The zygoma.
3. The occipital bone.
4. The spine of the scapula
5. The acromion process.
6. The clavicle.
7. Longus colli muscle.
8. Scalenus anticus.
9. Scalenus medius.
10. Scalenus posticus.
11. Levator anguli scapulæ.
12. Splenius.
13. Complexus.
14. Cut edge of the trapezius.
15. Rhomboideus minor.
16. Serratus posticus superior.
17. Supra-spinatus.
18. The first rib.
19. Œsophagus and trachea.
20. Inferior constrictor of the pharynx.
21. Middle constrictor.
22. Superior constrictor.

the apex of the triangle is wider than usual, a portion of the com plexus may be seen, and not unfrequently, where the attachment of the sterno-mastoid to the clavicle is not well developed, both the anterior scalenus and the phrenic nerve lying on it appear in the posterior space.

The triangle is subdivided into two lesser triangles by the posterior belly of the omo-hyoid muscle, at a variable distance above the clavicle.

The *upper* or *occipital triangle* contains the superficial branches of the cervical plexus derived from the first four cervical nerves ; the spinal-accessory nerve (which may be traced from the level of the transverse process of the atlas along the outer surface of the levator anguli scapulæ into the trapezius, where it communicates with branches of the 3rd and 4th cervical nerves) ; muscular branches of the cervical plexus to the levator anguli scapulæ, scalenus medius and trapezius ; communicating branches with the spinal accessory ; the occipital artery, the transverse cervical vessels, the posterior internal jugular vein, the upper cords of the brachial plexus, and some of the lymphatic glands placed along the posterior border of the sterno-mastoid.

The *lower* or *supra-clavicular triangle* contains the cords of the brachial plexus and their supra-clavicular branches ; the third part of the subclavian artery ; the nerve to the subclavius ; the transverse cervical vessels ; the supra-scapular vessels and nerve ; and the external jugular vein, with its lower tributaries ; all of which must now be dissected. The size of this space varies with the level at which the omo-hyoid crosses the neck, with the extent of clavicular attachment of the sterno-mastoid, and, more importantly, with the degree of elevation of the clavicle.

[The process of deep fascia binding down the tendon of the omo-hyoid is to be traced to its attachment below, and then carefully removed. The external jugular vein, the transverse cervical and supra-scapular arteries and veins, and the supra-scapular nerve are then to be carefully dissected and preserved. The last will be found behind the clavicle, and the small nerve to the subclavius from the brachial plexus must also be sought as it passes downwards over the subclavian artery. A process of deep fascia connected with the scalenus anticus binds down the subclavian artery, and must be removed to expose it.]

The tendon of the **Omo-hyoid Muscle** (Fig. 190, 29) is bound down to the back of the clavicle and to the first rib by a process of the deep cervical fascia, so that either belly of the muscle may act from this fixed point. Upon the back of the tendon may be traced a branch of the communicans cervicis nerve, which supplies the posterior belly. The origin and insertion of the muscle are found in other dissections.

The **Transverse Cervical Artery** (Fig. 190, 25) is generally found at the level of the tendon of the omo-hyoid, and the **Vein** a little above it, so that their relations to the subdivisions of the triangle are somewhat different.

The artery, a branch of the thyroid axis [subclavian], passes transversely under the sterno-mastoid and over the scalene muscles, crosses the posterior triangle, and divides under the border of the trapezius into the superficial cervical and posterior scapular arteries. The *superficial cervical* goes to the trapezius, the anterior border of which it supplies, and terminates by anastomosing with superficial branches of the princeps cervicis of the occipital; the *posterior scapular* runs beneath the levator anguli scapulæ muscle to the vertebral border of the scapula, where it is seen in the dissection of the back. The posterior scapular artery, however, often arises as a separate trunk from the second or third part of the subclavian artery, the superficial cervical then alone occupying the position of the transverse cervical. The transverse cervical *vein* lies above the level of the artery, and usually joins the external jugular.

The **Supra-scapular Artery** and **Vein** (Fig. 190, 31) lie close behind the clavicle. The artery is nearly always a branch of the thyroid axis, but occasionally arises from the second or third part of the subclavian. It runs in front of the third stage of the subclavian artery, and passes behind the clavicle to reach the upper border of the scapula. The *vein* opens into the external jugular, just before it joins the subclavian vein.

The **Third portion of the Subclavian Artery** (Fig. 190, 30) extends from the outer border of the anterior scalenus, obliquely downwards and outwards behind the clavicle, to the outer border of the first rib, where it becomes the axillary artery. It has *in front* the skin, platysma, superficial nerves, deep fascia, clavicle, subclavius muscle, and supra-scapular vessels; and is crossed by the small nerve to the subclavius, and by the external jugular vein, which is joined at this point by the supra-scapular and transverse cervical veins. *Behind* are the scalenus medius and the pleura. *Above* run the cords of the brachial plexus; and *below*, at some distance and in an anterior plane, is the subclavian vein. The subclavian groove on the first rib lies *behind and below* the artery owing to the downward slope of the rib, and a bursa will often be found between the bone and the vessel. In a little more than half of the cases this portion gives off no branch, but should there be one it will probably be the posterior scapular artery, more rarely the supra-scapular.

Surgery.—The position, relations and direction of the third portion of the subclavian should be especially noticed, because it is here that a ligature is most frequently applied for aneurism lower down. The student should particularly accustom his finger to feel for the scalene tubercle on the first rib and the outer edge of the scalenus anticus muscle, which are taken as the guides to the commencement of the third stage of the artery. It should be noticed how materially the relations of the vessel are altered by raising or depressing the shoulder, as the effect of an aneurism in the axilla is to raise the clavicle considerably, and thus to complicate the operation.

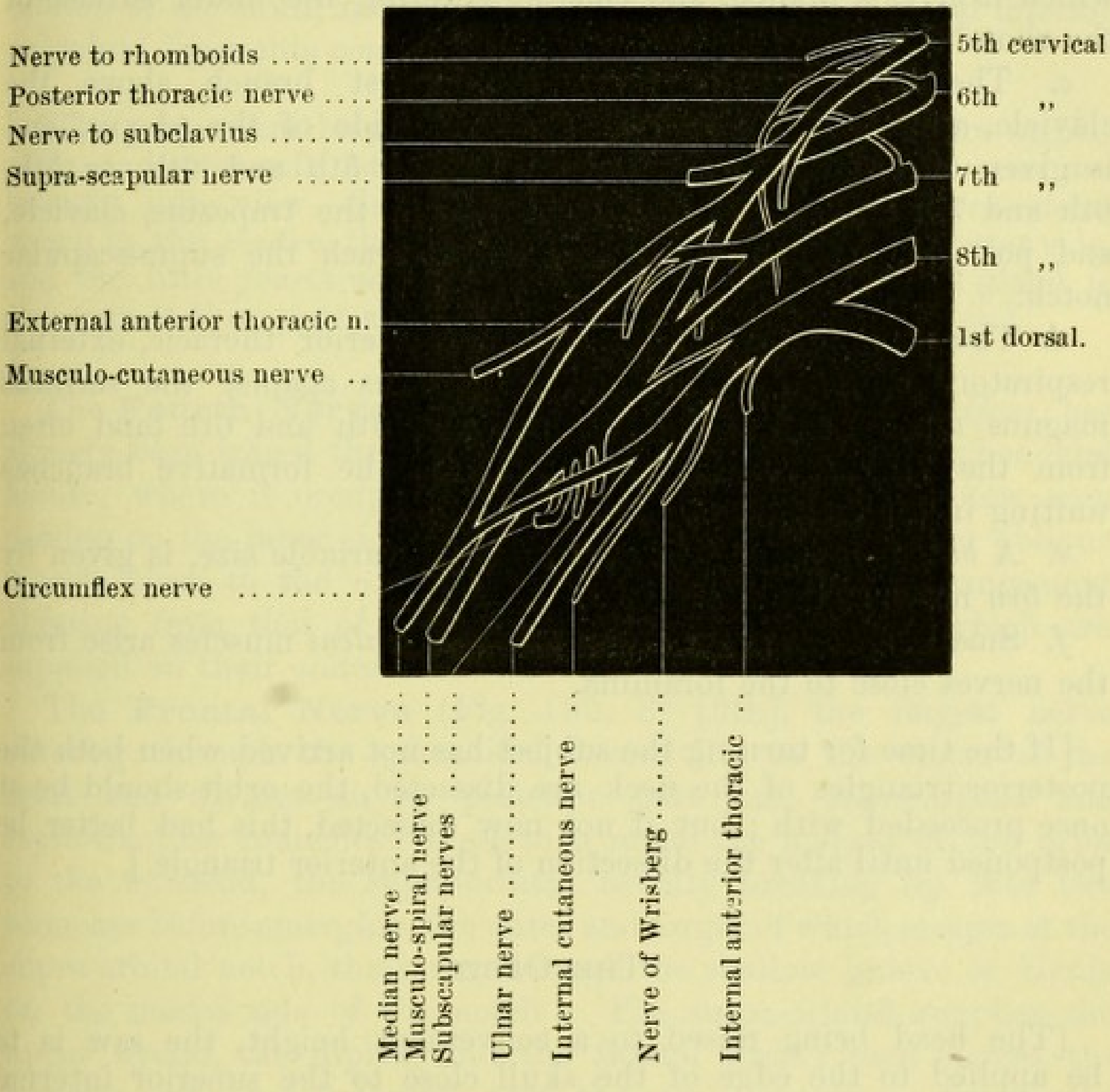
The operation of tying the subclavian in its third part is thus performed. The head being thrown back and the shoulder depressed as much as possible, the skin of the lower part of the triangle is to be drawn down upon the clavicle, and a lunated incision carried from the edge of the trapezius to the sterno-mastoid, cutting at once on to the bone. The skin being then allowed to resume its natural position, the incision will be immediately above the clavicle, and may be deepened at the anterior part. The external jugular vein is to be carefully guarded, and held aside if necessary, and a cautious dissection made until the finger can feel the scalenus anticus and the tubercle on the first rib, to which it is attached. Immediately behind this will be found the artery, and even in the uninjected state it will be readily recognised by its rolling on the bone beneath the finger. The aneurism needle should be passed from *above*, so as to avoid the brachial nerves, which are more liable to be included in the ligature than the vein, since this is quite below the artery ; and great care must be taken to avoid injury to the pleura, behind the innermost portion of this stage of the vessel.

[If the dissection of the axilla is sufficiently advanced, the clavicle should now be divided at the outer border of the sterno-mastoid, and again at the edge of the trapezius. The knife being then passed carefully beneath and close to the bone to detach the subclavius, the piece may be removed, but the parts will still be retained in position by the muscle. The supra-scapular artery and vein will now also be better seen, and can be thoroughly cleaned. The subclavius muscle is to be divided close to the trapezius, when the scapula will fall back, and the brachial plexus will be fully exposed and should be carefully cleaned. The upper digitation of the serratus magnus, which was mentioned as forming part of the floor of the subclavian triangle, is also visible.]

The **Brachial Plexus** (Fig. 192) is formed by the anterior divisions of the 5th, 6th, 7th, and 8th cervical nerves and part of the 1st dorsal nerve, with a small branch of communication from the lowest cord of the cervical plexus (4th). The nerves appear at the outer border of the anterior scalenus as four cords, because the 8th cervical and 1st dorsal unite close to the vertebral foramina; they all lie against the scalenus medius and posticus, and above the level of the subclavian artery. The 5th and 6th next unite, and thus three cords are formed.

The three trunks formed by the junction of the five nerves subdivide and reunite to form three cords, as follows. Each trunk divides

Fig. 192.



into an anterior and a posterior branch; the anterior branches of the upper and middle trunks form the outer cord, the anterior branch of the lowest forms the inner cord, and the three posterior branches unite to form the posterior cord. Several varieties have been described in the arrangement of the cords; but this will be found to be the most common.

Fig. 192.—Diagram of the brachial plexus (after Lucas).

The *branches above the clavicle* (Fig. 192)—

a. The *nerve to the subclavius* is a small branch lying in front of the plexus, and derived from the trunk formed by the 5th and 6th nerves above the supra-scapular nerve. It crosses the 3rd stage of the subclavian artery to reach the muscle, and communicates with the phrenic nerve.

b. The *nerve to the rhomboids* is from the 5th nerve. It pierces the scalenus medius, passes beneath the levator anguli scapulæ, to which it gives a branch, and ends by entering the under surface of the rhomboids.

X *c.* The *Supra-scapular nerve*, the largest branch above the clavicle, appears above and at the outer side of the plexus, and is given off from the cord formed by the 5th and 6th, or 5th, 6th and 7th nerves. It disappears behind the trapezius, clavicle, and posterior belly of the omo-hyoid, to reach the supra-scapular notch.

X *d.* The *nerve to the serratus magnus* (posterior thoracic, external respiratory of Bell) lies behind the plexus against the serratus magnus muscle, and is derived from the 5th and 6th (and often from the 7th) nerves before they join, the formative branches uniting in the scalenus medius.

e. A *branch to the phrenic nerve*, of very variable size, is given by the 5th nerve at the upper part.

f. Small *branches to the longus colli and scaleni* muscles arise from the nerves close to the foramina.

[If the time for turning the subject has not arrived when both the posterior triangles of the neck are dissected, the orbit should be at once proceeded with ; but if not now dissected, this had better be postponed until after the dissection of the anterior triangle.]

The Orbit.

[The head being raised to a convenient height, the saw is to be applied to the edge of the skull close to the superior internal and inferior external angles of the orbit (the proper points being readily ascertained with the finger), and the cuts carried into the orbit. With the chisel these incisions are to be prolonged backwards till they meet at the sphenoidal fissure, when the portion of bone comprising the roof and outer wall of the orbit can be readily tilted forward by a blow with the hammer. Any small remnant of bone can be removed so as to expose the cavity, but the margin of the optic foramen should be left untouched. The dissection for the lenticular ganglion should be carried out later by dividing and reflecting the external rectus and exposing the structures from the outer side. Any attempt to demonstrate these branches by the ordinary dissection from above is likely to fail.]

The first thing exposed on opening the orbit is the **Periosteum**, which is detached from the bone. It will be seen to be continuous with the dura mater of the skull through the sphenoidal fissure and the optic foramen. At the border of the orbit it splits into two layers : one, continuous around the margin with the external periosteum of the skull, and the other, forming the superior and inferior palpebral ligaments connecting the eyelids with the bone.

[The periosteum being divided in the centre and carefully turned aside, and some soft fat removed, three nerves and two arteries are brought into view—the *frontal nerve* [5th] with the *supra-orbital artery* in the centre, the *lacrymal nerve* and *artery* on the outer side, and the little *fourth nerve* on the inner side ; the lacrymal gland is also seen at the upper and outer part of the front of the orbit.]

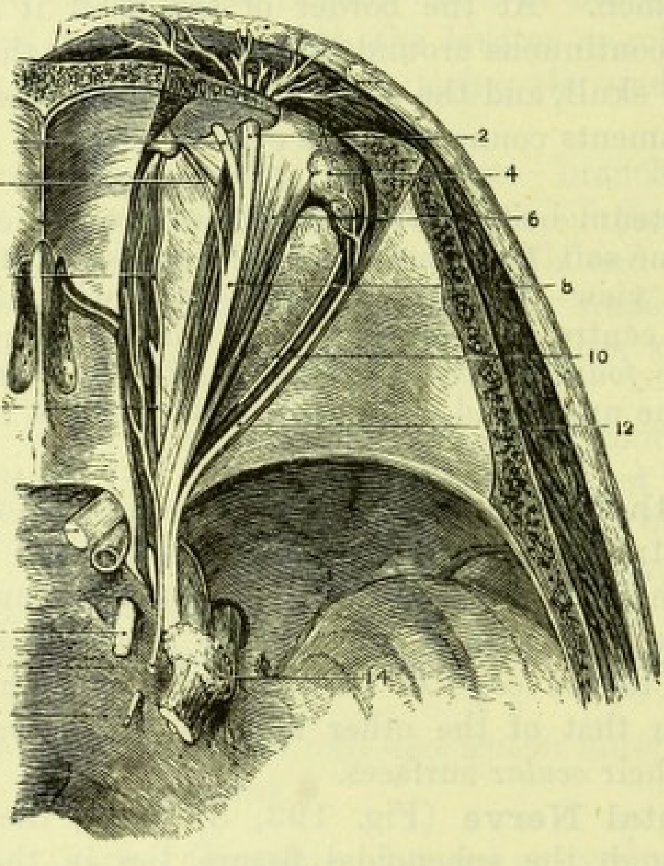
The **Fourth Nerve** (Fig. 193, 13) (*trochlearis* or *patheticus*) has already been traced through the cavernous sinus to the sphenoidal fissure, where it occupies the highest position, and is now seen passing on the inner side of the orbit to enter the superior oblique muscle close to the edge of its *orbital* surface ; this arrangement differing from that of the other muscles of the orbit, which are supplied on their *ocular* surfaces.

The **Frontal Nerve** (Fig. 193, 8) [5th], the largest nerve entering through the sphenoidal fissure, lies in the centre of the orbit and divides at its posterior part into *supra-orbital* and *supra-trochlear* branches ; these turn round the margin of the orbit to the forehead, the supra-orbital usually breaking up into two branches before emerging, the outer and larger of which escapes at the supra-orbital notch, the inner through the shallow groove of Henle on the mesial side of the notch. The supra-orbital supplies the upper eyelid, the diploë, and the frontal sinus ; then pierces the muscles and is distributed over the scalp nearly as far as the lambdoid suture. The supra-trochlear passes out at the internal superior angle of the orbit, and supplies the frontal integument close to the median line.

The **Lacrymal Nerve** (Fig. 193, 12) [5th] lies on the outer side of the orbit and passes to the lacrymal gland, which it supplies. It sends a twig to join the orbital branch of the superior maxillary nerve, and finally perforates the palpebral ligament and is distributed over the outer part of the upper eyelid.

The **Supra-Orbital Artery** (Fig. 194, 8) is a branch of the ophthalmic artery, and accompanies the supra-orbital nerve to the forehead. The supra-orbital and supra-trochlear **veins** form the commencement of the facial vein. frontal

Fig. 193.



The **Lacrymal Artery** (Fig. 194, 12) is a smaller branch also from the ophthalmic, and supplies the lacrymal gland. It is joined by twigs from the middle meningeal, and sends some small branches to the eyelids, and others through the temporal bone to the temporal fossa.

The **Lacrymal Gland** (Fig. 194, 4) is about the size and

Fig. 193.—Superficial dissection of the nerves of the orbit (from Hirschfeld and Leveillé).

1. Inner division of supra-orbital nerve.
2. Outer division of supra-orbital nerve.
3. Supra-trochlear nerve.
4. Lacrymal gland.
5. Infra-trochlear nerve.
6. Levator palpebræ superioris.
7. Nasal nerve (5th).
8. Frontal nerve (5th).
9. Second nerve, with internal carotid artery on its inner side.
10. Rectus superior.
11. Third nerve.
12. Lacrymal nerve.
13. Fourth nerve on superior oblique.
14. Gasserian ganglion of fifth.
15. Sixth nerve.

shape of a small almond, of a reddish-brown colour, and is situated in the anterior and outer part of the orbit. It is convex on its superior aspect, to fit into the lacrymal fossa in the orbital plate of the frontal bone; and concave beneath, where it is placed over the eye-ball. Its ducts, seven or eight in number, carry the secretion, the tears, to the surface of the conjunctiva beneath the outer part of the upper eyelid.

[The frontal nerve is to be divided, and a hook inserted into the upper eyelid so as to put the levator palpebræ in the centre of the orbit on the stretch; this muscle and the superior oblique are then to be cleaned, care being taken not to destroy the little pulley through which the tendon of the latter works.]

The **Obliquus Superior** (Fig. 199, 2), the most superficial muscle of the orbit, *arises* from the upper margin of the optic foramen, above and a little to the inner side of the levator palpebræ. Its belly runs along the superior internal angle of the orbit, and ends in a round tendon which passes through the *trochlea* or pulley-like ring of fibrous tissue attached to the trochlear impression on the forepart of the orbital surface of the frontal bone, and turns abruptly downwards, backwards and outwards to the eye-ball. The tendon expands near its *insertion*, and passes beneath the superior rectus to be attached to the outer side of the

Fig. 194.

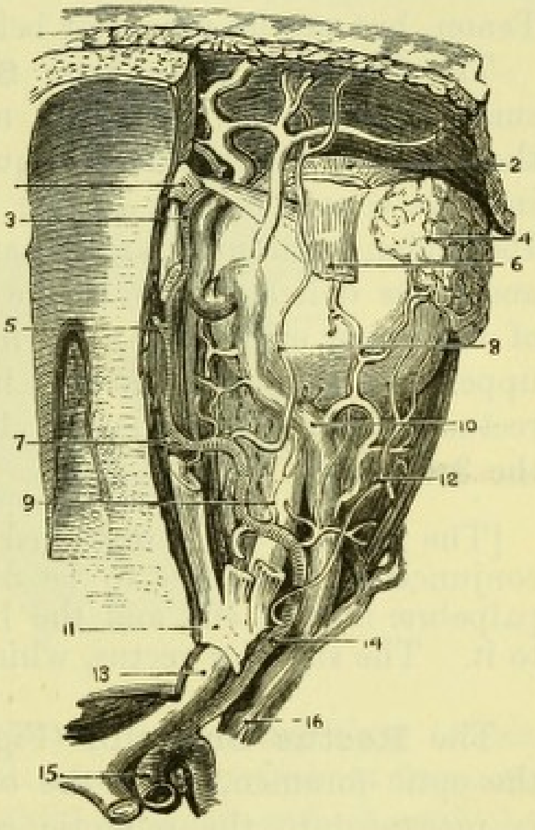


Fig. 194.—Arteries and veins of the orbit (from Hirschfeld and Leveillé).

1. Pulley of superior oblique tendon.
2. Levator palpebræ (cut).
3. Trunk of ophthalmic artery from which the frontal, nasal, and palpebral branches are derived.
4. Lacrymal gland.
5. Anterior ethmoidal artery.
6. Rectus superior (cut).
7. Posterior ethmoidal artery.
8. Supra-orbital artery.
9. Ciliary arteries.
10. Ophthalmic vein.
11. Origins of obliquus superior, levator palpebræ, and superior rectus.
12. Lacrymal artery.
13. Optic nerve.
14. Ophthalmic artery.
15. Carotid artery.
16. Cavernous sinus.

posterior half of the eye-ball, between the superior and the external recti. With a little dissection a delicate synovial membrane can be seen, lubricating the tendon where it passes through the *trochlea.* The muscle is *supplied* by the 4th nerve on its orbital aspect. Its *action* is to turn the pupil downwards and outwards, and to rotate internally the upper extremity of the vertical meridian of the globe.* Its tendon is invested by a process of the capsule of Tenon, but not its muscular belly.

The **Levator Palpebræ Superioris** (Fig. 199, 1) *arises* by a small tendon from the upper margin of the optic foramen, below the origin of the superior oblique ; it expands in front to be *inserted* into the convex border of the tarsal cartilage of the upper eyelid. Its tendon contains a large quantity of involuntary muscular fibre, and gives delicate slips to the inferior palpebral ligament and skin of the upper eyelid. As its name denotes, it is an elevator of the upper lid ; and in this action it is assisted slightly by the superior rectus and occipito-frontalis. It is *supplied* by the upper division of the 3rd nerve.

[The hook is to be removed from the eyelid and fixed into the conjunctiva, which is to be drawn gently forwards ; the levator palpebræ is to be cut, and the little branch of the 3rd nerve traced to it. The superior rectus, which is then seen, should be cleaned.]

The **Rectus Superior** (Fig. 199, 3) *arises* from the margin of the optic foramen, below the origin of the levator palpebræ ; and is *inserted* into the sclerotic coat of the eyeball at its upper and anterior part, giving also a small slip to the upper part of the tarsal cartilage. It is *supplied* by the upper division of the 3rd nerve, which can be seen entering its under-surface when the muscle is divided. Its *action* is to elevate and adduct the cornea and to rotate inwards the vertical meridian, and it aids the levator palpebræ in raising the upper lid. Like the rest of the muscles of the globe it is invested by a closely adherent process of the capsule of Tenon (see p. 431).

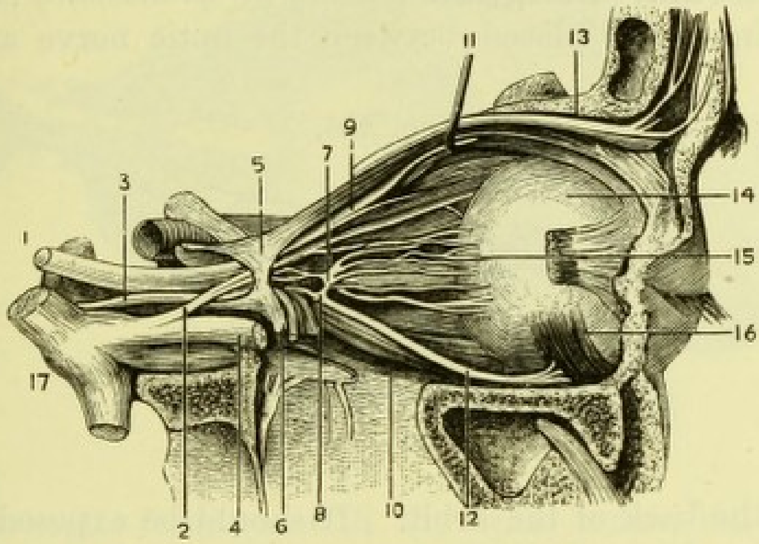
[The rectus having been divided, a quantity of fat will be brought into view, through which the optic nerve passes to the eyeball. The nasal branch of the 5th is at once to be looked for crossing the optic nerve from without inwards, and the lenticular ganglion, a minute

* The 'vertical meridian' is an imaginary plane bisecting the globe perpendicularly in an antero-posterior direction through the middle of the cornea and central point of the eye. Rotation 'inwards' or 'outwards' of the meridian refers to the upper extremity of this plane.

ink body, is to be found on the outer side of the optic nerve near he back of the orbit, by tracing back some of the small *ciliary* nerves which pass to the eyeball round the optic nerve, and some of which pring from the ganglion. It will be better seen from the outer ide after division of the external rectus. All branches of the ophthalmic artery should be preserved.]

The **Nasal Nerve** (Figs. 193, 7, and 195, 2), [5th] enters the

Fig. 195.



orbit between the heads of the external rectus, and then crosses above the optic nerve and internal rectus from without inwards, to pass through the anterior ethmoidal foramen and re-enter the cranium. Thence it runs into the nose through a slit by the side of the anterior part of the crista galli of the ethmoid bone, to appear ultimately on the face between the nasal bone and the superior lateral nasal cartilage. It gives off, 1, the *long root* to the lenticular

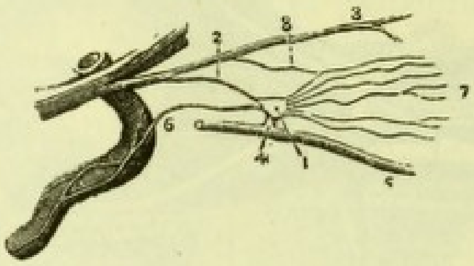
Fig. 195.—Nerves of the orbit, seen from the outer side (from Hirschfeld and Leveillé).

1. Third nerve.
2. Nasal nerve, giving off a long ciliary nerve in the orbit, and the long root of the lenticular ganglion before entering the orbit.
3. Sixth nerve.
4. Trunk of ophthalmic nerve (5th).
5. Ligament of Zinn.
6. Origin of external rectus.
7. Lenticular ganglion (the long root is joining it behind).
8. Short root of lenticular ganglion.
9. Branch of third nerve to levator palpebræ superioris and superior rectus.
10. Inferior rectus.
11. Hook placed on superior rectus.
12. Branch of third nerve to obliquus inferior.
13. Frontal nerve (cut).
14. Eyeball.
15. Short ciliary nerve.
16. Inferior oblique.
17. Gasserian ganglion.

ganglion, on the outer side of the optic nerve ; 2, two *long ciliary nerves,* which run with the short ciliary branches and perforate the sclerotic near the entrance of the optic nerve ; 3, the *infra-trochlear nerve,* which, arising just before the nerve enters the ethmoidal foramen, passes forwards to escape from the orbit beneath the pulley of the superior oblique. It communicates with the supra-trochlear nerve, and is distributed to the integument of the eyelids and side of the nose, the lacrymal sac, the conjunctiva, and the caruncula lacrymalis.

The **Lenticular Ganglion** (*ciliary* or *ophthalmic*) (Fig. 196) is a minute pink body placed between the optic nerve and external

Fig. 196.



rectus near the back of the orbit. It should be exposed, as already mentioned, by division of the external rectus after the removal of the outer wall of the orbit. It has, like all the cranial ganglia, sensory, motor, and sympathetic roots. The *sensory* or long root (2) is derived from the nasal branch of the 5th, and enters the posterior superior angle of the ganglion. The *motor* or short root (4) is derived from the branch of the 3rd nerve supplying the inferior oblique, which can be seen passing along the bottom of the orbit ; this root enters the ganglion at its posterior inferior angle. The *sympathetic* root (6) comes from the cavernous plexus on the internal carotid artery, and enters the orbit through the sphenoidal fissure ; it joins the ganglion between the other two roots, but can rarely be seen in an ordinary dissection.

The *short ciliary branches* of the ganglion arise from its upper and lower angles in front, and are eight or ten in number. They pierce the back of the sclerotic coat of the eyeball around the optic nerve,

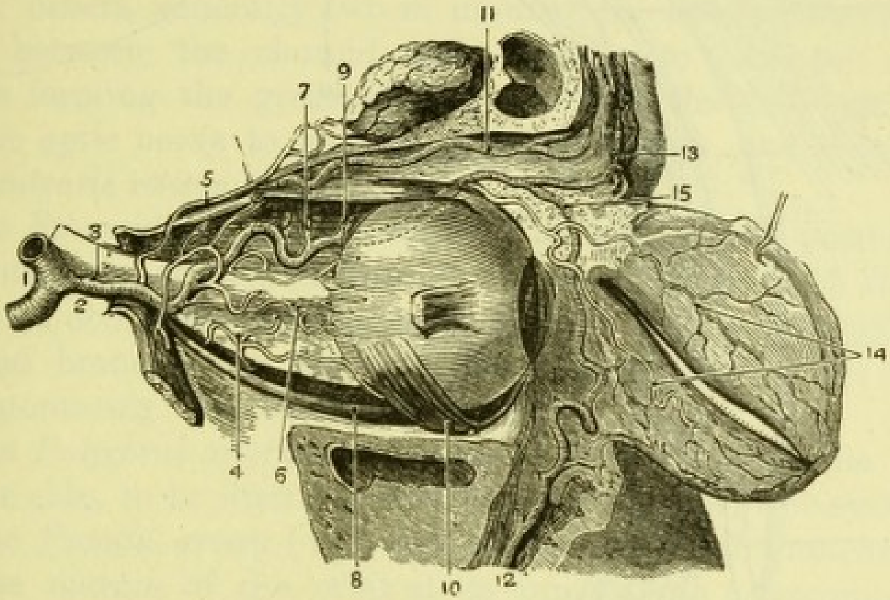
Fig. 196.—Diagram of the lenticular ganglion (from Hirschfeld and Leveillé).

1. Lenticular ganglion.
2. Long root from—
3. Nasal branch of fifth.
4. Short root from—
5. Nerve to inferior oblique.
6. Sympathetic root from cavernous plexus.
7. Short ciliary nerves.
8. Long ciliary nerves.

and running between the choroid and sclerotic with the long ciliary nerves supply the iris, the ciliary muscle, and the cornea.

The **Ophthalmic Artery** (Fig. 197, 2) arises from the internal carotid close to the anterior clinoid process, and enters the orbit

Fig. 197.



through the optic foramen with the optic nerve, but to its outer side. It gives off the following branches :—

a. The *Lacrymal artery* (5) accompanies the lacrymal nerve along the external superior angle of the orbit to the lacrymal gland, which it supplies. It gives twigs to the conjunctiva and eyelids, and others through small foramina to reach the temporal fossa. It is joined by a twig from the middle meningeal.

b. The *Supra-orbital artery* (11) ascends to join the frontal nerve, and afterwards accompanies the supra-orbital nerve through the supra-orbital notch to the forehead.

c. *Muscular branches* (4) are given to all the muscles of the orbit, entering them on their ocular surfaces.

d. The *Ciliary branches* (Fig. 198) are numerous small arteries

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Fig. 197.—Arteries of the orbit from the outer side (from Hirschfeld and Leveillé).

1. Internal carotid.
2. Ophthalmic artery.
3. Arteria centralis retinæ.
4. Muscular branches.
5. Lacrymal artery.
6. Ciliary artery.
7. Posterior ethmoidal artery.
8. Rectus inferior.
9. Anterior ethmoidal artery.
10. Obliquus inferior.
11. Supra-orbital artery.
12. Facial artery.
13. Frontal artery.
14. Palpebral arteries.
15. Nasal artery.

Fig. 198.

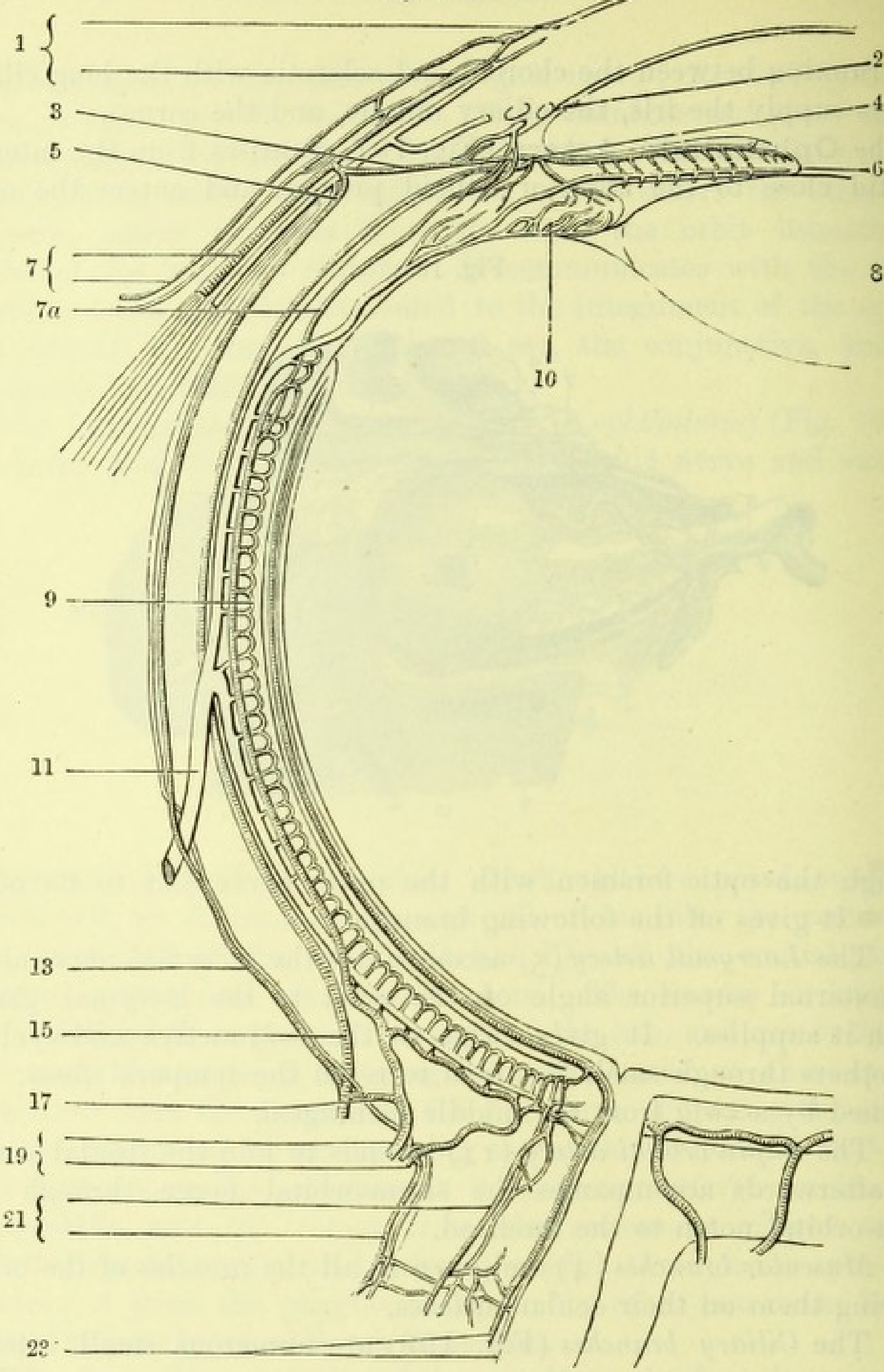


Fig. 198.—Scheme of circulation in eye (after Leber).

1. Conjunctival vessels.
2. Sinus circulus venosus.
3. Anterior ciliary artery.
4. Greater arterial circle of iris.
5. Recurrent branch of anterior ciliary artery.
6. Iris.
7. Muscular and conjunctival vessels.

7a. Artery to ciliary processes.

8. Lens.
9. Chorio-capillaris.
10. Ciliary plexus.
11. Vena vorticosa.
13. Episcleral branch of long ciliary.
15. Deep branch of long ciliary.
17. Long ciliary artery.
19. Short ciliary artery.
21. Smaller retinal vessels.
23. Central vessels of retina.

for the supply, mainly, of the choroid, ciliary processes, and iris, and have been divided into *anterior* and *posterior*, the latter piercing the sclerotic near the entrance of the optic nerve, the former usually derived from muscular branches perforating the sclerotic close to the margin of the cornea. Of the posterior ciliary, some, the *short ciliary* (19), break up at once to form the arterial plexus of the choroid ; others, generally two in number, the *long ciliary* (17), run forward between the choroid and sclerotic to join the anterior ciliary in forming the great arterial circle of the iris. A branch enters the optic nerve to run in it to the retina, and is called the *arteria centralis retinæ* (23).

e. The *Ethmoidal arteries*, anterior (Fig. 197, 9) and posterior (7), pass through the ethmoidal foramina in the inner wall of the orbit, the anterior accompanying the nasal nerve. They supply meningeal twigs, and branches to the nose, the anterior ending on the face and anastomosing with the lateralis nasi.

f. The *Palpebral arteries*, two in number (14), leave the orbit at the inner side, to be distributed to the upper and lower eyelids.

g. The *Frontal artery* (13), one of the terminal branches, turns round the margin of the orbit at its inner angle to accompany the supra-trochlear nerve on the forehead. It supplies the muscles and integument and anastomoses with the supra-orbital.

h. The *Nasal artery* (15), the other terminal branch, leaves the orbit at the inner side above the tendo oculi, and anastomoses on the side of the nose with the angular branch of the facial artery (12).

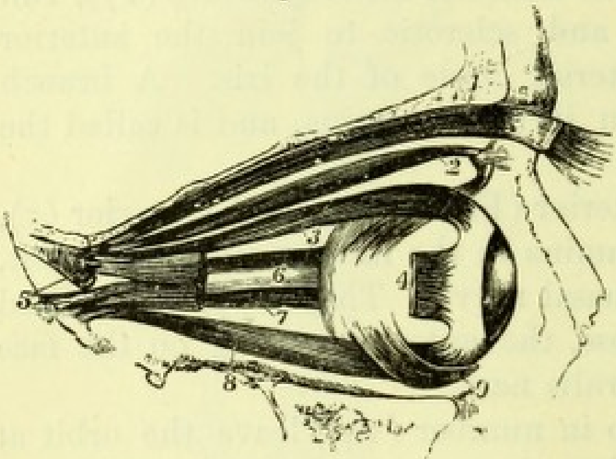
The **Ophthalmic Veins** (Fig. 194, 10) are formed by tributaries which correspond generally with the branches of the artery and form two trunks, a *superior*, communicating with the facial vein and running through the sphenoidal fissure between the heads of the external rectus to end in the cavernous sinus, and an *inferior*, which either communicates with the pterygoid plexus through the spheno-maxillary fissure, or terminates by joining the superior, or opens separately into the cavernous sinus. The *venæ vorticosæ* which return the blood from the choroid are four in number. They do not run with the ciliary arteries, but pierce the sclerotic near the equator of the globe to join the ophthalmic veins.

The **Optic Nerve** (Fig. 194, 13) (2nd) enters by the optic foramen, and passing through the centre of the orbit to the eyeball, pierces the back of the sclerotic about $\frac{1}{10}$th of an inch to the inner side of the axis of the eyeball to end in the retina. It has a complex sheath derived from the meninges of the brain.

[The optic nerve is to be divided, and the globe turned forwards to bring into view the muscles beneath.]

The remaining **Recti Muscles** (Fig. 199) are seen below, and to the inner and outer sides of, the optic nerve, and are named accordingly, *inferior*, *internal*, and *external*. They *arise* by a common tendinous origin (ligament of Zinn), which is attached round the upper, inner, and lower sides of the optic foramen, and then stretches across the inner part of the sphenoidal fissure as far as a prominent bony tubercle on its lower margin. The external rectus, the strongest, is fixed partly to this tubercle, blending with the inferior rectus, partly by another head which arises from the upper margin of the sphenoidal fissure, and blends with the superior rectus. Between these two heads is a tendinous arch, which gives passage to the 3rd nerve, the nasal branch of the 5th nerve, the 6th nerve, and the superior ophthalmic vein.

Fig. 199.



The recti are to be traced forward to their *insertion* into the sclerotic coat, a quarter of an inch behind the cornea. It will be found that the attachment of the *internal rectus* is nearest to the corneal margin ($2\frac{1}{2}$ lines), that of the *external rectus* about $\frac{3}{4}$ of a line farther back, and that of the *superior rectus* the farthest removed (4 lines). All of these muscles are ensheathed by processes of the capsule of Tenon. In *action*, the external rectus is a pure abductor, and the internal rectus an adductor of the cornea; while the inferior rectus, in addition to depressing the cornea, aids the internal and superior recti in adduction, and the inferior oblique in rotating the superior end of the vertical meridian outwards.

The **Sixth Nerve** (Fig. 195, 3) (abducens) is seen on the inner surface of the rectus externus, which it supplies.

The **Third Nerve** (Fig. 195) (motor oculi) enters the orbit in two parts, one above and the other below the nasal nerve. In its

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Fig. 199.—Muscles of the eyeball. The view is taken from the outer side of the right orbit (from Wilson).

1. Levator palpebræ superioris.
2. Obliquus superior.
3. Rectus superior.
4. Insertion of rectus externus.
5. Double origin of rectus externus.
6. Optic nerve.
7. Rectus internus.
8. Rectus inferior.
9. Obliquus inferior.

course it receives communications from the cavernous plexus and the nasal nerve.

The *upper division* (9) has been traced above the optic nerve to the levator palpebræ and superior rectus muscles ; the *lower division* (12) is now seen running below the optic nerve to give small branches to the internal and inferior recti, and a long branch which runs on the inferior rectus to the inferior oblique muscle, and supplies the short root to the lenticular ganglion. The nerve to the inferior oblique is the only long muscular nerve in the orbit.

[To expose the obliquus inferior, it will be necessary to draw the eyeball to the upper and outer angle of the orbit, and to remove the conjunctiva at the lower and inner part.]

The **Obliquus Inferior** (Fig. 199, 9) muscle lies obliquely in the orbit beneath the rectus inferior. It *arises* from the floor of the orbit just outside the lacrymal groove, and passing below the inferior rectus, then between the external rectus and sclerotic, is *inserted* into the globe a little behind the equator, above the level of the rectus externus, and close to the insertion of the obliquus superior. Like the other muscles, it receives an investment from the capsule of Tenon. It rotates the upper end of the vertical meridian of the globe outwards (antagonising the superior oblique) and aids in abduction and elevation of the cornea.

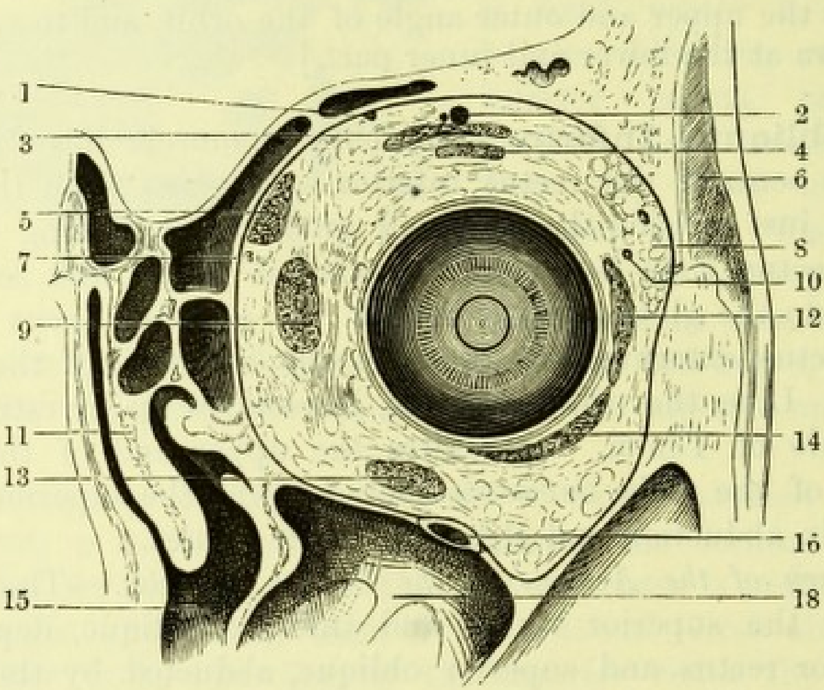
Summary of the Actions of the Ocular Muscles.—The cornea is raised by the superior rectus and inferior oblique, depressed by the inferior rectus and superior oblique, abducted by the external rectus, and adducted by the internal rectus. The upper end of the vertical meridian of the eye is rotated outwards by the inferior oblique and inferior rectus, and inwards by the superior oblique and superior rectus. The oblique upward and downward movements of the cornea are effected by the same muscles as the direct movements, aided by the external and internal recti : thus, the eye is directed upwards and outwards by the combined action of the superior and external recti and the inferior oblique, downwards and inwards by the superior and internal recti and the inferior oblique, etc.

The **Capsule of Tenon** may be demonstrated upon the subject without any serious difficulty, and should be carefully studied.

The capsule proper invests and is co-extensive with the sclerotic. It is attached in front to the margin of the cornea (where it forms the 'subconjunctival tissue' of ophthalmic surgeons) and behind to the sheath of the optic nerve. Its inner surface is smooth, and is separated by a kind of lymph space from the sclerotic, while its outer surface is connected with the adipose tissue of the orbit by bands of connective tissue.

It is pierced by the vessels, nerves, and muscles of the eye, and gives off *six vaginal processes*, one to each muscle. That to the superior oblique covers only the reflected tendon and terminates at the pulley, the others form each a loose sheath for the tendon, but blend intimately with the perimysium of the muscular belly and become less and less demonstrable as they approach the origin.

Fig. 200.



With each of the vaginal processes, except that to the superior oblique, is connected a *process of fixation* which is directly or indirectly attached to the bony wall of the orbit in such a manner as to limit the contraction of the muscle and alter somewhat its line of action. These secondary processes are of considerable strength and contain unstriped muscular fibre. The external rectus process is attached to the outer margin of the orbit, the internal rectus process goes to

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Fig. 200.—Frontal section of orbit (after Merkel).

1. Supra-trochlear nerve.
2. Frontal nerve.
3. Levator palpebræ.
4. Superior rectus.
5. Superior oblique.
6. Temporal muscle.
7. Infra-trochlear nerve.
8. Lacrymal gland.
9. Internal rectus.
10. Lacrymal nerve.
11. Middle turbinate bone.
12. External rectus.
13. Inferior rectus.
14. Inferior oblique.
15. Infundibulum.
16. Superior maxillary nerve.
18. Antrum.

the lacrymal crest, while those of the superior and inferior recti pass to the orbital border of the tarsal cartilages, and only indirectly to the orbital margin through the tarsal ligaments. In addition to these structures, Mr. Lockwood describes a *suspensory band* which is attached to the inner and outer walls of the orbit, and forms a kind of hammock passing beneath and supporting the globe.

If all the contents of the orbit are removed, the *orbital branch of the superior maxillary nerve* (*temporo-malar*) may be seen passing through the spheno-maxillary fissure, and dividing into two branches—the *subcutaneus malæ*, which pierces the malar bone, and the *temporal branch*, which pierces the outer wall of the orbit to reach the temporal integument (p. 394); and the spheno-maxillary fissure will be found closed by involuntary muscular fibre, the *orbitalis*.

The Side of the Neck.

[The head is to be drawn as far back as possible by means of a hook placed in the chin, and the side to be dissected (by preference the right side first) should be made prominent by means of blocks placed beneath. Before beginning the dissection, the student should pass his finger along the median line of the neck, and recognise the following points. Firstly, the lower jaw, and from an inch and a half to two inches below it the slight projection of the hyoid bone; next a hollow, corresponding to the thyro-hyoid membrane, and below this the projecting angle of the thyroid cartilage (pomum Adami), which is very small in women; about an inch below the pomum Adami is a depression corresponding to the crico-thyroid space, through which laryngotomy is performed; still lower will be felt the hard ring of the cricoid cartilage, and in a thin subject the rings of the trachea may be recognised lower down; sometimes also the isthmus of the thyroid body may be felt crossing the trachea, usually over the second and third rings.

An incision is to be made from the chin to the sternum, and another outwards along the clavicle as far as the incision previously made in the dissection of the posterior triangle, and the flap of skin is to be dissected up over the face. The platysma may be cleaned in the upper part of the space at once, and it will facilitate the operation if the part detached from the clavicle is held down with hooks.]

The **Platysma Myoides** (Fig. 190, 6) is now seen to reach to the side of the lower jaw, where it is partially inserted, but most of its fibres blend with the muscles of the lower lip. The muscle decussates in the median line with its fellow of the opposite side for a short distance above, but at the lower part of the neck a large

Fig. 201.

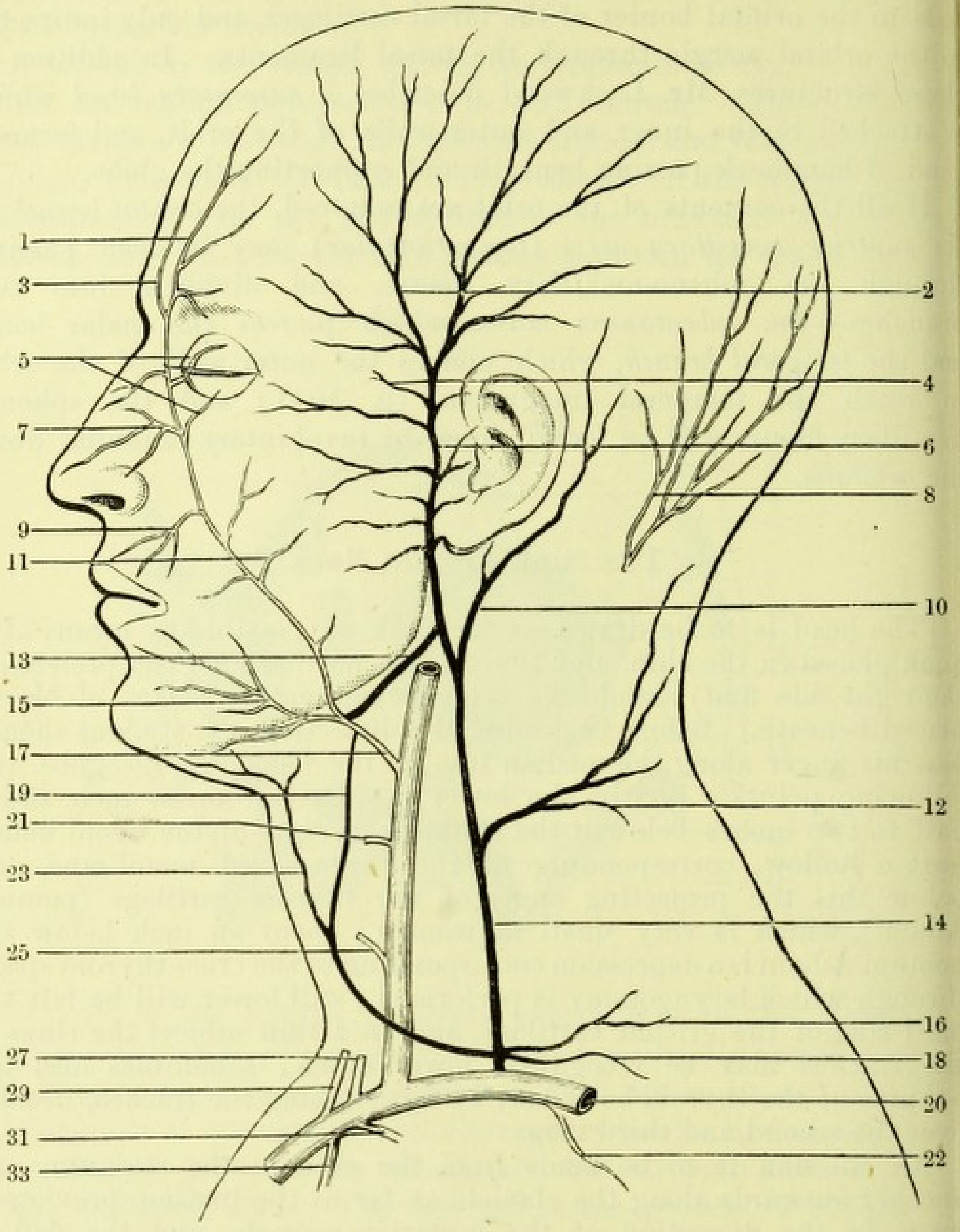

Fig. 201.—Diagram of veins of head and neck. The temporo-maxillary and external jugular system in black, the internal jugular system in double outline.

1. Supra-orbital.
2. Anterior temporal.
3. Supra-trochlear.
4. Middle temporal.
5. Palpebral.
6. Temporal, receiving transverse facial, parotid, and auricular tributaries, and joining with internal maxillary (not shown) to form temporo-maxillary.
7. Lateral nasal.
8. Occipital vein disappearing to reach the deep veins of the neck.
9. Superior labial.
10. Posterior auricular.
11. Deep facial.
12. Posterior external jugular.
13. Communicating facial.
14. External jugular.

triangular interval exists between the two. A few small branches of the superficial cervical nerve will be found piercing the muscle, and the external and anterior jugular veins may sometimes be seen through its fibres.

[The platysma is to be carefully reflected upwards like the skin the superficial nerves are to be dissected out, and the sterno-mastoid cleaned by removing that part of the deep cervical fascia which forms the superficial layer of its sheath.]

The **External Jugular Vein** (Fig. 201, 14) is formed by the junction of the internal maxillary and temporal veins in the parotid gland. The trunk so formed (*temporo-maxillary*) is soon joined by the *posterior auricular* (10) and sometimes by the *occipital* vein, and gives off a large communicating vessel, the *communicating facial* (13) to the common trunk of the lingual and facial veins (internal jugular); it then crosses the sterno-mastoid between this muscle and the platysma, and receives, near the middle of the neck, the *posterior external jugular* (12) from the cervical and occipital region. Reaching the outer border of the sterno-mastoid, close to its clavicular origin, it is joined by three tributaries, the *transversalis colli* (16) and *supra-scapular* (18) on the outer side, and the *anterior jugular* (23) in front. Finally it pierces the deep fascia and opens into the subclavian vein. The vein and its principal tributaries are valved before their terminations.

The **Anterior Jugular Vein** (Fig. 201, 23) begins beneath the chin by the union of small superficial and deep branches, and passes down the neck, near the middle line, to reach the sterno-mastoid. It here receives a tributary (19), sometimes of considerable size, communicating with the facial above, and running along the anterior border of the sterno-mastoid. It then pierces the deep fascia, runs beneath the sterno-mastoid a little above its origin, and ends, as stated, in the external jugular. The two anterior jugular veins are joined together, just above the sternum, by a transverse branch, which runs in the fat between the two layers of the deep cervical fascia. The vessel may be wounded in the operation for wry-neck.

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15. Inferior labial.
16. Transversalis colli.
17. Common trunk of lingual and facial (lingual not seen).
18. Supra-scapular (should be larger).
19. Anterior jugular communicating.
20. Subclavian.
21. Superior thyroid.
22. Cephalic.
23. Anterior jugular.
25. Middle thyroid.
27. Vertebral.
29. Inferior thyroid.
31. Superior intercostal.
33. Internal mammary.

The **Superficial Cervical Nerve** (Fig. 190, 17), a nerve of small size, is seen to divide into two or three branches supplying the skin over the anterior triangle, the upper one communicating with branches of the facial nerve below the jaw.

The **Sterno-Cleido-Mastoid Muscle** (Fig. 190, 28) *arises* by a rounded tendon from the anterior surface of the manubrium sterni, about half an inch below the supra-sternal notch, and by a broad tendinous bilaminar origin from the inner third of the upper part of the clavicle. Between the two heads of origin is a cellular interval, which may extend for some distance up the neck. The sternal portion of the muscle is *inserted* into the anterior border and outer surface of the mastoid process of the temporal bone (*sterno-mastoid*), and into the outer half of the superior curved line of the occipital bone (*sterno-occipitalis*). The superficial lamina of the clavicular head (*cleido-mastoid*) forms a muscular belly, which passes to the mastoid process beneath the insertion of the sternal head; and the deep lamina (*cleido-occipitalis*) runs to the superior curved line of the occipital bone underneath the hinder portion of the sternal head. Along the posterior border of and beneath the muscle will be seen several small lymphatic glands.

The *action* of the sterno-cleido-mastoid is (1) to flex the neck at all the cervical articulations below the second; (2) to lateralise the head towards the shoulder of the same side, moving all the cervical joints except the second; and (3) to rotate the face towards the opposite shoulder, partly through the atlanto-axial joint, and partly at the other cervical articulations. Thus, during complete contraction, the face would be made to look upwards and to the opposite side while the neck is inclined forwards. If both muscles act together from below they would directly flex the neck at the cervical articulations below the second, but they would tend to extend the head at the occipito-atlantal joint. If the head and neck be fixed the muscle raises the sternum and so aids in inspiration.

The superficial layer of the **Deep Cervical Fascia**, which has been described as extending from the trapezius across the posterior triangle, and then as forming a sheath for the sterno-mastoid (p. 414), is now seen to cover in the parts included in the anterior triangle, and to extend to the median line closing in the carotid and submaxillary triangles (p. 438). Above it adheres to the body of the hyoid bone and, after ensheathing the submaxillary gland, is attached to the inferior maxilla; below it is fixed to the upper border of the sternum, there splitting into two laminæ, between which are included some fat and a transverse branch uniting the two anterior jugular veins. A *Second*, deeper layer of fascia covers the sterno-hyoid, thyro-hyoid and omo-hyoid, binding down the central tendon of the latter muscle to the clavicle, and sending a process called the *mediastinum colli* backwards between the cervical viscera (œsophagus, larynx and trachea, &c.) and the common carotid artery, to join the prevertebral aponeurosis opposite the cervical transverse processes. A *Third* and still deeper layer ensheaths the thyroid body, fixes its isthmus to the hyoid bone, and its lateral lobes to the extremities of the first and second tracheal rings (*superior and lateral thyroid ligaments*); and passing downwards becomes connected with the front of the pericardium. The *carotid sheath* is formed by the junction of the various layers of cervical fascia surrounding the vessels.

Well marked lymph spaces may be demonstrated between the fascial layers in the neck in certain situations. The chief of these are (1) the *pre-visceral fissure*, in front of the trachea and thyroid body, extending downwards behind the lower extremities of the sterno-hyoid and sterno-thyroid muscles into the superior mediastinum; (2) the *retro-visceral fissure*, between the pharynx and œsophagus in front and the vertebral column and pre-vertebral muscles behind. This is bounded on each side by the *mediastinum colli*, and may be traced above as far as the base of the cranium and downwards into the superior and posterior mediastina; (3) the *sterno-mastoid fissure*, behind the lower part of the sterno-mastoid muscle. It extends downwards into the axilla and into the superior mediastinum. These fissures have considerable influence upon the direction followed by pus in cases of disease of the cervical vertebræ, or deep suppurations in the neck.

[Opportunity should be taken, before the tissues are in any way disturbed, to notice the parts involved in the operation of tying the common carotid artery. The vessel may be felt and indistinctly seen enclosed in a sheath of fascia, and the point where the ligature would usually be applied is at the angle formed by the sterno-mastoid and omo-hyoid muscles, the latter of which can now be seen through the fascia. The anterior triangle is then to be dissected, after the enumeration of its contents in the following four paragraphs has been carefully read.]

The **Anterior Triangle** (Fig. 190) of the neck is a space bounded *in front* by the median line from the symphysis menti to the sternum; *behind* by the sterno-mastoid muscle; its *base* is formed by the lower jaw and a line from the angle of the jaw to the mastoid process; and its *apex* is below, at the top of the sternum.

It is covered in by the skin and superficial fascia, the platysma, the superficial layer of the deep fascia, and the superficial vessels and nerves, and is subdivided into three smaller triangles by the anterior belly of the omo-hyoid, the stylo-hyoid and posterior belly of the digastricus, and the body of the hyoid bone.

The **Submaxillary Triangle** is bounded *above* by the lower border of the inferior maxilla and the stylo-maxillary ligament ; *in front* by the midline from chin to hyoid bone, and *below* by the hyoid bone and the stylo-hyoid and posterior belly of the digastricus. Its *floor* is formed by the anterior belly of the digastricus, the mylo-hyoid, the hyo-glossus, and the middle constrictor ; and it *contains* parts of the facial and lingual vessels, with their submental and submaxillary branches, the submaxillary salivary and lymphatic glands, the hypoglossal nerve, and the mylo-hyoid branches of the inferior dental vessels and nerve.

The **Superior Carotid Triangle**, a small but very important space, is bounded by the stylo-hyoid and posterior belly of the digastricus *above*, the anterior belly of the omo-hyoid *below*, and the sterno-mastoid *behind*. Its *floor* is formed by the hyoid bone, the thyroid cartilage, the thyro-hyoid membrane and ligament, the spine, with the prevertebral muscles, the hyo-glossus, the middle and inferior constrictors and a small portion of the thyro-hyoid muscle. It *contains* parts of the common, internal, and external carotid arteries, with the superior thyroid, lingual, facial, ascending pharyngeal, occipital, and posterior auricular branches of the last ; the superior thyroid, lingual, facial, communicating facial, and pharyngeal veins ; lymphatic glands and vessels ; the vagus nerve, with its pharyngeal, laryngeal and superior cardiac bsanches ; branches of the superior cervical ganglion ; and the hypoglossal nerve, with its thyro-hyoid and descendens cervicis branches.

The common carotid artery comes into view between the sterno-mastoid and omo-hyoid muscles, with the descendens cervicis nerve superficial to it, and the internal jugular vein to its outer side ; the pneumo-gastric nerve being concealed behind and between the vessels, and the sympathetic nerve lying still deeper beneath their sheath. The commencement of the external and internal carotids is seen at, or near, the upper border of the thyroid cartilage, and both vessels are crossed superficially by the hypoglossal nerve, a small twig of which to the thyro-hyoid muscle should be preserved ; the superior laryngeal nerve appears on the inner side of the carotid vessels, passing behind the internal and external carotid arteries to enter the larynx through the interval between the hyoid bone and the thyroid cartilage, between the middle and inferior constrictors of the pharynx. Lower down, a branch of this nerve, the *external laryngeal*, ending in the crico-thyroid, should be sought for.

The superior thyroid, lingual, and facial arteries are partly visible in the anterior portion of the space ; and the occipital artery is seen turning backwards below the digastric, with the hypoglossal nerve curving round its sterno-mastoid branch (or around the sterno-mastoid artery).

The **Inferior Carotid Triangle** is bounded in *front* by the median line from hyoid bone to sternum, *behind* and *above* by the omo-hyoid, *behind* and *below* by the sterno-mastoid. Its *floor* is formed by the sterno-hyoid and sterno-thyroid muscles, the thyroid body, the larynx, trachea, and œsophagus, the thyroid vessels, some small nerves, and lymphatics.

[It will be advisable to examine the ligaments of the inner end of the clavicle, before detaching it. The sternal origin of the sterno-mastoid must be cut, and any remains of the pectoralis major must be removed, in order that the ligaments between the clavicle, sternum, and first rib, and also between the two clavicles, may be cleaned.

It is supposed that the clavicle has been cut close to the attachment of the sterno-mastoid in the dissection of the posterior triangle of the neck, but if this has not been the case it should now be divided. The inner end of the bone being then drawn up, the costo-clavicular ligament is to be divided, and the knife passed into the sterno-clavicular articulation from below, and close to the clavicle. By this, one of the two synovial membranes will be opened, and the other can be exposed by cutting from above close to the sternum, thus leaving the inter-articular cartilage uninjured. The inter-articular fibro-cartilage is to be divided and the inner end of the bone dislocated, the fibres of the sterno-hyoid which are attached to it being separated. The sterno-mastoid (with the portion of the clavicle) is then to be turned back, being carefully separated from the fascia beneath. The spinal-accessory nerve will be found to pierce it at the upper part, and a branch of the 2nd cervical nerve enters the under-surface of the muscle.]

Parts beneath the Sterno-Mastoid Muscle.—By the removal of the sterno-mastoid the following structures will be brought into view, which must be subsequently studied in detail. Above are seen the posterior belly of the digastric and the stylo-hyoid ; with the posterior auricular artery and parotid gland at the upper border of the digastric, and the occipital artery at the lower border of the same muscle. Lower down and posteriorly are parts of the splenius capitis, levator anguli scapulæ, and scalenus medius, with the cervical nerves and lymphatic glands. In front, immediately below the

Fig. 202.

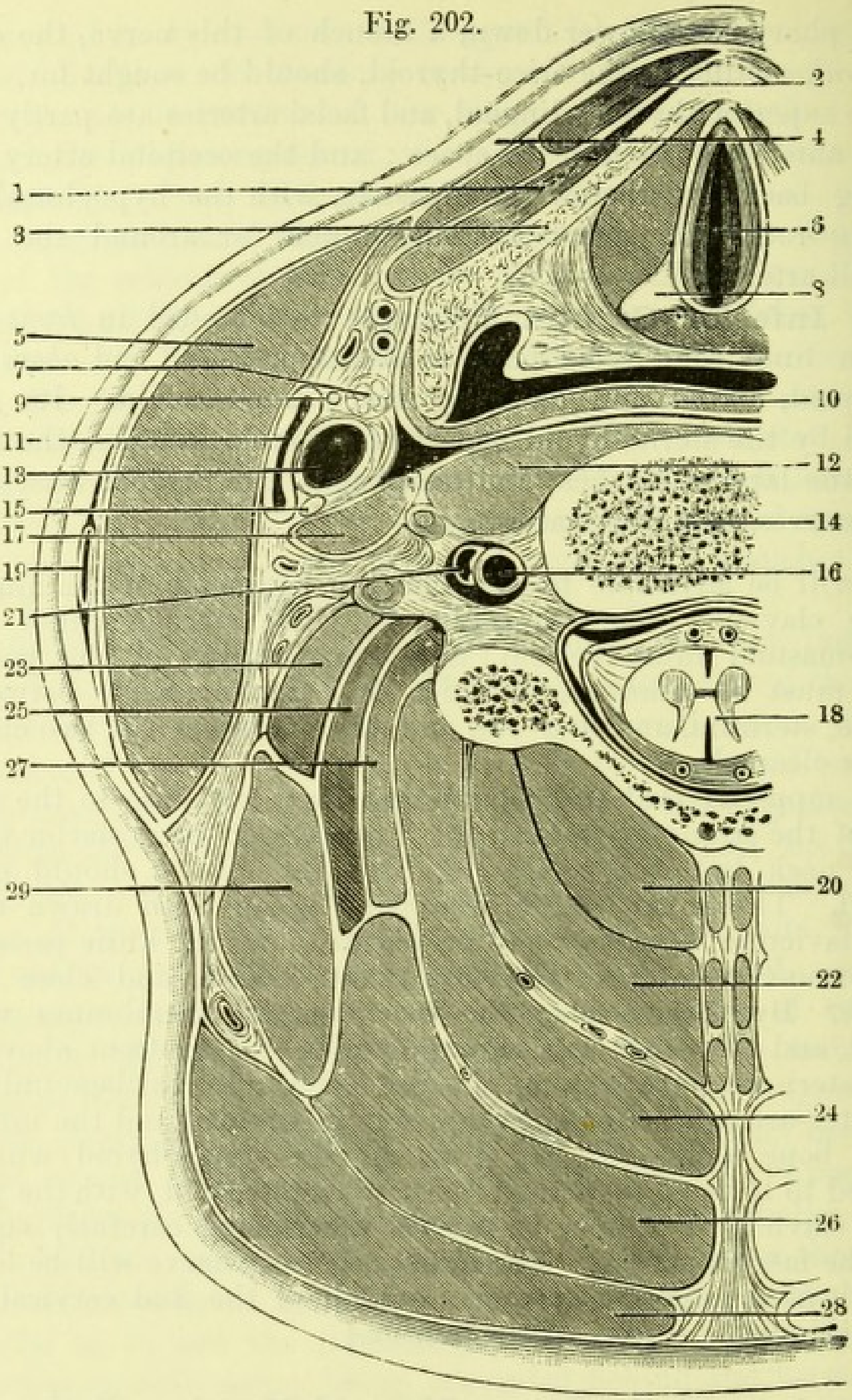


Fig. 202.—Transverse section of neck, opposite 5th cervical vertebra. (Modified from Braune.)

1. Thyro-hyoid.
2. Sterno-hyoid (omo-hyoid lies to the left).
3. Thyroid cartilage.
4. Space for platysma between the layers of the superficial fascia (muscle not represented).
5. Sterno-mastoid.
6. Glottis.
7. Lymphatic gland.
8. Arytenoid cartilage.
9. Descendens cervicis nerve.
10. Inferior constrictor.
11. Internal jugular vein.
12. Longus colli.
13. Common carotid artery.
14. 5th cervical vertebra (near upper surface).

digastric, the spinal-accessory nerve and a branch of the anterior division of the 2nd cervical nerve will be found piercing the deep fibres of the sterno-mastoid, and the hypoglossal nerve arching forward over the carotid vessels. The common carotid, with the internal jugular vein external to it, and the pneumo-gastric nerve lying deeply between the two, appears in a sheath of fascia above the border of the omo-hyoid; and the descendens cervicis nerve lies either upon or in the sheath, and forms one or more loops with the communicating branches from the cervical plexus. The bifurcation of the carotid will be seen about the level of the upper border of the thyroid cartilage, the internal carotid passing upwards by the side of the jugular vein, with the external carotid in front of it; the anterior branches of the latter reaching forward beyond the sterno-mastoid, and the superior and middle thyroid veins opening into the internal jugular. Near the clavicle are the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles, the transversalis colli and transversalis humeri veins, the anterior jugular vein near its termination, and, deeper, the anterior scalenus with the phrenic nerve upon it. On the left side of the body, the thoracic duct will be found arching above and in front of the subclavian artery to open into the junction of the internal jugular and subclavian veins. A similar but smaller duct (*right lymphatic trunk*) may be found on the right side.

The small **Descendens Cervicis Nerve** (Fig. 204, 14) is now to be dissected out. It lies either upon or within the sheath of the carotid vessels, and is to be traced upwards to the hypoglossal nerve (which crosses the carotid sheath just below the digastric muscle), and downwards to supply the muscles in the front of the neck, viz. sterno-hyoid, sterno-thyroid, and omo-hyoid. A branch, which may be double, will be found to come forward from the cervical plexus to join the hypoglossal and form a loop, the *ansa hypoglossi*, beneath the sterno-mastoid. This is the *communicans cervicis* nerve (7), and comes from the 2nd and 3rd cervical nerves.

The **Nerve to the Thyro-hyoid** is seen coming from the hypoglossal in front of the origin of the descendens cervicis. These two branches, together with the nerve to the genio-hyoid, are

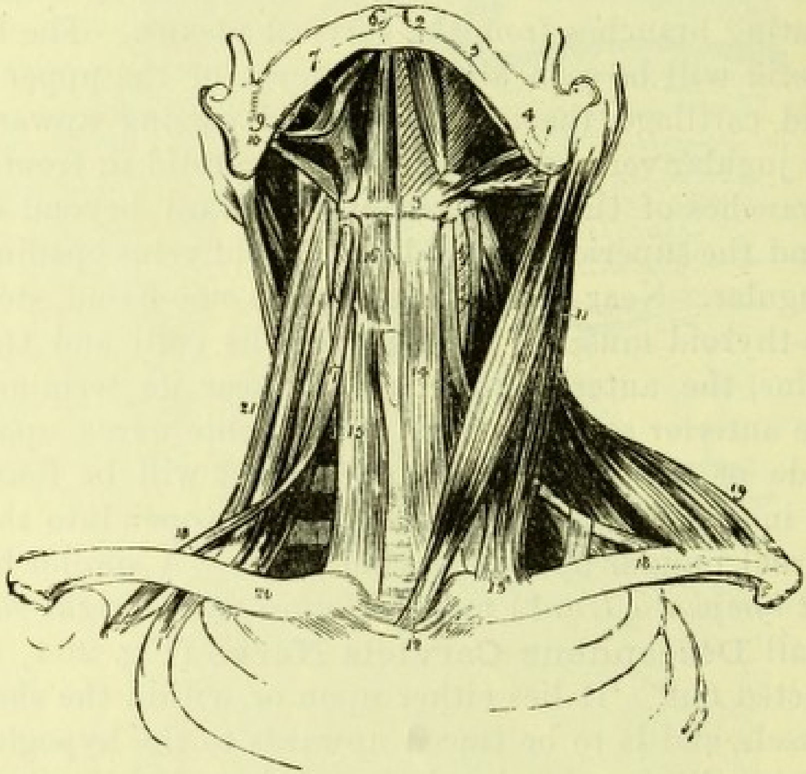
---

15. Vagus.
16. Vertebral artery.
17. Scalenus anticus and rectus capitis anticus major.
18. Spinal cord.
19. External jugular vein (beneath platysma).
20. Multifidus spinæ.
21. Vertebral vein.
22. Semispinalis colli.
23. Scaleni medius and posticus.
24. Complexus.
25. Cervicalis ascendens.
26. Splenius capitis et colli.
27. Transversalis capitis et colli.
28. Trapezius.
29. Levator anguli scapulæ.

really derived from the communicating branch given to the hypoglossal by the anterior division of the first cervical nerve and are not of intra-cranial origin.

[The fascia is now to be removed from the superficial muscles of the triangle, but the carotid sheath should be left untouched for the present.]

Fig. 203.



The **Sterno-hyoid** (Fig. 203, 14) is the most superficial muscle; it is separated from its fellow of the opposite side by only a small

Fig. 203.—Muscles of the anterior aspect of the neck; on the left side of the figure the superficial muscles are seen, on the right the deep (from Wilson).

1. Posterior belly of digastric.
2. Its anterior belly. Aponeurotic pulley, through which its tendon is seen passing, attached to the body of the os hyoides, 3.
4. Stylo-hyoid muscle.
5. Mylo-hyoid muscle.
6. Genio-hyoid muscle.
7. Stylo-glossus.
8. Hyo-glossus.
9. Styloid process.
10. Stylo-pharyngeus.
11. Sterno-cleido-mastoideus.
12. Its sternal origin.
13. Its clavicular origin.
14. Sterno-hyoid.
15. Sterno-thyroid of the right side.
16. Thyro-hyoid.
17. Anterior belly of the omo-hyoid.
18, 18. Its posterior belly; on the left side, the tendon of the muscle is seen to be bound down by a portion of the deep cervical fascia.
19. Clavicular portion of the trapezius.
20. Scalenus anticus, of the right side.
21. Scalenus posticus; the scalenus medius is seen between the two.

cellular interval above, but diverges from it below. It *arises* from the back of the first piece of the sternum, the posterior sterno-clavicular ligament, and the inner extremity of the clavicle ; and is *inserted* into the body of the hyoid bone.

It is a depressor of the hyoid bone, fixing it during the action of the supra-hyoid muscles. It may act feebly as a muscle of inspiration, by raising the sternum when the hyoid bone is fixed from above.

The **Sterno-thyroid** (Fig. 203, 15) is deeper and broader than the preceding muscle, by which it is partly covered. It *arises* from the back of the sternum below the sterno-hyoid, and from the first or sometimes the second costal cartilage ; and is *inserted* into the oblique line on the side of the thyroid cartilage. It very generally has a transverse tendinous intersection in its fibres. It is separated from its fellow above by a considerable interval, but comes into close contiguity with it below.

It is a depressor of the thyroid cartilage, and a feeble elevator of the sternum when the cartilage is drawn upwards and fixed.

The **Thyro-hyoid** (Fig. 203, 16) is a direct continuation of the last muscle. It *arises* from the oblique line of the thyroid cartilage, and passing beneath the omo-hyoid is *inserted* into the lower border of the body and greater cornu of the hyoid bone.

It is an elevator of the thyroid cartilage acting from above, and a depressor of the hyoid bone acting from below, when the thyroid cartilage is drawn downwards and fixed.

The **Omo-hyoid** (Fig. 203, 17) can now be seen in its whole length, crossing the neck beneath the sterno-mastoid, and consisting of two bellies united by a small tendon, which has been seen to be held down to the clavicle and first rib by a process of the deep cervical fascia. It *arises* from the upper margin of the scapula close to the notch, and from the transverse ligament which converts the supra-scapular notch into a foramen ; and is *inserted* into the body of the hyoid bone externally to the sterno-hyoid, and superficially to the thyro-hyoid muscle.

It is a depressor of the hyoid bone and a feeble elevator of the scapula.

These three muscles are all *supplied* by the descendens cervicis nerve, except the posterior belly of the omo-hyoid, which receives a branch from the *ansa hypoglossi*.

The **Digastric** (Fig. 203, 1) muscle consists of two bellies, placed above the hyoid bone, to which the intermediate tendon is attached by fascia. It *arises* from the digastric fossa on the inner side of the mastoid process of the temporal bone ; and is *inserted* into a rough surface at the lower border of the inferior maxilla, close to the median line. Its *action* is to depress the lower jaw, or if the jaw is fixed, to raise the hyoid bone and larynx. Its posterior belly is *supplied* by a branch of the facial nerve, and the anterior by the mylo-hyoid branch of the inferior dental nerve (5th). The submaxillary salivary gland lies in the angle between the two bellies.

The **Stylo-hyoid** (Fig. 203, 4) is the muscle in immediate connection with the posterior belly of the digastric, and is pierced by the tendon of the latter close to the hyoid bone. It *arises* from the outer or posterior part of the base of the styloid process of the temporal bone, and is *inserted* into the upper surface of the body of the hyoid bone at its junction with the great cornu. It is an elevator of the hyoid bone and is *supplied* by the digastric branch of the facial nerve.

[In order to show the sheath of the carotid vessels completely, the sterno-hyoid and sterno-thyroid must be reflected. But before doing so the dissector of the left side should seek the termination of the thoracic duct (*v.* p. 458).

After the muscles have been reflected the sheath is to be opened. The descendens cervicis nerve has already been traced upon it, and within will now be found the common carotid artery nearest the median line ; more externally the internal jugular vein, and between but behind these the pneumo-gastric (or vagus) nerve. Behind the sheath will be found the trunk of the sympathetic nerve, lying parallel with the vessels ; and crossing behind these at the level of the 6th cervical vertebra will be seen the inferior thyroid artery and recurrent laryngeal nerve. The sheath is to be carefully dissected away, and the branches of the artery and the vein followed out and cleaned, as far as the dissection will permit. The large hypoglossal nerve will be found looping round the occipital or sterno-mastoid artery, and crossing in front of the external and internal carotids in a curved direction immediately below the digastric muscle ; and the superior laryngeal branch of the pneumo-gastric crosses behind the vessels a little lower down.]

The **Common Carotid Artery** (Fig. 204, 14) has the same relations on both sides of the neck from the sterno-clavicular articulation upwards, though its origin is different on the two sides. On the right side it commences behind the top of the sterno-clavicular articulation, by the bifurcation of the innominate into common carotid and subclavian arteries, but on the left side it begins at the arch of the aorta. Its direction in the neck is upwards and a little outwards, and would be sufficiently indicated by a line from the inner end of the clavicle to the front of the mastoid process.

It ordinarily divides at the level of the upper border of the thyroid cartilage into external and internal carotids.

Its *relations* are—*in front* superficial structures including the

Fig. 204.

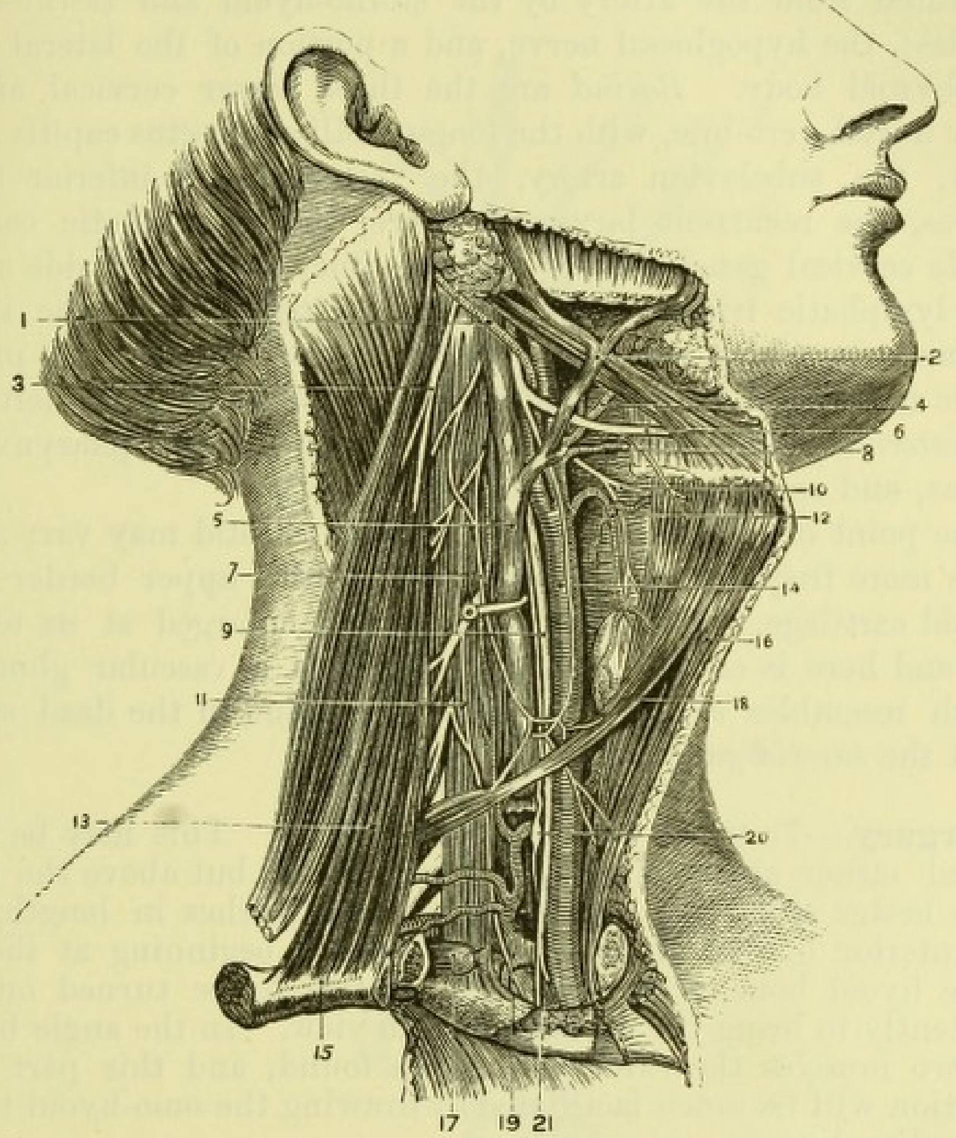


Fig. 204.—The side of the neck (drawn by J. T. Gray).

1. Occipital artery.
2. Facial vein.
3. Spinal-accessory nerve.
4. Facial artery.
5. Internal jugular vein.
6. Hypoglossal nerve.
7. Communicans cervicis nerve.
8. Lingual artery.
9. Pneumo-gastric nerve.
10. Superior laryngeal nerve.
11. Phrenic nerve.
12. Superior thyroid artery.
13. Sterno-cleido-mastoid (reflected).
14. Common carotid artery with descendens cervicis nerve.
15. Inner end of clavicle (reflected).
16. Sterno-hyoid.
17. Subclavian vein (cut).
18. Omo-hyoid.
19. Subclavian artery giving off the thyroid axis and the internal mammary artery.
20. Middle cervical ganglion of sympathetic.
21. Apex of pleura.

platysma, the sternal origin and anterior border of the sterno-mastoid, the lower portion of the sterno-hyoid and sterno-thyroid muscles, the sterno-mastoid branch of the superior thyroid artery, the internal jugular vein at the root of the neck on the left side, the middle and superior thyroid veins, the anterior jugular vein (separated from the artery by the sterno-hyoid and sterno-thyroid muscles), the hypoglossal nerve, and a portion of the lateral lobe of the thyroid body. *Behind* are the three lower cervical and two upper dorsal vertebræ, with the longus colli and rectus capitis anticus major, the subclavian artery, the vertebral and inferior thyroid arteries, the recurrent laryngeal nerve, the sympathetic cord and middle cervical ganglion, the thoracic duct on the left side and the right lymphatic trunk on the right. *Externally* are the internal jugular vein, which overlaps it below on the left side, the pneumo-gastric nerve, and the apex of the lung (especially on the left side); and *internally* the trachea, larynx, thyroid body, pharynx, œsophagus, and recurrent laryngeal nerve.

The point of bifurcation of the common carotid may vary a little, but is more frequently above than below the upper border of the thyroid cartilage. The vessel is somewhat enlarged at its termination, and here is closely related in front to a vascular glomerulus (which resembles a mass of connective tissue in the dead subject) called the *carotid ganglion*.

Surgery.—*To tie the common carotid artery.* This may be accomplished either above or below the omo-hyoid, but above the muscle is the better situation. An incision, three inches in length, along the anterior border of the sterno-mastoid, beginning at the level of the hyoid bone, will allow that muscle to be turned outwards sufficiently to bring the omo-hyoid into view. In the angle between the two muscles the carotid is to be found, and this part of the operation will be much facilitated by drawing the omo-hyoid towards the median line.

The descendens cervicis nerve may be seen on the sheath of the vessels, and is to be avoided, and the sheath is to be carefully opened on its inner side, so as to avoid possible injury to the internal jugular vein, which usually is not exposed. The needle is to be passed from the outer side, care being taken not to include the pneumo-gastric or the sympathetic nerve. On the dead body the vein is frequently empty, and is liable to be injured unless the sheath be opened well to its inner side.

The operation below the omo-hyoid might be performed through a similar incision along the border of the lower part of the sterno-mastoid, but would be facilitated by dividing the sternal origin of the muscle. The sterno-hyoid and sterno-thyroid muscles must be turned inwards, or even divided, in order to reach the vessel.

The **Internal Carotid Artery** (Fig. 205, 8) ascends to the base of the skull, lying close to the pharynx, and upon the prevertebral muscles, the vagus, and the sympathetic cord. It is first to the

Fig. 205.

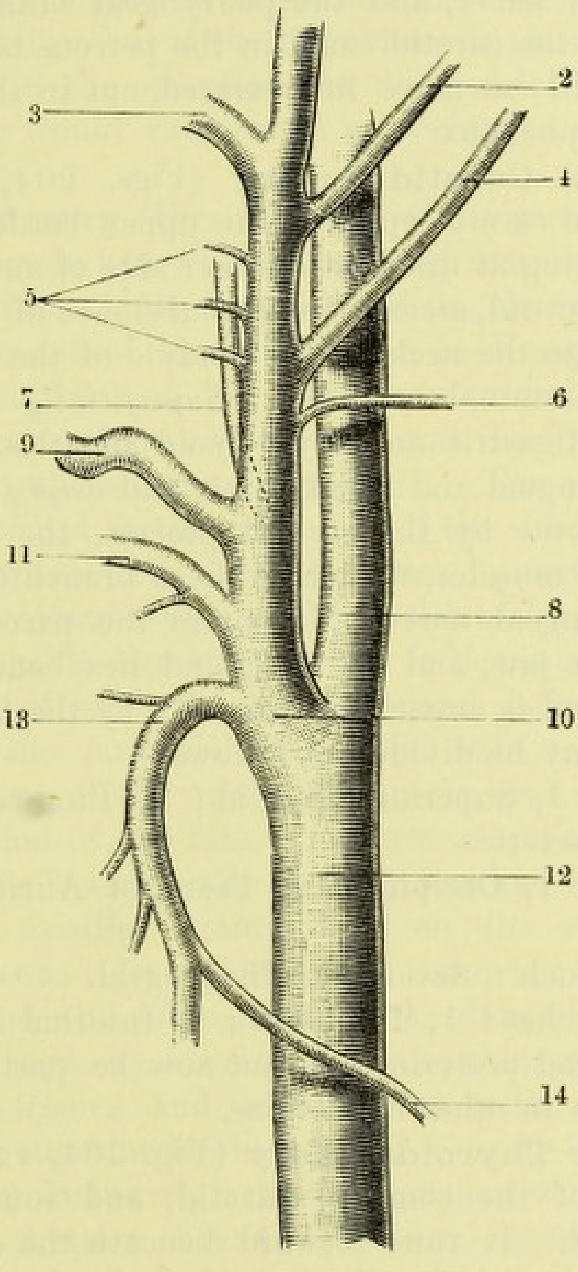


Fig. 205.—The carotid arteries (W. A.).

1. Temporal.
2. Posterior auricular.
3. Internal maxillary.
4. Occipital.
5. Parotid and masseteric.
6. Sterno-mastoid.
7. Ascending pharyngeal.
8. Internal carotid.
9. Facial.
10. Enlargement of carotid at bifurcation.
11. Lingual.
12. Common carotid.
13. Superior thyroid.
14. Sterno-mastoid branch of superior thyroid.

outer side of the external carotid, and is crossed *in front* by the hypoglossal nerve, the digastric and stylo-hyoid muscles, and the posterior auricular and occipital arteries; and *behind* by the superior laryngeal branch of the pneumo-gastric. In its further course it is deeper than the external carotid, and is separated from it by the styloid process, the stylo-glossus and stylo-pharyngeus muscles, the glosso-pharyngeal nerve, and the pharyngeal branch of the vagus. Finally it enters the carotid canal in the petrous bone.

The artery will be more fully traced out in the deep dissection of the neck and pharynx.

The **External Carotid Artery** (Figs. 204, 205) is derived from the common carotid opposite the upper border of the thyroid cartilage, and, lying at first to the inner side of and then superficial to the internal carotid, ascends in the substance of the parotid gland to a point opposite the neck of the condyle of the lower jaw, where it gives off its terminal branches. *Superficially* in the neck it is crossed by the digastric and stylo-hyoid muscles, the hypoglossal nerve, and the lingual and facial veins, and *deeply* is separated from the internal carotid by the styloid process, the stylo-glossus and stylo-pharyngeus muscles, the pharyngeal branch of the vagus, and the glosso-pharyngeal nerve. It enters the parotid gland behind the angle of the jaw, and in the gland lies beneath the temporo-maxillary vein and is crossed superficially by the facial nerve.

Its *branches* may be divided as follows :—

Anterior set: 1, Superior Thyroid; 2, Lingual; 3, Facial; 4, Parotid and Masseteric.

Posterior set: 1, Occipital; 2, Posterior Auricular; 3, Sterno-Mastoid.*

Ascending branch: Ascending Pharyngeal.

Terminal branches: 1, Temporal; 2, Internal Maxillary.

The anterior and posterior sets can now be partly dissected; the rest will be given in other dissections.

The **Superior Thyroid Artery** (Fig. 204, 12) arises close to the bifurcation of the common carotid, and sometimes from the main artery itself. It runs forward beneath the depressor muscles of the hyoid bone, and then downward to the thyroid body to anastomose with the inferior thyroid artery from the subclavian and with the thyroid vessels of the opposite side. It gives off an *inferior hyoid branch*, which runs along the lower border of the hyoid bone, and anastomoses with the hyoid branch of the lingual artery; a

* The sterno-mastoid is perhaps more frequently derived from the occipital than from the trunk itself.

superior laryngeal branch, which pierces the thyro-hyoid membrane with the corresponding nerve; a *crico-thyroid branch*, anastomosing with its fellow of the opposite side across the crico-thyroid membrane; and a *superficial descending branch*, which supplies the depressor muscles of the hyoid bone, and gives off a *sterno-mastoid artery*.

The crico-thyroid branch is considered to be one of the causes of danger in laryngotomy, but if the membrane is pierced transversely, as it ordinarily is in the operation, its division is unlikely; moreover, its small size would cause such an accident to be of but little importance.

The **Lingual Artery** (Fig. 204, 8).—Only a very small portion of the lingual artery is now visible, running first upwards and then transversely upon the middle constrictor of the pharynx, immediately above the greater cornu of the hyoid bone, to disappear beneath the edge or through the fibres of the hyo-glossus muscle. It is crossed by the digastric and stylo-hyoid muscles and the hypoglossal nerve, and overlapped by the submaxillary gland. The remainder of the vessel will be described in the dissection of the submaxillary region.

The **Facial Artery** (Fig. 204, 4) passes upwards and forwards beneath the digastric and stylo-hyoid muscles and hypoglossal nerve, and forms a remarkable sigmoid curve as it lies in a deep groove on the posterior part of the submaxillary gland before reaching the jaw. It crosses the jaw with the facial vein to its outer side, immediately in front of the masseter muscle, and will be followed out in the dissection of the face. Its *inferior palatine* branch may be seen disappearing between the stylo-glossus and stylo-pharyngeus muscles, and the *tonsillar* branch between the stylo-glossus and pterygoideus internus; its *submaxillary* branches (two or three) enter the gland, and the *sub-mental branch*, often of large size, runs forward over the mylo-hyoid muscle to the chin, where it supplies the surrounding tissues and anastomoses with the sublingual, inferior labial and superior hyoid arteries.

The facial artery frequently arises in common with the lingual.

The **Occipital Artery** (Fig. 204, 1) is only seen in its first part. It runs backwards along the inferior border of the digastric, and then beneath its origin in a special groove in the mastoid portion of the temporal bone, and may usually be recognised by the fact that the hypoglossal nerve hooks round its sterno-mastoid branch when this is present. The artery crosses the hypoglossal nerve, internal carotid artery, pneumo-gastric nerve, internal jugular vein, spinal accessory nerve, and sympathetic trunk. It usually gives off a *sterno-mastoid* branch. Its further course will be traced later.

The **Posterior Auricular Artery**, of much smaller size than the last and not easily seen unless carefully looked for, arises beneath the digastricus and turns around its upper border to reach the mastoid process, which it crosses. Near the mastoid process it gives off the *stylo-mastoid branch* into the stylo-mastoid foramen, and then supplies *auricular*, *mastoid*, and *temporal* branches to the pinna and the structures of the mastoid and posterior temporal region, besides sending a small branch beneath the posterior belly of the occipito-frontalis. It anastomoses with the temporal and occipital arteries.

The **Sterno-Mastoid Artery** is a branch of uncertain origin, coming either from the external carotid artery near its commencement, or from the occipital artery; the hypoglossal nerve winding round it in either case. It is of small size and enters the under surface of the sterno-mastoid muscle, crossing the carotid sheath to anastomose with the sterno-mastoid branch of the superior thyroid.

The **Veins** corresponding to the branches of the external carotid artery do not take quite the same course as those vessels. The internal maxillary and temporal veins unite in the parotid to form the *temporo-maxillary vein*, which afterwards receives the *posterior auricular vein*, and passes down in the substance of the gland on the outer side of the external carotid artery and facial nerve; at the angle of the jaw it divides into the *external jugular* and the *facial communicating*. The latter joins the facial vein to form the *common facial*, which enters the Internal Jugular. The *facial* vein is more superficial than the artery and runs over the submaxillary gland. The *lingual* vein usually joins the facial. The *occipital* vein seldom accompanies the artery, but generally ends in a network beneath the complexus.

The **Internal Jugular Vein** (Fig. 204, 5) is deeply placed to the outer side of the internal carotid artery immediately below the base of the skull, and afterwards holds the same relation to the common carotid artery. It is crossed by the styloid process and stylo-pharyngeus muscle, the spinal-accessory nerve (which, however, is sometimes beneath the vein), the digastric and stylo-hyoid muscles and the occipital artery. It is covered by the sterno-mastoid in the lower part of its course. It has the pneumo-gastric nerve between it and the internal and common carotid arteries, and is enclosed in the carotid sheath of cervical fascia. It receives the *facial*, *lingual*, *pharyngeal*, *superior thyroid*, and *middle thyroid* veins, and unites with the subclavian vein to form the *vena innominata*. Its relation to the carotid artery differs on the two sides.

At the root of the neck, on the left side, it somewhat overlaps the artery, but on the right is separated from it by a small angular interval.

[The inner end of the clavicle having been removed with the sterno-mastoid, a little dissection close above the sternum will readily expose the scalenus anticus muscle attached to the first rib, having the phrenic nerve lying upon it, and branches of the thyroid axis crossing it. The pneumo-gastric if traced down will be found to cross the first part of the subclavian artery, which with its branches is to be defined. The sympathetic, and the thoracic duct on the left side, are to be carefully preserved.]

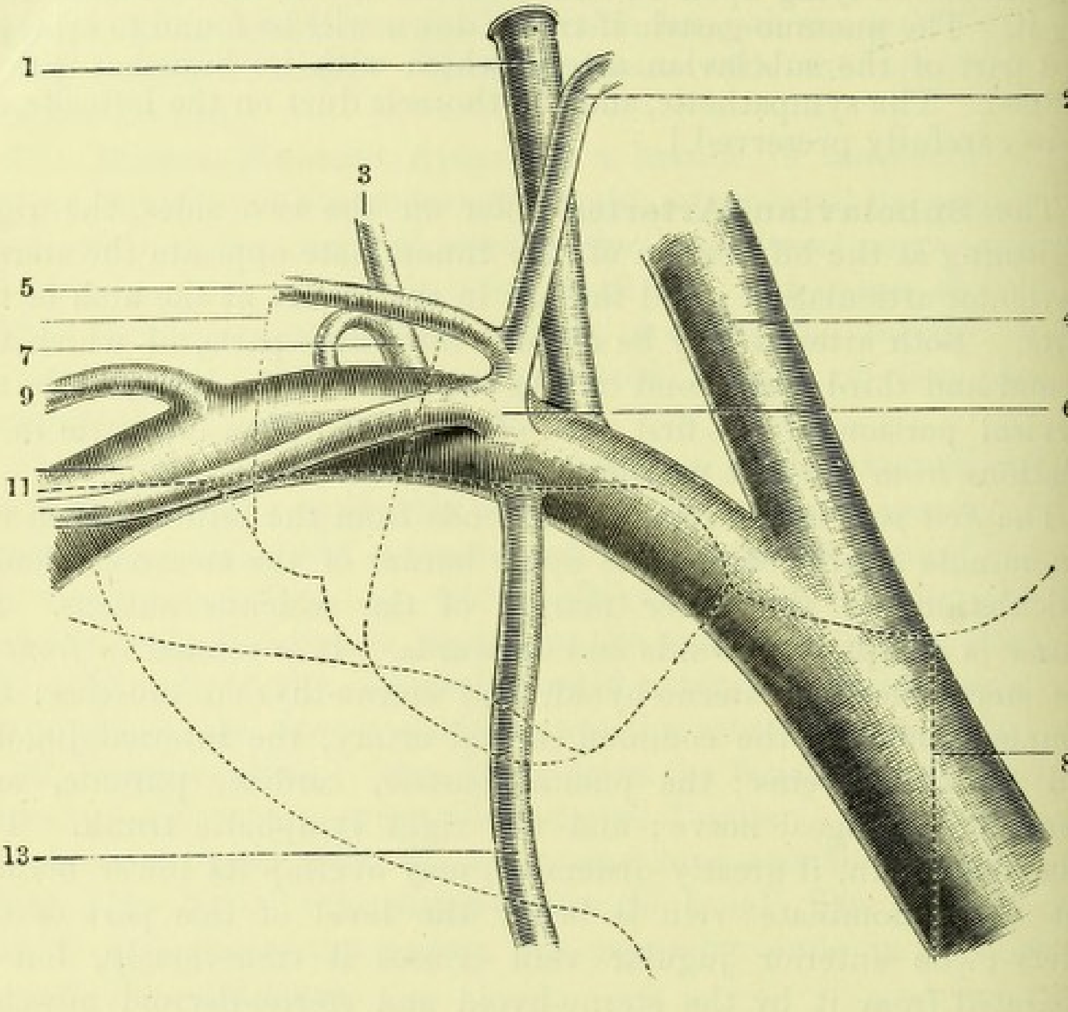
The **Subclavian Arteries** differ on the two sides, the right beginning at the bifurcation of the innominate opposite the sterno-clavicular articulation ; and the left in the thorax at the arch of the aorta. Both arteries may be divided into three parts, of which the second and third correspond on the two sides of the body, while the cervical portion of the first part of the left differs but little in its relations from the first part on the right side.

The *first part on the right side* extends from the bifurcation of the innominate artery, behind the upper border of the sterno-clavicular articulation, to the inner margin of the scalenus anticus. Its course is obliquely upwards and outwards. It is related *in front* to the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles ; the commencement of the common carotid artery, the internal jugular and vertebral veins ; the pneumo-gastric, cardiac, phrenic, and recurrent laryngeal nerve ; and the right lymphatic trunk. The subclavian vein, if greatly distended, may overlap its lower border, but the innominate vein is below the level of this part of the artery ; the anterior jugular vein crosses it transversely, but is separated from it by the sterno-hyoid and sterno-thyroid muscles. *Behind* it lie the apex of the pleura, the recurrent laryngeal nerve (which also passes around it below), the sympathetic cord, and some cardiac nerves.

The *first part on the left side* extends from the arch of the aorta to the inner border of the scalenus anticus, and may be conveniently subdivided into a thoracic and a cervical portion. The relations of the cervical part are the same as those on the right side, with these exceptions :—The recurrent laryngeal nerve does not wind around it ; the thoracic duct arches above and in front of the artery to join the subclavian vein close to its union with the internal jugular ; and the internal jugular vein, overlapping the common carotid artery, is less extensively related to the subclavian artery than on the right side.

The Branches of the first part of the subclavian artery are (1) Vertebral, (2) Internal Mammary, and (3) Thyroid Axis. The Superior Intercostal artery arises from the first part of the subclavian on the left side, but on the right is usually a branch of the second part, and is concealed by the inner border of the scalenus anticus.

Fig. 206



1. The **Vertebral Artery** (Fig. 206, 1) is seen now in only a small part of its course. It arises from the posterior part of the upper border of the subclavian (occasionally from the aorta on the left side), and runs upwards in front of the transverse process of the 7th cervical vertebra, lying in an interspace between the scalenus

Fig. 206.—The right subclavian and its branches. The dotted outlines represent the position of the sternum, first rib, clavicle, and scalenus anticus (W. A.).

1. Vertebral extending upwards to foramen in 6th cervical vertebra.
2. Inferior thyroid.
3. Deep cervical.
4. Common carotid.
5. Transverse cervical.
6. Thyroid axis.
7. Superior intercostal.
8. Innominate (the dotted line corresponds to the mesial plane).
9. Posterior scapular (inconstant).
11. Supra-scapular.
13. Internal mammary.

anticus and the longus colli muscles. In front of it are the inferior thyroid artery, the middle cervical ganglion, two minute branches from the inferior cervical ganglion of the sympathetic, and the internal jugular and vertebral veins. It enters the foramen in the transverse process of the 6th cervical vertebra, and passes through the vertebrarterial foramina in all the vertebræ above, inclining outwards to reach its passage on the atlas, then winding inwards upon the atlas to enter the foramen magnum and supply the brain. It is about 2 inches in length between its origin and the point at which it enters the vertebrarterial canal. In the neck it gives off *spinal* branches, which enter the spinal canal through the intervertebral foramina and are distributed to the walls of the canal, the nerve roots, the spinal cord, and the meninges; and *muscular* branches supplying the retro-spinal muscles, and anastomosing with the princeps and profunda cervicis arteries beneath the complexus.

The *Vertebral vein*, much smaller than the artery, commences in small branches about the foramen magnum and atlas. It takes the same course as the artery, receiving corresponding branches, and also the *ascending cervical* and *deep cervical* veins, and, after emerging from the foramen in the sixth vertebra, is joined by a small tributary which runs through the foramen in the seventh vertebra, and crosses the subclavian artery to open into the innominate vein. It sometimes escapes through the foramen in the transverse process of one of the other cervical vertebræ.

2. The **Internal Mammary Artery** (Fig. 206, 13) arises from the lower part of the anterior surface of the subclavian artery on the distal side of the vertebral below the origin of the thyroid axis, and at once descends into the thorax. It is crossed superficially by the phrenic nerve close to its origin. The artery passes behind the costal cartilages of the true ribs, giving off a comes nervi phrenici, anterior intercostal, mediastinal, pericardiac, and perforating branches, and finally divides opposite the seventh cartilage into two terminal branches—superior epigastric and musculo-phrenic. These will be further seen in the dissection of the thorax. The artery is accompanied by *venæ comites,* which unite above and join the innominate vein.

3. The **Thyroid Axis** (Fig. 206, 6) is a short thick trunk arising from the upper part of the anterior surface of the subclavian, close to the inner border of the scalenus anticus and external to the origin of the vertebral. It divides immediately into three branches, (*a*) inferior thyroid, (*b*) transversalis colli, and (*c*) supra-scapular or transversalis humeri.

a. The *Inferior Thyroid artery* (2) runs first upwards and inwards

Fig. 207.

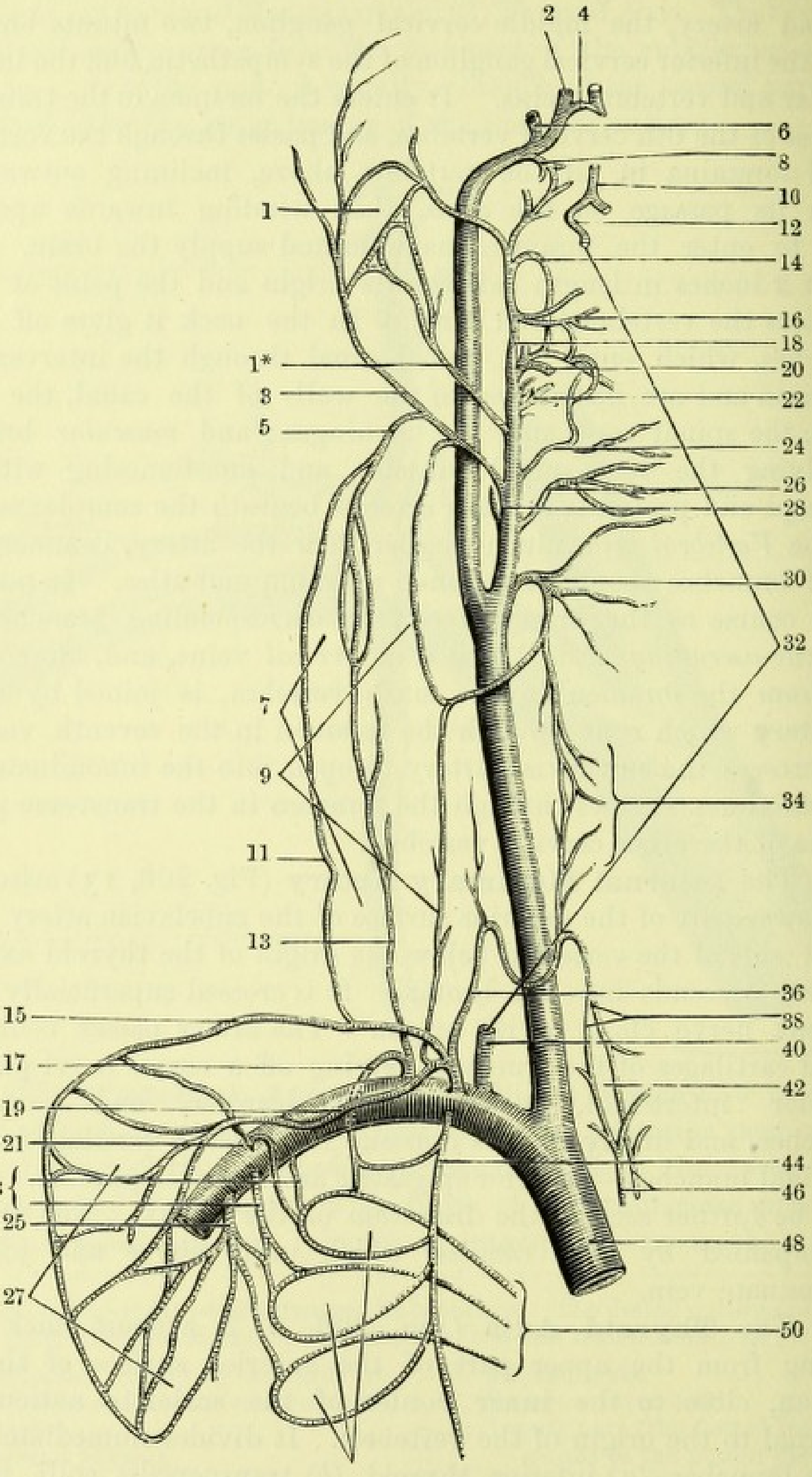


Fig. 207.—Scheme of the principal anastomoses of the subclavian and carotid arteries (W. A.).

across the vertebral artery and behind the carotid sheath and sympathetic trunk. It curves inwards and downwards opposite the transverse process of the 6th cervical vertebra, then descends as far as the lower border of the thyroid body, and after passing inwards behind the recurrent laryngeal nerve (an important surgical relation) it turns upwards, forming a second curve, and breaks up into branches which supply the thyroid body and anastomose with the superior thyroid artery (Fig. 211). Besides *œsophageal*, *tracheal*, and a small *inferior laryngeal* branch, it usually gives off close to its origin, the *ascending cervical*, which runs upwards in front of the anterior tubercles of the transverse processes of the vertebræ between the attachments of the scalenus anticus and rectus capitis anticus major, supplying the prevertebral muscles and anastomosing with branches of the vertebral artery. The middle cervical ganglion usually rests upon its first curve. The walls of this artery are said to be very thin and lacerable.

The *Inferior Thyroid veins* pass down in front of the trachea, after forming a plexus below the isthmus of the thyroid body. They open into the innominate veins; the right often crossing obliquely over the innominate artery to end in the left innominate, or, less frequently, in the right innominate.

b. The *Transverse Cervical artery* runs transversely outward in front of the scalenus anticus and phrenic nerve, and has been seen, in the posterior triangle of the neck, to divide into superficial cervical and posterior scapular branches (when the latter does not arise from the third part of the subclavian). The *Transverse Cervical vein* opens into the external jugular.

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1. Auricular anastomosis.
1* Posterior auricular.
2. Anterior cerebral.
3. Occipital.
4. Anterior communicating.
5. Princeps cervicis.
6. Middle cerebral.
7. Posterior cervical anastomosis.
8. Ophthalmic.
9. Sterno-mastoid anastomosis.
10. Basilar.
11. Superficial cervical.
12. Termination of vertebral.
13. Deep cervical.
14. Middle temporal.
15. Posterior scapular.
16. Transverse fascial.
17. Superior intercostal.
18. Temporal.
19. Supra-scapular.
20. Internal maxillary.
21. Acromio-thoracic.
22. Parotid and masseteric.
23. Thoracic.
24. Facial.
25. Subscapular.
26. Lingual.
27. Scapular anastomosis.
28. Ascending pharyngeal.
29. Intercostal anastomosis.
30. Superior thyroid.
32. Vertebral.
34. Thyroid anastomoses.
36. Inferior thyroid.
38. Tracheal and œsophageal.
40. Origin of vertebral.
42. Tracheal and œsophageal anastomoses.
44. Internal mammary.
46. Tracheal and œsophageal branches of aorta.
48. Innominate.
50. Aortic intercostals.

The artery is frequently of small size or altogether wanting, as the posterior scapular or the transverse cervical itself may arise from the third, or sometimes the second, part of the subclavian.

c. The *Supra-scapular artery* runs outward in front of the scalenus anticus, the phrenic nerve, and the third portion of the subclavian artery, immediately behind the clavicle, and has been seen in the posterior triangle of the neck. It gives off *sterno-mastoid*, *supra-sternal*, *clavicular* and *supra-acromial* branches in the neck, and a small *subscapular* branch at the upper border of the scapula ; and passes over the transverse ligament of the scapula to supply the supra and infra-spinous fossæ (p. 42). The *Supra-scapular vein* opens into the external jugular.

The **Second Part of the Subclavian Artery** (Fig. 208, 27) is placed behind the scalenus anticus, and has the same relations on both sides of the body. It is related *in front* to the platysma, the cervical fascia, the clavicular origin of the sterno-mastoid, and the scalenus anticus, and *behind* to the apex of the pleura, the scalenus medius, and the ascending part of the first dorsal nerve. *Above* it are the cords of the brachial plexus, and *below* is a small portion of the inner border of the first rib.* The *subclavian vein* is below the level of the artery at this point, and separated from it by the scalenus anticus. The only branch of the second part of the subclavian artery is the *superior intercostal* artery on the right side, the left artery usually arising on the inner side of the anterior scalenus.

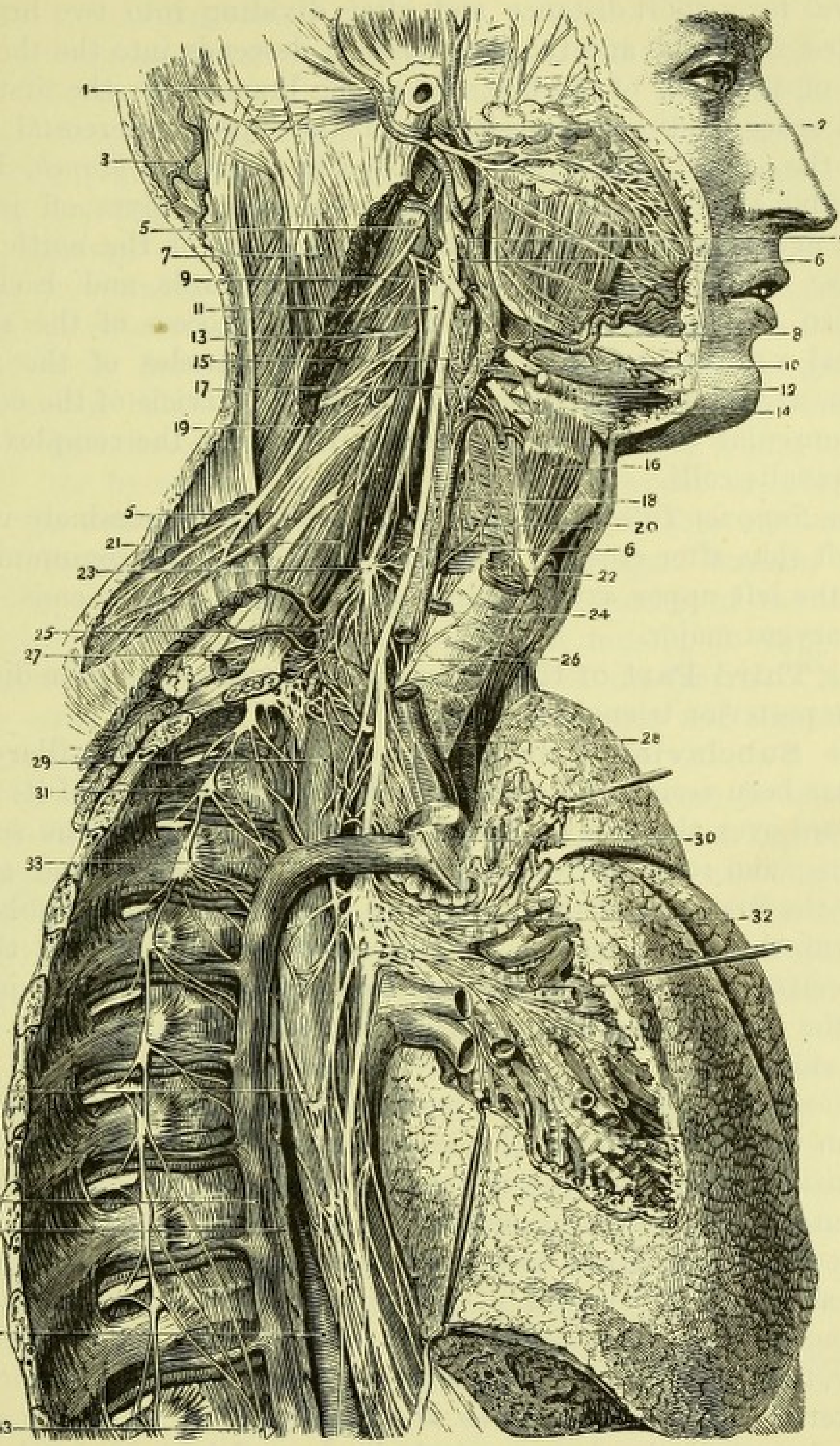
The **Superior Intercostal Artery** (Fig. 206, 7) springs from the posterior part of the superior border of the subclavian about a

Fig. 208.—Distribution of the ninth, tenth and eleventh nerves of the right side (from Hirschfeld and Leveillé).

1. Posterior auricular artery.
2. Temporal artery.
3. Occipital artery.
4. Glosso-pharyngeal nerve.
5, 5. Spinal-accessory nerve.
6, 6. Pneumo-gastric nerve.
7. Sterno-mastoid (cut).
8. Facial artery.
9. Hypoglossal nerve with communication from 2nd cervical nerve.
10. Lower end of ditto.
11. Superior cervical ganglion of sympathetic.
12. Digastricus.
13. Third cervical nerve.
14. Superior laryngeal nerve.
15. Internal carotid.
16. Thyro-hyoideus.
17. External carotid.
18. Common carotid.
19. Fourth cervical nerve.
20. Inferior constrictor of pharynx.
21. Phrenic nerve on scalenus anticus.
22. Crico-thyroideus.
23. Middle cervical ganglion.
24. Trachea.
25. Thyroid axis.
26. Recurrent laryngeal nerve.
27. Subclavian artery.
28. Innominate artery.

* The phrenic nerve is commonly given as one of the anterior relations of this part of the artery, but it reaches the inner border of the scalenus above the vessel, and crosses the first part of the subclavian.

Fig. 208



29. Œsophagus.
30. Vena cava superior (cut).
31. Gangliated cord of sympathetic.
32. Posterior pulmonary plexus.
33. Phrenic nerve (cut).
35. Œsophageal plexus.
37. Vena azygos major.
39. Thoracic duct.
41. Thoracic aorta.
43. Great splanchnic nerve.

third of an inch external to the origin of the vertebral. It runs *upwards* for a short distance and after dividing into two branches, the *first intercostal* and the *deep cervical*, descends into the thorax in front of the neck of the first rib, giving branches to the first intercostal space, and anastomosing with the upper intercostal artery from the aorta in the second space. The *intercostal branch*, besides supplying the first and second intercostal spaces, gives off *posterior spinal* and *muscular branches* after the manner of the aortic intercostals. The *deep cervical branch* passes upwards and backwards between the first rib and the transverse process of the seventh cervical vertebra, to be distributed to the muscles of the nuchal region, and to anastomose with the princeps cervicis of the occipital and muscular branches of the vertebral between the complexus and semispinalis colli.

The *Superior Intercostal Vein* opens into the innominate vein on the left side, after crossing the arch of the aorta and communicating with the left upper azygos vein; on the right side it ends in the vena azygos major.

The **Third Part of the Subclavian Artery** has been dissected in the posterior triangle of the neck (p. 417).

The **Subclavian Vein** is the continuation of the axillary vein, and has been seen to lie anterior to but below the level of its artery. It passes over the groove on the first rib in front of the scalenus anticus; and runs in front of the apex of the pleura and a little below the first part of the artery, and joins the internal jugular vein to form the innominate. The thoracic duct opens into the left subclavian vein close to its junction with the internal jugular, and the right lymphatic trunk occupies a similar position on the right side.

Tributaries.—The *external jugular* vein terminates in the subclavian on the outer side of the scalenus anticus, and the *cephalic* vein usually joins it while it lies upon the first rib. The vertebral and anterior jugular occasionally open into it.

The **Thoracic Duct** may be seen, on careful dissection, rising as high as the lower border of the seventh cervical vertebra, then crossing behind the carotid sheath and in front of the vertebral artery, the first stage of the subclavian artery, and the phrenic nerve to enter the subclavian vein as above stated. It is closely related to the lowest of the deep cervical glands, and is endangered during the operation for the removal of these. It is sometimes double. It conveys the whole of the lymph of the body, with the exception of that passing through the right trunk. The **Right Lymphatic Trunk** drains the right side of the head, neck, and chest, the right pleura and lung, and the right side of the heart ; and terminates in the right subclavian vein.

The **Pneumo-gastric Nerve** (Figs. 208 & 209) (10th nerve) is only seen in its cervical portion at present. It is enclosed in a separate compartment of the carotid sheath, lying between and behind the jugular vein and common carotid artery, and enters the superior aperture of the thorax on the inner side of the phrenic nerve, passing, on the right side, between the subclavian artery and the innominate vein, and on the left side between the common carotid and subclavian arteries, and behind the innominate vein.

Its *Superior Laryngeal* branch (14 & 9) springs from the ganglion of the trunk below the jugular foramen, and running forwards beneath the internal jugular vein and internal carotid artery, appears opposite the hyoid bone, and pierces the thyro-hyoid membrane to supply the mucous membrane of the larynx. Before entering the larynx the nerve gives a small *external laryngeal* branch, which runs obliquely downwards, along the upper border of the inferior constrictor and beneath the sterno-thyroid muscle, to supply the crico-thyroid, one of the intrinsic muscles of the larynx. It gives off also some filaments to the inferior constrictor and sometimes a small cardiac branch.

The *Recurrent Laryngeal Nerve* (26 & 21) (inferior) is seen running upwards along the side of the trachea, between this and the œsophagus, and after passing under cover of the lateral lobe of the thyroid body, disappears beneath the lower border of the inferior constrictor. It lies superficial to the ligamentous band which fixes the lateral lobe of the thyroid body to the upper tracheal rings before passing beneath the constrictor, and it is here that it might be wounded during ablation of the body unless care is exercised (Fig. 211). Its *course* differs on the two sides of the body ; on the right it arises from the pneumo-gastric in the neck, in front of the subclavian artery, and winds below and then behind the vessel ; on the left it arises in the thorax, and turns in like manner round the arch of the aorta external to the ductus arteriosus. It gives off cardiac, tracheal, and œsophageal branches and twigs to the inferior constrictor, and supplies all the intrinsic muscles of the larynx except the crico-thyroid. It communicates by a small filament with the superior laryngeal.

The *Cardiac* (17) branches of the pneumo-gastric are *superior*, given off high in the upper part of the neck, and joining the sympathetic ; and *inferior*, arising a little above the upper opening of the thorax, through which they pass to join the cardiac plexuses.

The *Pharyngeal* branch and some small *communicating* branches arising at the upper part of the nerve are not yet visible.

Fig. 209.

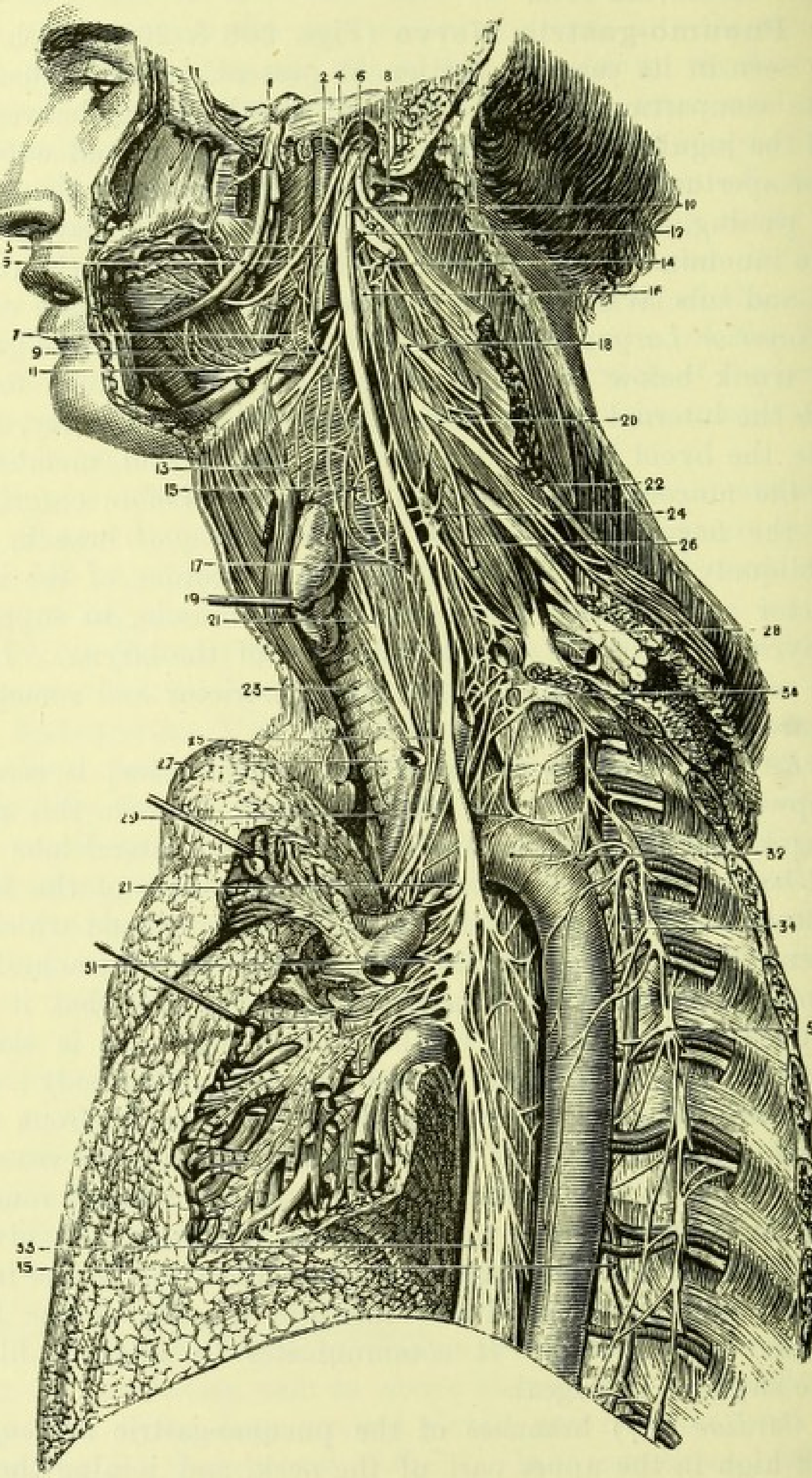


Fig. 209.—Distribution of the ninth, tenth and eleventh nerves on the left side (from Hirschfeld and Leveillé).

1. Gasserian ganglion of 5th nerve. 2. Internal carotid artery.

The **Hypoglossal Nerve** (Fig. 208, 9) (12th nerve) after *communicating* with the first cervical nerve and superior cervical ganglion appears below the posterior belly of the digastric muscle, hooking round the sterno-mastoid artery, and curving forward superficially to the great vessels. It afterwards passes beneath the stylo-hyoid and posterior belly of the digastricus close to the hyoid bone, and is then seen in the angle between the two bellies of the digastric muscle, lying upon the hyo-glossus below the lingual branch of the fifth; finally disappearing beneath the posterior border of the mylo-hyoid muscle to supply the muscles of the tongue (Fig. 209, 11).

Its *descending branch* (ramus descendens cervicis) arises opposite the occipital artery, and runs downward and forward either upon or within the carotid sheath, to supply the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, and to form a loop (*ansa hypoglossi*) with one or more branches from the 2nd and 3rd nerves of the cervical plexus, the *communicantes cervicis* (Fig. 204, 7).

The *nerve to the thyro-hyoid muscle* is a very delicate branch given off from the 12th nerve just before it passes beneath the digastric. This and the last as well as the branch to the genio-hyoid are to be traced to the communication from the 1st cervical nerve.

The **Sympathetic** (Figs. 208 & 209) in the neck lies behind the carotid sheath upon the prevertebral muscles. It is a slender greyish cord bearing three cervical ganglia, of which only one can now be seen.

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3. Pharyngeal branch of pneumogastric.
4. Glosso-pharyngeal nerve.
5. Lingual nerve.
6. Spinal-accessory nerve.
7. Middle constrictor of pharynx.
8. Internal jugular vein (cut).
9. Superior laryngeal nerve.
10. Ganglion of trunk of pneumogastric nerve.
11. Hypoglossal nerve on hyo-glossus.
12. Ditto communicating with spinal-accessory and first cervical nerve.
13. External laryngeal nerve.
14. Second cervical nerve looping with first.
15. Pharyngeal plexus on inferior constrictor.
16. Superior cervical ganglion of sympathetic.
17. Superior cardiac nerve of pneumogastric.
18. Third cervical nerve.
19. Thyroid body.
20. Fourth cervical nerve.
21, 21. Left recurrent laryngeal nerve.
22. Spinal-accessory communicating with cervical nerves.
23. Trachea.
24. Middle cervical ganglion of sympathetic.
25. Inferior cardiac nerve of pneumogastric.
26. Phrenic nerve (cut).
27. Left carotid artery.
28. Brachial plexus.
29. Phrenic nerve (cut).
30. Inferior cervical ganglion of sympathetic.
31. Pulmonary plexus of pneumogastric.
32. Thoracic aorta.
33. Œsophageal plexus.
34. Vena azygos superior.
35. Vena azygos minor.
36. Gangliated cord of sympathetic.

The *middle cervical* or *thyroid ganglion* (23 & 24), small and often scarcely distinguishable, lies opposite the 6th cervical vertebra, and usually over the first loop of the inferior thyroid artery. From this ganglion branches of *communication* go to the fifth and sixth cervical nerves; *thyroid* branches are distributed upon the inferior thyroid artery; and the *middle cardiac nerve* (the deep or great cardiac nerve) passes into the thorax, communicating with the recurrent laryngeal nerve to form the *ansa Vieussenii* (Fig. 210).

The **Spinal Accessory Nerve** (Fig. 208, 5) (11th nerve) after passing generally superficial to, sometimes beneath the internal jugular vein, appears below the digastric muscle and crosses over or just below the extremity of the transverse process of the atlas. It pierces the deep surface of the sterno-mastoid muscle, giving branches to it, and then crosses the posterior triangle, running upon the levator anguli scapulæ to reach the trapezius, which it supplies. In the sterno-mastoid it communicates with the nerve from the cervical plexus to that muscle, and in the posterior triangle and trapezius it is joined by branches from the third and fourth cervical nerves.

The **Cervical Plexus** (Fig. 204) is formed by the anterior branches of the four upper cervical nerves, but the loop from the 1st nerve to the 2nd is of very small size, and cannot be well seen in this stage of the dissection. The 2nd, 3rd, and 4th nerves appear between the rectus capitis anticus major and the middle scalenus, lying beneath the sterno-mastoid. Each of these nerves communicates with the one above and below it, and gives off superficial and deep cervical branches. The superficial branches of the cervical plexus have been already dissected in the posterior triangle, and can now be traced to their sources,—the great auricular, small occipital, and superficial cervical branches to the 2nd and 3rd nerves, and the descending branches to the 3rd and 4th nerves.

The deep branches of the cervical plexus are—

1. *Communicating* branches with the 9th, 10th, and 12th cranial nerves and the sympathetic. These will afterwards be dissected.

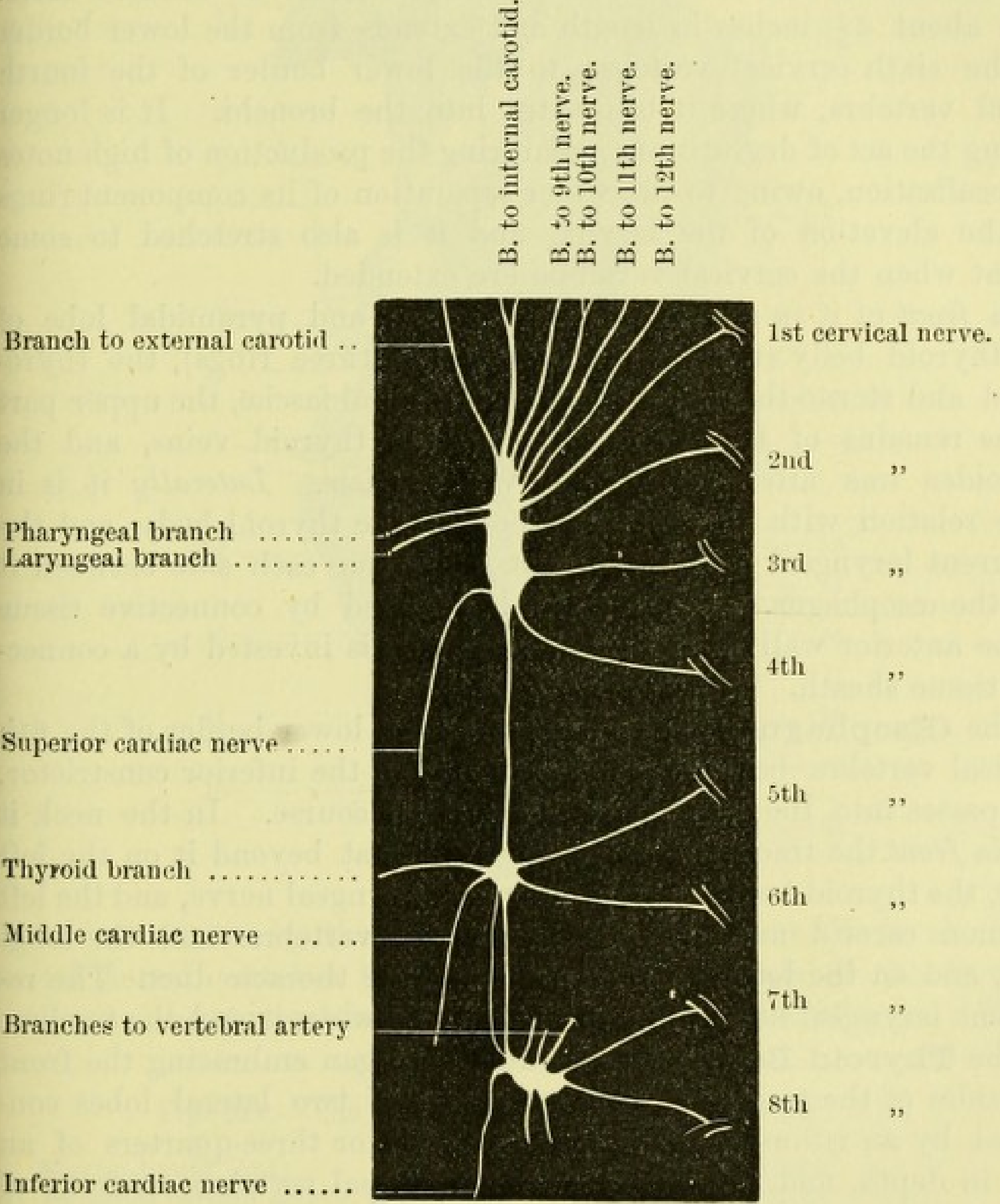
2. *Muscular branches*, passing forwards to the rectus capitis anticus major, rectus minor, and rectus lateralis (from the 1st); others are directed backwards, and go to the sterno-mastoid (2nd), levator anguli scapulæ (3rd), trapezius (4th), and scalenus medius (3rd and 4th). Those to the sterno-mastoid and the trapezius communicate with the spinal accessory nerve.

3. The *Communicantes Cervicis* (7), usually consisting of two

branches from the 2nd and 3rd nerves. They join the descendens cervicis branch of the hypoglossal to form the ansa hypoglossi, and supply a branch to the posterior belly of the omo-hyoid.

4. The *Phrenic nerve* (11) arising from the 4th nerve (or from

Fig. 210.



the 3rd and 4th) receives a branch of communication from the 5th, and runs downwards upon the scalenus anticus, getting to its inner border at the lower part of the neck. It then crosses in front of the

Fig. 210.—Diagram of the superior, middle, and inferior cervical ganglia of the sympathetic (drawn by J. T. Gray).

first stage of the subclavian artery and the root of the internal mammary artery and behind the innominate vein, to enter the thorax. It communicates here with the sympathetic, and also, frequently, with the nerve to the subclavius from the brachial plexus, and will subsequently be traced to the diaphragm in the dissection of the thorax.

The **Trachea** is now sufficiently exposed for the examination of its relations in the neck, but its structure must be studied later. It is about $4\frac{1}{2}$ inches in length and extends from the lower border of the sixth cervical vertebra to the lower border of the fourth dorsal vertebra, where it bifurcates into the bronchi. It is longer during the act of deglutition, and during the production of high notes in vocalisation, owing to the wider separation of its component rings by the elevation of the larynx, and it is also stretched to some extent when the cervical vertebræ are extended.

In *front* of it *in the neck* lie the isthmus and pyramidal lobe of the thyroid body (usually over the upper three rings), the thyrohyoid and sterno-thyroid muscles, the cervical fasciæ, the upper part of the remains of the thymus, the inferior thyroid veins, and the thyroidea ima artery when this vessel exists. *Laterally* it is in close relation with the lateral lobes of the thyroid body, and the recurrent laryngeal nerves run in a groove on each side between it and the œsophagus. *Posteriorly* it is attached by connective tissue to the anterior wall of the œsophagus. It is invested by a connective tissue sheath.

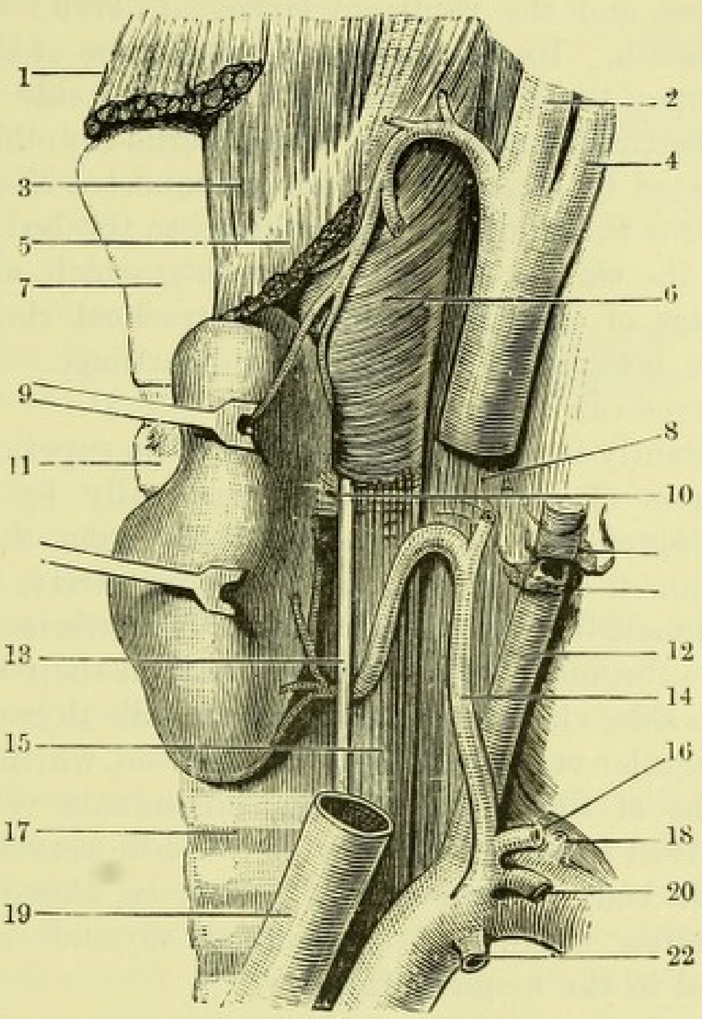
The **Œsophagus** also commences at the lower border of the 6th cervical vertebra below the lower border of the inferior constrictor, and passes into the chest after a very short course. In the neck it has *in front* the trachea (projecting somewhat beyond it on the left side), the thyroid body, the left recurrent laryngeal nerve, and the left common carotid artery. *Behind* are the vertebræ and the longi colli, and on the left side is, in addition, the thoracic duct. The recurrent laryngeal nerve runs in a groove between it and the trachea.

The **Thyroid Body** is a solid ductless organ embracing the front and sides of the trachea. It is composed of two lateral lobes connected by an isthmus. The *isthmus* is half or three-quarters of an inch in depth, and lies opposite the first dorsal vertebra, in front of the second and third tracheal rings and behind the sterno-hyoid and sterno-thyroid muscles and anterior jugular veins. It is commonly crowned with a small process of glandular tissue called the *pyramidal lobe*,* which stretches upwards a little to the left of the middle line towards the hyoid bone; and it occasionally receives

* The pyramidal lobe probably represents the lower part of the thyro-glossal duct, a fœtal tube at one time opening at the foramen cœcum of the tongue.

a few muscular fibres passing to it from the hyoid bone, and known as the *levator glandulæ thyroideæ*. The *lateral lobes* are about two inches in length, somewhat conical in form, with their apices

Fig. 211.



upwards, and lie by the sides of the trachea from the level of the second dorsal vertebra to the lower part of the ala of the thyroid cartilage: they extend farther above than below the isthmus. Each

Fig. 211.—The thyroid body and its relations (W. A.).

1. Sterno-hyoid (cut).
2. External carotid artery, giving off its superior thyroid branch.
3. Thyro-hyoid.
4. Internal carotid artery.
5. Sterno-thyroid.
6. Inferior constrictor.
7. Thyroid cartilage.
8. Prevertebral aponeurosis.
9. Thyroid body drawn forwards.
10. Lateral ligament of thyroid body.
11. Cricoid cartilage.
12. Vertebral artery.
13. Recurrent laryngeal nerve.
14. Inferior thyroid artery.
15. Œsophagus.
16. Transversalis colli artery.
17. Trachea.
18. Superior intercostal artery.
19. Common carotid artery.
20. Supra-scapular artery.
22. Internal mammary artery.

lobe is in relation *anteriorly* with the sterno-hyoid, sterno-thyroid, omo-hyoid, and sterno-mastoid muscles, the anterior jugular vein, and the integument and fasciæ; *posteriorly* with the longus colli, and the common carotid (slightly), inferior thyroid, and vertebral arteries; *internally* with the lower part of the larynx and pharynx, the trachea and œsophagus, and the recurrent laryngeal nerve; *externally* with the carotid sheath. Its *base* approaches the dome of the pleura, and its *apex* lies upon the inferior constrictor by the side of the cricoid and thyroid cartilages under cover of the sterno-thyroid. The whole organ is invested by a capsule, which is connected above with a *suspensory ligament* running from the isthmus to the body of the hyoid bone, and at the sides with *lateral ligaments*, which are attached to the extremities of the first and second tracheal rings, and sometimes to the lower part of the thyroid cartilage. The recurrent laryngeal nerves run upon the latter.

It is abundantly supplied with blood by the superior and inferior thyroid arteries of each side, and occasionally by an additional branch, the *thyroidea ima*, which may come from the innominate, the right common carotid, the aorta, or more rarely, from the right internal mammary or right subclavian. The arteries freely anastomose in the substance of the body, and return their blood by three veins on each side, viz., the superior and middle thyroid, which join the internal jugular vein, and the inferior thyroid, which may be traced down the front of the trachea to the innominate vein. Its *nerve* supply is derived from the superior and middle cervical ganglia.

The thyroid body is composed of numerous closed vesicles containing a yellow fluid. Supplementary thyroids are not infrequently found in the neighbourhood.

The Face.

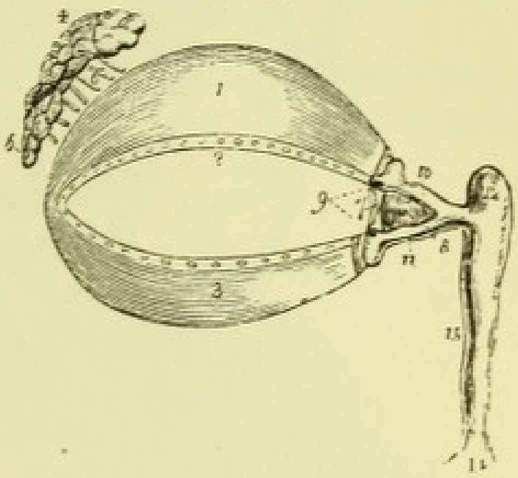
The face is a region in which it will be convenient to make different dissections on the two sides, *i.e.*, of the muscles and vessels on one, and of the nerves on the other; and the dissectors are therefore advised to adopt this method of proceeding.

Before commencing the dissection, the student should observe the external anatomy of the eye and its appendages, so that these may be seen in as natural a condition as possible (Fig. 212).

On the margin of the orbit is the *supercilium* or eyebrow, a ridge of thickened skin covered with hairs. The eyelids or *palpebræ* are two thin folds composed of a dense fibrous tissue (the so-called tarsal cartilage), and of muscle and fascia; covered externally by the skin, and lined internally by the conjunctiva palpebrarum continued from the surface of the eyeball. The points of junction of the two lids are called the inner and outer *canthi*, and along the free borders of the lids will be seen the *cilia* or eyelashes, which curve upwards from the upper, and downwards from the lower lid.

Before opening the lids they should be drawn forcibly outward towards the temple, in order to make tense and prominent the little *tendo oculi* or *internal palpebral ligament* by which their inner extremities are attached to the nasal process of the superior maxilla. A smaller and less distinct *external palpebral ligament* passes from the outer extremities to the frontal process of the malar bone, at the outer edge of the orbit.

Fig. 212.



The margins of the lids present the eyelashes and the orifices of the Meibomian glands, and are so bevelled that when they are closed, a canal, triangular in section, is left between them and the globe of the eye, and serves to convey the tears to the inner canthus.

The lids being separated, a small semilunar depression called the *lacus lacrymalis* will be seen at the inner canthus, and on the free margin of each lid close to this a little eminence (*papilla lacrymalis*) perforated by a minute hole, the *punctum lacrymale* (9). A small probe introduced vertically through the punctum may afterwards be made to pass horizontally along the *canaliculus* into the *lacrymal sac* (12). The *lacrymal sac*, situated in the groove in the lacrymal bone between the tendo oculi in front and the tensor tarsi muscle behind, is a delicate fibrous receptacle, wider above than

Fig. 212.—Appendages of the eye (from Wilson).

1. Superior tarsal body.
2. Lower border of the tarsal body, on which are seen the openings of the Meibomian glands.
3. Inferior tarsal body, along the upper border of this the openings of the Meibomian glands are likewise seen.
4. Lacrymal gland; its superior or orbital portion.
5. Inferior or palpebral portion.
6. Lacrymal ducts.
7. Plica semilunaris.
8. Caruncula lacrymalis.
9. Puncta lacrymalia of the lacrymal canals.
10. Superior lacrymal canal.
11. Inferior lacrymal canal.
12. Lacrymal sac.
14. Dilatation of the nasal duct, where it opens into the inferior meatus of the nose.
15. Nasal duct.

Fig. 213.

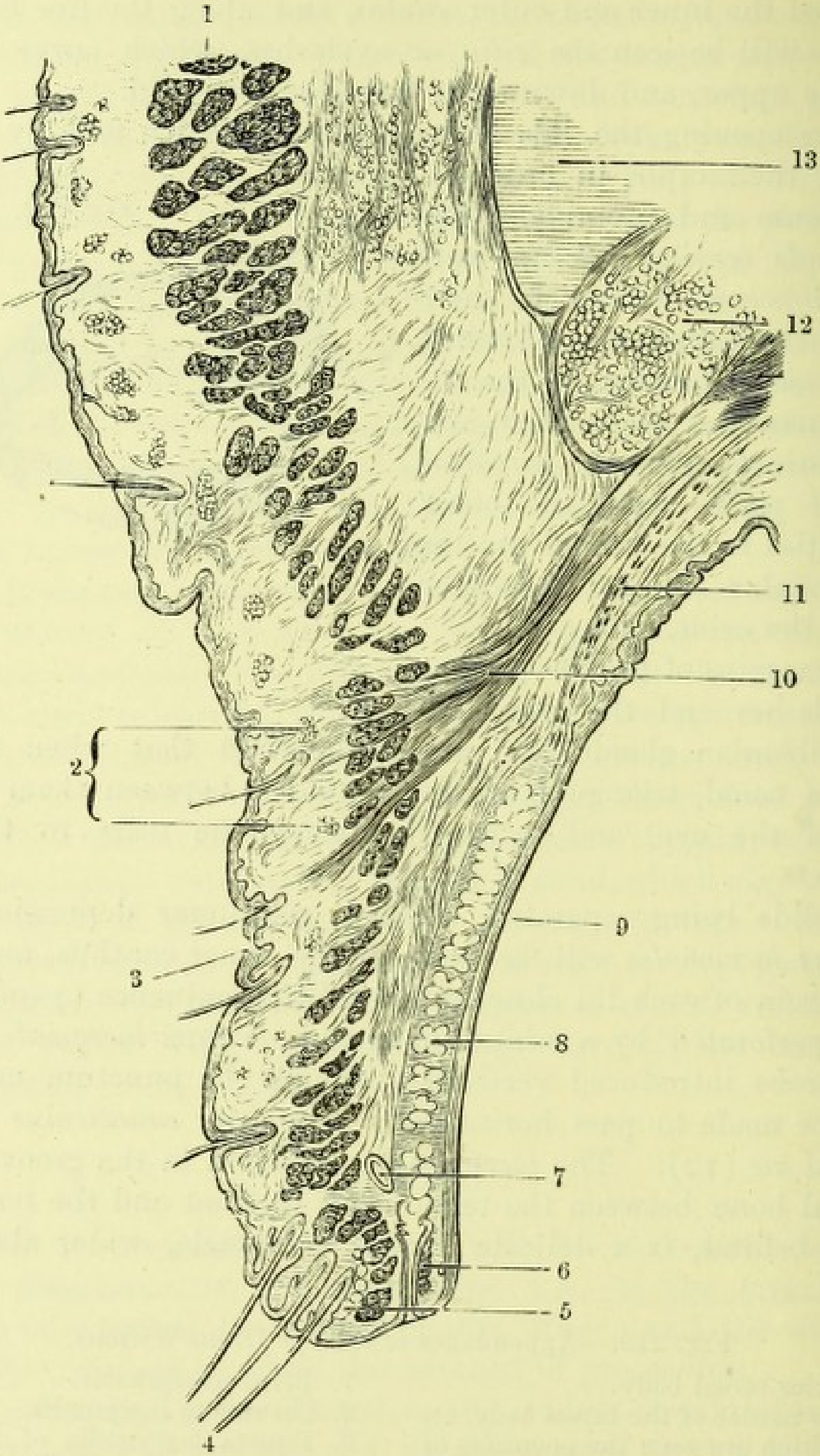


Fig. 213.—Section of upper eyelid (after Merkel).

1. Orbicularis palpebrarum.
2. Sudoriparous glands.
3. Skin.
4. Eyelashes.
5. Sebaceous glands of eyelash.
6. Ciliary muscle of Riolan.
7. Vein.
8. Meibomian glands.
9. Conjunctiva palpebræ.
10. Levator palpebræ. Fibres lost in integument.
11. Levator palpebræ.
12. Orbital fat.
13. Margin of orbit.

below, and continuous inferiorly with the nasal duct. It is lined with mucous membrane having a ciliated epithelium. The *canaliculi* may be opened up upon the probe with a fine-pointed pair of scissors, when a good-sized probe may be readily introduced into the sac, and pushed down into the nasal duct and inferior meatus of the nose. If the upper lid is everted over a probe, the conjunctival lining will be seen, with the subjacent *Meibomian glands* running to the free margin in parallel rows.

Within the lacus lacrymalis is a reddish body, the *caruncula lacrymalis* (8), containing modified sweat follicles and sebaceous glands and covered with a few small hairs. Externally to the caruncle is a minute semilunar fold of conjunctiva, called the *plica semilunaris* (7), the representative of the *membrana nictitans* of birds, crocodiles, and batrachia. The *conjunctiva palpebrarum* is reflected on to the eyeball, where it is loosely attached to the sclerotic, but becomes adherent at the margin of the cornea. Its epithelium is continuous with that of the cornea. If the conjunctiva is carefully divided over

Fig. 214.

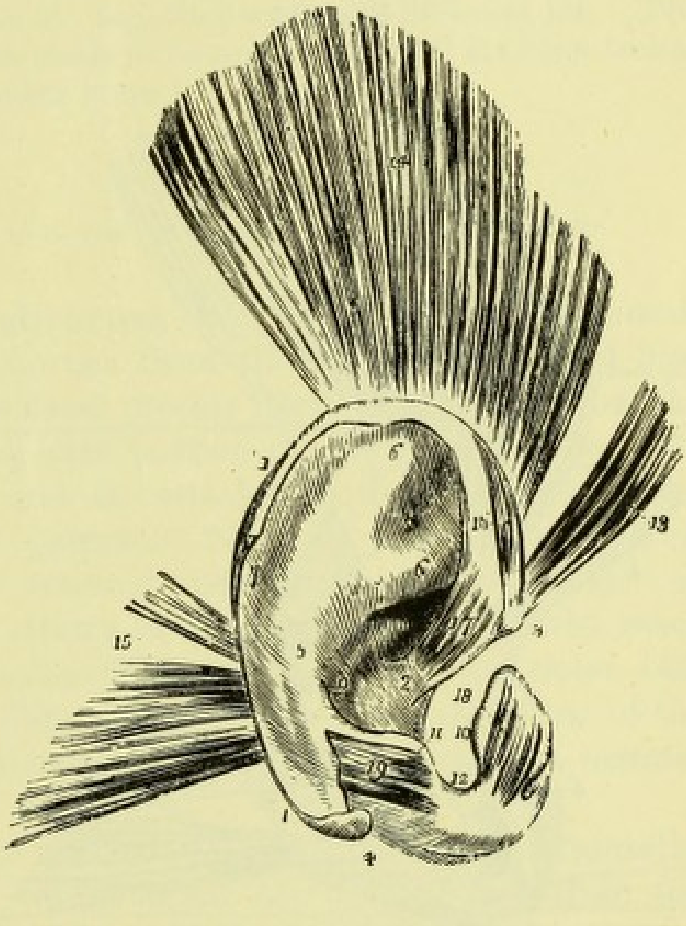


Fig. 214.—The pinna and its muscles (from Wilson, after Arnold).

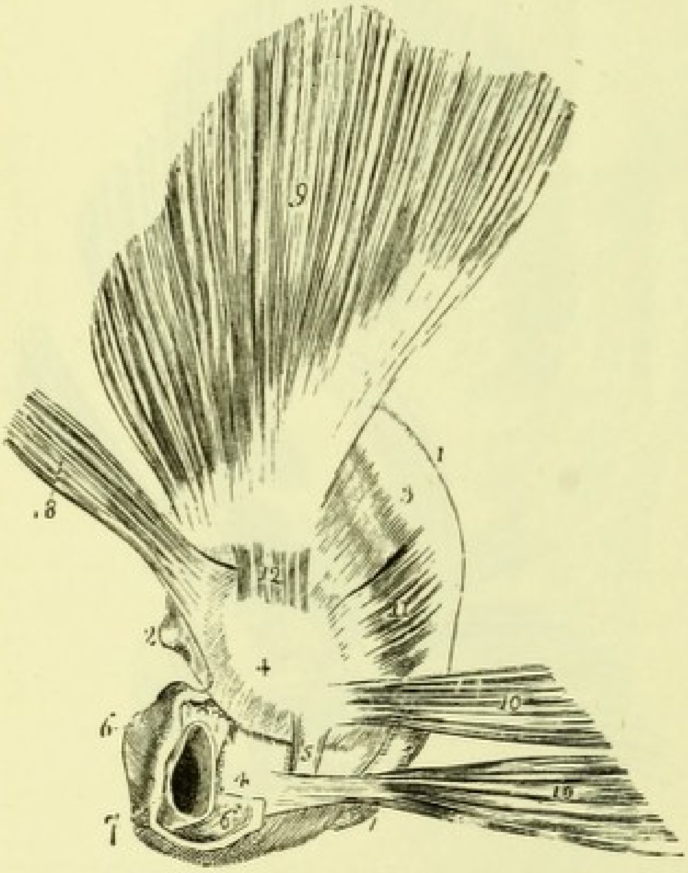
1, 1. Helix.
2. Crus helicis.
3. Spina helicis.
4. Processus caudatus helicis.
5. Antihelix.
6, 6. Crura antihelicis.
7. Fossa scaphoidea or fossa of the helix.
8. Fossa of the antihelix.
9. Concha.
10. Tragus.
11. Antitragus.
12. Incisura intertragica.
13. Attrahens auriculam.
14. Attollens auriculam.
15. Retrahens auriculam.
16. Major helicis muscle.
17. Minor helicis muscle.
18. Tragicus.
19. Antitragicus.

the sclerotic, the attachments of the muscles of the eyeball, and the anterior part of the capsule of Tenon may be seen.

The student should recognise with his finger the prominences of the nasal, malar, and maxillary bones, and the margin of the orbit. Opportunity should be taken also to examine the external ear, and, if possible, to see the membrana tympani with a speculum.

The **Pinna** (Fig. 214) is composed of fibro-cartilage covered with skin. Its outer rim is called the *helix* (1), and the forked elevation within it the *antihelix* (5); the groove between the two is the *fossa of the helix* (7), and the depression separating the two branches of the antihelix is the *fossa of the antihelix* (8). The deep cavity leading to the *meatus externus* is the *concha* (9), and the little nodule in front of it the *tragus* (10), the corresponding nodule behind being the *antitragus* (11). The lowest part of the ear is the *lobule*, which consists of fat-bearing connective tissue.

Fig. 215.



The extrinsic muscles of the auricle (anterior, superior and posterior) have been seen in the dissection of the scalp. Various small *intrinsic* muscles pass from one

Fig. 215.—The pinna and its muscles, as seen from behind (from Wilson, after Arnold).

1, 1. Border of the helix.
2. Spine of the helix.
3. Convexity corresponding with the fossa scaphoidea.
4, 4. Convexity of the concha; the fissure between the numbers corresponds with the crus helicis.
5. Ponticulus conchæ.
6, 6. Cartilage of the meatus.
7. Aperture of the meatus.
8. Attrahens auriculam.
9. Attollens auriculam.
10. Retrahens auriculam.
11. Transversus auriculæ.
12. Obliquus auriculæ.

point to another of the cartilage of the pinna, but these can be sufficiently seen in Figs. 214 and 215, and will not repay the trouble of dissection.

[The cheeks are now to be distended with cotton wool and the lips carefully sewn together. A little piece of wool may also be introduced beneath the eyelids with advantage. An incision is to be made from the temple in front of the ear, along the jaw to the chin (the scalp having been already dissected), and the skin is to be carefully reflected towards the median line. A cut around the orbit and mouth will avoid interference with the eyelids and lips. The position of the various muscles may be ascertained from the two following figures; they, as well as the vessels, are to be carefully preserved, but the small nerves are to be cut away, together with all the loose fat. The parotid gland in front of the ear is to be preserved, and its duct traced across the face below the malar bone.]

Muscles of the Face or Muscles of Expression.

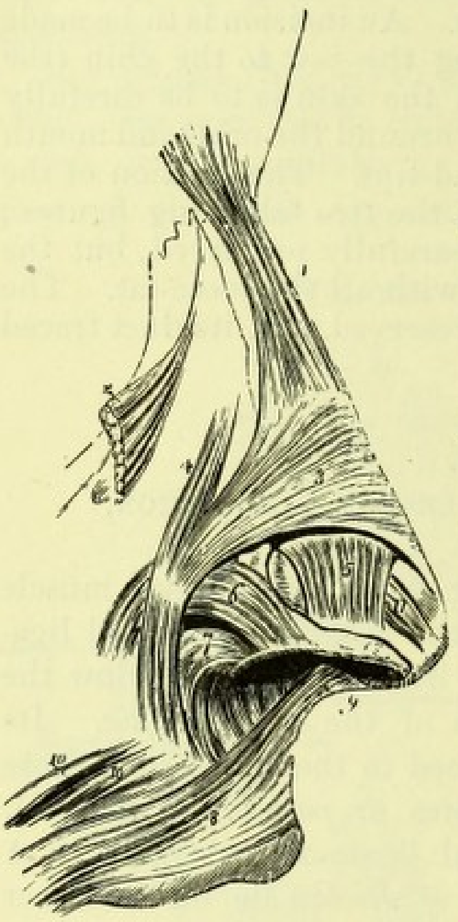
The **Orbicularis Palpebrarum** (Fig. 217, 4) is a broad muscle surrounding the orbit. It *arises* from the internal palpebral ligament (*v.* p. 467), from the nasal process itself above and below the ligament, and from the adjacent portion of the frontal bone. Its fibres surround the orbit and are attached to the skin; and those passing over the lids (the palpebral fibres or *palpebralis* muscle), are in part attached to the external tarsal ligament externally. A few fibres constituting the *ciliary bundle of Riolan* lie on the inner side of the bulbs of the lashes (Fig. 213, 6). On the outer side of the orbit the muscular fibres adhere to the frontal process of the malar bone and to the adjacent temporal fascia in such a manner as to represent an external attachment.

Accessory fibres join the orbicularis from the occipito-frontalis, and two slips (m. malaris) are given off one on each side from the lower border of the muscle to the integument of the cheek.

The orbicularis palpebrarum is the muscle which closes the eyelids, and is therefore the direct antagonist of the levator palpebræ. Its orbital fibres wrinkle the skin around the lids. The upper half of the muscle is capable of acting independently of the lower half. Its power of compressing the globe is serviceable in violent weeping or in other conditions in which the ocular vessels are distended with blood.

The **Corrugator Supercilii** will be seen by removing the portion of the orbicularis covering the brow. It *arises* from the inner part of the superciliary ridge, and running upwards and outwards is *inserted* into the orbicularis about the centre of the eyebrow, some fibres reaching the deep surface of the integument. It draws the eyebrow downwards and inwards and produces vertical wrinkles (as in frowning) in the middle of the brow.

Fig. 216.



The **Pyramidalis Nasi** (Fig. 216, 1) is a small slip of muscle lying along the nasal bone, continuous with the occipito-frontalis above, and joining the tendon of the compressor naris below. Taking its fixed point from below, it draws down the integument over the root of the nose, producing central transverse wrinkles. Acting from above it probably aids the action of the compressor naris upon the nostril.

The **Levator Labii Superioris Alæque Nasi** (Fig. 217, 8) *arises* from the upper part of the nasal process of the superior maxilla close to the margin of the orbit; it widens as it descends, and divides into two slips, which are *inserted* into the deep surface of the upper part of the curved integumental furrow bounding the ala of the nose, and into the upper lip, where it is attached to the skin and blends with the orbicularis and levator labii superioris. The action of the muscle is expressed by its name.

The **Compressor Naris** (Fig. 216, 3) is to be traced beneath

Fig. 216.—Muscles of the nose (from Wilson, after Arnold).

1. Pyramidalis nasi.
2. Upper part of the levator labii superioris alæque nasi, turned aside.
3. Compressor naris.
4. An anomalous slip.
5. Levator proprius alæ nasi anterior.
6. Levator proprius alæ nasi posterior.
7. Part of the depressor alæ nasi.
8. Upper segment of the orbicularis oris.
9. Naso-labialis.
10, 10. Fasciculi accessorii of the orbicularis.
11. A small muscle termed by Arnold compressor narium minor; it extends between the end of the nose and the alar cartilage. Its existence is doubtful.

the preceding muscle to its attachment into the deep circular fold of integument separating the nostril from the side of the nose, and many anatomists describe an origin from the canine fossa of the superior maxilla. The muscle is triangular in shape, and passes forwards, spreading in a fan-like manner to join the pyramidalis above and unite with its fellow in an aponeurosis over the middle line of the nose. It is intimately connected with the skin, but glides over the superior lateral cartilages. It is probably a dilator of the nostril.

The **Depressor Alæ Nasi** (Fig. 216, 7) is a small muscle, which should be exposed by everting the lip (at a later stage) and removing the mucous membrane. It *arises* from the myrtiform fossa over the incisor teeth of the upper jaw, and is *inserted* into the posterior part of the columna and the ala of the nose. It contracts the aperture of the nostril.

Fig. 217.

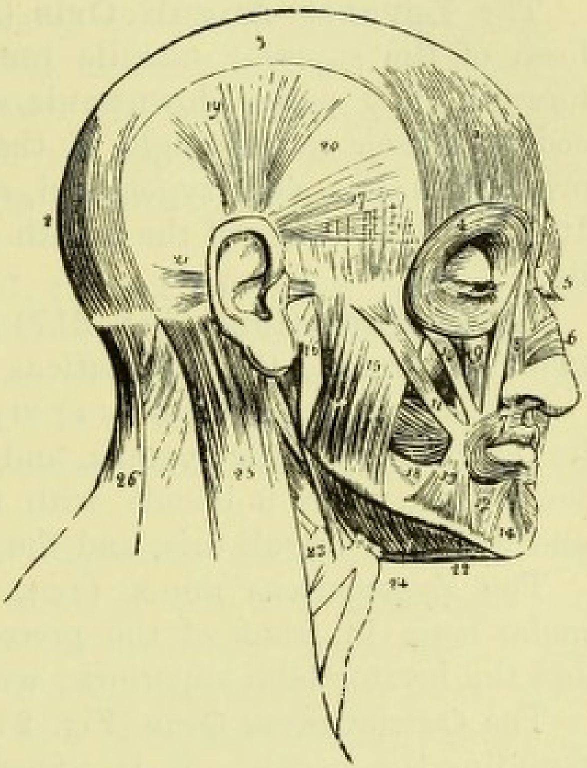


Fig. 217.—Muscles of the head and face (from Wilson).

1. Frontal portion of the occipito-frontalis.
2. Its occipital portion.
3. Its aponeurosis.
4. Orbicularis palpebrarum, which conceals the corrugator supercilii and tensor tarsi.
5. Pyramidalis nasi.
6. Compressor naris.
7. Orbicularis oris.
8. Levator labii superioris alæque nasi; the adjoining fasciculus between figures 8 and 9 is the labial portion of the muscle.
9. Levator labii superioris proprius: the lower part of the levator anguli oris is seen between the muscles 10 and 11.
10. Zygomaticus minor.
11. Zygomaticus major.
12. Depressor labii inferioris.
13. Depressor anguli oris.
14. Levator menti.
15. Superficial portion of the masseter.
16. Part of its deep portion.
17. Attrahens auriculam.
18. Buccinator.
19. Attollens auriculam.
20. Temporal fascia covering the temporal muscle.
21. Retrahens auriculam.
22. Anterior belly of the digastric.
23. Stylo-hyoid pierced by posterior belly of the digastric.
24. Mylo-hyoid.
25. Sterno-mastoid.
26. Trapezius.

The **Levator Labii Superioris Proprius** (Fig. 217, 9) *arises* from the superior maxilla and margin of the malar bone above the infra-orbital foramen, and is *inserted* into the upper lip, blending with the outer side of the levator labii superioris alæque nasi, and its innermost fibres may be traced beneath this muscle to the back of the wing of the nose. Its *action* is similar to that of the levator labii superioris alæque nasi.

The **Levator Anguli Oris** (Fig. 217) *arises* from the canine fossa of the superior maxilla immediately below the infra-orbital foramen, and passes downwards and outwards beneath the preceding muscle to the angle of the mouth, joining the fibres of the orbicularis oris and zygomatici, some passing into the lower lip. It raises the corner of the mouth and assists in elevating the lower lip.

The **Zygomaticus** (Fig. 217) is either a single muscle, or has two slips forming the zygomaticus major and minor.

The Zygomaticus major (11) *arises* from the malar bone close to its junction with the zygoma, and passes obliquely to the angle of the mouth, where it blends with the orbicularis oris, the levator and depressor anguli oris, and the skin.

The Zygomaticus minor (10), much smaller, *arises* from the malar bone in front of the preceding, and is *inserted* between it and the levator labii superioris, with which it unites.

The **Orbicularis Oris** (Fig. 217, 7) is the sphincter muscle surrounding the mouth. It is joined by all the other muscles which are inserted into the lips: in fact, the fibres from the buccinator, risorius, levator anguli oris and depressor anguli oris, constitute the major part of the so-called 'orbicularis.' It is *attached* on each side to the septum of the nose by a small slip (naso-labialis) (Fig. 216, 9), and by two other accessory fasciculi to the superior maxilla close to the incisor tooth, and to the lower jaw close to the canine tooth. The true orbicular fibres are difficult to demonstrate. Its *action* is to pucker and protrude the lips as in whistling.

On the side of the jaw will be seen the insertion of the **Platysma Myoides,** continuous more or less with the orbicularis oris at the angle of the mouth, and with the muscles below the lip. Occasionally there is a strong skin muscle, probably an appendage to the platysma, passing transversely from the fascia over the masseter to the angle of the mouth, called the **Risorius Muscle of Santorini.** This draws outwards the corner of the mouth, and acting with its fellow compresses the lips.

The **Depressor Anguli Oris** (Fig. 217, 13) (triangularis menti) is a triangular muscle *arising* from the outer surface of the lower jaw, below and a little externally to the mental foramen, and *inserted* into the angle of the mouth, some fibres passing into the upper lip, and decussating with the levator anguli oris. It not only depresses the angle of the mouth, but draws the upper lip slightly downwards.

The **Depressor Labii Inferioris** (Fig. 217, 12) (quadratus menti) *arises* from the oblique line on the outer surface of the lower jaw, between the symphysis and the mental foramen. Its fibres run upwards and inwards to the lower lip, some crossing the middle line and decussating with those of the opposite muscle. A median triangular interval is left between the two over the chin. It is a depressor of the lower lip.

The **Levator Menti** (Fig. 217, 14) is a triangular muscle placed internally to the depressor of the lower lip, *arising* from the incisive fossa of the lower jaw and running downwards and forwards to be *inserted* into the skin of the chin. It is best dissected by everting the lower lip and removing the mucous membrane. It is an elevator of the chin and lower lip.

All the muscles of the face are *supplied* by the facial nerve. In health the muscles of the two sides of the face antagonise one another, and an equilibrium is unconsciously maintained; but should the nerve of one side be divided, or become paralysed from any cause, the balance of power will be destroyed, and the face is at once drawn to the healthy side by the preponderating muscles. The paralysed side is immovable, the eye remains open, the patient is unable to whistle, and food tends to accumulate in the cheek-pouch of the affected side on account of the paralysis of the buccinator.

The **Parotid Gland** is the largest of the salivary glands, and is placed in front of the ear. Its superficial part overlaps the masseter muscle, reaching as high as the zygoma and as far back as the mastoid process, and below, it is separated from the submaxillary gland by the stylo-maxillary ligament. An anterior lobe, more or less detached from the rest, lies upon the masseter and is known as the *socia parotidis*. The deep portion presents three processes; one occupies the posterior part of the glenoid fossa, the second accompanies the internal maxillary artery beneath the lower jaw, and the third passes backwards beneath the sterno-mastoid, and reaches the root of the styloid process and the deep vessels and nerves of the neck. The *duct of Stenson* (ductus Stenonis) is about 3 inches in length. It arises from the anterior part of the gland below the socia parotidis, and receiving a small duct from the latter passes transversely across the masseter, and turns sharply round in front of this muscle to open into the mouth through the buccinator muscle, opposite the second molar tooth of the upper jaw. Immediately below the duct is a large branch of the facial nerve, and above it the transverse facial artery. The gland is traversed by the external carotid artery, which gives off its two terminal branches (temporal and internal maxillary), as well as some parotid and masseteric twigs in its substance; by the transverse facial artery; by the temporo-maxillary vein; and by the pes anserinus of the facial nerve. The auriculo-temporal nerve lies between it and the bone, and a branch of the great auricular nerve (cervical plexus) supplies the skin over it. The structure of the parotid is that of a compound racemose gland, like other salivary glands.

It receives *arteries* from the temporal artery and external carotid,
Secretory and its special *nervous supply* from the auriculo-temporal and sympathetic, as well as from the facial and great auricular nerves.

The gland is covered by a *fascia*, the *parotideo-masseteric*, which joins in front of the masseter with the *bucco-pharyngeal* aponeurosis, an investment of the superior constrictor and buccinator.

[The remains of the platysma are to be removed to show the facial artery and vein in front of the masseter, and the artery is to be followed out to the inner angle of the eye, with as little injury to the muscles as possible.]

The **Facial Artery** (Fig. 218) [external carotid], the cervical portion of which has been already dissected (p. 449), appears on the face immediately in front of the masseter muscle, where it lies on the lower jaw anterior to the facial vein, and is crossed by the platysma. It then becomes very tortuous, and passes upwards and inwards beneath the zygomatici to the side of the nose, lying upon the buccinator, levator anguli oris, and the levator labii superioris muscles in its course. At the side of the nose it is crossed by the outer portion of the levator labii superioris alæque nasi, and reaches the angle of the orbit to anastomose with the nasal branch of the ophthalmic artery. This is therefore one of the points of communication between the external and internal carotid vessels. The branches of the facial anastomose at various points with those of the internal maxillary and the temporal.

Branches.—As the artery crosses the jaw it gives—

1. *Masseteric* branches, anastomosing with branches from the external carotid and internal maxillary.

2. The *Inferior Labial* (13) branch, which runs midway between

the chin and the mouth, passing transversely beneath the depressor anguli oris. It anastomoses with the submental and inferior coronary, and with its fellow of the opposite side.

Fig. 218.

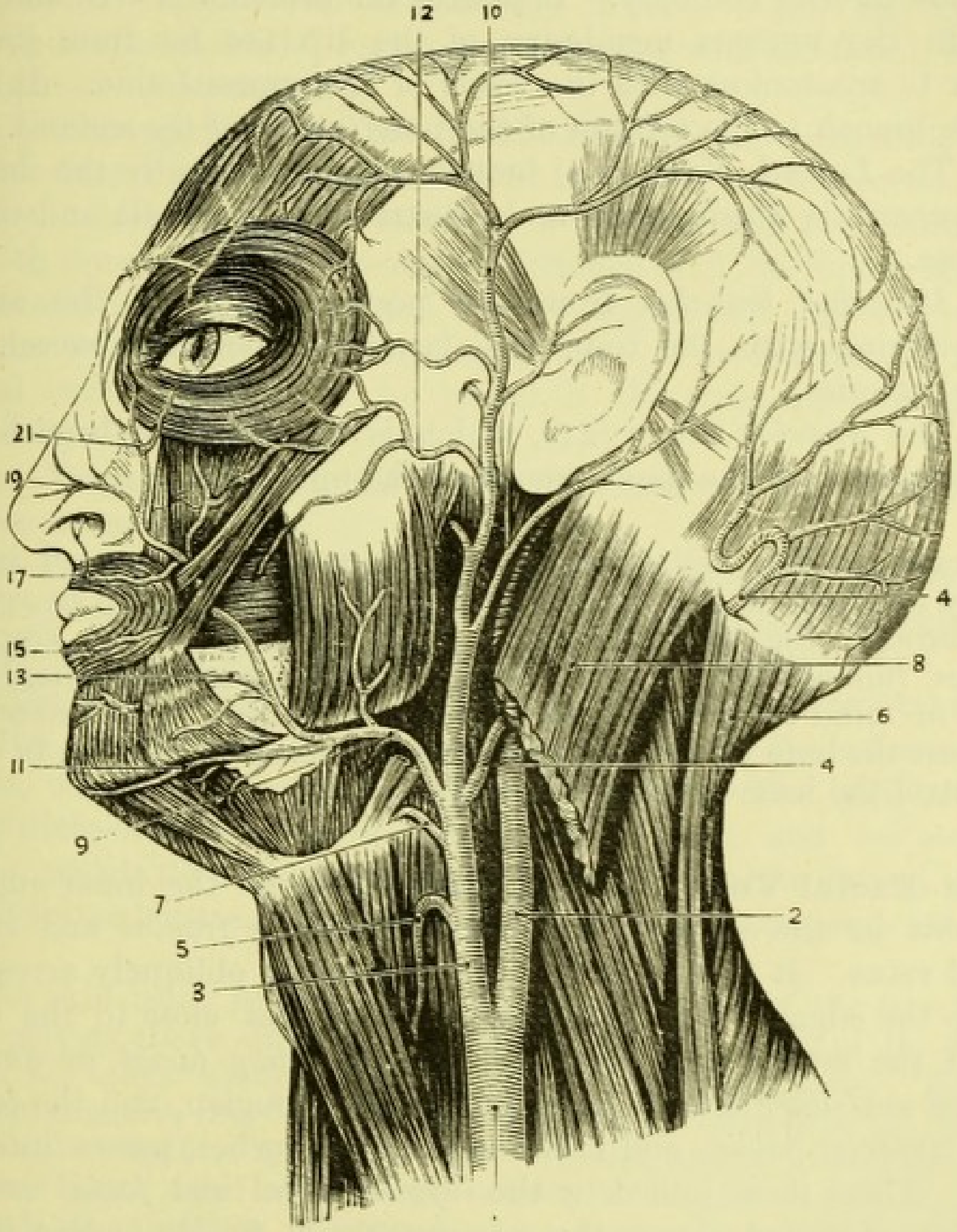


Fig. 218.—The arteries of the face and head (drawn by G. E. L. Pearse).

1. Common carotid.
2. Internal carotid.
3. External carotid.
4, 4. Occipital artery.
5. Superior thyroid artery.
6. Trapezius.
7. Lingual artery.
8. Sterno-mastoid.
9. Facial artery
10. Temporal artery, dividing into anterior and posterior branches.
11. Submental branch.
12. Transverse facial artery.
13. Inferior labial branch.
15. Inferior coronary branch.
17. Superior coronary branch.
19. Lateral nasal branch.
21. Angular branch.

3. The *Inferior Coronary* (15) branch, taking the same course as the preceding, but nearer the margin of the lip and close to the mucous membrane. It anastomoses with the inferior labial, and also with the vessel of the opposite side.

4. The *Superior Coronary* (17) branch, often arising in common with the inferior coronary. It pierces the orbicularis oris, and runs beneath the mucous membrane of the lip not far from its free border to anastomose with the vessel of the opposite side. It gives a little branch to the septum of the nose (*artery of the septum*).

5. The *Lateral Nasal* (19) branch, passing beneath the levator labii superioris alæque nasi to be distributed to the ala and side of the nose.

6. *Muscular branches* from the posterior side of the artery, anastomosing with the transverse facial, infra-orbital, buccal, and mental arteries.

7. The *Angular artery* (21), which is the terminal branch and anastomoses with the nasal branch of the ophthalmic.

Surgery.—The facial artery may be compressed or tied immediately in front of the masseter, where its pulsation can be readily felt through the thin platysma. The position of the coronary arteries immediately beneath the mucous membrane should be borne in mind in operating for hare-lip or cancer, as it is necessary to thrust the hare-lip pin deeply into the substance of the lip, in order to control the hæmorrhage effectually.

The **Facial Vein** (Fig. 201) commences at the inner angle of the orbit in the *angular* vein, formed by the *frontal* and *supra-orbital* veins. It then runs in a straight course obliquely across the face to the edge of the masseter, where it lies close to the outer side of the artery, and, after receiving the *deep facial* or *anterior internal maxillary* branch from the pterygoid region, and the *lateral nasal*, *superior labial*, and facial *muscular* branches, passes into the neck. There it is joined by the *inferior labial* and *facial communicating* veins and forms the *common facial*, finally ending in the internal jugular vein. It is crossed by the zygomatic muscles, but lies upon Stenson's duct, and in the neck is superficial to the submaxillary gland.

Its tributaries do not run with the arterial branches corresponding to them in name. The superior labial vein collects a number of small branches from the upper lip and runs upwards to join the main vein near the wing of the nose, the inferior labial in like manner runs obliquely downwards and enters the facial trunk below the jaw. The *deep facial* joins the vein while it is crossing the buccinator, and establishes a communication with the deep pterygoid plexus and through this with the cavernous sinus.

The **Transverse Facial Artery** (Fig. 218, 12) arises from the temporal artery in the parotid gland, and appears on the face above the parotid duct, to run transversely inwards below the zygoma towards the infra-orbital region, anastomosing with the facial, buccal, and infra-orbital arteries.

In a well-injected body the terminations of the infra-orbital and inferior dental arteries will be found emerging at the infra-orbital and mental foramina, with branches of the 2nd and 3rd divisions of the 5th nerve. The infra-orbital foramen will be found between the levator labii superioris and levator anguli oris, and the mental foramen beneath the depressor anguli oris. The frontal and supra-orbital arteries should also be traced, if the scalp has not already been fully dissected (*v.* p. 394).

The **Transverse Facial Vein** terminates in the temporal or temporo-maxillary vein.

The **Lymphatics** of the face (Fig. 185) cannot be demonstrated in the course of an ordinary dissection, but some small glands (*pre-auricular)* may be seen in the fascia covering the parotid gland. They drain the cheek and lateral frontal region, while the mid-frontal region and the greater part of the face are drained by the *sub-maxillary* glands, which lie beneath the angle of the jaw. The lymphatics of the parieto-occipital region end in the *mastoid* and *sub-occipital* glands, which lie a short distance below the superior curved line of the occipital bone and its continuation on to the temporal bone.

[The skin being removed from the opposite side of the face in the same way as above directed, a dissection is to be made of the nerves alone, all other tissues being sacrificed for that purpose. To find the facial nerve, the best way is to cut transversely into the parotid gland about half an inch below the zygoma, and to dissect carefully to some depth until some large branch of the nerve, which passes through its substance, is reached. One having been found, it is to be followed carefully backwards and forwards, when it will lead to other branches ; and the parotid gland is to be removed piecemeal to show the ramifications of the nerve, which are then to be traced as far as possible towards the median line.]

The **Facial** or **Seventh Nerve** (Fig. 219, 17) leaves the skull at the stylo-mastoid foramen, and gives off immediately the *posterior auricular*, *digastric*, and *stylo-hyoid* branches.

The *posterior auricular nerve* (13) winds below the meatus to

Fig. 219.

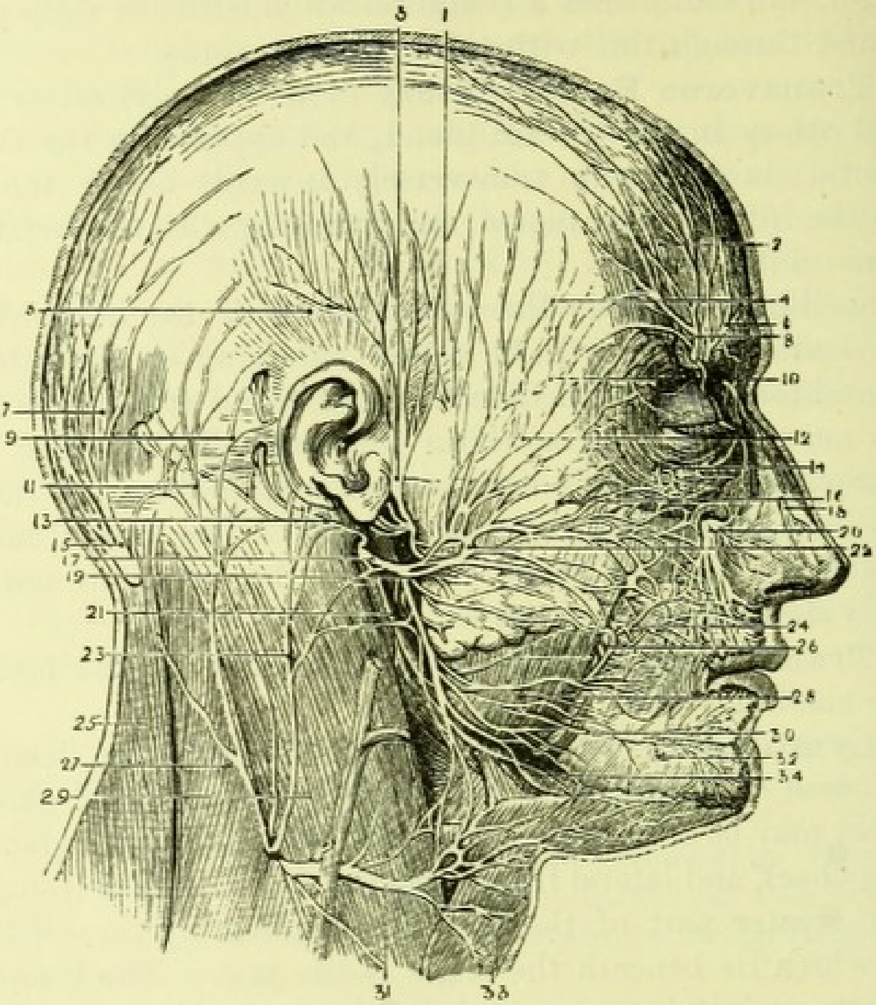


Fig. 219.—Nerves of the face and scalp (from Hirschfeld and Leveillé).

1. Attrahens auriculam muscle.
2. Anterior belly of occipito-frontalis.
3. Auriculo-temporal nerve.
4. Temporal branches of facial nerve (7th).
5. Attollens auriculam muscle.
6. Supra-trochlear nerve (5th).
7. Posterior belly of occipito-frontalis.
8. Supra-orbital nerve (5th).
9. Retrahens auriculam muscle.
10. Temporal branch of orbital nerve (5th).
11. Small occipital nerve.
12. Malar branches of facial nerve.
13. Posterior auricular nerve (7th).
14. Malar branch of orbital nerve (5th) (ramus subcutaneus malæ).
15. Great occipital nerve.
16. Infra-orbital branches of facial nerve (7th).
17. Facial nerve (7th).
18. Nasal nerve (5th).
19. Cervico-facial division of 7th.
20. Infra-orbital nerve (5th).
21. Branches to digastric and stylo-hyoid (7th).
22. Temporo-facial division of 7th.
23. Great auricular nerve.
24. Buccal branches of facial nerve.
25. Trapezius.
26. Buccal nerve (5th)
27. Splenius capitis.
28. Masseter.
29. Sterno-mastoid.
30. Supra-maxillary branches of facia nerve (7th).
31. Superficial cervical nerve.
32. Mental nerve (5th).
33. Platysma.
34. Infra-maxillary branches of facia nerve (7th).

the back of the ear and communicates with the great auricular nerve (23). It divides into an *auricular* branch, which supplies the posterior and sometimes the superior auricular muscle, and an *occipital* branch, which supplies the posterior belly of the occipito-frontalis and unites with the small occipital nerve.

The *digastric* and *stylo-hyoid nerves* (21) arise together and supply the posterior belly of the digastricus and the stylo-hyoid. A branch from the digastric nerve perforates the digastric muscle and communicates with the glosso-pharyngeal nerve, and the stylo-hyoid nerve communicates with the sympathetic on the external carotid.

Passing forwards deeply in the parotid gland, the facial nerve divides into two large portions, the *temporo-facial* (22) and the *cervico-facial* (19), from which numerous branches arise, causing by their interlacement the appearance termed the *pes anserinus*, or goose-foot. The temporo-facial division receives communicating branches from the auriculo-temporal nerve (5th) in front of the pinna, and the cervico-facial division receives one or two branches from the great auricular nerve of the cervical plexus.

From each division of the facial nerve three sets of branches are derived, whose direction is indicated by their names.

Temporo-facial division	Temporal (4). Malar (12). Infra-orbital (16).	Cervico-facial division	Buccal (24). Supra-maxillary (30). Infra-maxillary (34).

These branches all ramify upon the face, to supply the facial muscles and communicate with the several divisions of the 5th nerve, excepting the infra-maxillary, which runs below the jaw to the neck and communicates with the superficial cervical nerve (31). The branches are to be traced to all the "muscles of expression," and also to the buccinator, a muscle of mastication as well as of expression.

The distribution is somewhat irregular, but commonly the *malar* ends in the orbicularis palpebrarum, the *temporal* supplies all the muscles above the palpebral fissure, including the upper part of the orbicularis, as well as the anterior and sometimes the superior auricular; the *infra-orbital*, all the muscles between the palpebral and labial fissures, including the lower part of the orbicularis palpebrarum and upper part of the orbicularis oris. The *buccal* nerve supplies the buccinator and ends in the orbicularis oris, the *infra-maxillary* is distributed to the muscles of the lower lip, and the *supra-maxillary* to the platysma. All the facial muscles receive sensory branches from the divisions of the 5th nerve.

The *three* divisions of the **5th Nerve** appear upon the face (Fig. 220).

Fig. 220.

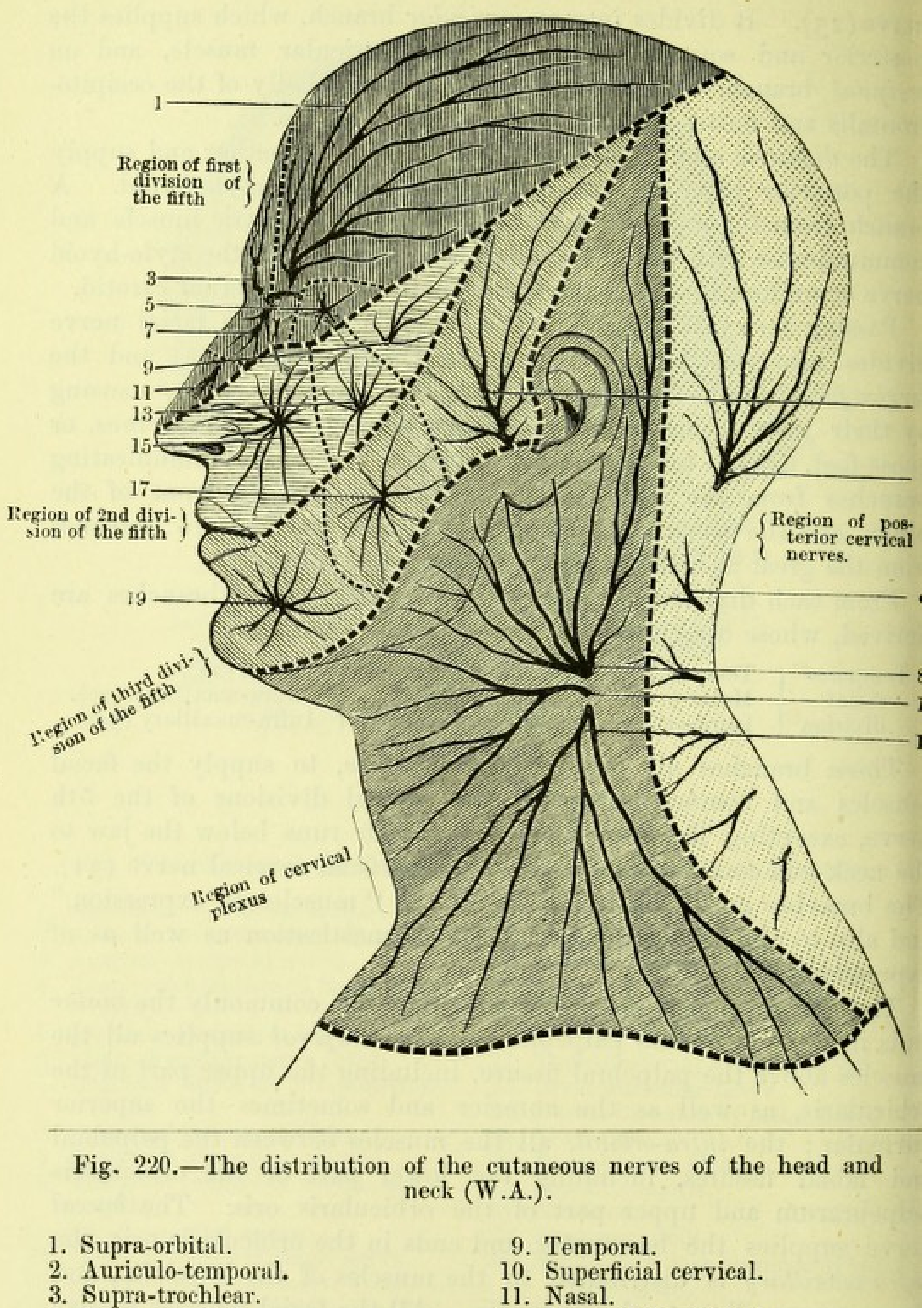


Fig. 220.—The distribution of the cutaneous nerves of the head and neck (W.A.).

1. Supra-orbital.
2. Auriculo-temporal.
3. Supra-trochlear.
4. Great occipital.
5. Lacrymal.
6. Post-cervical cutaneous.
7. Infra-trochlear.
8. Great auricular.
9. Temporal.
10. Superficial cervical.
11. Nasal.
12. Descending cervical.
13. Malar.
15. Infra-orbital.
17. Buccal.
19. Mental.

The **First** or **Ophthalmic Division** (Fig. 219) appears (1) as the *supra-trochlear nerve* (6) at the inner angle of the orbit; (2) at and internal to the supra-orbital notch as the *supra-orbital nerve* (8), which has been traced to the forehead; (3) as the *lacrymal nerve*, below the external angular process; (4) as the *infra-trochlear nerve*, emerging below the pulley of the superior oblique; and (5) as the *nasal nerve* (18), which will now be found emerging from between the nasal bone and lateral cartilage, on the side of the nose. These supply the structures of the vertex, anterior temporal region, forehead, upper eyelid, and part of the nose. Long Post. Long Ciliaries.

Frontal

Lachrym.

Nasal

The **Second** or **Superior Maxillary Division** (Fig. 219) appears (1) as the *infra-orbital nerve* (20) at the infra-orbital foramen, between the levator labii superioris and the levator anguli oris, and is to be traced to the upper lip, which it supplies with numerous large *labial* branches, forming a plexus with the facial nerve; it also sends *nasal* branches to the wing of the nose and *palpebral* twigs to the lower eyelid; (2) as the *malar branch of the temporo-malar nerve* (14), appearing through the malar bone after piercing the outer wall of the orbit; and (3) as the *temporal branch of the temporo-malar nerve* (10) piercing the temporal fascia immediately above the zygoma (*v.* p. 394). Branches 2 and 3 supply the soft parts over the malar bone and anterior part of the temporal region.

The **Third** or **Inferior Maxillary Division** (Fig. 219) appears (1) as the *mental nerve* (32) at the mental foramen, and is to be traced to the chin and lower lip; (2) as the Long *buccal nerve* (26) upon the surface of the buccinator muscle, where it will be found supplying the skin and mucous membrane of the buccal region and some filaments to the muscles, communicating with the facial nerve; and (3) as the *auriculo-temporal nerve* (3), passing beneath the parotid gland and running upwards over the zygoma immediately in front of the ear, to supply the mid-temporal region.

These are all purely sensory nerves. They join freely with the facial nerve, and supply sensation to the muscles; to part of the mucous membrane of the buccal cavity; and to the whole of the skin of the face, except that covering the parotid gland, which is supplied by the great auricular nerve of the cervical plexus. The cutaneous areas of distribution are shown in Fig. 220.

[The anatomy of the eyelids and of the nasal cartilages can be examined on either side of the face, by removing the superjacent tissues.]

The **Eyelids** (Fig. 212).—These have been partially described on page 467, but may now be further investigated. On removing the thin palpebral fibres of the orbicularis from the lids, the *superior* and *inferior palpebral ligaments* will be seen extending from the margin of the orbit. They are continuous with the periosteum of the skull at the orbital margin, and are attached to the convex edge of the tarsal cartilage in each lid. The *tarsal bodies* or *cartilages* consist of dense connective tissue, and according to later observers contains no cartilage. The upper is larger than the lower, and is semilunar in shape. They are attached to the margin of the orbit by the corresponding palpebral ligaments above and below; externally by the *external tarsal ligament*, and internally by the *internal tarsal ligament* or *tendo oculi*. The fibres of the orbicularis must be cut away from the tendo oculi, and the attachment of the latter to the nasal process of the superior maxilla, immediately in front of the groove for the lacrymal sac, will then be seen.

Beneath the palpebral ligament in the upper lid, will be found the expansion of the tendon of the levator palpebræ superioris, attached to the convex margin of the superior tarsal body. Both lids are lined with conjunctiva, and on removing this the Meibomian glands may be seen embedded in the substance of the tarsi.

The structures composing the upper eyelid (Fig. 213) are—

1. Skin.
2. Orbicularis palpebrarum.
3. Tarsal body, palpebral ligament, and tendon of levator palpebræ.
4. Meibomian glands.
5. Conjunctiva.

The structures in the lower lid are the same, *minus* the levator palpebræ.

This will be the best opportunity to dissect the **Tensor Tarsi Muscle** of Horner, by dividing the outer tarsal ligaments and detaching the eyelids, so as to turn them over the nose and expose their internal surfaces. By removing the conjunctiva over the inner canthus, the little slip of muscular fibre will be seen *arising* from the ridge on the lacrymal bone, and passing behind the lacrymal sac, to be *inserted* into the tarsal bodies and canaliculi. It is thus apparent that the lacrymal sac occupies a position between the internal palpebral ligament and palpebral fibres of the orbicularis in front, and the tensor tarsi behind.

Cartilages of the Nose (Figs. 221 and 222).—Only the superior lateral cartilages and the cartilages bounding the nostrils can now be seen, but the cartilage of the septum will be examined later, in the dissection of the nasal fossæ (p. 537). The *superior lateral* cartilage is triangular, its posterior border being in contact with the opposed border of the nasal bone and nasal process of the maxilla, and its anterior border intimately united with the anterior edge of the cartilage of the septum.

The *inferior lateral cartilage* is an elongated plate, so bent upon itself that while the angle between the two parts forms one half of the point of the nose, the two parts themselves surround the anterior part of the nostril, the inner limb uniting with the septum. It has no attachment to bone, but is embedded in the dense cellular tissue of the ala nasi. There are frequently two or three little additional nodules of fibro-cartilage, *sesamoid cartilages*, which prolong the outer part of this cartilage backwards along the

Fig. 221.

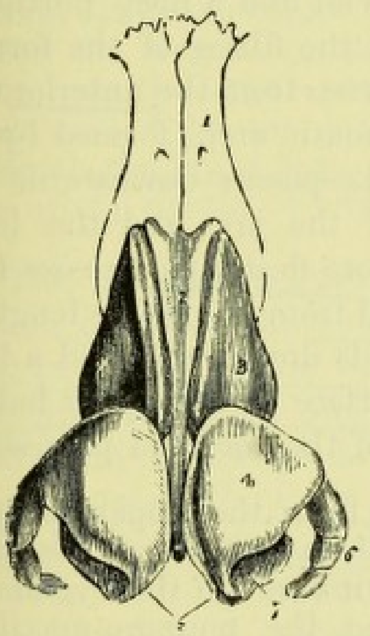


Fig. 222.

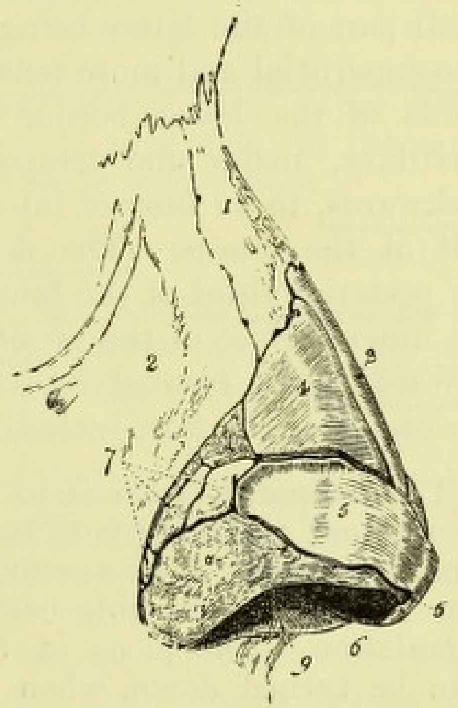


Fig. 221.—The fibro-cartilages of the nose (from Wilson).

1. One of the nasal bones.
2. Cartilage of the septum.
3. Lateral cartilage.
4. Alar cartilage.
5. Central portions of the alar cartilages which constitute the columna.
6. Cartilagines minores or sesamoid cartilages.
7. The nostril.

Fig. 222.—The fibro-cartilages and bones of the nose viewed from the side (from Wilson, after Arnold).

1. Nasal bone.
2. Nasal process of the superior maxillary bone.
3. Cartilage of the septum.
4. Lateral cartilage.
5, 5. Alar cartilage.
6. Inner portion of the alar cartilage.
7. Sesamoid cartilages.
8. Areolar tissue of the ala nasi.
9. Aperture of the nostril.

upper part of the alar furrow, but the greater part of the wing is composed of fibrous tissue. The inferior cartilages of the two sides are in contact at the tip of the nose, and are attached to the superior lateral cartilages by fibrous tissue. All the nasal cartilages except the sesamoid nodules are of the hyaline variety.

The Pterygo-Maxillary Region and Zygomatic Fossa.

[The head being laid on one side, the facial nerve and parotid duct are to be divided and turned forward, and the remains, if any, of the parotid gland are to be cleaned out from between the ear and the jaw, the auriculo-temporal nerve being carefully preserved. The surface of the masseter muscle is then to be cleaned.]

The **Masseter** (Fig. 217, 15) is the most superficial muscle of mastication, and is divisible into a superficial and a deep portion, a small part of the latter being seen behind the fibres of the former. The superficial and more tendinous part *arises* from the anterior two-thirds of the lower border of the zygomatic arch, formed by the maxillary, malar and temporal bones; it passes downwards and backwards, to be *inserted* into the angle of the jaw and the lower half of the ramus. The deeper and more fleshy part *arises* from the posterior third of the lower border and from the whole length of the inner surface of the zygoma; it extends downwards and a little forwards, to be *inserted* into the outer surface of the upper half of the ramus of the jaw, including the root of the coronoid process.

[The temporal fascia is to be detached from the upper border of the zygoma, and a cut is to be made with the saw through the malar bone in front of the masseter, and behind it through the zygoma, as near its root as possible without injuring the temporo-maxillary articulation. The piece of bone with the masseter attached can then be turned down, when the deep fibres of the muscle will be seen attached to the lower jaw, and the *masseteric* branch of artery and nerve will be found emerging through the sigmoid notch behind the coronoid process, and must necessarily be divided. The temporal muscle is to be cleaned and the fat beneath the masseter removed, so as to expose the buccinator muscle thoroughly, together with its branch of nerve and artery, which appear in front of the coronoid process and are to be preserved.]

The **Temporal Muscle** (Fig. 228, 2) *arises* from the whole of the temporal fossa, except the anterior wall formed by the malar bone; by deep fibres from the pterygoid ridge on the great wing of the sphenoid; and from the under surface of the temporal fascia, which has been seen to be attached to the whole length of the temporal ridge. Its anterior fibres are nearly vertical, the posterior nearly horizontal; they converge to a tendon, which is *inserted* into the apex, anterior and posterior borders, and inner surface of the coronoid process, extending along the inner surface of the ramus of the lower jaw nearly as far as the last molar tooth. The process is embedded in the temporal.

[A section is made by the saw downwards from the anterior margin of the neck of the jaw parallel to the posterior border of the ramus, as far as a level with the alveolar process. A second section is carried horizontally forwards from this point in such a way as to detach the greater part of the ramus with the coronoid process, but leaving a narrow line of bone connecting the condyle with the angle. On turning up the segment with the temporal muscle the zygomatic fossa is well exposed.

On removing the portion of ramus thus separated, the periosteum will probably be left behind, and on this being dissected away, the inferior dental nerve and artery will be seen lying on the internal lateral ligament before entering the dental foramen, and in front of these the lingual (gustatory) nerve. Crossing both nerves transversely at the upper part of the space now exposed is the external pterygoid, with the internal maxillary artery lying either upon or beneath the lower head of the muscle. If superficial to the muscle the artery should be cleaned and held aside with a hook.]

The **External Pterygoid Muscle** (Fig. 223, 1) *arises* by two heads, one from the outer surface of the external pterygoid plate Lowest. and tuberosity of the maxilla; the other from the under surface of Higher the great wing of the sphenoid below the pterygoid ridge. Its fibres run backwards and outwards, converging to be *inserted* into the hollow on the front of the neck of the lower jaw, and into the capsular ligament and inter-articular fibro-cartilage of the joint.

Temporo-Maxillary Articulation.—The joint surfaces are surrounded by a *capsule* which is thickened externally, internally and posteriorly to form the external lateral, short internal lateral, and posterior ligaments. It is connected to the circumference of the inter-articular fibro-cartilage, and gives insertion to some of the fibres of the external pterygoid. The *external lateral ligament* (Fig. 224, 5) is a short thick band of fibres, broader above than below, and passes obliquely downwards and backwards from the lower border of the preglenoid tubercle to the neck of the jaw. The *short internal lateral ligament* (Henle) runs from the margin of the Glaserian fissure to the inner side of the neck of the jaw. The *posterior ligament* (Sappey) consists of elastic fibres which are attached above to the post-glenoid process, and below to the posterior border of the articular cartilage and to the posterior surface of the neck of the bone. It is stretched during depression of the jaw when the condyle advances upon the eminentia articularis. By dividing the ligaments, the inter-articular cartilage and the synovial membranes above and below it will be brought into view.

The *inter-articular fibro-cartilage* (Fig. 225, 3) is adapted to the glenoid cavity and eminentia articularis above and the condyle of the lower jaw below, its upper surface being concavo-convex from before backwards, the lower surface concave. If the condyle is detached from the temporal bone and turned forward with the

Fig. 223.

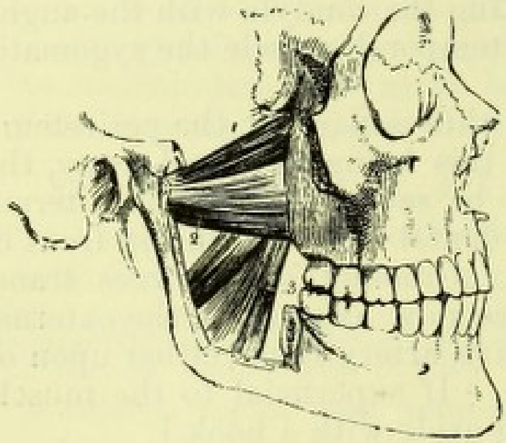
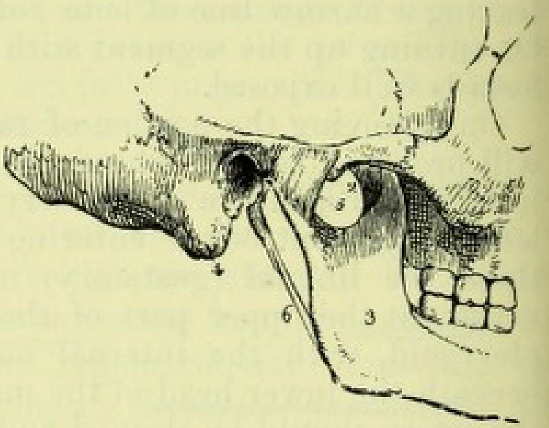


Fig. 224.



external pterygoid muscle, the cartilage will be found to be oval in outline and thicker at the margins than in the centre, where it is occasionally perforated (6).

The *long internal lateral ligament* (Fig. 226, 4), now fully exposed, does not form a part of the capsule; it is a membranous band, narrow above, where it is fixed to the spine of the sphenoid bone, and widening below to be attached to the projecting spine at the entrance of the dental canal. Between the ligament and the jaw are found the external pterygoid muscle, the internal maxillary vessels with their auricular, tympanic, meningeal, and inferior dental branches, the auriculo-temporal nerve, the inferior dental nerve and some acini of the parotid gland. The lower attachment of the ligament is pierced by the mylo-hyoid vessels and nerve.

The *stylo-maxillary ligament* is merely a thickened portion of the

Fig. 223.—The two pterygoid muscles (from Wilson). The zygomatic arch and the greater part of the ramus of the lower jaw have been removed in order to bring the muscles into view.

1. The sphenoid origin of the external pterygoid.
2. Its pterygoid origin.
3. The internal pterygoid.

Fig. 224.—External view of the articulation of the lower jaw (from Wilson).

1. Zygomatic arch.
2. Tubercle of the zygoma.
3. Ramus of the lower jaw.
4. Mastoid portion of the temporal bone.
5. External lateral ligament.
6. Stylo-maxillary ligament.

deep cervical fascia, extending from the styloid process to the angle of the jaw. It separates the parotid from the sub-maxillary gland.

The *synovial membranes* are two in number, one above, the other below the inter-articular fibro-cartilage. The two synovial cavities communicate when the cartilage is perforate.

The **movements of the jaw** are as follows :—

1. *Elevation and depression*, taking place around a transverse axis

Fig. 225.

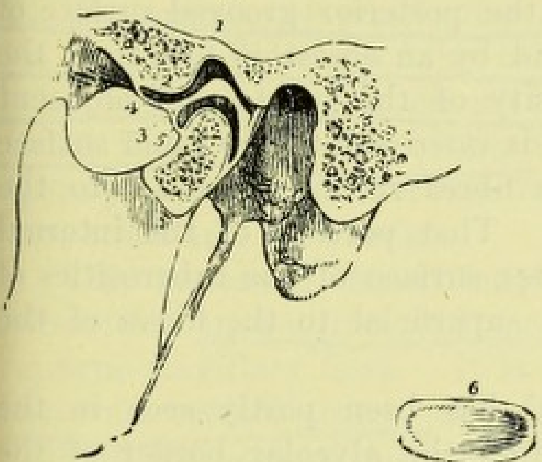
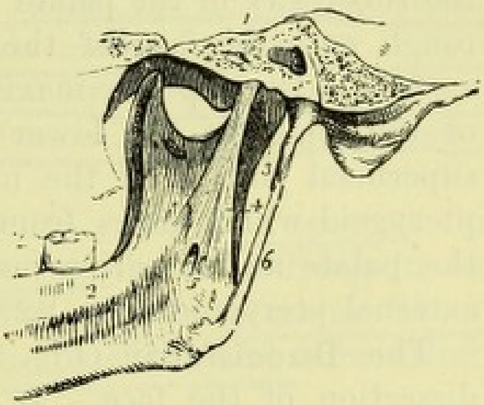


Fig. 226.



passing through the rami near the inferior dental spines. When the jaw is depressed the condyle moves forward upon the eminentia articularis, returning to the glenoid fossa during elevation. The elevation is effected by the temporal, masseter and internal pterygoid muscles ; depression by the digastric, mylo-hyoid, genio-hyoid and platysmal muscles, aided by the external pterygoid which draws forward the condyle upon the articular eminence.

2. *Forward and backward grinding movements.*—The forward movement is accomplished by the superficial portion of the masseter,

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Fig. 225.—A section of the temporo-maxillary articulation to show the position of the inter-articular fibro-cartilage, and the manner of its adaptation to the articulating surfaces (from Wilson).

1. Glenoid fossa.
2. Eminentia articularis.
3. Inter-articular fibro-cartilage.
4. Superior synovial cavity.
5. Inferior synovial cavity.
6. An inter-articular fibro-cartilage, removed from the joint, in order to show its oval and concave form ; it is seen from below.

Fig. 226.—Internal view of the articulation of the lower jaw (from Wilson).

1. Section through the petrous portion of the temporal bone and spinous process of the sphenoid.
2. Internal surface of the ramus and body of the lower jaw.
3. Capsular ligament.
4. Long internal lateral ligament.
5. Aperture through which the mylo-hyoid nerve passes.
6. Stylo-maxillary ligament, a process of the deep cervical fascia.

the anterior fibres of the temporal, and the external and internal pterygoids. The *backward* movement by the deep portion of the masseter, the posterior fibres of the temporal, and the depressors.

3. *Oblique grinding movements.*—These take place around a vertical axis passing through one condyle, which remains in the glenoid cavity, while the other advances upon the articular eminence. They are effected by the alternating actions of the muscles of the two sides.

The **Internal Pterygoid Muscle** (Fig. 223, 3) is placed beneath the internal lateral ligament. It *arises* from the internal surface of the external pterygoid plate, from the posterior grooved surface of the tuberosity of the palate bone, and by an accessory slip from the rough outer surface of the tuberosity of the palate and adjacent surface of the superior maxilla. It is *inserted* into the inner surface of the angle of the lower jaw, its fibres running parallel to the superficial portion of the masseter. That portion of the internal pterygoid which arises from the outer surface of the tuberosities of the palate and superior maxilla is superficial to the fibres of the external pterygoid (Fig. 228).

The **Buccinator** (Fig. 228, 14) has been partly seen in the dissection of the face. It *arises* from the alveolar border of the superior maxilla opposite the molar teeth; from a corresponding portion of the inferior maxilla; and between the jaws from the anterior border of the pterygo-maxillary ligament, which separates its fibres from those of the superior constrictor. Its inner surface is lined with mucous membrane, and externally it is related to the maxilla and to the sucking pad of cheek fat. It is *inserted* into the lips and angle of the mouth, joining the orbicularis oris, and probably becomes continuous with the opposite muscle in the middle line of both lips. Its upper and lower alveolar fibres will be seen to pass to the upper and lower lip respectively, while the intermediate fibres from the pterygo-maxillary ligament decussate, the superior passing to the lower lip, the inferior to the upper.* The fibres are perforated by the duct of the parotid gland opposite the second molar tooth of the upper jaw. The principal action of the buccinator is to keep the food between the teeth during mastication. It also expels air from the mouth (and hence the name "trumpeter"), as in using the blowpipe; and the muscle acting with its fellow aids in the expression of the face by drawing outwards the corners of the mouth and pressing the lips tightly together and against the teeth.

Stenson

P. 475.

Facial Nerve.

* The superior constrictors and buccinators thus form an annular plane of muscle interrupted only by the pterygo-maxillary ligaments and posterior median raphe; and the buccinators act as a 'button-hole' sphincter of the labial fissure.

The **Pterygo-Maxillary Ligament** (Fig. 229) is a somewhat indistinct fibrous line, resembling a tendinous intersection or raphe rather than a ligament, and extending between the hamular process of the internal pterygoid plate and the lower jaw, close to the last molar tooth. By its anterior border it gives attachment to the buccinator, and by its posterior border to the superior constrictor of the pharynx; its inner surface, covered by mucous membrane, may thus be regarded as a boundary line between the cavities of the mouth and the pharynx.

The muscles of mastication are all *supplied* by the motor portion of the third division of the 5th nerve, except the buccinator, which although receiving a branch from this nerve, derives its motion from the facial nerve (7th), as is shown by the fact that in facial paralysis the buccinator fails in its action, and food collects between the teeth and the cheek.

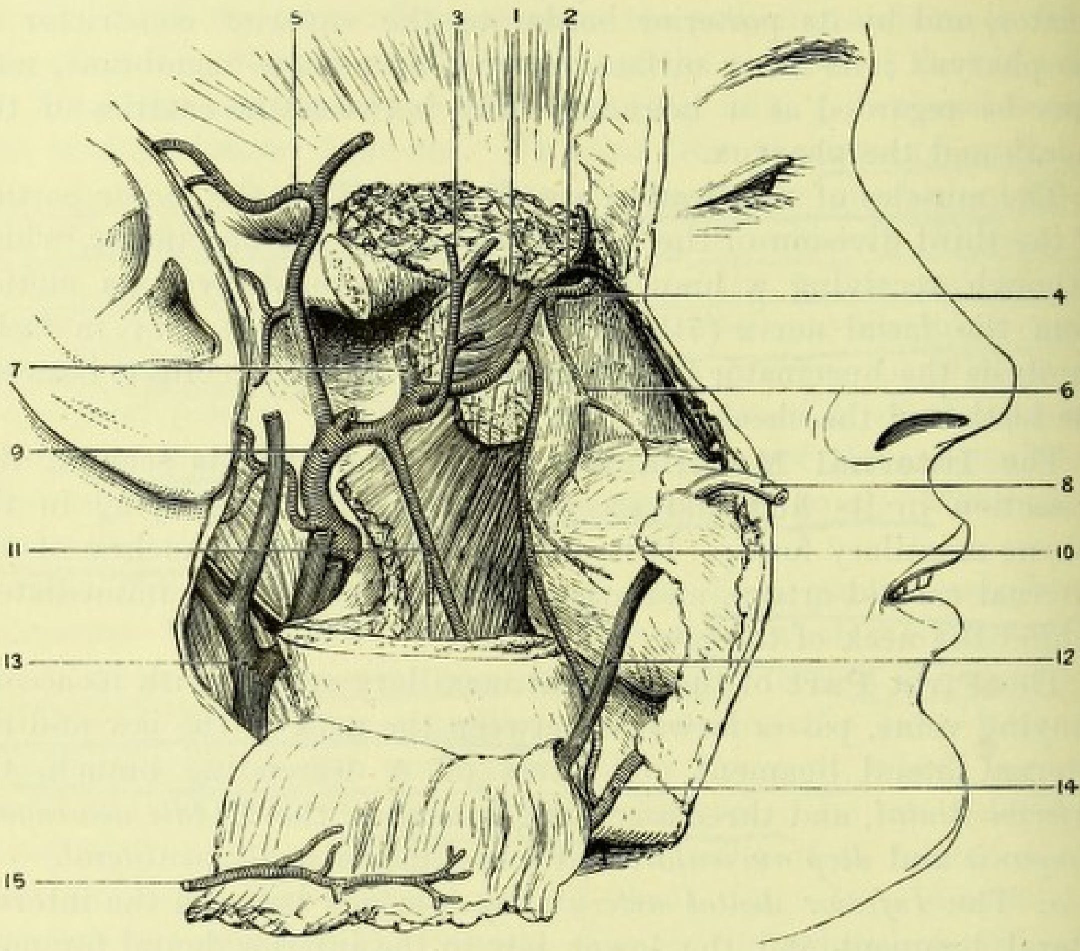
The **Internal Maxillary Artery** (Fig. 227) is seen in this dissection in its first and second portions, the third lying in the spheno-maxillary fossa. It is one of the terminal branches of the external carotid artery, and arises in the parotid gland immediately behind the neck of the jaw.

The **First Part** of the internal maxillary artery, with its accompanying veins, passes forwards between the neck of the jaw and the internal lateral ligament. It gives off a descending branch, the *Inferior dental*, and three ascending branches, the *Middle meningeal*, *tympanic* and *deep auricular*, and sometimes a *small meningeal*.

a. The *Inferior dental artery* (11) descends between the internal lateral ligament and the lower jaw to the inferior dental foramen, giving off, before it enters the bone, a mylo-hyoid branch and a small twig to accompany the lingual (gustatory) nerve; it then runs in the inferior dental canal supplying the posterior teeth, and after giving an *incisor branch* to the front teeth, appears on the face as the *mental* artery at the mental foramen, with the mental branch of the third division of the 5th nerve. Its *mylo-hyoid branch* pierces the internal lateral ligament in company with a nerve of the same name, and runs in a groove on the internal surface of the lower jaw to the cutaneous surface of the mylo-hyoid and to the anterior belly of the digastric muscle, joining the sub-mental artery.

b. The *Middle meningeal artery* (7) ascends on the deep surface of the external pterygoid muscle, following the long internal lateral ligament to the sphenoidal spine. It passes between the two roots of the auriculo-temporal nerve to the foramen spinosum, by which it enters the skull (Fig. 229, 11). Before doing so, it usually gives off the *meningea parva* to enter the foramen ovale, but this may arise separately from the main vessel. It is accompanied by *venæ comites* and a recurrent branch of the inferior maxillary nerve, and is surrounded by a sympathetic plexus.

Fig. 227.



c, d. Two small arteries, the *tympanic* entering the Glaserian fissure, and the *deep auricular* passing to the external meatus, are irregular in their origin, but usually arise before the middle meningeal.

The **Second Part** of the internal maxillary artery passes forwards and upwards to the pterygo-maxillary fissure, varying in position in different subjects. It is always intermuscular, but it may lie between the temporal and external pterygoid, or between the ex-

Fig. 227.—The internal maxillary artery (from University College Museum).

1. External pterygoid muscle.
2. Anterior deep temporal artery.
3. Posterior deep temporal artery, giving a pterygoid branch.
4. Infra-orbital artery.
5. Temporal artery.
6. Posterior dental artery.
7. Middle meningeal artery.
8. Stenson's duct.
9. External carotid.
10. Buccal branch communicating with facial artery.
11. Inferior dental artery giving off mylo-hyoid branch.
12. Facial vein.
13. External jugular vein.
14. Facial artery.
15. Masseteric branch (turned down).

ternal and internal pterygoid muscles. When it runs superficially to the external pterygoid, it passes between the two heads of the muscle to reach the spheno-maxillary fossa. Its branches are all *muscular, i. e.*, to the muscles of mastication. There are two *deep temporal* branches, anterior (2) and posterior (3), running in the substance of the temporal muscle; a *masseteric* branch (15) passing through the sigmoid notch to the under surface of the muscle, now necessarily divided; two *pterygoid* branches, uncertain in origin and course; and a *buccal* branch (10), which generally pierces the external pterygoid muscle to accompany the nerve to the surface of the buccinator.

Analogy 7s Peter Wilson's Pet Subject

The **Third Part** of the artery extends from the pterygo-maxillary fissure into the spheno-maxillary fossa. Two of its branches arising at the entrance of the fossa, may be seen in the present stage of dissection, the alveolar and infra-orbital; the rest, the spheno-palatine, nasal, Vidian, and pterygo-palatine are given off within the fossa.

Part 3 Palatine.

The *Alveolar artery* (6) runs over the body of the maxilla, extending beneath the malar process to anastomose with the infra-orbital artery. It gives off the *posterior superior dental artery*, which enters one of the foramina on the posterior surface of the superior maxilla, runs in the bone, supplying it and the molar teeth, and giving off twigs to the antrum, gums, and buccinator.

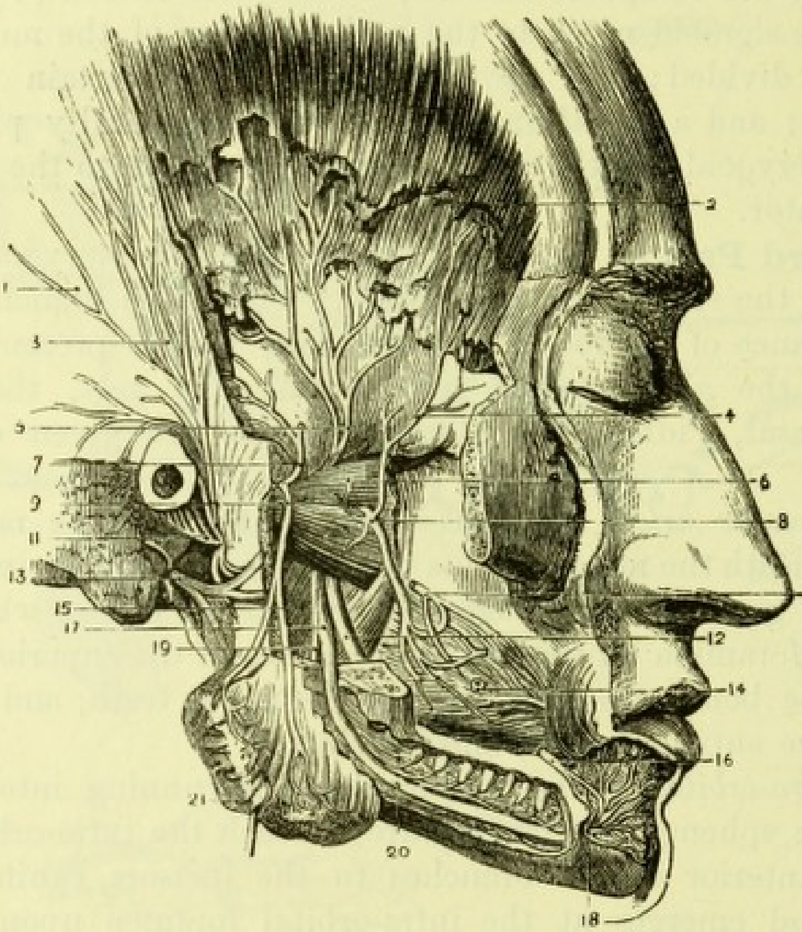
The *Infra-orbital Artery* (4) may be seen running into the back part of the spheno-maxillary fissure to reach the infra-orbital canal. It gives anterior dental branches to the incisors, canine, and bicuspids, and emerges at the infra-orbital foramen upon the face, where it supplies muscles and integument, and anastomoses with the alveolar, facial, and transverse facial arteries.

The **Internal Maxillary Vein** receives branches corresponding to those of the artery, and between the muscles forms the *pterygoid plexus*, which communicates with the facial vein by the *deep facial vein*, and with the ophthalmic vein and the cavernous sinus by means of the veins coming from the orbit, and through the foramen lacerum medium. The internal maxillary vein finally enters the parotid gland, to join the temporal vein and form the temporo-maxillary vein.

The **Inferior Maxillary Nerve** (Figs. 228 and 229) (3rd division of 5th), emerges from the foramen ovale, lying in front of the middle meningeal vessels and external to the otic ganglion. After giving off a small *recurrent* branch, which passes through the foramen spinosum with the middle meningeal artery and supplies the mastoid cells and great wing of the sphenoid, the trunk breaks up into *motor* and *sensory divisions*, each of which, however, contains both motor and sensory fibres.

The **Motor Division** (Fig. 228) is of small size. It is placed

Fig. 228.



externally to the sensory portion, and is distributed to the muscles of mastication, running with the corresponding branches of the internal maxillary artery. Its branches are, *anterior* and *posterior*

Fig. 228.—Pterygo-maxillary region and fifth nerve (from Hirschfeld and Leveillé).

1. Temporal fascia.
2. Temporal muscle.
3. Temporal branches of auriculo-temporal neve.
4. Anterior deep temporal branch from buccal nerve.
5. Posterior deep temporal nerve.
6. Pterygoideus externus.
7. Deep temporal branch of masseteric nerve (inconstant).
8. Buccal nerve.
9. Masseteric nerve.
10. Buccal branch of facial (7th).
11. Auriculo-temporal nerve
12. Lingual nerve.
13. Facial nerve (7th) at stylo-mastoid foramen.
14. Buccinator muscle.
15. Pterygoideus internus.
16. Supra-maxillary branch of facial.
17. Inferior dental nerve.
18. Its mental branches.
19. Its mylo-hyoid branch.
20. Inferior dental canal opened.
21. Masseter (turned down).

temporal (4 & 5), *masseteric* (9), *internal* and *external pterygoid* and *buccal* (8).

The *temporal* branches run outwards and upwards in the temporal muscle and supply it. A third temporal branch is occasionally present. The *Masseteric* branch passes over the sigmoid notch to enter the deep surface of the muscle. The *nerve to the internal pterygoid* also pierces the deep surface of its muscle, and is connected with the otic ganglion. The *nerve to the external pterygoid* passes between the two heads, giving a branch to each. Lastly the *buccal nerve*, the only branch that is not motor, is very large and distinct, and commonly arises with the anterior deep temporal. It enters the muscle, supplying sensory filaments to it, and to the mucous membrane and integument investing it, and communicates with the buccal branch of the facial.

The **Sensory Division** (Fig. 229) breaks up, close to the base of the skull, into three branches, the *Lingual Nerve* the most anterior ; the *Inferior Dental Nerve* (which has some motor fibres in the middle ; and the *Auriculo-Temporal nerve* posteriorly.

[The auriculo-temporal nerve is to be carefully dissected out from the tough fibrous tissue of the articulation, and traced through the parotid to the pinna and temple.]

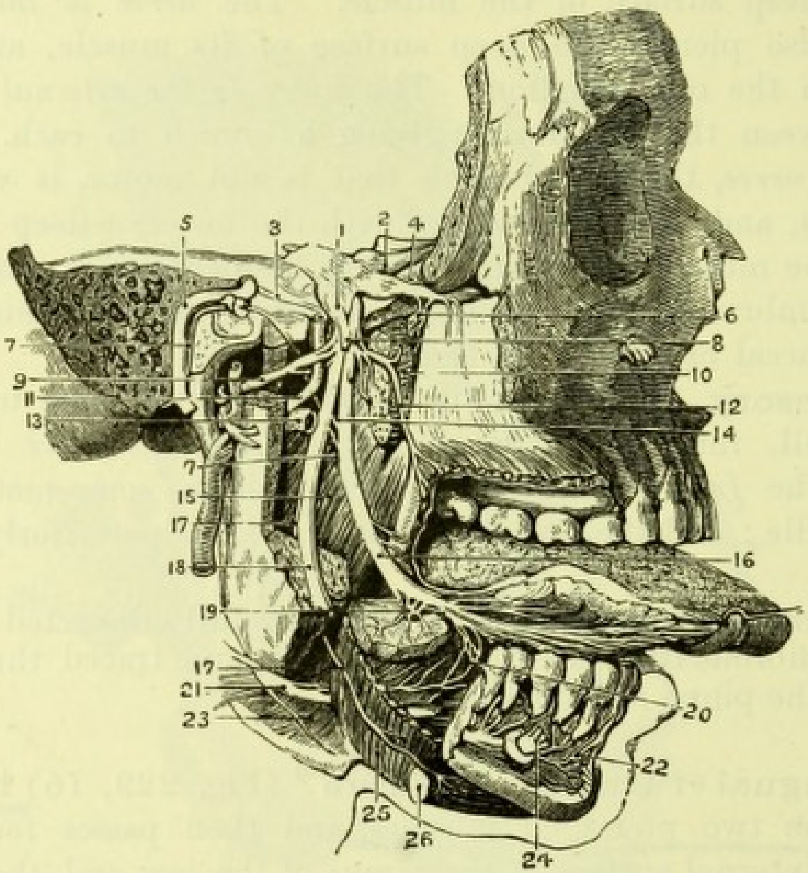
The **Lingual** or **Gustatory Nerve** * (Fig. 229, 16) lies at first between the two pterygoid muscles, and then passes forward between the internal surface of the ramus of the jaw and the internal pterygoid muscle ; it will be afterwards traced to the side and tip of the tongue. Beneath the external pterygoid the nerve is joined at an acute angle by the small *chorda tympani nerve* (7). The chorda tympani is a branch of the facial nerve given off in the temporal bone, and passing through the tympanum between the handle of the malleus and the long process of the incus, to emerge through the canal of Huguier at the inner side of the Glaserian fissure, to which it should now be traced.

The **Inferior Dental Nerve** (Fig. 229, 18) has a branch of communication with the lingual trunk, and then descends with the inferior dental artery (p. 491) between the ramus of the jaw and internal pterygoid muscle and the long internal lateral ligament, to reach the dental foramen. After entering the bone it supplies all the teeth of the lower jaw, partly by direct filaments, partly by its

* Since the glosso-pharyngeal nerve has been conclusively shown to be the special nerve of taste, it is desirable that the term "gustatory" as applied to the lingual branch of the fifth should be abandoned.

incisor branch (22), and emerges at the mental foramen as the *mental* nerve, with its accompanying artery, supplying sensory fibres to the muscles, mucous membrane, and integument of the lower lip,

Fig. 229.



and to the body of the lower jaw. Immediately before entering the dental foramen it gives off the *mylo-hyoid* nerve (17), which pierces

Fig. 229.—Third or inferior maxillary division of the fifth nerve (from Hirschfeld and Leveillé).

1. Third division of fifth nerve.
2. First division of fifth nerve.
3. Superficial petrosal nerve.
4. Second division of fifth nerve.
5. Facial nerve (7th).
6. Meckel's ganglion.
7, 7. Chorda tympani.
8. Muscular branches (divided).
9. Auriculo-temporal nerve.
10. Pterygoideus externus.
11. Middle meningeal artery.
12. Buccal nerve.
13. Internal maxillary artery.
14. Communicating branch of lingual and inferior dental nerves.
15. Pterygoideus internus.
16. Lingual nerve.
17, 17. Mylo-hyoid nerve.
18. Inferior dental nerve.
19. Submaxillary ganglion on the deep portion of submaxillary gland.
20. Communication between fifth and hypoglossal nerves.
21. Hypoglossal nerve.
22. Incisor branches of inferior dental nerve.
23. Hyo-glossus muscle.
24. Mental branch of inferior dental nerve.
25. Mylo-hyoid muscle.
26. Anterior belly of digastric.

the internal lateral ligament with the accompanying artery, and, after running in a groove on the inner surface of the bone, is distributed to the mylo-hyoid and anterior belly of the digastric.

The **Auriculo-Temporal Nerve** (Fig. 229, 9) commonly has two roots of origin, which embrace the middle meningeal artery. It passes horizontally outwards and backwards beneath the external pterygoid muscle, and behind the temporo-maxillary articulation. It then turns upwards in front of the ear, under cover of the parotid gland, and becomes distributed over the temple (*v.* p. 396). It gives off *anterior auricular* branches to the pinna, the external auditory meatus, and the membrana tympani, *glandular* branches to the parotid, *articular* branches to the temporo-maxillary joint, and *temporal* branches to the greater part of the temporal region. It communicates with the temporo-facial portion of the *facial* nerve and with the *otic ganglion.*

THE SUBMAXILLARY REGION.

The Submaxillary region has been partially dissected with the anterior triangle of the neck. It is triangular in shape, and is bounded by the lower border of the lower jaw above, the mid-line from symphysis to hyoid bone in front, and the body of the hyoid body with the stylo-hyoid and posterior belly of the digastricus below. Its *floor* is formed by the anterior belly of the digastricus, the mylo-hyoid, the hyo-glossus, and the middle constrictor. It *contains* the superficial portion of the submaxillary salivary gland with its capsule; the submaxillary lymphatic glands; the facial artery, giving off its submaxillary, submental, ascending palatine, and tonsillar branches; the facial vein; the hypoglossal nerve; and the mylo-hyoid nerve and vessels. It is covered in by the superficial and deep fasciæ, the platysma, infra-maxillary branches of the facial nerve, and branches of the superficial cervical nerve. Under cover of the jaw may also be seen in this dissection the stylo-glossus, the stylo-pharyngeus, the superior constrictor, the glosso-pharyngeal and lingual (gustatory) nerves, Wharton's duct, and the ranine vein; but these do not belong to the triangle.

[The facial artery is to be divided at the jaw, and together with the submaxillary gland turned back, without displacing a deep portion of the gland which lies beneath the posterior part of the mylo-hyoid muscle; the latter, forming the floor of the submaxillary triangle, will be exposed, and on its surface will be seen the mylo-hyoid branch of artery and nerve derived from the inferior dental trunks, the artery anastomosing with the submental branch of the facial. By cutting through the digastric muscle at its insertion, detaching it and the stylo-hyoid from the hyoid bone, and turning them back, the mylo-hyoid muscle will be fully exposed, and should be put on the stretch by means of a hook attached to the larynx.]

The **Mylo-hyoid Muscle** (Fig. 229, 25) *arises* from the mylo-hyoid ridge on the inner surface of the lower jaw, and its fibres pass downwards and forwards to be *inserted* into the body of the hyoid bone between the insertions of the genio-hyoid and sterno-hyoid, and to meet the muscle of the opposite side in a median raphe between the hyoid bone and the lower jaw. It forms the muscular floor of the mouth.

The mylo-hyoid is an elevator of the hyoid bone, and this bone being fixed, a depressor and retractor of the jaw. Its contraction raises the whole tongue towards the floor of the mouth, and is thus of importance in deglutition. It is *supplied* (with the anterior belly of the digastric) by the mylo-hyoid branch of the inferior dental nerve.

[The mylo-hyoid is to be detached from the lower jaw and turned forward, when three structures will be seen lying in the following order from above downwards on the hyo-glossus muscle, viz., the lingual nerve (5th), the deep portion of the submaxillary gland with Wharton's duct and the sublingual gland, and the hypoglossal nerves (12th). In addition, immediately below the 12th nerve there is very frequently a large ranine vein corresponding to a part of the lingual artery. In front of the hyo-glossus will be seen the genio-hyoid stretching between the chin and the hyoid bone, and a few fibres of the genio-glossus, together with the terminal branch (ranine) of the lingual artery. The jaw should now be divided just externally to the genio-hyoid, when it can be turned up, and the tongue being drawn out of the mouth, the fold of mucous membrane forming the *frænum linguæ* will be seen, with the horseshoe like *sublingual fold*, on to which open the ducts of Walther, the *papilla submaxillaris* on each side, with the common opening of Wharton's and Rivini's ducts, and the *fimbriated folds* outside these (Fig. 256). The tongue may now be put on the stretch with hooks, and the dissection can be proceeded with by cleaning the deep part of the submaxillary gland and its duct, and raising the mucous membrane from the sublingual gland, beneath which the duct passes.]

The **Submaxillary Gland** (Fig. 229) consists of two portions, superficial and deep. The *superficial part* lies in the angle between the two bellies of the digastricus under cover of a portion of the body of the lower jaw. It is related *externally* to the submaxillary impression upon the inner surface of the jaw and lymphatics, and below this to the facial vein, branches of the facial nerve, and the platysma and integument. *Internally* its deeper surface rests upon the mylo-hyoid, the posterior part of the hyo-glossus, the lingual vessels, and the hypoglossal nerve. The facial artery is embedded in a deep groove in its substance and gives many branches to it : and five or six submaxillary lymphatic glands lie within or upon it. It is separated posteriorly from the parotid gland by the stylo-maxillary ligament.

The *deep portion* of the gland is continuous with the superficial portion around the posterior border of the mylo-hyoid. It lies upon the hyo-glossus and below the mucous membrane of the floor of the mouth, its anterior extremity touching the hinder end of the sublingual gland.

The *duct* (Wharton's) arises from the deep portion and is about two inches in length. It runs forward upon the hyo-glossus and genio-glossus to open upon the summit of a papilla close to the frænum linguæ. It lies above the hypoglossal nerve, and at first below the lingual nerve, but afterwards passes beneath and above the latter.

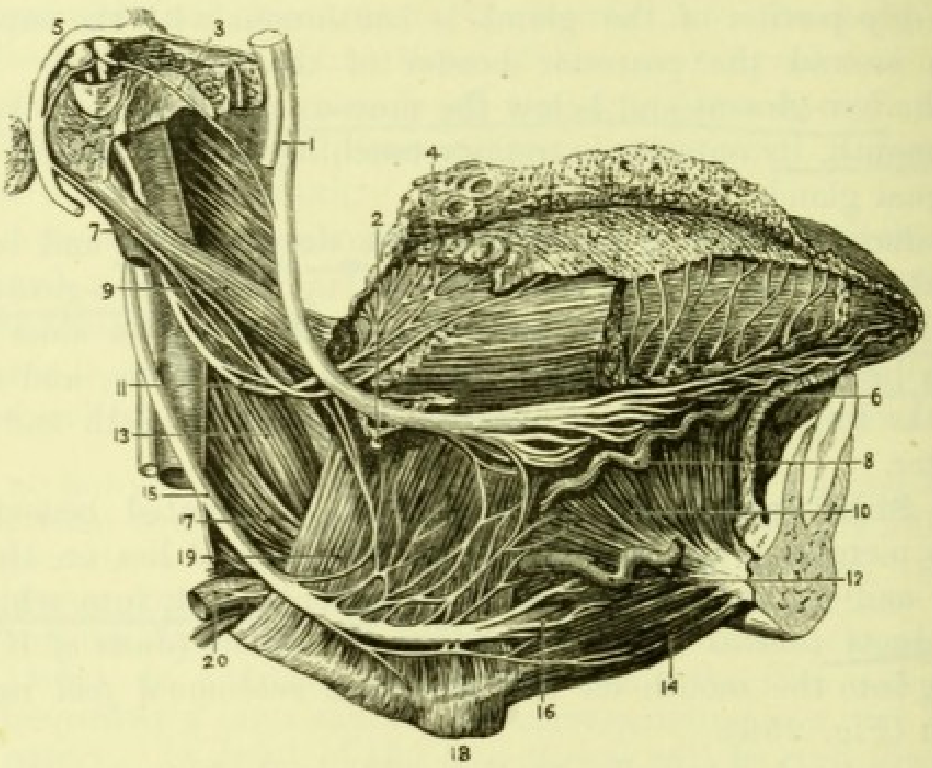
The **Sublingual Gland** (Fig. 229) is situated beneath the mucous membrane by the side of the tongue, and lies on the hyo-glossus and genio-glossus close to Wharton's duct, into which one of its ducts (*ductus Riviniani*) opens, the others (*ducts of Walther*) opening into the mouth on the crescentic *sublingual fold* near the frænum (Fig. 256).

It is related *externally* to the sublingual fossa on the inner surface of the lower jaw ; *internally* to the hyo-glossus, genio- hyo—
glossus, genio-hyoid, Wharton's duct, and the hypoglossal and lingual nerves ; *below* to the mylo-hyoid ; and *above* to the glosso-maxillary reflection of mucous membrane. Its *anterior extremity* reaches to the frænum and lies in contact with its fellow, and its posterior end touches the deep portion of the submaxillary gland.

The *apical gland of Nuhn* is a small gland lying under the mucous membrane of the under surface of the tongue near the tip.

The **Lingual Nerve** (Fig. 230, 1) (Gustatory of 5th) appears at the anterior border of the pterygoideus internus, where it lies against the pterygo-maxillary ligament, and afterwards runs between the jaw and the mucous membrane of the mouth to reach the hyo-glossus, upon which it is at first placed above Wharton's duct and the 12th nerve. Upon the hyo-glossus it crosses the duct and lies below it, but, if followed to the side of the tongue, will be found to pass again between the duct and the hyo-glossus. It is distributed to all the structures of the anterior part of the tongue, to the mucous membrane of the mouth beneath the tongue, to the gums, and to the sublingual gland. Branches of *communication* pass across the hyo-glossus to the hypoglossal nerve, and a little below the level of the trunk, opposite the deep portion of the submaxillary gland, may be found a branch to the submaxillary ganglion. It is connected with the facial and glosso-pharyngeal nerves through

Fig. 230.



the chorda tympani (p. 550), and has less important communications with the inferior dental nerve and the mylo-hyoid branch of this.

The **Submaxillary ganglion** (2) is of small size, and lies upon the hyo-glossus below the lingual nerve. It has three roots, the sensory derived from the lingual; the motor from the facial (7th)

Fig. 230.—Nerves of the tongue (from Hirschfeld and Leveillé).

1. Lingual nerve (5th).
2. Submaxillary ganglion.
3. Chorda tympani nerve.
4. Distribution of glosso-pharyngeal nerve to circumvallate papillæ.
5. Facial nerve (7th).
6. Distribution of lingual nerve (5th).
7. Communication between facial and glosso-pharyngeal nerve.
8. Ranine artery.
9. Stylo-glossus.
10. Genio-glossus.
11. Glosso-pharyngeal nerve.
12. Sublingual artery.
13. Stylo-pharyngeus.
14. Genio-hyoideus.
15. Hypoglossal nerve (12th).
16. Distribution of twelfth nerve.
17. Middle constrictor of pharynx.
18. Hyoid bone.
19. Hyo-glossus.
20. Lingual artery.

by means of the *chorda tympani,* which is prolonged on the lingual nerve to the ganglion ; and a sympathetic root from the plexus on the facial artery (superior cervical ganglion). The branches of distribution are given to the submaxillary gland. The *chorda tympani* is afterwards prolonged to the tongue, conveying the lingual gustatory filaments from the glosso-pharyngeal nerve, but its distribution there is uncertain. Probably, however, it supplies the fungiform and filiform papillæ, and gives a branch to the inferior lingualis muscle.

The **Hypoglossal Nerve** (Fig. 230, 15) (12th) has been seen crossing the upper part of the anterior triangle, after hooking round the sterno-mastoid or occipital artery, to disappear beneath the submaxillary gland and posterior border of the mylo-hyoid. It is now seen to lie upon the hyo-glossus, which separates it from the lingual artery, and after communicating with the lingual nerve, it ends in the genio-glossus muscle. It gives branches in this part of its course to the stylo-glossus, hyo-glossus, genio-glossus, and genio-hyoid muscles, and also to the intrinsic muscles of the tongue itself. Its branches and communications are described on p. 461.

The **Hyo-Glossus** (Fig. 231, 6) *arises* from the outer part of the body of the hyoid bone, from the upper margin of the whole length of its great cornu, and from the lesser cornu. It runs upwards and forwards, and is *inserted* into the side of the dorsum of the tongue, where its fibres blend with those of the stylo-glossus and lie outside the inferior lingualis. It is sometimes described as consisting of three separate portions, corresponding to its three attachments to the hyoid bone—basio-glossus, kerato-glossus, and chondro-glossus.

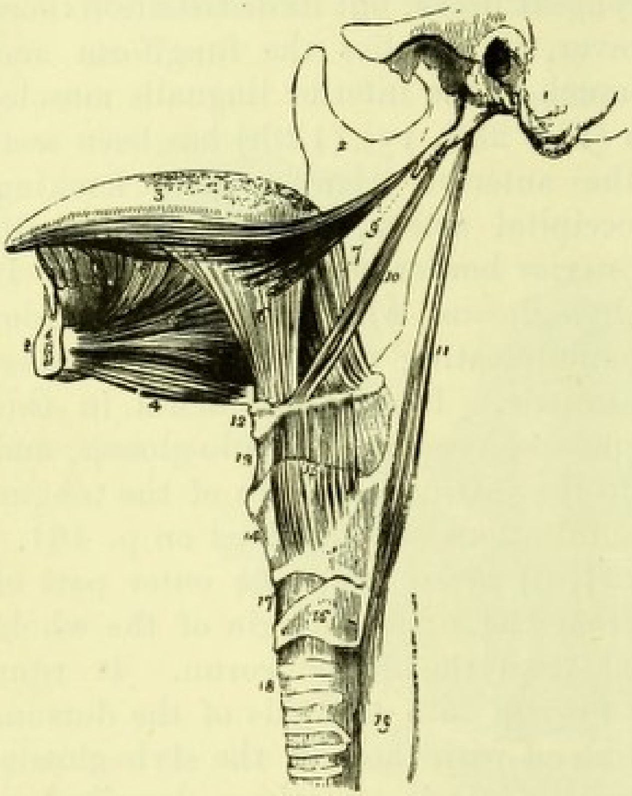
On the *outer* side of the hyo-glossus are the mylo-hyoid, stylo-hyoid, digastricus, and stylo-glossus muscles, the ranine vein, the gustatory and hypoglossal nerves, the submaxillary ganglion, the sublingual and deep portion of the submaxillary glands, and Wharton's duct. On the *deep* or *inner* side are the genio-glossus, the inferior lingualis, the origin of the middle constrictor, the lingual artery with its venæ comites, and the glosso-pharyngeal nerve.

The hyo-glossi draw the tongue downwards and backwards into the floor of the mouth. One hyo-glossus contracting alone, draws the side of the tongue downwards and inclines the whole organ towards the side from which the muscle acts. It is *supplied* by the hypoglossal nerve.

The **Stylo-Glossus** (Fig 231, 9) *arises* from near the tip of the styloid process and from the stylo-hyoid ligament, and passing obliquely forwards and downwards, reaches the side of the tongue, into which it is *inserted*, the fibres blending with those of the hyo-glossus behind, and with the inferior lingualis beyond the anterior border of the hyo-glossus.

The stylo-glossi raise the margins of the tongue and draw the organ upwards and backwards, retracting it into the mouth when it has been protruded, and assisting the hyo-glossus and the anterior fibres of the genio-glossus. One muscle acting singly would retract the tongue and draw it towards the cheek of the same side. It is *supplied* by the hypoglossal nerve.

Fig. 231.



The **Stylo-Pharyngeus** (Fig. 231, 11) *arises* from the root of the styloid process on its inner side, and passes downward to disappear between the superior and middle constrictors of the pharynx, opposite the hyoid bone. Its *insertion* into the posterior border of the thyroid cartilage and into the pharynx will be seen in the dissection of that region* (p. 525).

Fig. 231.—Styloid muscles and muscles of the tongue (from Wilson).

1. Temporal bone of the left side.
2, 2. The right side of the lower jaw divided at its symphysis; the left side having been removed.
3. Tongue.
4. Genio-hyoid.
5. Genio-glossus.
6. Hyo-glossus; its basio-glossus portion.
7. Its kerato-glossus portion.
8. Anterior fibres of the lingualis issuing from between the hyo-glossus and genio-glossus.
9. Stylo-glossus with part of the stylo-maxillary ligament.
10. Stylo-hyoid.
11. Stylo-pharyngeus.
12. Os hyoides.
13. Thyro-hyoid membrane.
14. Thyroid cartilage.
15. Thyro-hyoid muscles arising from the oblique line of the thyroid cartilage.
16. Cricoid cartilage.
17. Crico-thyroid membrane.
18. Trachea.
19. Commencement of the œsophagus.

* It will assist the student in remembering the origins of the muscles from the styloid process if he notice that the origins are inversely as the insertions, *i.e.*, that the muscle which arises highest is inserted lowest down. Thus the order of the origin from above downwards is stylo-pharyngeus, stylo-hyoid, and stylo-glossus.

The stylo-pharyngeus is *supplied* by the glosso-pharyngeal nerve, which is seen winding round its posterior border.

[The hyo-glossus is to be divided near the hyoid bone to expose the lingual artery, the branches of which are to be dissected. The tongue being put on the stretch, all remains of mucous membrane covering the genio-hyoid and genio-glossus muscles are to be removed, and the muscles cleaned. It will be noticed that by stretching the tongue the natural curves of the lingual artery are more or less obliterated.]

The **Lingual Artery** (Fig. 232) has been seen in its first stage between its origin from the external carotid to the posterior border of the hyo-glossus, lying upon the middle constrictor and the superior laryngeal nerve, and crossed by the digastric and stylo-hyoid muscles, the communicating facial vein, and the hypoglossal nerve. It is now seen in its *second stage* passing beneath the hyo-glossus (occasionally piercing its fibres), and running a short distance above the greater cornu of the hyoid bone between the hyo-glossus and genio-glossus, and below the terminal branch of the glosso-pharyngeal nerve. Its *third stage* begins at the anterior border of the hyo-glossus and lies between the genio-glossus and the mucous membrane and below the inferior lingualis, terminating at the tip of the tongue.

Its *branches* are four in number :—

1. The *Superior Hyoid* (13) arises in the first stage, running along the upper border of the hyoid bone, anastomosing with the inferior hyoid branch of the superior thyroid, and giving branches to the adjacent structures.

2. The *Dorsalis linguæ* (3) arises near the posterior border beneath the hyo-glossus, and ascends to the dorsum of the tongue, supplying the muscle and mucous membrane of the posterior part of the organ, and giving branches to the tonsils and pillars of the fauces. This vessel is sometimes of large size, and if the lingual artery is ligatured in front of it as a preliminary to excision of the tongue, severe hæmorrhage may accompany the operation.

3. The *Sublingual* (8), generally of good size, comes off under cover of the hyo-glossus, a little in front of the origin of the dorsal artery, and runs forwards between the genio-glossus and the sub-lingual gland, both of which it supplies. It gives branches also to the mucous membrane of the mouth and the inside of the gum, and anastomoses with its fellow and with the submental branch of the facial.

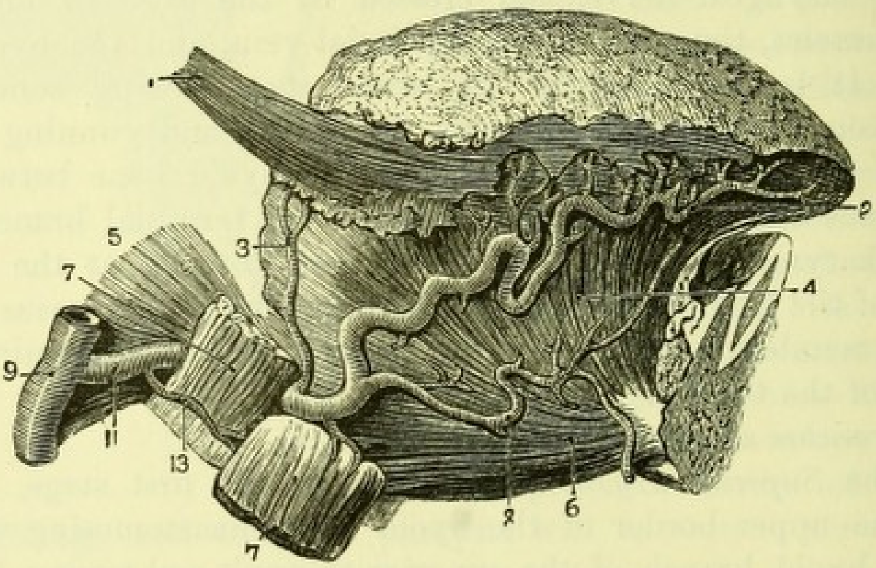
4. The *Ranine* (2) is the termination of the lingual artery, and lies upon the genio-glossus below the lingualis. It supplies the

muscle and mucous membrane, and is continued to the tip of the tongue, where it may anastomose, though slightly, with its fellow.

The anastomosis between the two lingual arteries in the middle line is very small, and consequently the tongue may be split mesially from apex to base without material loss of blood in the course of excision of the organ.

Surgery.—The lingual artery can be most conveniently tied in the triangle formed by the two bellies of the digastric and the hypo-glossal nerve, by dividing the fibres of the hyo-glossus horizontally near the hyoid bone. A curved incision from the symphysis menti

Fig. 232.



to near the angle of the jaw, reaching to the level of the hyoid bone, will show the lower border of the submaxillary gland, which must be raised so as to expose the digastric muscle. The hypo-glossal nerve, with the ranine vein, being drawn upwards, the hyo-glossus will be seen and can be divided. The author has on two occasions tied the lingual artery without difficulty by this method, which is much more satisfactory than attempting to find the vessel behind the great cornu of the hyoid bone.

The **Lingual Veins.**—Two small *venæ comites* accompany the lingual artery, and a large *ranine* vein passes superficially to the

Fig. 232.—Lingual artery and branches (from Hirschfeld and Leveillé).

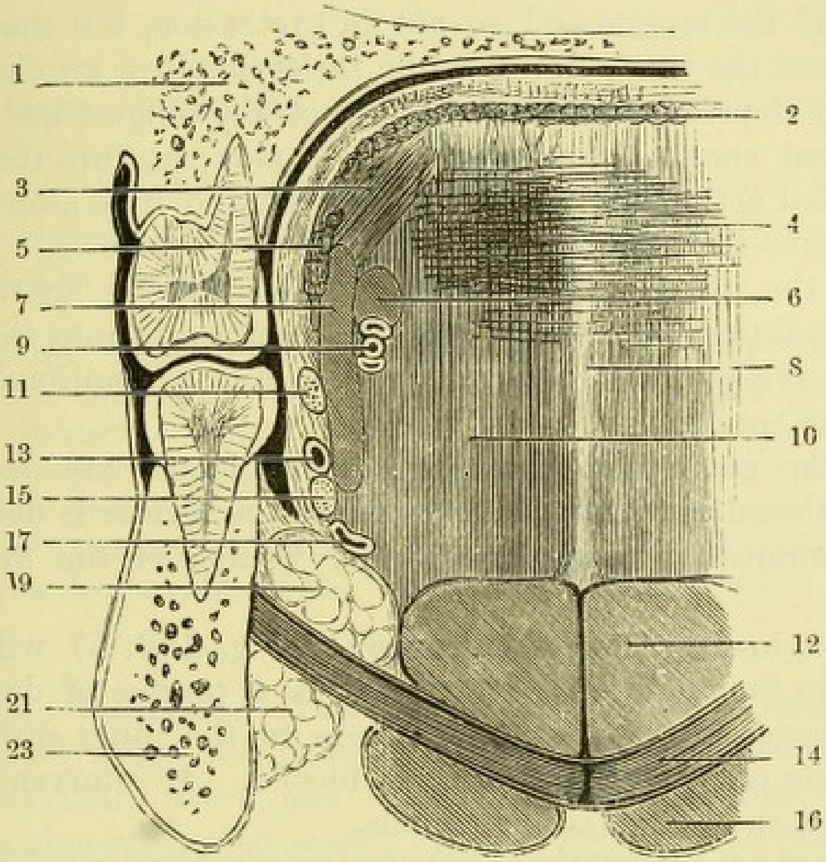
1. Stylo-glossus.
2. Ranine artery.
3. Dorsalis linguæ artery.
4. Genio-glossus muscle.
5. Middle constrictor.
6. Genio-hyoid muscle.

7, 7. Hyo-glossus (cut).
8. Sublingual artery.
9. External carotid artery.
11. Lingual artery.
13. Hyoid branch.

hyo-glossus muscle, with the hypoglossal nerve. These may unite with the *dorsalis linguæ* vein, or all three vessels may open separately into the internal jugular or the common facial vein.

The **Genio-hyoid** muscle (Fig. 232, 6) *arises* from the lower of

Fig. 233.



the two genial tubercles close to the symphysis menti, and passes backwards to be *inserted* into the body of the hyoid bone above the insertion of the mylo-hyoid. It is an elevator of the hyoid bone or depressor of the jaw, as it takes its fixed point from above or below, and retracts the lower jaw after it has been protruded.

The **Genio-glossus** muscle (Fig. 232, 4) *arises* from the upper

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Fig. 233.—Vertical section of the tongue in situ.

1. Superior maxilla.
2. Superior lingualis (longitudinal intrinsic fibres).
3. Oblique intrinsic fibres.
4. Transverse intrinsic fibres.
5. Stylo-glossus.
6. Inferior lingualis.
7. Hyo-glossus.
8. Median raphe.
9. Lingual artery and venæ comites.
10. Genio-glossus.
11. Lingual (gustatory) nerve.
12. Genio-hyoid.
13. Wharton's duct.
14. Mylo-hyoid.
15. Hypoglossal nerve.
16. Anterior belly of digastricus.
17. Ranine vein.
19. Sublingual gland.
21. Submaxillary gland (superficial portion).
23. Inferior maxilla.

genial tubercle. It is triangular or fan-shaped, and is *inserted* close to the median line all along the under surface of the tongue, a few fibres sometimes reaching the body of the hyoid bone above the genio-hyoid.

The genio-glossi assist the hyo-glossi in drawing the tongue towards the floor of the mouth ; their posterior fibres draw forwards the base of the tongue and so aid in protrusion, but their anterior fibres retract the tip. Acting while the stylo-glossi are elevating the sides, they depress the central portion of the tongue, and so form a longitudinal channel along which fluids may run into the pharynx. The isolated action of portions of the muscle may alter the form of the tongue in various ways.

When the genial attachments of these muscles are divided in tongue operations, the organ may fall backwards into the pharynx and cause symptoms of asphyxia, unless due precautions be taken against the accident.

Both the genio-hyoid and the genio-glossus are *supplied* by the hypoglossal nerve, but the branch to the former is derived from the communication from the anterior branch of the first cervical nerve.

The **Stylo-maxillary Ligament** (Fig. 226, 6) will be seen attached to the angle of the jaw. It is a process of deep cervical fascia, passing from the styloid process to the inner surface of the angle of the jaw, where it is much widened. It intervenes between the parotid and submaxillary glands.

The **Stylo-hyoid Ligament** is a narrow band passing from the styloid process downwards and forwards to the lesser cornu of the hyoid bone. It gives origin above to some fibres of the stylo-glossus, and below to fibres of the middle constrictor. It is frequently ossified to a considerable extent. With the styloid process and lesser cornu of the hyoid bone, it represents the second visceral arch of the embryo.

The **Inferior Palatine** and **Tonsillitic** branches of the *facial artery* can be seen ascending, the former between the stylo-glossus and stylo-pharyngeus muscles, and the latter either with it or between the stylo-glossus and pterygoideus internus, to the outside of the pharynx, where they lie upon the superior constrictor. They will be more fully seen in the dissection of the pharynx.

The **Glosso-pharyngeal Nerve** (Fig. 230, 11) (9th) is seen emerging from between the jugular vein and internal carotid artery, and winding round the outer surface of the stylo-pharyngeus muscle ; if the stylo-glossus be now divided, the nerve may be followed beneath that muscle to the base of the tongue, where it divides into two parts, and supplies gustatory filaments to the *papillæ circumvallatæ*, the mucous membrane of the sides and back of the tongue, the anterior surface and pharyngeal portion of the posterior surface of the epiglottis, the tonsils, and the pillars of the fauces. It also gives branches to the stylo-pharyngeus and to the pharynx in this part of its course. It will be seen again in another dissection.

Deep Dissection of the Side of the Neck.

It will be useful to make a deep dissection on one side of the subject, bringing into view parts which will be afterwards seen from behind in the dissection of the pharynx.

[Divide the internal lateral ligament of the lower jaw, and cut through the inferior dental and lingual nerves and reflect them carefully upwards. The branch to the internal pterygoid muscle, from the deep surface of the inferior maxillary nerve, can now be traced to the posterior border of the muscle, and in close connection with it may possibly be found a small pink body, the otic ganglion, lying on the deep aspect of the trunk of the third division of the fifth nerve.]

The **Otic Ganglion** (Fig. 234, 7) is seen as a small pinkish body situated below the foramen ovale, on the deep surface of the inferior maxillary nerve, and close to the cartilaginous portion of the Eustachian tube. Its *sensory root* is derived from the tympanic branch of the glosso-pharyngeal (Jacobson's nerve) through the small superficial petrosal nerve (long root of Arnold), by means of which nerve it is also probably placed in communication with the facial; its *motor root* (short root of Arnold) comes from the internal pterygoid nerve of the inferior maxillary division of the fifth; and its *sympathetic root*, which enters the ganglion behind, is given off from the plexus upon the middle meningeal artery.

The *communications* of the ganglion are six in number, four of which are with branches of the third division of the fifth, viz.: (1) buccal; (2) nerve to internal pterygoid *; (3) auriculo-temporal; (4) recurrent meningeal; a fifth with the chorda tympani; and a sixth with the Vidian, ending in Meckel's ganglion. The branch to the chorda tympani probably conveys glosso-pharyngeal filaments to the fungiform and filiform papillæ of the tongue.

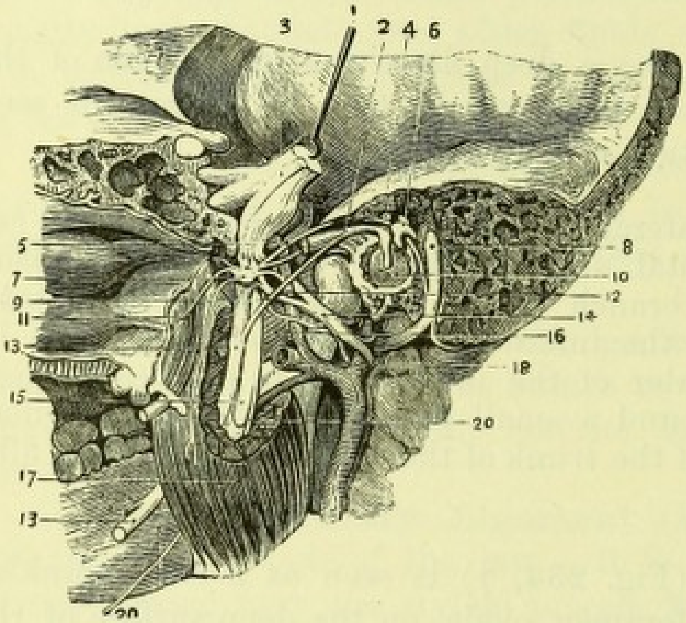
[The internal pterygoid muscle is to be cut through, and completely

* It is from this nerve and the ganglionic communication that the branches to the tensor tympani and tensor palati are derived.

removed from its attachment to the inner surface of the external pterygoid plate. The tensor palati lying upon the internal pterygoid plate will now be exposed, and posterior to it the superior constrictor of the pharynx, with the ascending pharyngeal artery lying upon the latter.]

The **Ascending Pharyngeal Artery** (Fig. 237, 9) can now be traced from the external carotid artery near its origin, along its course between the internal carotid and the pharynx. It gives branches to the prevertebral muscles, anastomosing with the ascending cervical artery, and near the base of the skull divides into palato-pharyngeal and meningeal branches.

Fig. 234.



The *meningeal branches* are very small, and enter the skull by the foramen lacerum medium and the foramen jugulare, to supply the dura mater.

The *palato-pharyngeal branches* supply the pharynx, and turn over the upper border of the superior constrictor to enter the soft palate, one accompanying the tendon of the tensor palati muscle.

The *pharyngeal veins* enter the pterygoid plexus and end in the internal maxillary trunk.

The **Tensor Palati** (Fig. 239, 4) is seen in part, but will be

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Fig. 234.—Internal view of the otic ganglion and tympanum (from Hirschfeld and Leveillé).

1. Sensory portion of 5th nerve with Gasserian ganglion.
2. Tensor tympani muscle.
3. Motor portion of 5th passing beneath the ganglion.
4. Malleus.
5. Small superficial petrosal nerve of Arnold.
6. Incus.
7. Otic ganglion.
8. Facial nerve.
9. Chorda tympani.
10. Membrana tympani.
11. Tensor palati muscle.
12. Middle meningeal artery.

13, 13. Lingual nerve (5th).

14. Auriculo-temporal nerve.
15. Inferior dental nerve (5th).
16. Pterygoideus externus.
17. Pterygoideus internus.
18. Internal maxillary artery.

20, 20. Mylo-hyoid nerve.

more fully exposed by cutting away the external pterygoid plate with bone-forceps. Its vertical fibres, covering the internal pterygoid plate, *arise* from the scaphoid fossa at the root of the internal plate, extending as far as the spine of the sphenoid; and from the outer surface of the cartilaginous portion of the Eustachian tube. The tendon winds round the hamular process to its *insertion* into the hard and soft palate; but this is obscured at present by the attachment of the fibres of the superior constrictor to the internal pterygoid plate. It is supplied by a branch from the nerve to the internal pterygoid, and may receive a few filaments from the communication of this nerve with the otic ganglion.

The **Superior Constrictor of the Pharynx** (Fig. 239, 7) is now seen *arising* from the inner surface of the lower third of the internal pterygoid plate and from the hamular process of the sphenoid bone; from the pterygoid maxillary ligament, which connects it with the buccinator; from the inner surface of the lower jaw above the posterior extremity of the mylo-hyoid ridge; and by deep fibres from the soft palate above, and from the side of the tongue below. The fibres curve backwards, leaving an interval between the muscle and the base of the skull in which is visible the fibrous aponeurosis of the pharynx, and are *inserted* into the pharyngeal spine and the median raphe of the pharynx (Fig. 237, 1). See also p. 523.

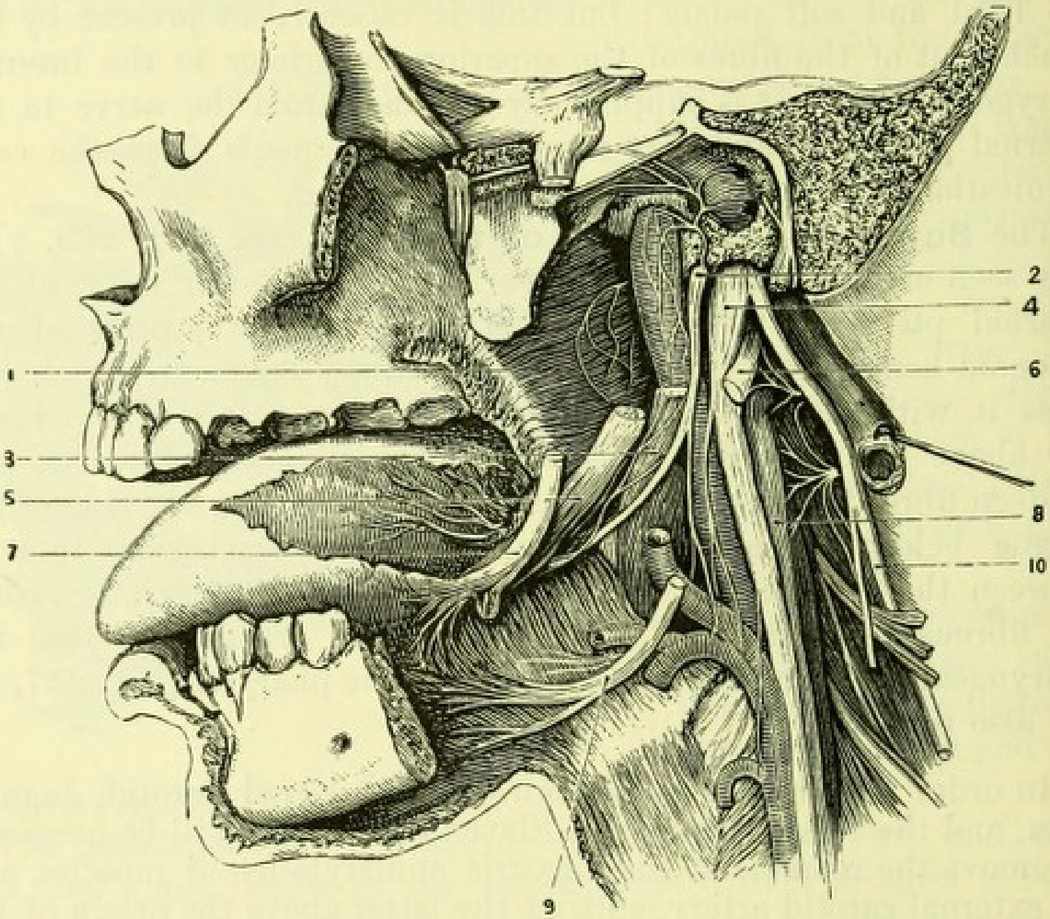
[In order to complete a side-view of the Internal Carotid, Jugular Vein, and the Ninth, Tenth and Eleventh nerves, it will be necessary to remove the remains of the digastric and stylo-hyoid muscles, and the external carotid artery, cutting the latter above the origin of the ascending pharyngeal branch. The stylo-glossus, which has been already dissected, will now be thoroughly exposed and should be carefully removed, when the Glosso-pharyngeal nerve lying upon the stylo-pharyngeus will be seen.]

The **Glosso-pharyngeal Nerve** (Fig. 235, 2) leaves the jugular foramen in front of the pneumo-gastric, and arches forward over the internal carotid artery to the stylo-pharyngeus muscle, against which it lies. Its further course has been traced (p. 506), but its connections and branches near the base of the skull cannot yet be seen.

The **Stylo-pharyngeus Muscle** (Fig. 235, 3) is now fully exposed in its *origin* from the inner surface of the root of the styloid process of the temporal bone. It will be seen passing obliquely forwards and downwards between the external and internal carotid arteries, to disappear between the superior and middle constrictors of the pharynx, and will be subsequently followed to its insertion.

The **Stylo-hyoid Ligament** appears between the stylo-glossus and stylo-pharyngeus muscles, giving origin to some fibres of the

Fig. 235.



stylo-hyoid above, and of the middle constrictor of the pharynx below. Its attachments have been already described (p. 506).

[The styloid process is to be cut through at its base and turned aside with the stylo-pharyngeus, when the careful removal of a process of fascia will expose the internal carotid, the jugular vein, and the glosso-pharyngeal, pneumo-gastric, spinal-accessory and hypoglossal nerves up to the base of the skull ; as well as the loop

Fig. 235.—The deep vessels and nerves of the base of the skull (from Hirschfeld and Leveillé).

1. Superior constrictor of pharynx.
2. Glosso-pharyngeal nerve.
3. Stylo-pharyngeus.
4. Pneumo-gastric nerve.
5. Stylo-glossus.
6. Hypoglossal nerve communicating with first cervical.
7. Lingual nerve (5th).
8. Superior cervical ganglion.
9. Hypoglossal nerve.
10. Spinal-accessory nerve.

between the first and second cervical nerves, and the superior cervical ganglion of the sympathetic. But, in order to show the nerves distinctly, the internal jugular vein is to be divided close to the jugular foramen, after its description has been read, and is to be turned down.]

The **Internal Carotid Artery** (Fig. 235) has been seen commencing at the point of bifurcation of the common carotid, usually opposite the upper border of the thyroid cartilage. It is at first external to and then beneath the external carotid, and, like it, is *covered by* the sterno-mastoid and platysma muscles, and crossed by the hypoglossal nerve, the occipital and posterior auricular arteries, and the digastric and stylo-hyoid muscles. It then lies beneath the parotid gland and to the inner side of the external carotid, and is separated from the latter by the styloid process, the stylo-pharyngeus muscle, the glosso-pharyngeal nerve, and the pharyngeal branch of the vagus. *Posteriorly* it rests against the sympathetic trunk and the rectus capitis anticus major, and is crossed, on the inner side and somewhat posteriorly, by the superior and external laryngeal branches of the pneumo-gastric. The pneumo-gastric nerve and internal jugular vein lie to its *outer* side in the whole of its course, except near the basis cranii, where they are posterior. The glosso-pharyngeal and hypoglossal nerves pass forwards between the artery and vein before crossing in front of the former; and the spinal-accessory nerve usually emerges between the two vessels and runs backwards and outwards in front of the vein, but occasionally passes behind it. To the *inner* side is the pharynx, with the tonsil and the ascending pharyngeal artery.

The artery enters the carotid canal of the temporal bone, in which it will be subsequently traced.

The **Internal Jugular Vein** (Fig. 235), which is formed by the junction of the lateral and inferior petrosal sinuses, commences outside the skull at the posterior part of the jugular foramen, in a dilatation called the *sinus* or *bulb*, the interval between the two formative vessels at the angle of junction being occupied by the ninth, tenth and eleventh nerves at their point of exit from the foramen. It lies at first behind the internal carotid artery in front of the rectus capitis lateralis, with the ninth, tenth, eleventh and twelfth nerves between, and afterwards descends on the outer side of the internal and common carotid arteries in the carotid sheath. It receives no branch above the hyoid bone, but below that level it is much increased in size by the influx of the lingual, facial, pharyngeal, and superior and middle thyroid veins; and finally joins the subclavian vein behind the inner end of the clavicle to form the innominate or brachio-cephalic vein (p. 450). Near the lower end is a single or double valve, often imperfect.

The **Pneumogastric** or **Vagus Nerve** (Fig. 235, 4) leaves the skull at the foramen jugulare, in front and to the inner side of the jugular vein, and in the same dural sheath as the spinal-accessory nerve. It follows the internal and common carotid arteries, lying between and behind them and the jugular vein, and in a separate compartment of the carotid sheath. Within the jugular foramen it forms an enlargement called the *jugular ganglion*, or *ganglion of the root*, from which arises an *auricular branch* (Arnold's nerve); and a little lower but close to the skull it is joined by the accessory portion of the spinal-accessory nerve, and expands to form the large *ganglion of the trunk*, from which the two following branches can now be traced. The nerve communicates with the hypoglossal, the spinal-accessory, the glosso-pharyngeal, the loop between the first two cervical nerves, and the upper ganglion of the sympathetic (see p. 519).

The *pharyngeal branch* (Fig. 209, 3) leaves the upper part of the ganglion of the trunk, and appears to be a continuation of the communicating fibres of the spinal-accessory nerve; it then passes in front of the internal carotid artery to the pharynx, where it joins the pharyngeal plexus (p. 521).

The *superior laryngeal nerve* (Fig. 209, 9) arises near the same point and takes an oblique course, behind and to the inner side of the internal carotid, beneath the lingual artery and upon the middle constrictor, to the thyro-hyoid membrane.

The *external laryngeal nerve* is a branch of the superior laryngeal. It arises about half an inch below the origin of the latter, and runs downwards and inwards along the upper border of the superior constrictor to supply the crico-thyroid and inferior constrictor muscles.

The cranial branches of the pneumo-gastric will be subsequently described (p. 519).

The **Spinal-Accessory Nerve** (Fig. 235, 10) leaves the jugular foramen in the dural sheath of the pneumo-gastric nerve. It gives *communicating branches* at or near the base of the skull to the trunk and both ganglia of the vagus, and to the superior cervical ganglion of the sympathetic, the branch to the lower ganglion of the vagus forming the pharyngeal and superior laryngeal branches of the latter. The principal or spinal part passes over or under the internal jugular vein, crosses the transverse process of the atlas, pierces and *supplies* the sterno-mastoid muscle, and ends in the trapezius after communicating freely with the third and fourth cervical nerves in the two muscles and in the posterior triangle (p. 416).

The **Hypoglossal Nerve** (Fig. 235, 6), emerging at the anterior condyloid foramen, comes forward between the pneumo-gastric and spinal-accessory nerves, being closely united with the ganglion of the trunk of the former nerve. It then passes outwards between the internal carotid artery and internal jugular vein, and crosses both the internal and external carotid arteries. It has branches of communication with the pneumo-gastric, the superior cervical ganglion, and the loop between the anterior branches of the first two cervical nerves, and gives a recurrent branch to the dura mater through the anterior condyloid foramen. Its distribution to the muscles of the hyoid bone and tongue has been already seen (p. 501).

The **Rectus Capitis Lateralis** (Fig. 236, 8) is now seen from the side, between the jugular vein and the vertebral artery. It *arises* from the upper surface of the transverse process of the atlas, and is *inserted* into the under surface of the jugular process of the occipital bone. It is supplied by a branch of the anterior division of the first cervical nerve. It slightly inclines the head laterally upon the atlas.

[By carefully removing the rectus lateralis, the small anterior branch of the first cervical nerve may be found beneath it upon the anterior arch of the atlas, forming a loop with the second nerve.]

The **First Cervical Nerve** (sub-occipital nerve) (Fig. 235) has a small anterior division, which leaves the posterior division on the posterior arch of the atlas. It runs forward beneath the vertebral artery, and lies on the anterior arch to the inner side of the rectus lateralis, which it supplies, giving also branches to the pneumo-gastric and the hypoglossal nerves, and to the superior ganglion of the sympathetic. In front of the vertebræ the first nerve forms a loop with the second cervical nerve, and supplies twigs to the two anterior recti.

The **Superior Cervical Ganglion** (Fig. 235, 8) of the sympathetic can now be seen. It is a fusiform enlargement of the sympathetic nerve, about an inch in length, lying behind the internal carotid artery, and upon the rectus capitis anticus major opposite the 1st, 2nd, and 3rd vertebræ. It gives branches of *communication* to the 9th, 10th, 11th, and 12th cranial nerves, to the four upper cervical nerves, and to the middle cervical ganglion; and branches of *distribution* (1) to the internal carotid artery, forming the carotid and cavernous plexuses; (2) to the branches of the external carotid artery (nervi molles); (3) to the pharyngeal plexus;

(4) laryngeal filaments which join the superior laryngeal artery; and (5) the *superior cardiac nerve* to the cardiac plexus (Fig. 238). It will be much more satisfactorily examined later on from behind (Fig. 237, 12). Its branches are very slender and lie in a delicate plane of connective tissue, from which they may be readily isolated in a fresh subject.

Prevertebral Region.

[The carotid arteries, with the jugular veins and the pneumogastric and sympathetic nerves, are to be divided at the level of the top of the sternum, and the trachea with the œsophagus is to be severed a little lower down. The neck is then to be bent forcibly backward so as to make the cut surface of the skull rest upon the table, and the œsophagus and trachea, with the vessels and nerves, being drawn forcibly forward, the cellular tissue between the pharynx and the front of the vertebral column is to be cautiously dissected through, until the under surface of the base of the skull is exposed. The saw is now to be applied in such a way that the section will pass vertically downwards through both external auditory meatus and emerge immediately in front of the anterior arch of the atlas, leaving the anterior part of the cranium and face with the pharynx and principal vessels and nerves, and the hinder part of the skull with the vertebral column and prevertebral muscles. This section will also give a very interesting view of the *auditory apparatus*, and if necessary, slices of the petrosa containing the middle and internal ear may be sawn off for subsequent study. The anterior part of the skull, with the pharynx and deep vessels and nerves, is to be wrapped up for subsequent examination, and the muscles attached to the vertebral column, with the posterior part of the skull, are now to be examined.]

The Scalene muscles have been seen already in part, but can now be fully dissected.

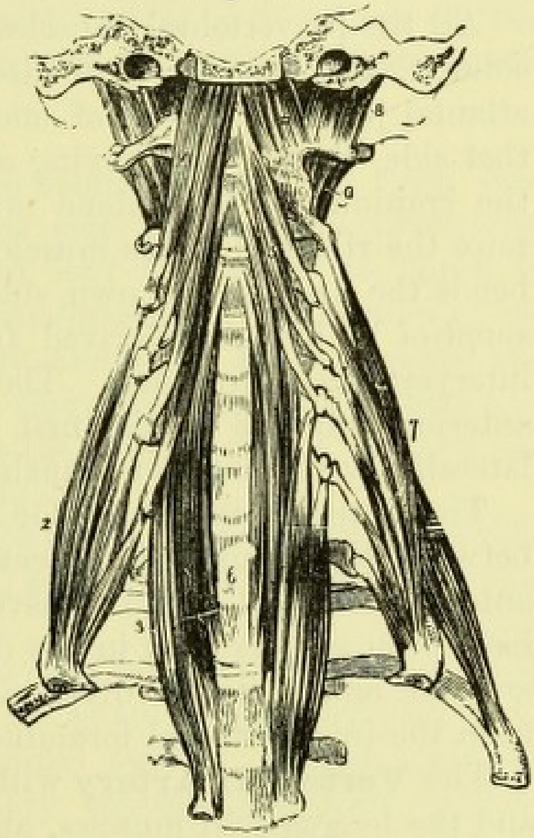
The **Scalenus Anticus** (Fig. 236, 2) *arises* from the tubercle on the inner border and upper surface of the first rib (scalene tubercle), and ascends to be *inserted* into the anterior tubercles on the transverse processes of the 3rd, 4th, 5th and 6th cervical vertebræ. A slip occasionally passes behind the subclavian artery and gives an expansion to the dome of the pleura. The phrenic nerve will be found on the anterior surface of the muscle, and behind it lie the cords of the brachial and lower part of the cervical plexuses, and the subclavian artery.

The **Scalenus Medius** (Fig. 236, 7) lies behind the subclavian artery and the cords of the cervical and brachial plexuses. It *arises* from the rough marking upon the upper surface of the first rib, behind the groove for the subclavian artery, and ascends to be *inserted* into the posterior tubercles on the transverse processes of the lower six cervical vertebræ.

The **Scalenus Posticus** (Fig. 236), the smallest of the three muscles, *arises* from a rough mark on the outer surface of the second rib, posterior to the attachment of the serratus magnus; and is *inserted* into the posterior tubercles on the transverse processes of the lowest three cervical vertebræ.

The **Rectus Capitis Anticus Major** (Fig. 236, 1) *arises* from the anterior tubercles on the transverse processes of the 3rd, 4th, 5th and 6th cervical vertebræ (thus corresponding to the insertion of the scalenus anticus), and is *inserted* into the under surface of the basilar process of the occipital bone. The insertions of this and the following muscles are very generally damaged by the section of the base of the skull.

Fig. 236.



The **Rectus Capitis Anticus Minor** (Fig. 236, 4) lies beneath the preceding muscle, which must be turned aside to show it. It *arises* from the front of the lateral mass of the atlas, and partly from its transverse process, and ascends obliquely inwards to be *inserted* into the under surface of the basilar process of the occipital bone, posterior to the rectus major.

The **Rectus Capitis Lateralis** (Fig. 236, 8) is now exposed, although not a prevertebral muscle (see p. 513).

The **Longus Colli** (Fig. 236) lies on the front of the cervical vertebræ, and is most conveniently divided into three portions, two oblique and one vertical.

Fig. 236.—Prevertebral muscles of the neck (from Wilson).

1. Rectus capitis anticus major.
2. Scalenus anticus.
3. Lower oblique part of the longus colli of the right side.
4. Rectus capitis anticus minor.
5. Upper oblique portion of the longus colli.
6. Vertical portion of longus colli.
7. Scalenus medius; behind which is seen the scalenus posticus.
8. Rectus lateralis, left side.
9. One of the inter-transversales.

The *inferior oblique portion* (3) *arises* from the bodies of the 1st, 2nd, and 3rd dorsal vertebræ, and passes obliquely upwards to be *inserted* into the transverse processes of the 5th and 6th cervical vertebræ.

The *superior oblique portion* (5) *arises* from the anterior tubercles on the transverse processes of the 3rd, 4th, and 5th cervical vertebræ, and passes upwards and outwards to be *inserted* into the anterior tubercle of the atlas.

The *vertical portion* (6) *arises* from the bodies of the two or three lower cervical and three upper dorsal vertebræ, and receives slips from the transverse processes of some of the lower cervical vertebræ. It is *inserted* into the bodies of the 2nd, 3rd, and 4th cervical vertebræ.

All the prevertebral muscles flex the upper part of the vertebral column, the anterior recti also bending the head at the occipito-atlantal joint; a muscle of one side acting alone draws the spine to that side, the anterior having also a slight but similar action upon the cranium. The scalene muscles, when the vertebræ are fixed, raise the ribs and act as muscles of inspiration. The rectus lateralis bends the head to its own side. The scaleni and longus colli are *supplied* by branches derived from the cervical nerves close to the intervertebral foramina. The recti antici are *supplied* by the anterior branches of the first and second cervical, and the rectus lateralis by the anterior branch of the first cervical nerve.

The anterior and posterior *Intertransverse muscles* may be seen between the transverse processes. The *anterior* pass between the anterior tubercles of the transverse processes; and the *posterior* ones have been already seen in the dissection of the back separating the anterior and posterior divisions of the cervical nerves at their exit from the intervertebral foramina.

The **Vertebral Artery** will be seen between the scalenus anticus and the longus colli muscles, and may be more conveniently traced through the foramina in the transverse processes now than at an earlier period (*v.* p. 452). The anterior divisions of the cervical nerves pass behind the vertebral vessels and in front of the posterior intertransverse muscles.

Dissection of the Pharynx.

Before dissecting the anterior half of the skull with the pharynx, the dissector should examine the fauces and upper part of the pharynx from the mouth. The soft palate, with the uvula in the median line, will be readily recognised, and passing from the soft palate on each side will be seen the two pillars of the fauces, with the tonsil between them. The anterior pillar extends vertically from the soft palate to the side of the tongue, and is formed by a fold of mucous membrane in which the palato-glossus muscle usually lies. The posterior pillar passes obliquely backwards, to the posterior wall of the pharynx, and is formed by a similar fold occupied by the palato-pharyngeus muscle. The tonsil is generally much shrunken in a subject which has arrived at this stage of dissection.

[The pharynx and upper part of the œsophagus are to be carefully distended with cotton-wool or tow, and the preparation being placed with the face downwards is to be secured over a small block with hooks, one set of which should draw the œsophagus down and keep the pharynx tense. The vessels and nerves at the back of the pharynx are to be examined before the pharyngeal structures are dissected.]

The vessels and nerves now to be examined have all been seen in part from either the front or the side in previous dissections. They are now all seen from behind, and this must be borne in mind, or the description will be misunderstood. The section of the base of the skull is seldom precisely similar on the two sides, and it will generally be found advisable therefore to trace the parts first brought into view on one side; and the carotid artery, etc., on the other, as in the illustration (Fig. 237).

The **Sympathetic Nerve** (Fig. 237), with its superior and middle cervical ganglia, is at once exposed, and some of its branches may be very conveniently traced.

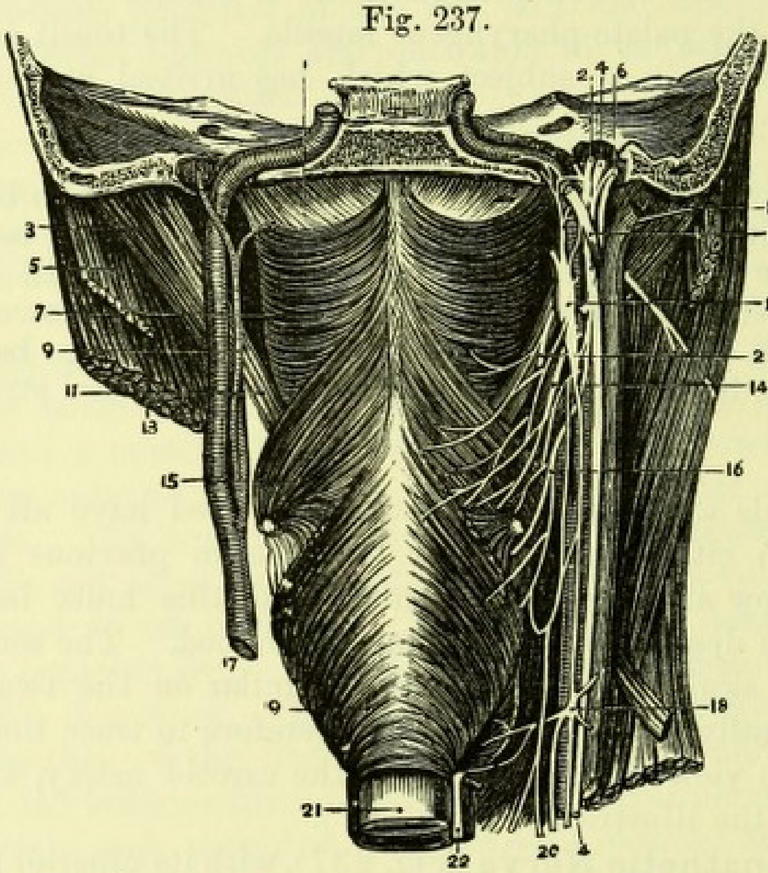
The *Superior cervical ganglion* (12) has been described on p. 513.

The *Middle cervical ganglion* (18) is of small size and is usually connected with the 5th and 6th spinal nerves. It lies upon the curve of the inferior thyroid artery opposite the sixth cervical vertebra, and gives off (1) *thyroid* branches upon the inferior thyroid artery; (2) the *middle cardiac nerve* (Fig. 238), and two or three descending branches of *communication*, which pass in front of and behind the first portion of the subclavian artery to form a loop known as the *ansa Vieussenii*, and join the inferior cervical ganglion.

The *Inferior cervical ganglion* lies below the transverse process of the last cervical vertebra and upon the neck of the first rib, and may be seen just above the first portion of the subclavian artery between the origins of the vertebral and superior intercostal arteries, and behind the inferior thyroid artery. It receives *communications* from the 7th and 8th cervical nerves, and from the middle cervical and first dorsal ganglia. Its branches of *distribution* are two filaments to the vertebral artery, branches to the subclavian artery, and the *inferior cardiac nerve* to the deep cardiac plexus.

The **Twelfth** or **Hypoglossal Nerve** (Fig. 237, 10) is necessarily cut off at the anterior condyloid foramen in making

Fig. 237.



the dissection, and should therefore be traced from below, where it will be found in relation with the occipital artery. The nerve has been described on pp. 501 and 513.

The **Internal Jugular Vein** (Fig. 237, 8) is exposed at its origin. Its course in the neck has been already seen (p. 511), and

Fig. 237.—Dissection of the pharynx with the carotid vessels and the ninth, tenth, and sympathetic nerves (drawn by J. T. Gray).

1. Fibrous bag of pharynx.
2, 2. Glosso-pharyngeal nerve.
3. Posterior belly of digastric.
4, 4. Pneumo-gastric nerve.
5. Splenius capitis.
6. Spinal-accessory nerve.
7. Superior constrictor of pharynx.
8. Internal jugular vein.
9. Ascending pharyngeal artery.
10. Hypoglossal nerve.
11. Stylo-pharyngeus.
12. Superior ganglion of sympathetic.
13. Sterno-mastoid.
14. Pharyngeal branch of pneumo-gastric.
15. Middle constrictor of pharynx.
16. Superior laryngeal nerve.
17. Common carotid artery.
18. Middle ganglion of sympathetic.
19. Inferior constrictor of pharynx.
20. Cardiac nerves.
21. Œsophagus.
22. Recurrent laryngeal nerve.

it should now be divided close to the skull and removed, if this has not been previously done.

The **Spinal-accessory Nerve** (Fig. 237, 6) emerges from the foramen jugulare, where it is closely connected with the pneumo-gastric nerve, and may be traced to the deep surface of the sterno-mastoid muscle. Its relation to the transverse process of the atlas should be noticed, since it is here that it might be exposed for surgical treatment in cases of spasmodic torticollis (Fig. 235, 10).

The **Pneumo-gastric Nerve** (Fig. 237, 4) leaves the foramen jugulare in the same sheath as the spinal-accessory nerve, with which it has communicating branches. Two ganglia are found upon the pneumo-gastric nerve, viz., the superior or ganglion of the root, and the inferior or ganglion of the trunk (see p. 512).

The *ganglion of the root* is very small, and is placed in the jugular foramen. It has minute branches of communication with the glosso-pharyngeal spinal accessory, and superior cervical ganglion, and gives off a *recurrent meningeal branch* to the dura mater and an *auricular* branch (*Arnold's nerve*). The *Auricular branch* enters a hole within the jugular fossa, and passes through the temporal bone to escape at the auricular fissure between the mastoid process and petrosa (Fig. 238, 17); it may communicate with the trunk of the facial in the aqueductus Fallopii, and on emerging from the auricular fissure it divides into two branches, both of which communicate with the posterior auricular branch of the facial and supply the back of the concha. It is sometimes called the "alderman's nerve" because it is supposed to be the source of a premonitory gouty pain near the entrance of the external meatus.

The *ganglion of the trunk* is three-quarters of an inch long, and of a pink colour, and has branches of communication with the spinal-accessory, hypoglossal, superior cervical ganglion, and the loop between the first and second cervical nerves. It gives off pharyngeal and superior laryngeal branches, which have been described at p. 512.

The *cervical cardiac* branches, two or three in number, are slender filaments arising a little below the ganglion of the trunk; communicating usually with the external laryngeal, and ending on the left side in the superficial cardiac plexus, and on the right in the deep plexus.

The **Glosso-pharyngeal Nerve** (Fig. 237, 2) lies in a little special notch in the lower border of the petrous bone as it leaves the jugular foramen, and is separated from the tenth and eleventh nerves by a process of dura mater. Its further course has been already traced (pp. 506 and 509).

It presents two small ganglia, one at the upper part of the foramen, the *superior* or *jugular ganglion*, which is of very small size, and the other at the lower part of the foramen, which is larger, and is called the *inferior* or *petrous ganglion* or *ganglion of Andersch* (Fig. 238, 2).

Fig. 238.

The upper ganglion involves only some of the fibres of the nerve, but all pass through the lower ganglion.

The lower ganglion gives five branches of *communication*, one with the superior ganglion of the vagus, one to the auricular branch of the same nerve; one with the superior ganglion of the sympathetic; one with the facial nerve and carotid plexus through Jacobson's nerve (see p. 521), and a fifth with the spinal accessory (Fig. 238).

The glosso-pharyngeal nerve gives off the following branches in its course to the tongue :—

1. *Carotid branches*, which join the sympathetic plexus on that vessel, and communicate with the pharyngeal branch of the pneumogastric.

2. A *muscular branch* to the stylo-pharyngeus, probably derived from the spinal accessory.

Fig. 238.—Diagram of the ninth, tenth, eleventh, twelfth, and sympathetic nerves (from Hirschfeld and Leveillé).

1. Facial nerve.
2. Glosso-pharyngeal nerve with its petrous ganglion.
3. Pneumo-gastric nerve.
4. Spinal-accessory nerve.
5. Hypoglossal nerve.

3. *Pharyngeal branches*, which assist in forming the pharyngeal plexus, and supply the constrictors and mucosa. The motor filaments probably come from the spinal-accessory communication.

4. *Tonsilitic branches* to the tonsils and the soft palate.

5. *Lingual branches*, which have been before traced to their termination (p. 506).

[By cautiously cutting away the temporal bone with the bone-forceps so as to open the cavity of the tympanum, the dissector may, in a favourable subject, see some of the branches of Jacobson's nerve on the inner wall of this cavity.]

The *Tympanic branch of the glosso-pharyngeal nerve* (Jacobson's nerve) (Fig. 238, 9) arises from the petrous ganglion, and enters an aperture in the ridge of bone between the carotid foramen and the jugular fossa. It pierces the floor of the tympanum and grooves the *promontory* on the inner wall of the cavity, giving branches to the *fenestra ovalis* (12), the *fenestra rotunda* (13), and the lining membrane of the tympanum and Eustachian tube (11). The *communicating branches* are three in number: one joining the carotid plexus in the carotid canal (10); the second to the great superficial petrosal nerve (15); and the third running through the temporal bone to the otic ganglion, as the small superficial petrosal nerve of Arnold (14). (*See* also Fig. 234.) This probably conveys gustatory fibres to the chorda tympani.

Opportunity may be taken at this point to examine the ossicles of the tympanum (p. 550).

The **Pharyngeal Plexus** (Figs. 237 and 238) is to be found upon the middle and inferior constrictors of the pharynx. It supplies the constrictors and sends branches to the mucous membrane of the pharynx, tongue and larynx. Minute ganglia are sometimes seen

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6. Superior cervical ganglion of sympathetic.
7. Loop between 1st and 2nd cervical nerves.
8. Carotid branch of sympathetic.
9. Tympanic nerve (Jacobson).
10. Its branch to carotid plexus.
11. Its branch to Eustachian tube.
12. Its branch to fenestra ovalis.
13. Its branch to fenestra rotunda.
14. Its union with small superficial petrosal nerve.
15. Its union with large superficial petrosal nerve.
16. Otic ganglion.
17. Auricular nerve of pneumo-gastric.
18. Junction of pneumo-gastric with spinal-accessory.
19. Junction of hypoglossal nerve and 1st cervical nerve.
20. Junction of mastoid branch of spinal-accessory and 2nd cervical nerve.
21. Pharyngeal plexus.
22. Superior laryngeal nerve.
23. External laryngeal nerve.
24. Middle cervical ganglion of sympathetic.
25. Junction of digastric nerve (7th) with glosso-pharyngeal.

on the nerves. The branches forming the plexus are derived from the nerves which have been examined, viz., the glosso-pharyngeal, the pneumo-gastric (pharyngeal and superior laryngeal branches), and the superior cervical ganglion of the sympathetic.

[In all probability the carotid canal in the temporal bone will have been opened on one or both sides in making the section of the skull, but if not, this may now be done with the bone-forceps or chisel.]

The **Internal Carotid Artery** (Fig. 237) has been already seen from the front in the dissection of the neck; its connections before it enters the skull are given at p. 511.

The artery takes a tortuous course in the temporal bone and cranium, making two sigmoid turns, one, the longer, in the petrous bone, and the other by the side of the sella turcica in its petrosal curve; it lies in close relation to the anterior inferior part of the inner wall of the tympanum, and may be involved in tubercular disease of the middle ear or wounded in puncturing the tympanic membrane. In this part of its course it is more or less surrounded by a plexus of nerves derived principally from the superior cervical ganglion of the sympathetic.

The **Ascending Pharyngeal Artery** has been described at p. 508. Its *vein* opens into the internal jugular.

[The constrictor muscles of the pharynx are to be cleaned in the direction of the fibres by removing the pharyngeal fascia which covers them, beginning at the lower border of the inferior constrictor. In order to see the origin of the superior constrictor, it will be necessary to remove the internal pterygoid on one side, if this has not been already done. The pharyngeal plexus must necessarily be destroyed in the course of the dissection, but the superior and inferior laryngeal, and the glosso-pharyngeal nerves are to be preserved.]

The Pharynx is now seen as a plane of muscle invested on both sides by fibrous tissue, and lined anteriorly or internally by mucous membrane continuous with that of the respiratory and digestive passages and the tympana. It is fixed to the base of the skull above and merges into the œsophagus below, at the level of the lower border of the sixth cervical vertebra. Its lateral borders are curved forwards and are attached in succession to the internal pterygoid plate and its hamular process, to the pterygo-maxillary ligament (or becomes directly continuous with the buccinator), to the posterior extremity of the mylo-hyoid ridge of the lower jaw, to the stylo-hyoid ligament and the lesser and greater cornua of the hyoid bone, and to the thyroid and cricoid cartilages. It is also connected by accessory slips to the soft palate and side of the tongue.

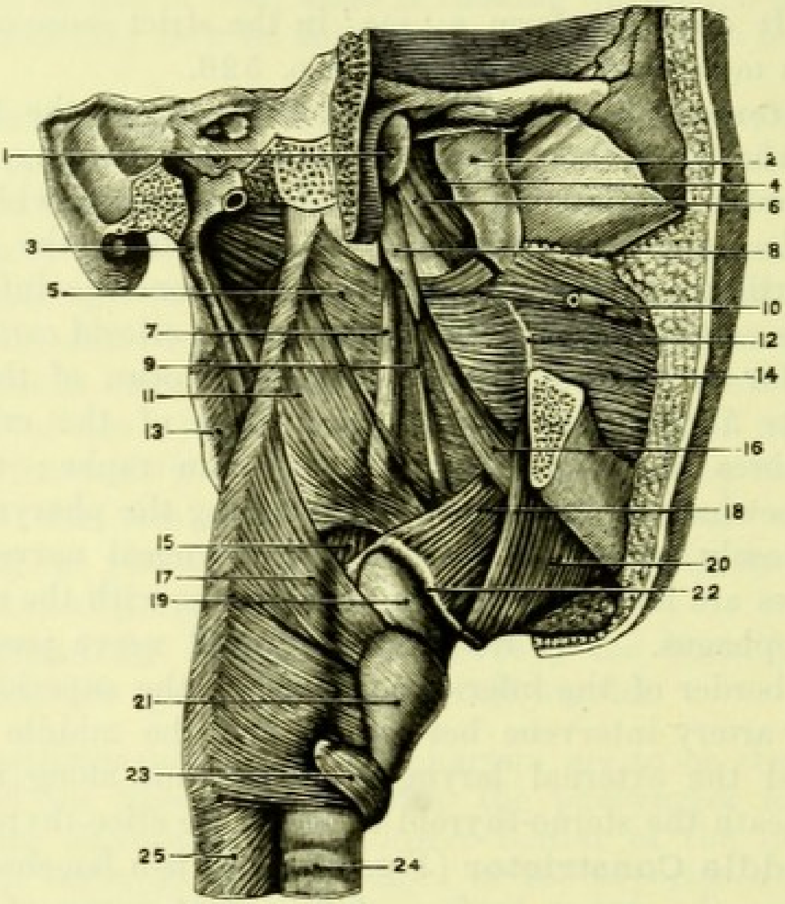
It is about six inches in length. When *in situ* it lies flat against the vertebral column and prevertebral muscles in the greater part of its extent, curving forward only at its lateral attached borders. It does not form a 'sac' in the strict sense of the term. Its mucous membrane is described on p. 526.

The **Inferior Constrictor** (Fig. 239, 17) is the lowest and most superficial of the three muscles of the pharynx, the upper oblique border overlapping the middle constrictor, which in turn overlaps the superior constrictor. It *arises* from the ala of the thyroid cartilage behind the oblique line, from the inferior cornu of the same cartilage, and from the side of the cricoid cartilage below the facet for articulation with the inferior cornu of the thyroid; some of its fibres often passing into those of the crico-thyroid. All the fibres are *inserted* into the median raphe; the highest ascend somewhat steeply, sometimes reaching the pharyngeal spine, and are closely related to the external laryngeal nerve, while the lowest fibres are horizontal and are continuous with the upper fibres of the œsophagus. The recurrent laryngeal nerve passes beneath the lower border of the inferior constrictor; the superior laryngeal nerve and artery intervene between it and the middle constrictor above; and the external laryngeal nerve runs along its attached border beneath the sterno-thyroid to reach the crico-thyroid.

The **Middle Constrictor** (Fig. 239, 11) is a fan-shaped muscle *arising* from the upper surface of the great cornu of the hyoid bone, from the lesser cornu, and from the stylo-hyoid ligament. Its fibres radiate, the upper ascending nearly as far as the pharyngeal spine; and it is *inserted* into the median raphe of the pharynx, overlapped by the inferior, and overlapping the superior constrictor. It is separated from the superior constrictor by the stylo-pharyngeus muscle.

The **Superior Constrictor** (Fig. 239, 5) *arises* from the lower third of the internal pterygoid plate and from the hamular process of the sphenoid bone; from the pterygo-maxillary ligament opposite the attachment of the buccinator; from the inner surface of the lower jaw above the posterior extremity of the mylo-hyoid ridge; and by deep slips from the soft palate and from the side of the root of the tongue. The fibres curve backwards, leaving an interval above, between the muscle and the base of the skull, in which the fibrous aponeurosis of the pharynx is visible; and are *inserted* into the median raphe and pharyngeal spine, being overlapped at the lower part by the middle constrictor and sometimes also by the inferior constrictor. The stylo-pharyngeus muscle is related to it laterally, and passes between its lower fibres and the upper portion of the middle constrictor. The levator palati muscle

Fig. 239.



and the Eustachian tube cross obliquely inwards above the upper curved border, and the palatine branch of the ascending pharyngeal artery follows the same course.

The three constrictors are *supplied* by the pharyngeal plexus of

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Fig. 239.—Side view of the pharynx (from Sappey).

1. Eustachian tube.
2. External pterygoid plate.
3. Left styloid process.
4. Tensor palati.
5. Superior constrictor.
6. Levator palati.
7. Stylo-pharyngeus, upper part.
8. Right styloid process.
9. Stylo-hyoid muscle.
10. Stenson's duct.
11. Middle constrictor.
12. Pterygo-maxillary ligament.
13. Internal pterygoid.
14. Buccinator muscle.
15. Stylo-pharyngeus, lower part.
16. Stylo-glossus.
17. Inferior constrictor.
18. Hyo-glossus.
19. Thyro-hyoid membrane,
20. Mylo-hyoid muscle.
21. Thyroid cartilage.
22. Hyoid bone.
23. Crico-thyroid muscle.
24. Trachea.
25. Œsophagus.

nerves; the superior has also branches from the glosso-pharyngeal, and the inferior from the external and recurrent laryngeal nerves.

Their chief *action* is to contract above the portion of swallowed fluid or food in such a way as to force it in the direction of the stomach, and this they are able to accomplish even against gravitation. The palatal fibres of the superior constrictor have also the important function of shutting off the communication between the nasal and buccal portions of the pharynx during deglutition, and are aided in this by the contraction of the palato-pharyngei, which bring together the posterior pillars of the fauces. The superior, almost vertical, fibres of the inferior constrictor help to raise the larynx and lower part of the pharynx.

The **Stylo-Pharyngeus Muscle** (Fig. 239, 7) has already been seen at its origin, and can now be followed to its insertion by dividing some of the fibres of the middle constrictor. It *arises* from the root of the styloid process of the temporal bone, and passes downwards by the side of the superior constrictor, then beneath the upper border of the middle constrictor, and expands between the two muscles to be *inserted* into the median raphe and muscular wall of the lower part of the pharynx, and into the posterior border of the thyroid cartilage. Slender fasciculi may also be traced in some subjects to the upper border of the thyroid cartilage and side of the epiglottis. It is *supplied* by the glosso-pharyngeal nerve, which winds around it to reach the back of the tongue.

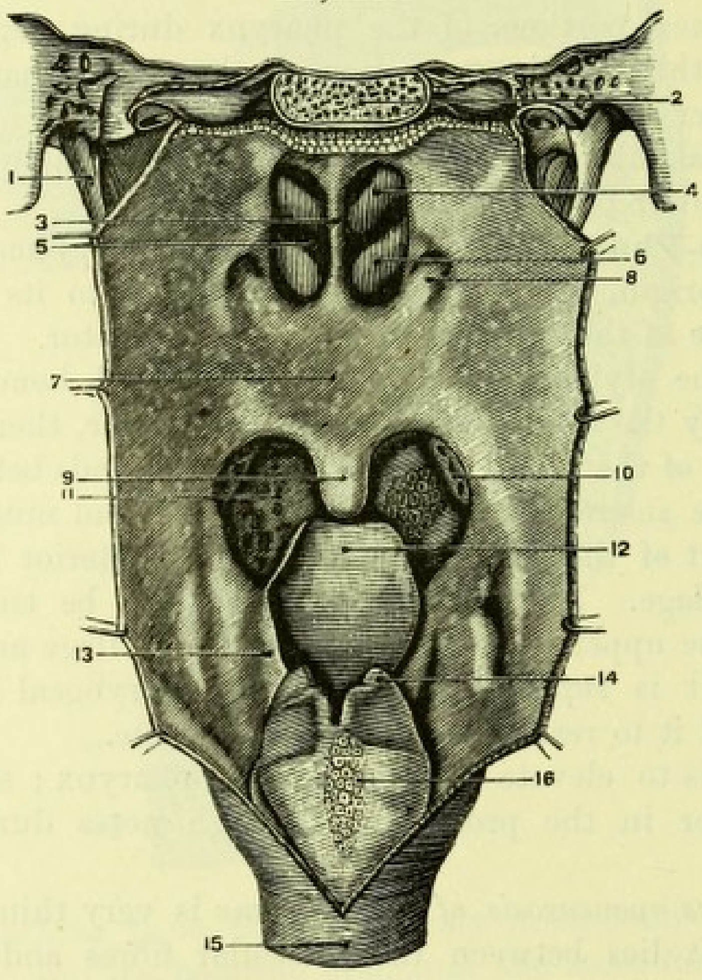
Its *action* is to elevate the larynx and pharynx; so assisting in deglutition, or in the production of high notes during vocalisation.

The *Fibrous aponeurosis of the Pharynx* is very thin at the lower part, where it lies between the muscular fibres and the mucous membrane, but above the upper border of the superior constrictor it is much stronger, and is expanded from side to side, covering in the Eustachian tubes and the levatores palati muscles. At the base of the skull it is attached to the basilar process of the occipital bone by a fibrous band (*cranio-pharyngeal ligament*), to the Eustachian tube, and to the under surface of the petrous portion of the temporal bone; and is carried forwards as far as the root of the pterygoid process and the internal pterygoid plate of the sphenoid bone.

[The pharynx is to be opened from behind by an incision in the median line from the basilar process to the commencement of the œsophagus. The fibrous aponeurosis is to be detached from the occipital bone on each side and held widely open with hooks, and the whole of the cotton-wool is to be removed from the interior of the pharynx.]

The **Mucous Surface** or **Interior of the Pharynx** (Fig. 240) is in communication with the nose, ears, mouth, larynx, and œsophagus by the following seven openings named in order from above downwards; (1 and 2) the two posterior nares (*choanæ*), separated by the vomer; (3 and 4) the two Eustachian tubes; (5) the *isthmus*

Fig. 240.



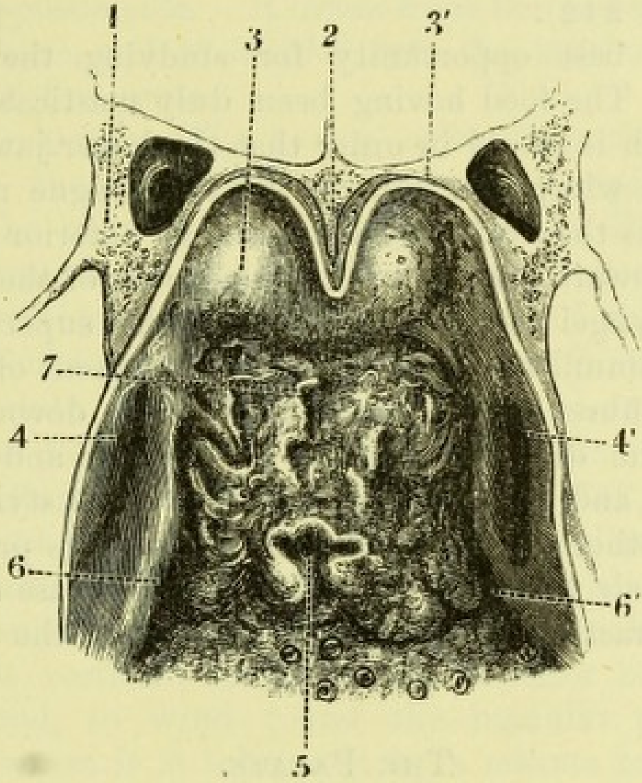
faucium or opening of the mouth, bounded above by the soft palate, below by the tongue, and at the sides by the anterior pillars of the fauces; (6) the superior aperture of the larynx, guarded by the epiglottis; and (7) the commencement of the œsophagus.

Fig. 240.—Pharynx laid open from behind (from Sappey).

1. Styloid process.
2. Body of occipital bone.
3. Septum nasi.
4. Middle turbinate bone.
5. Posterior naris.
6. Inferior turbinate bone.
7. Soft palate.
8. Eustachian tube.
9. Uvula.
10. Tonsil.
11. Back of tongue.
12. Epiglottis.
13. Arytæno-epiglottidean fold.
14. Tip of arytænoid cartilage.
15. Œsophagus.
16. Back of cricoid cartilage.

The character of the epithelium varies in different situations, being squamous below the level of the palate, but columnar and ciliated above that point. Close to the base of the skull is a collection of follicular glands, extending across from one Eustachian tube to the other, and forming the *pharyngeal tonsil* of Kölliker (Fig. 241).

Fig. 241.



These glands are hypertrophied in cases of congenital cleft-palate, when they can be readily seen, and appear to assist in closing the communication between the nose and the mouth during deglutition. In the median line, beneath the basilar process of the occipital bone, may be seen a depression called the *bursa pharyngea*, which represents the remains of an opening which in early fœtal life passes through the base of the cranium into the pituitary fossa. The shallow pouch on each side above the upper border of the superior constrictor, where the pharyngeal wall is deficient in muscular fibres, is known as the *sinus of Morgagni*.

The opening of the Eustachian tube appears behind the lower

Fig. 241.—The posterior wall of the pharynx.

1. Sphenoid.
2. Vomer.
3. Posterior end of nasal fossa.
3′. Cut edge of mucous membrane.
4, 4′. Opening of Eustachian tube.
5. Opening of bursa pharyngea.
6, 6′. Recessus pharyngeus.
7. Adenoid tissue of pharynx.

part of the aperture of the posterior nares, about half an inch posterior to the hinder extremity of the inferior turbinate body, and the free extremity of the cartilage forms a distinct projection (*tubal eminence*) behind the orifice. Behind the tubal eminence is a deep recess, the *fossette of Rosenmüller* (into which a wrongly-directed Eustachian catheter might readily slip), and below it may be seen the rounded ridge of the levator palati descending to the soft palate (Fig. 242).

This is the best opportunity for studying the **Process of Deglutition.** The food having been duly masticated and insalivated, the mouth is closed in order that the lower jaw may afford a fixed point from which the muscles of the tongue may act. The portion of food is then carried back past the anterior pillars of the fauces by the upward and backward movement of the tongue, while the palato-pharyngei and palatal fibres of the superior constrictor shut off the communication with the nasal segment of the pharynx. The constrictor fibres now contract from above downwards, forcing the bolus in the direction of the œsophagus, and at the same time the larynx and pharynx are elevated by the stylo- and palato-pharyngei and other muscles, and the epiglottis is pressed over the aperture of the air passage against the retracted base of the tongue. Lastly, the contraction of the œsophagus carries the food down to the stomach.

The Palate.

[The soft palate is to be stretched by inserting a hook into the uvula, and the mucous membrane is to be removed from the upper surface of the palate and the neighbouring bones, so as to expose the muscles above the palate and the Eustachian tube. The levator palati will be found passing obliquely inwards, the azygos uvulæ in the median line of the palate, and the tensor palati can be best seen by dividing the levator and detaching the fibres of the superior constrictor from the hamular process, when the muscle will be found upon the internal pterygoid plate, between it and the internal pterygoid.]

The **Soft Palate** (*velum pendulum palati*) is a musculo-membranous curtain attached to the posterior border of the hard palate in front, and terminating behind in a free border, to the middle of which is appended the *uvula.* It consists of a strong fibrous aponeurosis attached to the palate bones; a number of muscles connected with the hard palate, the base of the skull, the pharynx, and the tongue; and a covering of mucous membrane on both its surfaces, that on the oral surface presenting a thick layer of mucous glands. From behind forwards the soft palate comprises 1. Pharyngeal mucous membrane ; 2. Thin attachment of palato-pharyngei ; 3. Azygos uvulæ ; 4. Levatores palati ; 5. Thicker attachment of palato-pharyngei ; 6. Tensores palati ; 7. Fibrous aponeurosis ; 8. Palato-glossi ; 9. Oral mucous membrane with mucous glands.

The **Azygos Uvulæ** (Fig. 242, 8) consists of a small muscular slip, placed parallel to the median line and in close contact with its fellow of the opposite side. It *arises* from the posterior nasal spine of the palate bone, and is *inserted* into the mucous membrane of the extremity of the uvula.

The **Levator Palati** (Fig. 242, 5) *arises* from the under surface of the apex of the petrous portion of the temporal bone, and slightly from the outer and hinder part of the Eustachian tube. It passes inwards above the border of the superior constrictor muscle, in a direction almost parallel to that of the cartilaginous portion of the Eustachian tube and in contact with its outer surface, and is *inserted* into the soft palate by a broad expansion, which meets that of its fellow muscle in the median line.

The **Circumflexus** or **Tensor Palati** (Fig. 242, 6) arises *above* from the scaphoid fossa at the root of the internal pterygoid plate, extending outwards as far as the spine of the sphenoid bone ; and from the outer surface of the cartilage of the Eustachian tube. The tendon descends vertically between the superior constrictor and internal pterygoid, to wind round the hamular process of the sphenoid bone, where it is lubricated by a minute bursa, and then taking a horizontal direction becomes *inserted* into the transverse ridge on the under surface of the palate bone, and, by means of a strong fan-like expansion of tendinous fibres, into the aponeurosis of the soft palate, meeting with the fibres of the opposite muscle in the middle line.

The **Palato-glossus** lies immediately above the buccal layer of mucous membrane of the soft palate, and descends in front of the tonsil in the anterior pillar of the fauces, to enter the side of the hinder portion of the tongue. It is attached *above* to the anterior portion of the soft palate, meeting its fellow in the median line, and *below* joins with the posterior transverse intrinsic fibres of the tongue. The two muscles together form a faucial sphincter.

The **Palato-pharyngeus** (Fig. 242, 9) is attached *above* to the soft palate and its fibrous aponeurosis by two slips, which are separated by fibres of the levator palati and azygos uvulæ, and meet in the middle line with the fellow muscle of the opposite side. It descends behind the tonsil in the posterior pillar of the fauces ; its fibres then diverge, and becoming closely connected with those of the stylo-pharyngeus, reach their *lower* attachment to the posterior borders of the thyroid cartilage, and into the pharynx, blending with the constrictors, and extending behind as far as the median raphe. The muscle may thus be divided into palato-laryngeal and palato-pharyngeal portions, the latter forming, with the corresponding fibres of the opposite side, an oblique elliptical sphincter between the nasal and buccal portions of the pharynx.

The **Salpingo-pharyngeus** is an inconstant slip, extending from the cartilaginous portion of the Eustachian tube to join the outer fibres of the palato-pharyngeus, of which it may be regarded as a part.

Actions.—The *levatores palati* raise the soft palate, and are of service in vocalisation. They probably have no action upon the Eustachian tubes. The *tensores palati* render the anterior part of the soft palate tense and resistent, during the passage of the bolus of food beneath it during deglutition: at the same time they open the Eustachian tubes, their palatal attachment then representing the origin and the tubal fibres the insertion of the muscles. The two *azygos uvulæ* shorten the soft palate and uvula. The *palato-glossi* narrow the isthmus faucii sphincterically, and so bring the gustatory mucous membrane into close contact with the food during its passage. The *palato-pharyngei* draw down the soft palate, and, meeting in the middle line, shut off the buccal portion of the pharynx from the nasal portion and form an inclined plane along which the food can glide. They are assisted in this action by the palatal fibres of the superior constrictor. The laryngeal and palatal attachments serve equally as fixed points during deglutition, lowering the hinder portion of the palate and raising the larynx and pharynx. The muscles also aid in vocalization by drawing up the larynx during the production of high notes. The *salpingo-pharyngei*, when present, aid in opening the Eustachian tubes during deglutition.

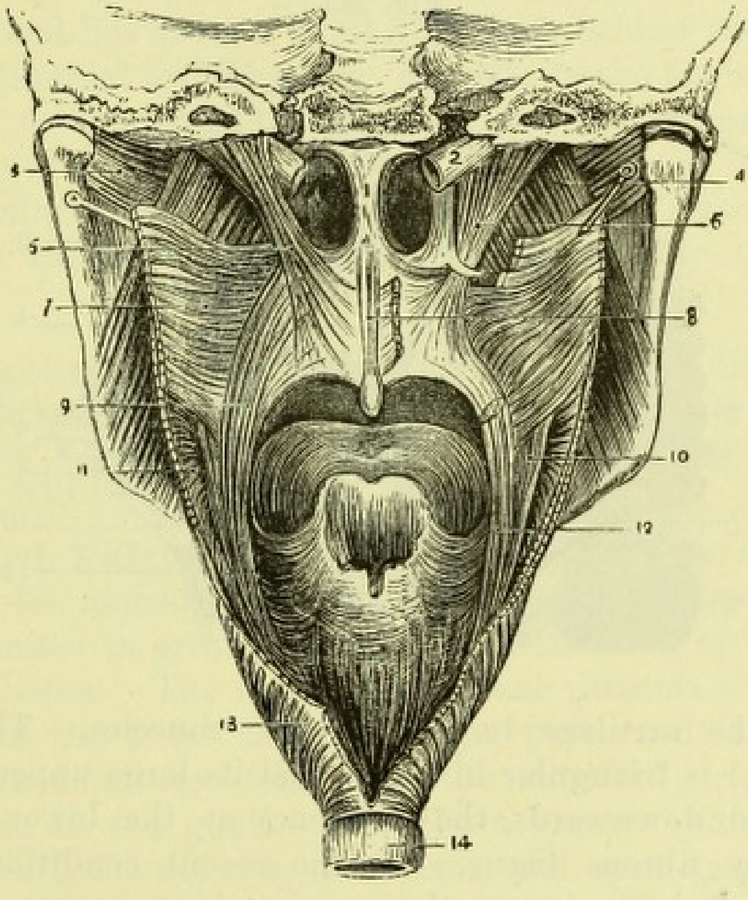
The levator palati and azygos uvulæ are *supplied* by palatine branches from the facial through the posterior palatine branch of the spheno-palatine (Meckel's) ganglion; the tensor palati by the 3rd division of the 5th and otic ganglion; and the palato-glossus and palato-pharyngeus by the glosso-pharyngeal nerve and by the pharyngeal plexus.

The soft palate is supplied by posterior branches of the descending palatine artery, which reach it through the accessory palatine canals, by the ascending palatine and tonsillar branches of the facial artery, and by twigs from the ascending pharyngeal artery. Its nerves are derived from the middle and posterior palatine branches of Meckel's ganglion.

Surgery.—The muscles above the palate, and especially the levatores and tensores palati, are of interest surgically in relation to the operation for closure of a congenital cleft palate, as it is these which draw apart the two segments of a fissured soft palate during efforts at deglutition, and it is hence necessary to divide them before closing the fissure.

Opportunity is to be taken, before the pillars of the fauces are dissected, to observe the important surgical fact that a bistoury, if

Fig. 242.



made to transfix the tonsil directly from before backwards, will pass on the inner side of the internal carotid artery, unless the point of the instrument is directed outwards. It is desirable that the back of the knife should be turned towards the vessel.

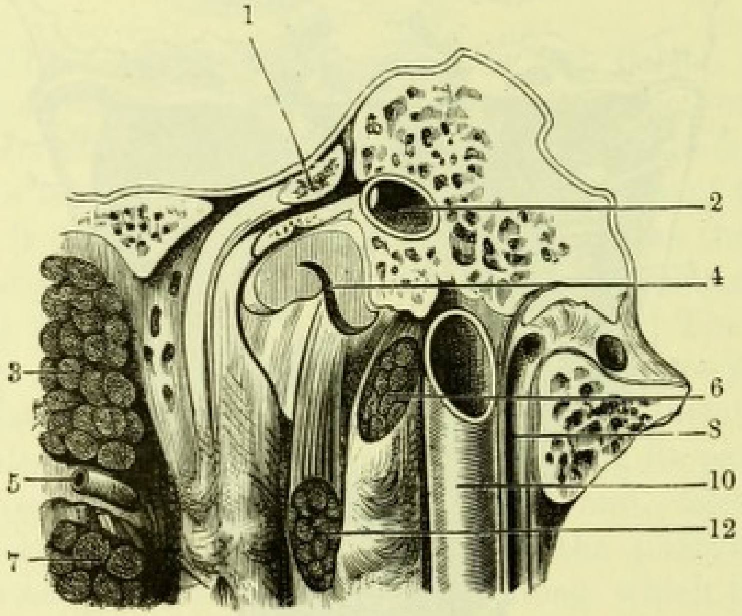
The **Eustachian Tube** (Fig. 242, 2) is a channel of communication between the upper portion of the pharynx and the tym-

Fig. 242.—Muscles of the palate (drawn by J. T. Gray).

1. Septum narium.
2. Eustachian tube.
3. Pterygoideus externus.
4. Pterygoideus internus.
5. Levator palati.
6. Circumflexus palati.
7. Superior constrictor of pharynx.
8. Azygos uvulæ.
9. Palato-pharyngeus.
10. Stylo-pharyngeus.
11. Middle constrictor of pharynx.
12. Palato-pharyngeus (cut).
13. Inferior constrictor of pharynx.
14. Œsophagus.

panic cavity. It is about an inch and a quarter in length, and runs obliquely downwards, forwards, and inwards, to its pharyngeal opening. Its walls, in the outer two-fifths of its extent, are formed by the petrous portion of the temporal bone ; in the rest of the canal they are composed partly of cartilage, partly of fibrous tissues. The whole length of the passage is lined with ciliated mucous membrane, continuous with that of the tympanum and naso-pharynx. The inner aperture has already been seen (p. 527) as well as the

Fig. 243.



relation of the cartilage to the palatine muscles. The cartilage (Fig. 243, 4) is triangular in shape, and its large upper end is bent forwards and downwards, the deficiency at the lower part being completed by fibrous tissue. In the recent condition the thick mucous membrane converts the opening into a mere vertical slit. This is generally closed, but during the process of deglutition it is opened by the action of the tensor palati muscle, aided by the salpingo-pharyngeus when present, and thus the equilibrium of the air in the tympanum is maintained.

[The palate is to be drawn up so as to put the pillars of the fauces

Fig. 243.—Section of the Eustachian tube and the adjacent structures (after Poirier).

1. Inferior maxillary nerve.
2. Internal carotid artery.
3. External pterygoid.
4. Cartilaginous portion of Eustachian tube.
5. Internal maxillary artery.
6. Levator palati.
7. Internal pterygoid.
8. Internal jugular vein.
10. Internal carotid artery.
12. Tensor palati.

on the stretch as much as possible, and the mucous membrane is to be removed to expose the palato-glossus and palato-pharyngeus muscles.]

The **Amygdala** or **Tonsil** is placed between the palato-glossus and palato-pharyngeus muscles, and is usually much shrunken after death. It consists of lymphoid tissue with a number of mucous follicles, the orifices of which may be seen on the internal surface. The outside of the tonsil is in close relation with the superior constrictor of the pharynx and with the ascending pharyngeal artery, and lies about a third of an inch behind and to the outer side of the internal carotid artery, opposite to the angle of the lower jaw. It is to be noticed that it is anatomically impossible for any enlargement of the tonsil to obstruct the Eustachian tube, and thus produce deafness, but the inflammatory process associated with or causing the enlargement, may readily extend into the tube and tympanum.

[The tongue and the larynx are to be detached by dividing all the structures between them and the palate, and are to be carefully preserved for subsequent examination. By inverting the skull the hard palate will then be brought into view.]

The **Hard Palate** (Fig. 247, 10) is continuous with the soft palate, but its mucous membrane is much more dense, and is inseparably united in great part with the periosteum of the maxillary and palate bones. The mucous membrane presents a median ridge indicative of the fœtal division of the parts, and is thrown into more or less transverse folds near the anterior part, where it is prolonged on to the gums. Numerous mucous glands lie immediately beneath the mucous membrane, and open upon its surface.

The *descending palatine* artery will be found emerging from its bony canal a little behind and internal to the last molar tooth. From this point it runs forwards in its groove, giving branches outwards to the gums and inwards to the bone and mucous membrane, and anastomoses in front with the naso-palatine artery, which appears through the foramen of Stenson. It is accompanied by its vein, some lymphatics, and the large or anterior *palatine nerve*. The *naso-palatine* nerves pierce the foramina of Scarpa, the left in front.

The **Gums** (Fig. 244) are composed of dense fibrous tissue, covered by the mucous membrane of the mouth and inseparably united with the periosteum of the alveolus. They are prolonged into the sockets of the teeth, and become continuous with the periodontal membrane covering them.

The **Teeth** (Fig. 244) of the upper jaw are 16 in number, viz., 4 incisors, 2 canines, 4 bicuspids, and 6 molars, the most posterior molars being the *dentes sapientiæ* or wisdom teeth. Each tooth consists of a crown, a neck, and a fang, and upon extracting a molar tooth it will be found to have three fangs, two being on the outer (buccal) and one on the inner (palatine) side, but in the case of the wisdom teeth these are commonly fused together.

The teeth of the lower jaw correspond in number to those of the upper jaw, but have been necessarily interfered with in the progress of the dissection. The lower molar teeth differ from those of the upper jaw in presenting only two fangs, placed one in front of the other.

The **Lips** (Fig. 244) are covered externally by skin, and are lined internally by mucous membrane containing large mucous glands and a good deal of lymphoid tissue, the latter sometimes becoming hypertrophied in strumous subjects. Between the skin and mucous membranes are the muscles already described (p. 474); some intrinsic muscular fibres passing from skin to mucous membrane through the thickness of the lip; the labial veins and lymphatics; and the coronary arteries, the last lying near the free border of the lip close to the mucous membrane, and anastomosing freely across the middle line. A fold of mucous membrane called the *frænum labii* connects each lip with the alveolus in the median line, and is more prominent in the upper than in the lower lip.

The Superior Maxillary Nerve.

[The skull being placed with the base downwards, a cut with the chisel is to be carried in a straight line from the sphenoidal fissure to the foramen ovale. The side of the skull is then to be sawn through at right angles to the first incision, meeting it at the foramen ovale. The saw being then placed obliquely on the malar bone, so that the incision shall pass downwards and outwards from the lower and outer angle of the orbit, the cut is to be carried into the spheno-maxillary fissure. The piece of bone will now be detached and may be removed, and with the bone-forceps any remaining bone is then to be taken away, so as to expose the whole extent of the superior maxillary nerve.]

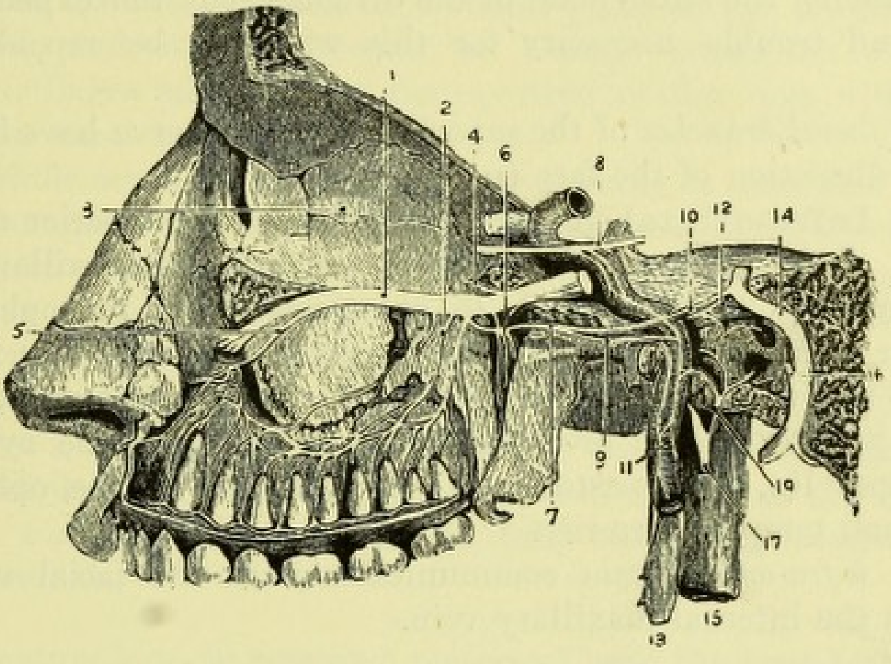
The **Superior Maxillary Nerve** (Fig. 244, 1) (second division of the 5th) leaves the cranium at the foramen rotundum, and, having crossed the upper extremity of the spheno-maxillary fossa, traverses the infra-orbital canal and appears on the face at the infra-orbital foramen. It gives off the following branches :—

1. A small *recurrent filament to the dura mater* close to its origin from the Gasserian ganglion.

2. *Temporo-malar branch* (4), which enters the orbit by the spheno-maxillary fissure, piercing the unstriped muscle (*orbitalis*) bridging the cleft, and divides into two branches (*malar* and *temporal*), which have been seen in the dissection of the face and scalp.

3. *Spheno-palatine branches*, which descend into the spheno-

Fig. 244.



maxillary fossa to Meckel's ganglion (6), and become continuous with the descending palatine nerves (p. 543).

Posterior dental branches (2), which supply the gum and adjacent portion of the mucous membrane of the cheeks, and then enter the canals on the posterior aspect of the upper jaw, to supply the molar and bicuspid teeth and the antral mucous membrane, and to

Fig. 244.—Dissection of the superior maxillary nerve and Meckel's ganglion (from Hirschfeld and Leveillé).

1. Superior maxillary nerve.
2. Posterior dental nerves.
3. Inner wall of orbit.
4. Temporo-malar (cut).
5. Anterior dental nerve.
6. Meckel's ganglion.
7. Vidian nerve.
8. Sixth nerve.
9. Carotid branch of Vidian.
10. Superficial petrosal nerve.
11. Carotid plexus of sympathetic.
12. Lesser petrosal nerve.
13. Superior cervical ganglion.
14. Facial nerve.
15. Internal jugular vein.
16. Chorda tympani.
17. Glosso-pharyngeal nerve.
18. Jacobson's nerve.

communicate with the anterior dental nerve. The bicuspid teeth are sometimes supplied by a separate branch, the *middle dental.*

4. *Anterior dental branch* (5), which arises from the nerve in the infra-orbital canal, and can only be seen by laying the canal open. It descends in a special canal in the wall of the antrum to the incisor and canine teeth, and has a communication with the posterior dental nerve. It gives off a small *nasal branch* to the mucous membrane of the anterior part of the inferior meatus and the adjacent part of the floor of the nasal fossa.

The branches of the dental nerves can only be traced to the teeth by removing the outer plate of the alveolus, but the expenditure of time and trouble necessary for this will not be repaid by the results.

The *facial branches* of the superior maxillary nerve have been seen in the dissection of the face (p. 483).

The **Infra-orbital Artery** accompanies the superior maxillary nerve. It is the terminal branch of the internal maxillary artery, and gives an *orbital* branch to anastomose with the ophthalmic; and an *anterior dental* branch which accompanies the anterior dental nerve to supply the teeth and antrum. It ends, like the nerve, in twigs which are distributed to the nose, the eyelid, and the upper lip, and anastomoses with branches of the ophthalmic, facial and temporal arteries.

The *infra-orbital vein* communicates with the facial vein, and ends in the internal maxillary vein.

The Cavity of the Nose.

[In making a section of the nasal cavities, it will be found to be almost impossible to preserve the septum and the turbinate bones of both sides uninjured : the better plan therefore is to preserve the septum carefully at the expense of the turbinate bones of one side, and afterwards to remove it so as to obtain a good view of the turbinate bones and meatus of the nose on the opposite side. The saw being placed on one side of the septum and parallel to it, is to be carried through the cribriform plate of the ethmoid bone and the palatine processes of the maxillary and palate bones, and the soft palate having been split in the middle line, the skull will be divided into two portions, one of which can be used for the examination of the nose, and the other for the dissection of Meckel's ganglion, etc.]

The **Nasal Fossæ** are two long passages separated by the septum narium, and extending from the nostrils or anterior nares in front to open into the pharynx by the posterior nares behind. In the recent state they consist of a framework of bone and cartilage lined with mucous membrane.

The **Septum Narium** (Fig. 247, *i*) is a vertical plate, which, upon removal of the mucous membrane, will be found to be partly bony and partly cartilaginous. The bones entering into its formation are the crest of the nasal bone, the nasal spine of the frontal bone, the large perpendicular plate of the ethmoid bone, the vomer, a part of the rostrum of the sphenoid bone, and the crests of the maxillary and palate bones, upon which the vomer rests below. The *cartilage of the septum* is triangular in shape : it fits into the interval between the vertical plate of the ethmoid and the vomer, and extends forward to become connected with the lateral cartilages and support that portion of the nose which lies beyond the nasal bones.

The whole septum may be bent considerably to one side as the result of congenital malformation or of violence, and the cartilage may be perforated either congenitally or from disease. The vomer presents an oblique groove for the naso-palatine nerve, which will be afterwards seen upon the opposite side of the bone.

A careful examination of the mucous membrane of the septum may detect a minute aperture just above the position of the canal of Stenson, leading into a blind tube which represents the *organ of Jacobson*, a structure present in its fully developed condition in many mammals.

[The septum is to be removed piecemeal with the bone-forceps, so as to leave the mucous membrane on the opposite side untouched. The naso-palatine nerve and artery may be seen passing from behind forwards to the anterior palatine foramen, and some branches of the olfactory nerve may also be detected at the upper part of the membrane, if putrefaction is not too far advanced. The mucous membrane is then to be detached below and turned up, when the nasal cavity will be exposed.]

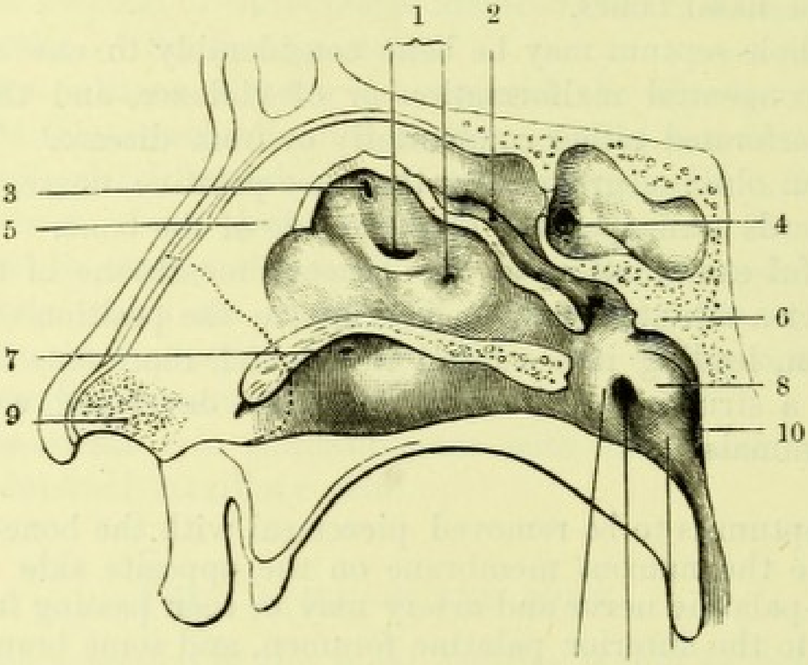
Each nasal fossa presents for notice an inner or septal wall, an outer wall, a roof, and a floor. The *inner* wall has just been described. The *outer* wall (Fig. 245) is of very complex form, and may be divided into three portions ; (1) The region of the *turbinated bodies* and the recesses beneath these, called *meatus.* (2) The region of the *Atrium*, in front of the turbinated bodies ; and (3) the *post-meatal* region between the posterior extremities of the turbinated bodies and the nasal portion of the pharynx.

The *Superior Meatus* is of small size and lies near the posterior and upper part of the outer wall below the small superior turbinated body; opening into it is the aperture of the posterior ethmoidal cells. (The spheno-palatine foramen which opens into the meatus in the skeleton is here covered in by the mucous membrane.) (Fig. 246, *a.*)

The *Middle Meatus*, of considerable length, presents anteriorly and close to the attachment of the turbinated body, the opening of the infundibulum, common to the frontal sinus and anterior ethmoidal cells; and a little below this the orifice of the antrum. A second antral aperture, corresponding to the gap in the skeleton behind the unciform process of the ethmoid, is sometimes present, but is usually covered in by mucous membrane. (Fig. 246, *g.*)

The *Inferior Meatus*, the largest, contains a single opening, that

Fig. 245.



of the nasal duct, about half an inch behind the anterior end of the turbinated body; this aperture is very small and may be either circular or slit-like. (Fig. 246, *k.*)

The *region of the atrium* is quite smooth, and lined with a mucous membrane bearing ciliated epithelium, except in the

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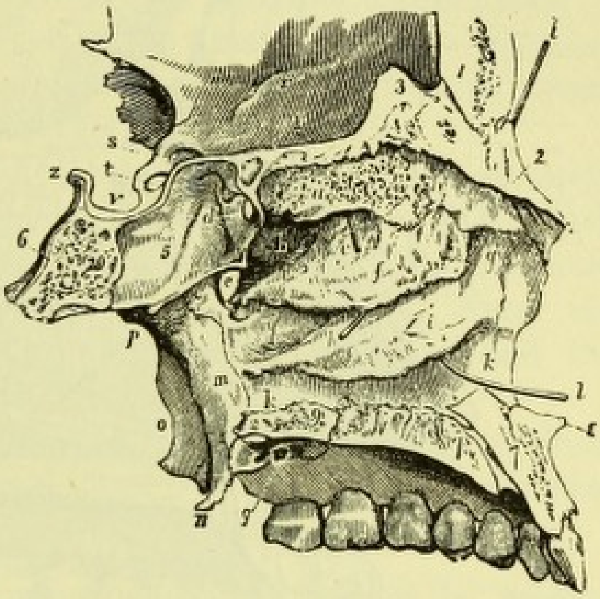
Fig. 245.—Outer wall of nasal fossa and pharynx (modified from Merkel).

1. Antral openings in middle meatus.
2. Middle turbinated bone (cut).
3. Orifice of infundibulum.
4. Sphenoidal sinus.
5. Atrium.
6. Sphenoid bone.
7. Orifice of nasal duct beneath cut inferior turbinated bone.
8. Tubal prominence.
9. Vestibule.
10. Fossette of Rosenmüller.
12. Ridge corresponding to Salpingo-pharyngeus.
14. Eustachian tube.
16. Ridge corresponding to levator palati.

vestibular portion near the nostril, where the surface has the character of skin, and is beset with bristly hairs. Its wall is partly bony, partly cartilaginous. The *post-meatal region* is also smooth and covered with ciliated mucous membrane. Its bony wall is formed by the internal pterygoid plate.

The *Roof* of the nasal fossa is horizontal in the middle, where it receives the branches of the olfactory nerves, but slopes downwards and forwards in front, and downwards and backwards behind. A little above and behind the superior meatus it presents the orifice of the sphenoidal sinus.

Fig. 246.



The *Floor* is horizontal from before backwards, and concave from side to side; its mucous lining is continuous with that of the pharyngeal surface of the soft palate.

It should be noticed that the orifice of the Eustachian tube is close to the posterior extremity of the inferior turbinate body, and that in using the Eustachian catheter, the point of the instrument must therefore be raised before it can enter the tube.

The *Mucous Membrane* lining the nasal fossæ is termed the

Fig. 246.—The outer wall of the nasal fossa in the skeleton (from Wilson).

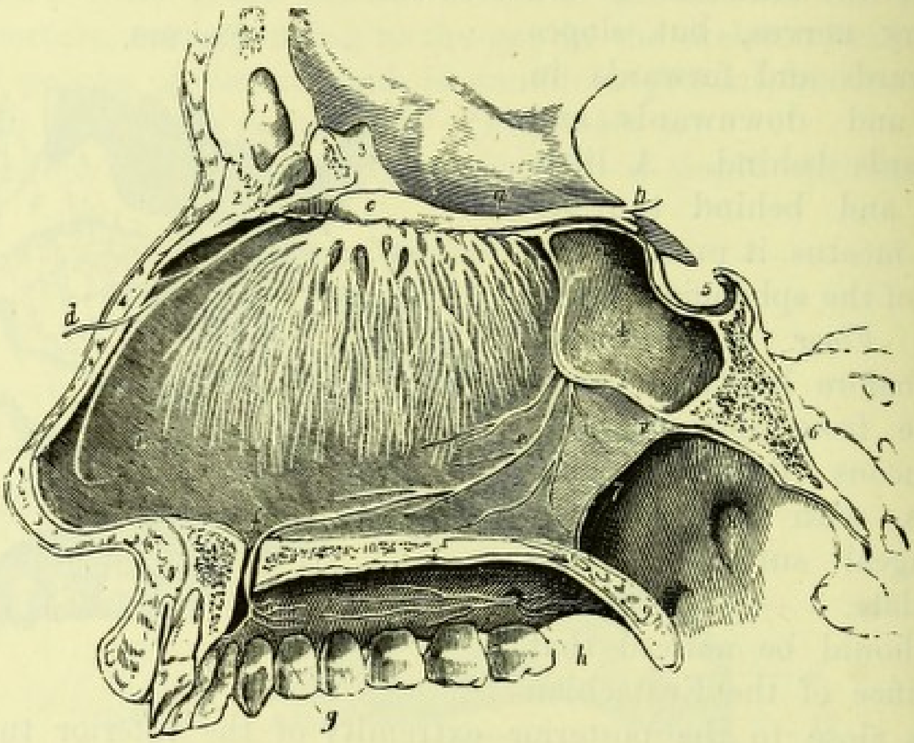
1. Frontal bone.
2. Nasal bone.
3. Crista galli of the ethmoid.
4. Cribriform plate of the ethmoid.
5. Part of the sphenoidal sinus.
6. Basilar portion of the sphenoid bone.
7, 7. Palatine process of the superior maxillary bone.
8. Nasal spine.
9. Palatine process of the palate bone.

a. Superior turbinate bone.
b. Superior meatus.
c. A probe passed into the posterior ethmoidal cells.
d. Opening of the sphenoidal sinus into the superior meatus.
e. Spheno-palatine foramen.
f. Middle turbinate bone.
g, *g*. Middle meatus.
h. A probe passed into the infundibulum leading from the frontal sinus and anterior ethmoidal cells; the triangular aperture immediately above the latter is the opening of the antrum.
i. Inferior turbinate bone.
k, *k*. Inferior meatus.
l, *l*. A probe passed up the nasal duct.
m. Internal pterygoid plate.
n. Its hamular process.
o. External pterygoid plate.
p. Root of the pterygoid process.
q. Posterior palatine foramina.

pituitary or *Schneiderian membrane*, and is thickest over the turbinate bones, particularly the lowest, and on the septum ; but is thin on the floor, and in the sinuses connected with the nose.

Over the lower and hinder part of the middle and inferior turbinated bodies the veins of the mucous membrane are much

Fig. 247.



dilated and very thin walled, and are liable to give way in conditions of congestion. Occasionally the thickened tissue in this position may assume a polypoid character, and if snared in mistake for a true polyp serious injury may follow.

The upper part of the mucous membrane both on the outer and

Fig. 247.—Left Olfactory nerve, with its distribution on the septum narium (from Wilson).

1. Frontal sinus.
2. Nasal bone.
3. Crista galli of ethmoid bone.
4. Sphenoidal sinus of left side.
5. Sella turcica.
6. Basilar process of sphenoid and occipital bone.
7. Posterior opening of the right naris.
8. Opening of the Eustachian tube in the upper part of the pharynx.
9. Soft palate divided through its middle.
10. Cut surface of the hard palate.

a. Olfactory nerve.
b. Its three roots of origin.
c. The olfactory bulb.
d. Nasal nerve (ophthalmic div. of 5th).
e. Naso-palatine nerve (from the spheno-palatine ganglion).
f. The anterior palatine foramen.
g. Branches of the naso-palatine nerve.
h. Anterior and posterior palatine nerves.
i. Septum narium.

inner walls of the nasal fossa has been named the Olfactory Region, from the fact that the branches of the olfactory or first nerve are distributed to it. It comprises the surface corresponding to the superior turbinated body and the upper half of the middle turbinate body, and the opposed portion of the septum. It is impossible to distinguish this region from the rest by the naked eye except immediately after death, but the mucous membrane is of a yellow colour in the recent state. Its epithelium is of the columnar variety, and has peculiar spindle-shaped cells connected with the terminations of the olfactory nerve. The remainder of the nasal lining has columnar ciliated cells, except in the neighbourhood of the nostril, where they are squamous and laminated like those of the skin.

The **Olfactory Nerve** (Fig. 247, *a*) is the special nerve of smell, and its branches, which are derived from the *olfactory bulb*, reach the nasal cavity by piercing the cribriform plate of the ethmoid bone, and are distributed to the olfactory region, *i.e.*, upon the superior and the upper half of the middle turbinate bones, and the upper third of the septum.

The nerves of common sensation to the nose are derived from Meckel's ganglion, and the internal nasal branch of the first division of the fifth. They will be afterwards dissected.

[With a strong pair of scissors the turbinate bones may be readily cut, so as to expose the several openings into the three meatus. The student should observe the small size of the openings of the antrum, the infundibulum, and the ductus ad nasum.]

The **Nasal Duct** communicates between the lacrymal sac and the inferior meatus of the nose, and is directed downwards and slightly backwards, and may incline slightly either inwards or outwards according to the lesser or greater breadth of the nasal passage. It grooves the superior maxillary, lacrymal, and inferior turbinate bones, and consists of a fibrous tube, lined with mucous membrane having a ciliated epithelium. Its nasal opening is seen in Fig. 245.

The *nasal branch of the fifth nerve* (ophthalmic division) (Fig. 274, *d*) may be found in a groove on the under surface of the nasal bone in its passage from the orbit to the face; in its course it gives a branch to the septum, before emerging between the nasal bone and the superior lateral cartilage.

DISSECTION OF MECKEL'S GANGLION, ETC.

Before beginning this dissection, the student should ascertain the position of the spheno-palatine foramen (Fig. 246, *e*), opposite to which the spheno-palatine ganglion is placed, and through which the spheno-palatine vessels and naso-palatine nerve enter the nose. It will be found in the post-meatal region, immediately behind and a little above the posterior end of the middle turbinated body. It is closed by mucous membrane in the recent state.

[The mucous membrane lining the vertical plate of the palate bone is to be removed, without injuring the underlying vessels and nerves passing through the spheno-palatine foramen. It must also be taken away from the back of the floor of the nasal fossa, and from the roof of the mouth behind the level of the posterior dental foramen, in doing which the terminal branches of the descending palatine nerve will be exposed, and may be traced forward to the hard palate and backwards to the soft palate. The hard palate is next to be chipped away behind the level of the posterior palatine foramen; the descending palatine nerves and vessels may then be easily exposed by cutting away with the chisel the thin plate of bone covering them, in a line between the spheno-palatine foramen and the posterior palatine foramen. By following up the descending palatine nerve, Meckel's ganglion will be found opposite the spheno-palatine foramen. By chipping away parts of the body of the sphenoid and other bones surrounding the space in which the ganglion lies, two branches may be traced up from the ganglion to the superior maxillary nerve, and the Vidian nerve may perhaps be followed backwards through the Vidian canal.]

The **Spheno-palatine,** or **Meckel's Ganglion** (Fig. 248, 1) is a minute pinkish body situated in the spheno-maxillary fossa opposite the spheno-palatine foramen. It is connected with the superior maxillary nerve by two branches (p. 535) (which probably pass into the palatine nerves without any important communication with the ganglion cells); with the facial nerve and with the sympathetic upon the internal carotid artery by the Vidian nerve (Fig. 244); and gives off branches of distribution to the orbit, palate, pharynx, and nasal passage.

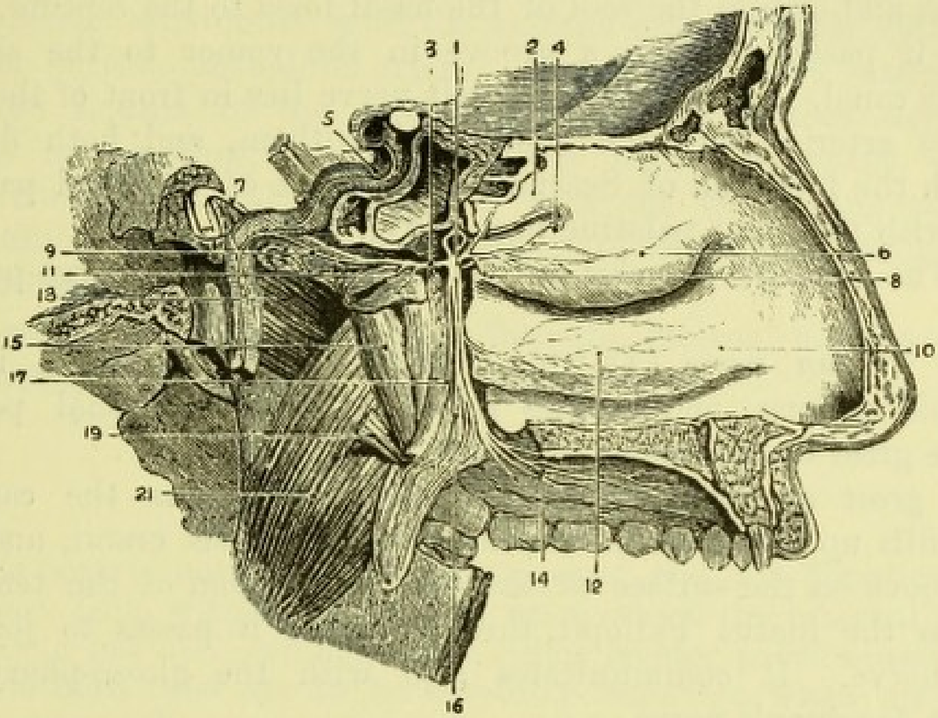
The **Branches** (Fig. 248) of the ganglion are ascending, descending, internal, and posterior.

1. The *ascending branches* are two or three of very small size, which pass to the periosteum of the orbit through the spheno-maxillary fissure, some piercing the inner wall of the orbit to reach the posterior ethmoidal and sphenoidal cells.

2. The *descending branches,* three in number, go to the palate, and are accompanied by branches of the internal maxillary vessels. They are probably in direct continuation with the so-called ganglionic branches of the superior maxillary nerve.

The *anterior* or *great palatine nerve* (14) descends through the posterior palatine canal to the hard palate, where it forms a junction with the naso-palatine nerve passing through the anterior palatine canal (Fig. 247, *g*), and supplies the mucous membrane. Whilst in the canal the nerve gives off *inferior nasal branches* to the

Fig. 248.



mucous membrane over the inferior turbinate body and the middle and inferior meatus.

The *middle* or *external palatine nerve* (16) is very small, and descends to the soft palate and tonsil.

The *posterior* or *small palatine nerve* (17), really a branch of the facial nerve passing through the ganglion, descends through a small canal behind the great nerve, and is distributed to the soft palate and uvula.

Fig. 248.—Meckel's ganglion and its branches (from Hirschfeld and Leveillé).

1. Spheno-palatine ganglion (Meckel).
2. Superior turbinate bone.
3. Vidian nerve.
4. Nasal branches.
5. Carotid artery in temporal bone.
6. Middle turbinate bone.
7. Greater superficial petrosal nerve joining the facial.
8. Naso-palatine nerve (cut).
9. Carotid branch of Vidian.
10. Inferior turbinate bone.
11. Pharyngeal nerve.
12. Inferior nasal branches.
13. Pterygoideus externus.
14. Anterior or great palatine nerve.
15. Tensor palati.
16. Middle or external palatine nerve.
17. Posterior palatine nerve.
19. Levator palati (cut).
21. Pterygoideus internus.

3. The *internal branches* pass through the spheno-palatine foramen to the nose, and are the superior nasal and the naso-palatine nerves.

The *superior nasal branches* (4) supply the mucous membrane of the upper and middle turbinate bodies and of the superior meatus.

The *naso-palatine nerve* (8) passes through the spheno-palatine foramen and crosses the roof of the nasal fossa to the septum, along which it passes through a groove in the vomer to the anterior palatine canal. In the canal the left nerve lies in front of the naso-palatine arteries, and the right behind them, and both descend through the foramina of Scarpa to the front of the hard palate to unite with the great palatine nerve (Fig. 247, *e*).

4. The *posterior branches* are the Vidian and the pterygo-palatine nerves.

The *Vidian nerve* (3) runs through the Vidian canal in the pterygoid process, and divides into the great superficial petrosal and the great deep petrosal branches.

The *great superficial petrosal branch* (7) pierces the cartilage which fills up the foramen lacerum medium basis cranii, and runs in a groove on the surface of the petrous portion of the temporal bone to the hiatus Fallopii, through which it passes to join the facial nerve. It communicates also with the glosso-pharyngeal through Jacobson's nerve.

The *great deep petrosal branch* (9) joins the sympathetic plexus upon the internal carotid artery.

The *pterygo-palatine* or *pharyngeal nerve* (11) is very small. It passes through the pterygo-palatine canal to the mucous membrane of the upper part of the pharynx, and sends filaments through the cartilage filling the foramen lacerum medium.

The **Internal Maxillary Artery** gives off five branches in the spheno-maxillary fossa: descending palatine, Vidian, pterygo-palatine, spheno-palatine, and infra-orbital, the last of which has been already examined. All of these are accompanied by branches of Meckel's ganglion.

1. The *posterior* or *descending palatine artery* accompanies the great palatine nerve through the posterior palatine canal. It gives branches which descend through the smaller palatine canals to the soft palate and uvula, and then runs forward on the hard palate, supplying it, and anastomosing with the naso-palatine artery in the anterior palatine canal.

2. The *Vidian artery* accompanies the nerve through the Vidian canal, and supplies the upper part of the pharynx and the Eustachian tube.

3. The *pterygo-palatine artery* is very small, and runs backwards through the pterygo-palatine canal to supply the upper part of the pharynx, the Eustachian tube, and the sphenoidal sinus.

4. The *superior nasal* or *spheno-palatine artery* enters the nose by the spheno-palatine foramen. It gives a naso-palatine branch, and smaller branches to the mucous membrane of the upper part of the cavity, which anastomose with the anterior and posterior ethmoidal branches of the ophthalmic artery. The *naso-palatine* branch runs down the septum of the nose with the naso-palatine nerve; it supplies the septum, and anastomoses with the artery of the septum from the facial trunk, and with the descending palatine artery after passing through the foramen of Stenson in the anterior palatine canal.

The *veins* correspond, and open into the internal maxillary vein and pterygoid plexus.

The Otic Ganglion.

[If the part is not too much decomposed, the otic ganglion may be exposed, from within, on the side upon which the internal pterygoid muscle has not been cut away. The levator palati muscle and the Eustachian tube are to be carefully removed, when upon the inner surface of the pterygoid muscle will be found the nerve to that muscle, and this if traced upwards will lead to the ganglion.]

It has been described on p. 507.

The Ear.

The **Meatus Auditorius Externus** may be examined on the sections made to separate the anterior part of the skull, with the pharynx, from the posterior segment (p. 514). It is a canal about an inch and a quarter in length, directed inwards along the transverse axis of the cranium, narrowest in the middle, and slightly curved in its course with the convexity upwards. It is closed internally by the membrana tympani and membrane of Shrapnell; and owing to the inclination of the axis of the membrane downwards and forwards, the lower wall is longer than the upper, and the anterior than the posterior, a point to be recollected in extracting impacted foreign bodies. The framework of the outer two-fifths is composed of the cartilage of the pinna; that of the inner three-fifths of bone (petrosa). It is lined with skin, which is intimately adherent to the periosteum in the bony part of the canal and presents hairs and ceruminous glands in the cartilaginous segment. A layer of cuticle is reflected on to the fibrous membrana tympani. The meatus receives *arteries* from the posterior auricular branch of the external carotid, the auricular branch of the internal maxillary, and the anterior auricular branch of the temporal. Its *nerves* are derived from the great auricular, the auriculo-temporal, and the auricular branch of the vagus. The deep portion of the passage is *related* above to the middle fossa of the cranium, in front and below to the glenoid fossa and vaginal process, and behind to the mastoid process.

The Tympanum.

[If the tympanum has not been damaged in the previous dissections, an attempt may be made to trace the facial nerve through the temporal bone in the following manner. The base of the skull being turned upward, the saw is to be carried through a line drawn from the stylo-mastoid foramen to the foramen ovale; or a more complete view may be obtained by making a vertical saw-cut in the skull, in a line from the interval between the external auditory meatus and the anterior border of the mastoid process towards the internal auditory meatus, until the posterior part of the aqueduct of Fallopius and the stylo-mastoid foramen are opened. The rest of the bone surrounding the aqueduct is then to be chipped away with bone forceps. By either of these cuts the tympanum will be divided, and it will be possible to examine its walls and ossicula, together with the seventh nerve and the chorda tympani.]

The **Tympanum** or **Middle Ear** is an air-containing chamber situated above the jugular fossa, and intervening between the external auditory meatus and the labyrinth. It is lined with mucous membrane continuous with that of the pharynx, and communicates in front with the Eustachian tube (by which air is admitted from the nasal portion of the pharynx), and behind with the mastoid cells through the mastoid antrum. Its transverse diameter is very narrow, from 1 to 3 lines, but its greatest antero-posterior and vertical diameters exceed half an inch (average $7\frac{1}{2}$ lines).

Its *outer wall* consists partly of bone, partly of membrane. The membrana tympani, a fibrous structure, is fixed into a narrow groove in an incomplete bony ring, the *annulus tympanicus,* and is connected to the roof of the tympanum at the point of deficiency (*notch of Rivini*) in the annulus by the *membrane of Shrapnell,* or membrana flaccida. The outer wall close to the annulus presents three apertures, (1) the *Glaserian fissure* above, which transmits the laxator tympani muscle and the anterior tympanic artery, and lodges the processus gracilis of the malleus ; (2) the *iter chordæ posterius,* close to the posterior part of the tympanic ring, for the entrance of the chorda tympani from the aqueductus Fallopii ; (3) the *iter chordæ*

Fig. 249.

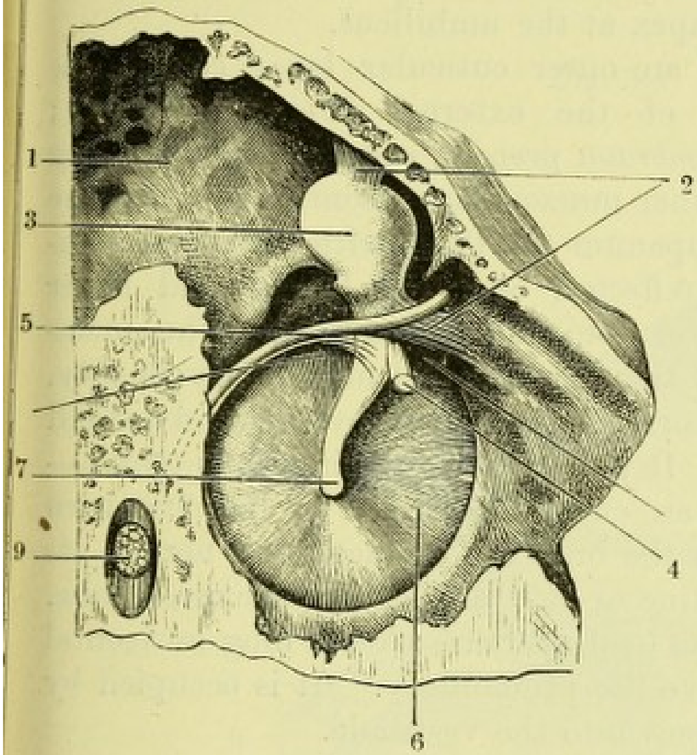
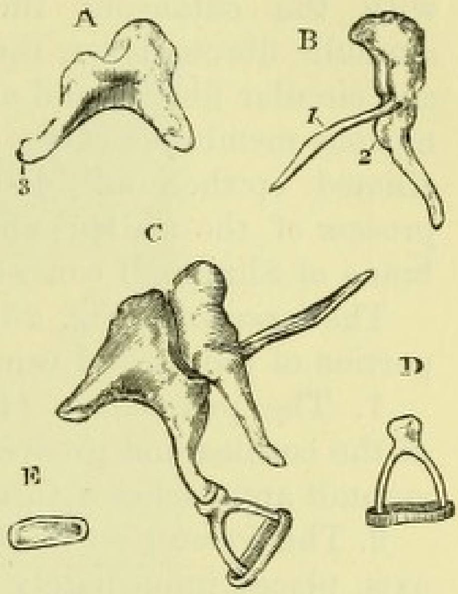


Fig. 250.



anterius or *canal of Huguier,* an aperture in front of the Glaserian fissure for the exit of the chorda tympani.

The *membrana tympani* is almost perfectly circular, about $\frac{2}{5}$ths of an inch in diameter, and looks outwards, downwards, and forwards, forming an acute angle with the inferior and anterior walls. The handle of the malleus runs vertically downwards on the inner side of the fibrous layer between this and the tympanic mucous layer, and is attached by its extremity to the *umbilicus* or centre of the

Fig. 249.—Outer wall of the tympanum.

1. Attic of tympanum.
2. Ligaments of malleus.
3. Head of malleus.
4. Tendon of tensor tympani.
5. Chorda tympani.
6. Membrana tympani.
7. Handle of malleus.
9. Facial nerve in aqueductus Fallopii.

Fig. 250.—The ossicula auditus (from Wilson).

A. Incus.
  3. Processus longus.
B. Malleus.
  1. Processus gracilis.
  2. Processus brevis.
C. Incus, malleus, and stapes articulated.
D. Stapes.
E. Base of stapes.

membrane, while the lesser process of the malleus forms a projection at the upper end of the membrane. The external face of the membrane is always concave, and when examined by reflected light shows two bright points, one above, circular, corresponding to the point of the processus brevis, the other triangular, extending downwards and forwards with its apex at the umbilicus.

The membrane consists of an outer cuticular layer continuous with the cutaneous lining of the external auditory meatus; a middle fibrous layer, the *membrana propria*, composed of radiating and circular fibres; and an inner mucous layer, continuous with the mucous membrane of the tympanum and lined with squamous non-ciliated epithelium. It is reflected over the handle and lesser process of the malleus and over the chorda tympani. The membrane of Shrapnell consists of the cuticular and mucous layers only.

The *inner wall* (Fig. 251) corresponds to the labyrinth and a small portion of the carotid canal. It presents many points for notice :—

1. The *promontory* (11), an eminence formed by the first turn of the cochlea and grooved by the branches of Jacobson's nerve; its summit approaches within a line or two of the tympanic membrane.

2. The *fenestra ovalis* (6), an oval aperture with a long horizontal axis, placed immediately above the promontory. It is occupied by the base of the stapes and opens into the vestibule.

3. The *fenestra rotunda* (19), a somewhat triangular aperture looking backwards and outwards and lying at the back of the promontory. It is closed by a membrane (*membrana secundaria*) and communicates with the scala tympani of the cochlea.

4. The *posterior pyramid* (8), situated behind the fenestra ovalis, and united to the promontory by a narrow bridge of bone. It is hollow, perforated at its extremity, and transmits the stapedius muscle.

5. The *anterior pyramid* (3), projecting from the junction of the anterior and inner walls in front of the fenestra ovalis and above the Eustachian tube. It transmits the tensor tympani muscle.

6. A *ridge* corresponding to the *aqueductus Fallopii* (1). This runs upwards behind the promontory, and then curves forwards immediately above the foramen ovale, where it is less distinct and may not be distinguishable.

7. A *ridge* corresponding to the *external semicircular canal*. Horizontal, placed above the foramen ovale and horizontal portion of the aqueductus Fallopii.

The *anterior wall* presents the opening of the Eustachian tube, which is separated from the canal for the tensor tympani by a septum of bone, the *processus cochleariformis*.

The *posterior wall* contains the opening of the *mastoid antrum*, which leads to the mastoid cells. Against it rests the short process of the incus.

The *floor,* narrow and irregular, lies above the jugular fossa and is pierced by Jacobson's nerve.

The *roof* is a thin portion of bone, separating the tympanum from

Fig. 251.

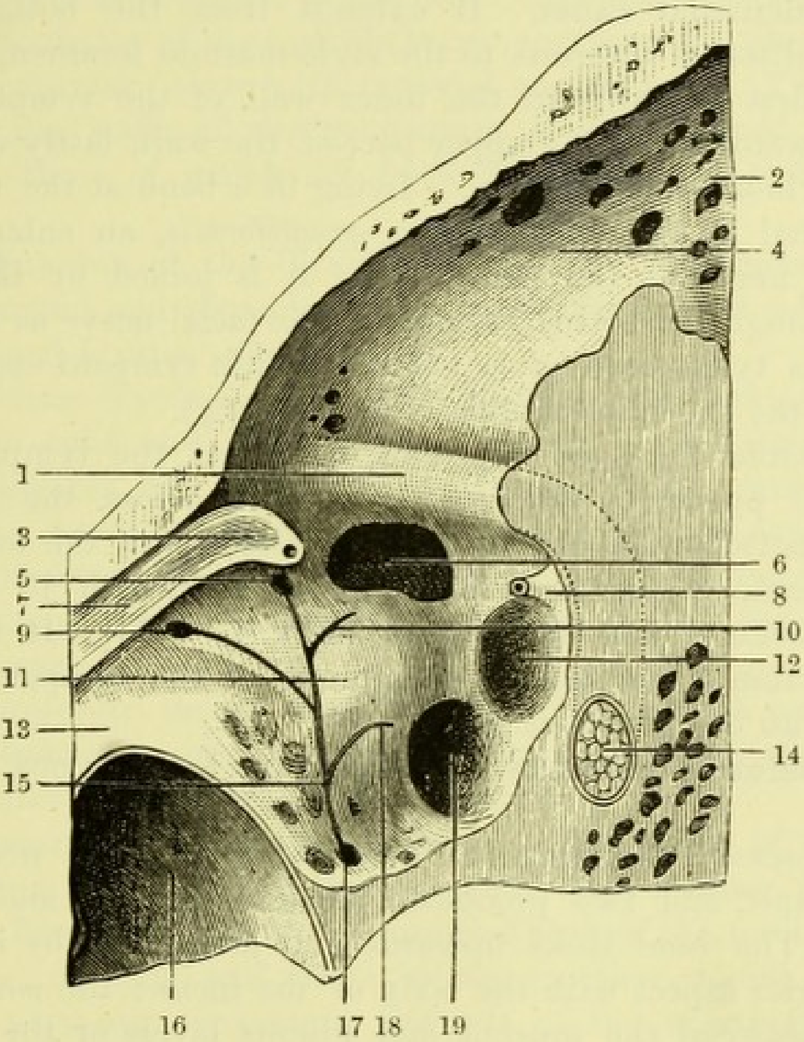


Fig. 251.—Inner wall of the tympanum (after Poirier).

1. Ridge corresponding to aqueductus Fallopii.
2. Mastoid cells.
3. Anterior pyramid.
4. Mastoid antrum.
5. Groove for small superficial petrosal nerve.
6. Fenestra ovalis.
7. Canal for tensor tympani.
8. Posterior pyramid.
9. Groove for twig to Eustachian tube.
10. Ditto to fenestra ovalis.
11. Promontory.
12. Sub-pyramidal fossette.
13. Eustachian tube.
14. Facial nerve in aqueductus Fallopii.
15. Groove for Jacobson's nerve.
16. Jugular fossa.
17. Aperture of entry of Jacobson's nerve in floor.
18. Groove for twig to fenestra rotunda.
19. Fenestra rotunda.

the middle fossa of the cranium. The upper portion of the tympanic cavity between the ossicles and the roof is called the *attic*. It is subdivided into two parts, anterior and posterior, by the suspensory ligament of the malleus.

The *Aqueduct of Fallopius* (1), or canal for the facial nerve, forms a slight projection curving behind the pyramid and is continued above the fenestra ovalis, between it and the eminence of the external semicircular canal. It extends from the bottom of the meatus auditorius internus to the stylo-mastoid foramen, its course being at first outwards to the inner wall of the tympanum, and then backwards along the upper part of the wall, lastly downwards to the stylo-mastoid foramen. Lying in a bend at the upper part of the canal is the *intumescentia gangliformis*, an enlargement of the facial nerve at the point where it is joined by the petrosal nerves through the hiatus Fallopii. The facial nerve as it descends behind the tympanum gives off the chorda tympani and a minute branch to the stapedius muscle (Fig. 244, 14).

The *Chorda Tympani* (Fig. 234, 9) enters the tympanum just below the pyramid, and passes forward across the membrana tympani, between the handle of the malleus and the long process of the incus, to the canal of Huguier, by which it leaves the temporal bone to join the lingual nerve (p. 495). It is invested by a reflection of the mucous membrane of the tympanum, which projects into the tympanic cavity.

The **Ossicula Auditus** (Fig. 250) are the malleus, incus, and stapes.

The *Malleus* (hammer) (B) consists of a head, neck, handle (manubrium), and two processes (processus gracilis and processus brevis). The *head* looks upwards and articulates by its internal and posterior aspect with the body of the incus; the *manubrium* is inserted between the mucous and fibrous layers of the membrana tympani, and is directed downwards and slightly forwards, its extremity reaching to the umbilicus; the *processus gracilis* passes forwards and somewhat downwards, and is inserted into the Glaserian fissure; the *processus brevis* gives attachment to the tensor tympani muscle, and rests against the upper part of the membrana tympani.

The *Incus* (anvil) (A) consists of a body and two processes. The *body* articulates with the head of the malleus; the *short process* is attached to the margin of the orifice of the mastoid antrum; the *long process* is nearly parallel to the handle of the malleus, and has at its extremity a small nodule of bone, the *os orbiculare,* separate in the fœtus, which articulates with the stapes.

The *Stapes* (stirrup) (D) has a small head and neck, connected to a relatively long oval base by two crura. It is articulated by its *head* with the long vertical process of the incus, and being at right angles to this is almost horizontal in position. The *base* is attached to the fenestra ovalis, but not quite closely, both the base of the stapes and the margin of the fenestra ovalis being coated with hyaline cartilage, and the two surfaces united by elastic fibres. The *neck* gives attachment to the small stapedius muscle.

The articulation of the ossicula to one another takes place by means of small capsular joints with synovial membranes. Their attachment to the walls of the tympanum is strengthened by minute ligaments, three of which are fixed to the malleus and one to the incus.

The **Muscles** of the Tympanum are two in number, viz., the tensor tympani and stapedius; and some anatomists add a laxator tympani, and laxator tympani minor.

The *Tensor Tympani* (Fig. 234, 2) *arises* from the cartilaginous Eustachian tube and the adjoining surface of the sphenoid, and runs backwards in a distinct canal above the processus cochleariformis, round the margin of which it bends as over a pulley, to be *inserted* into the root of the handle and the processus brevis of the malleus. It is *supplied* by a branch of the 3rd division of the 5th nerve.

The *Stapedius arises* from the interior of the pyramid, and emerges from its apex to be *inserted* into the neck of the stapes. It is *supplied* by a branch of the facial nerve.

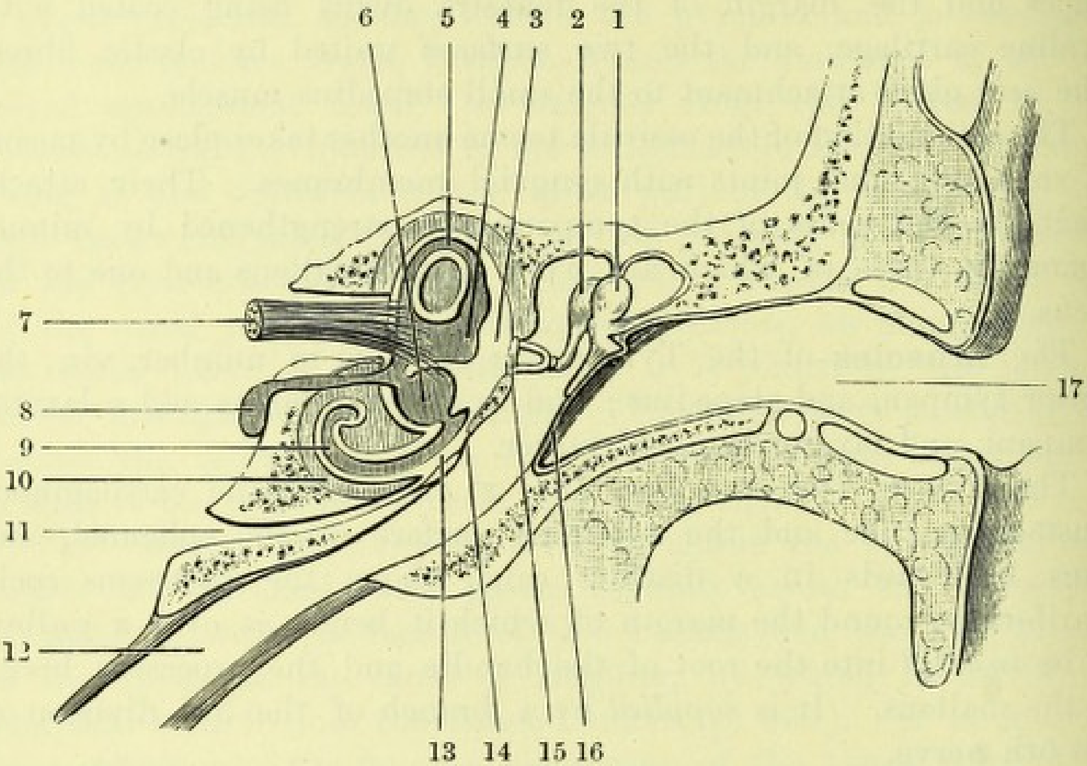
The *Laxator tympani* is inconstant. It consists of a few fibres arising from the spine of the sphenoid, and passing through the Glaserian fissure to be inserted into the neck of the malleus.

As the malleus and incus swing together round an antero-posterior axis, any movement inwards of the membrana tympani must produce a similar though slighter movement inwards of the base of the stapes, and, the cavity of the inner ear being filled with fluid, a corresponding bulging of the secondary membrane of the tympanum closing the fenestra rotunda must result.

The **Inner ear** or **labyrinth** (Fig. 252) consists of three portions, the vestibule, three semicircular canals, and the cochlea. The bony *Vestibule* (3) is a little chamber receiving the openings of the semicircular canals and of the scala vestibuli of the cochlea, and is connected with the tympanum by means of the fenestra ovalis. It contains a *membranous vestibule* divided into two sacs, the utricle and saccule, upon which are distributed branches of the auditory nerves; the *utricle* receives the *membranous semi-*

circular canals, the *saccule* communicates with the scala media of the cochlea by a short tube, the *canalis reuniens,* and the two sacs are brought into connection by two little tubes, which unite and

Fig. 252.



are prolonged outwards in the aqueductus vestibuli as the *saccus endolymphaticus.*

The *Cochlea* (Fig. 254) is a tube coiled into a helicoid spiral with two and a half turns, around an axis or *modiolus,* the base of which forms part of the bottom of the internal auditory meatus, and admits the cochlear filaments of the auditory nerve. The apex points forwards and inwards. Its tube is divided into three scalæ by bony and membranous septa (the *lamina spiralis ossea et membranacea* and the *membrane of Reissner*) ; the *scala vestibuli* opens into the bony vestibule ; the *scala tympani* is separated from

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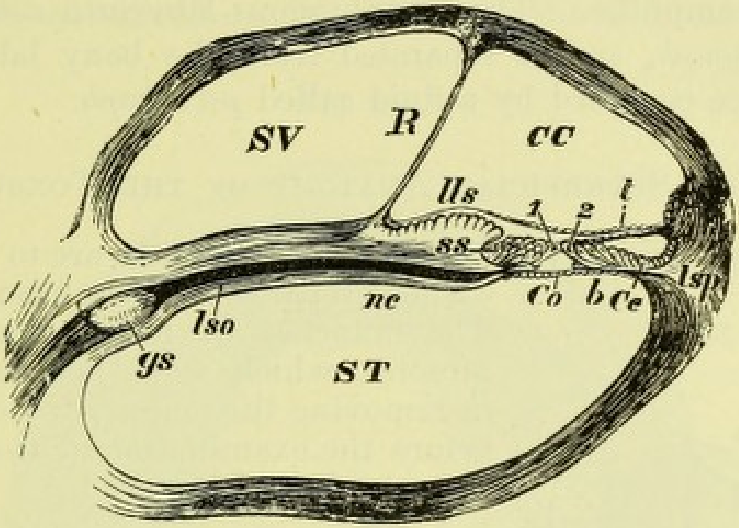
Fig. 252.—Scheme of auditory apparatus (after Poirier).

1. Malleus.
2. Incus (line passes through attic).
3. Perilymph in vestibule.
4. Utricle.
5. Superior semicircular canal.
6. Saccule.
7. Auditory nerve.
8. Saccus endolymphaticus.
9. Membrana cochleæ (canalis cochleæ).
10. Cochlea.
11. Aqueductus cochleæ.
12. Eustachian tube.
13. Scala tympani.
14. Fenestra rotunda.
15. Stapes.
16. Membrana tympani.
17. External auditory meatus.

the tympanum by the membrana secundaria, and communicates at its distal extremity with the scala vestibuli ; and the *scala media*, which belongs to the membranous labyrinth, communicates with

Fig. 253.



the saccule. The cochlear nerves are distributed upon complex terminal structures (*organ of Corti*) in connexion with the scala media (Fig. 253).

The *Semicircular Canals* are called *external*, *superior*, and *posterior*.

Fig. 254.

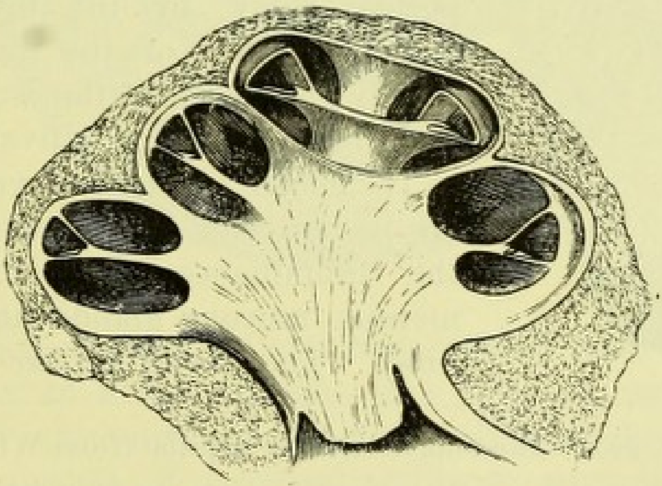


Fig. 253.—Section of coil of cochlea (from Wilson).

SV. Scala vestibuli.
R. Membrane of Reissner.
CC. Canalis cochleæ.
lls. Limbus laminæ spiralis.
t. Membrana tectoria.
lsp. Ligamentum spirale.
Co. Organ of Corti.
b. Membrana basilaris.
lso. Lamina spiralis ossea.
gs. Cochlear nerve with ganglion.
ST. Scala tympani.

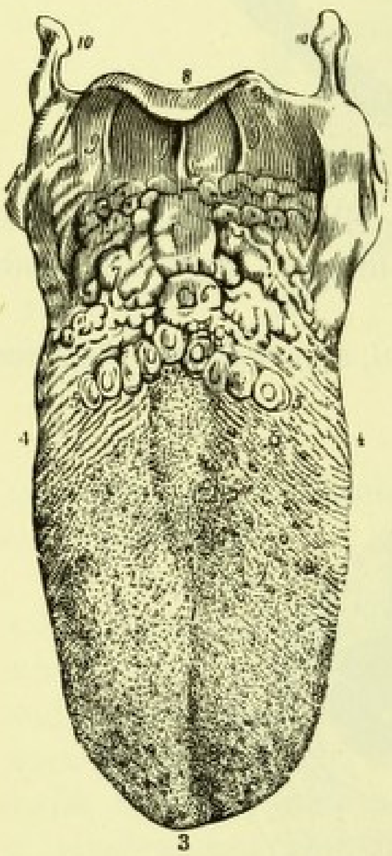
Fig. 254.—Vertical section of the cochlea of a calf (from Wilson).

Each presents an *ampulla* at one extremity, and the non-ampullated extremities of the posterior and superior canals join together, so that there are only five vestibular openings for three canals. Within the bony tubes are the *membranous semicircular canals*, which open into the utricle, and branches of the auditory nerve are distributed upon their ampullæ. The membranous labyrinth contains a fluid called *endolymph*, and is separated from the bony labyrinth by a distinct space occupied by a fluid called *perilymph*.

The Superficial Anatomy of the Tongue.

[The tongue and larynx. which were laid aside, are to be examined, without separating them from one another. The branches of nerves and the several muscles, which were necessarily divided in removing the tongue, are to be identified before the examination of the organ itself is proceeded with.]

Fig. 255.



The **Tongue** (Fig. 255) is connected with the os hyoides, styloid process, lower jaw, soft palate, and pharynx by its extrinsic muscles (p. 501); and with the epiglottis and floor of the mouth by reflections of mucous membrane. It is supported below by the mylo-hyoids and anterior bellies of the digastrici, and is closely related to the sublingual, submaxillary and apical salivary glands.

Its *dorsal surface* is covered by papillæ on its anterior two-thirds, and presents the prominences and orifices of numerous mucous glands and follicles behind. The *under surface* is smooth, and

Fig. 255.—The tongue with its papillæ (from Wilson).

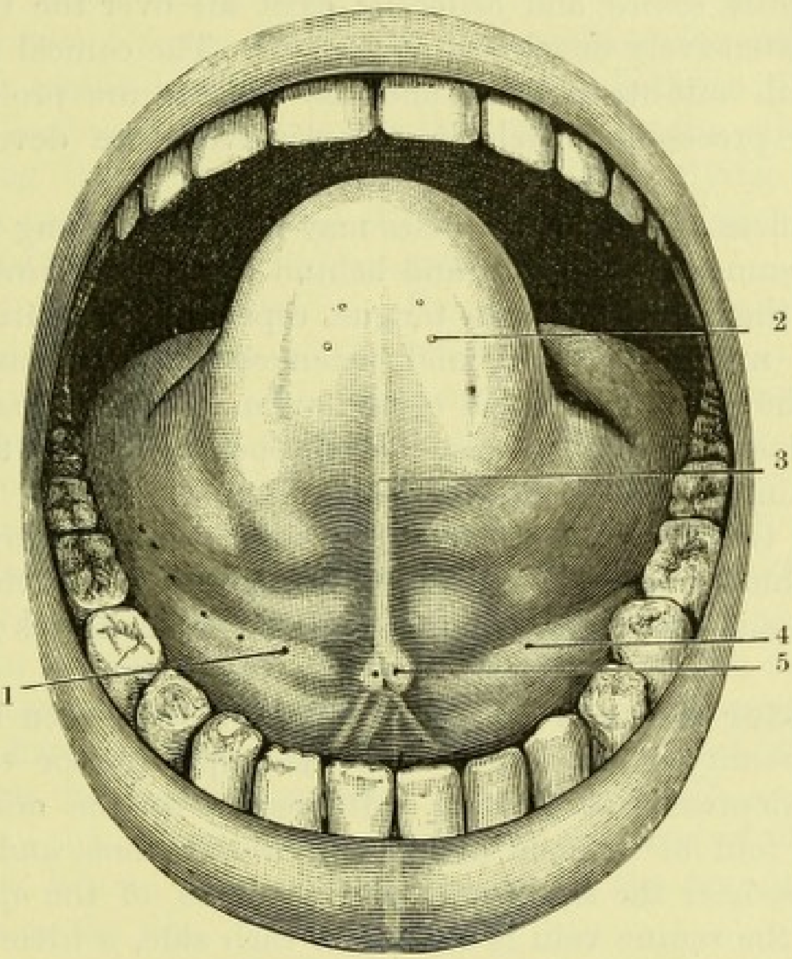
1. The raphe, which sometimes bifurcates on the dorsum of the tongue, as in the figure.
2, 2. Lobes of the tongue; the rounded eminences on this part, and near its tip, are the papillæ fungiformes. The smaller papillæ, among which the former are dispersed, are the papillæ conicæ and filiformes.
3. Tip of the tongue.
4, 4. Its sides.
5. 5. The V-shaped row of papillæ circumvallatæ.
6. Foramen cæcum.
7. Mucous glands of the root of the tongue.
8, 8. Epiglottis.
9, 9. Fræna epiglottidis.
10, 10. Greater cornua of the os hyoides.

presents at its point of junction with the floor of the mouth a sharply defined central fold of mucous membrane, the frænum, and a number of apertures connected with salivary glands (p. 556).

The **Papillæ** (Fig. 255) of the tongue are of three kinds, Circumvallate, Fungiform, and Filiform or Conical.

The *papillæ circumvallatæ* (5) are from eight to fifteen in number,

Fig. 256.



and are arranged in two oblique rows, which meet in the middle line posteriorly at a deep follicle, the *foramen cæcum*, representing the upper extremity of the thyreo-lingual duct (page 464). Each papilla consists of a central eminence, surrounded by a fossa and a circular outer wall, and is covered on its free surface with secondary papillæ. The circumvallate papillæ, as well as the

Fig. 256.—The under surface of the tongue (modified from Merkel).

1. Ducts of Rivini.
2. Ducts of Nuhn or Blandin (line crosses fimbriated fold).
3. Frænum.
4. Sublingual ridge.
5. Ducts of Wharton, opening on carunculæ salivales.

surface behind them, are supplied by the glosso-pharyngeal nerve.

The *papillæ fungiformes* are scattered over the tongue, but particularly at the tip and sides. They are globular in form, and have slender attachments to the surface of the tongue; they are of a dark red colour and are covered with secondary papillæ, which, like those of the other secondary papillæ, are concealed by the superjacent squamous epithelium.

The *papillæ conicæ* and *filiformes* exist all over the tongue, but are most extensively developed at the tip. The conical papillæ are covered with minute papillæ, and the filiform are prolonged into thread-like processes, which in the carnivora are developed into spines.

The orifices of mucous follicles may be found among the papillæ on the dorsum of the tongue, and behind the *papillæ circumvallatæ;* and along the margin of the tongue, especially opposite the molar teeth, are numerous compound racemose lingual glands, which lubricate the posterior portion of the organ. Some small salivary glands (*Ebner's glands*) are also found opening on to the dorsum along the line of the circumvallate papillæ.

Beneath the mucous membrane is a fibrous layer or *corium*, which gives attachment to many of the muscular fibres. In the centre of the tongue and dividing it into two symmetrical halves is a fibrous *raphe.*

The **Under Surface of the Tongue** may be seen by drawing up the extremity of the organ over the upper incisor teeth, when the jaw is depressed (Fig. 256). It presents in the middle line a prominent fold of mucous membrane, the *frænum*, and on either side of this, near the tip, some minute orifices of the *apical glands of Nuhn;* the ranine vein is visible on each side, a little nearer the margin of the organ, and sometimes a little mucous ridge, the *fimbriated fold.* At the junction of the tongue with the floor of the mouth is visible the eminence of the sublingual gland, with a row of small apertures of the *ducts of Rivini;* and immediately on each side of the middle line at the root of the frænum is a papilla (*caruncula salivalis*), upon which opens the *duct of Wharton.* In front of the caruncles may often be found a little group of accessory salivary glands (*incisive glands*), which lie in contact with the lower jaw opposite the roots of the middle incisors.

The **Intrinsic Muscles** are the Lingualis Superior, the Lingualis Transversus, the Lingualis Verticalis and the Lingualis Inferior (Fig. 233).

The *Lingualis Superior* (2) is a broad thin plane of fibres extending along the dorsal surface of the tongue immediately beneath the mucous membrane.

The *Lingualis Transversus* (4) constitutes the chief bulk of the tongue, and is placed beneath the lingualis superior. Its fibres are attached to the median septum and pass outwards to the mucous membrane.

The *Lingualis Verticalis* or *Obliquus* (3) consists of fibres most numerous near the lateral borders of the tongue, passing from the upper to the lower free surface.

The *Lingualis Inferior* (6) is to be seen on the under surface of the tongue, after removal of the hyo-glossus, lying between this muscle and the genio-glossus. It is larger than the lingualis superior, and extends along the under surface of the tongue, giving ascending fibres which pass between those of the transverse muscle, and being closely connected with the stylo-glossus muscle.

Glands of Nuhn or *Blandin.*—By removing the mucous membrane on the under surface of the tongue near the tip, a couple of oval glands may be seen. They are similar in structure to the sublingual glands, although distinct from them, and are sometimes united in front, forming a single mass of an arched form.

The **Nerves** (Fig. 230) of the tongue have been already examined, but may now be followed out minutely. They are the *Hypoglossal nerve* (12th) to the muscular structure of the tongue; the *Lingual nerve* (5th) to the fungiform and filiform papillæ on the dorsum and apex of the tongue, but this probably derives its gustatory fibres from the glosso-pharyngeal through the communication of the chorda tympani with the lesser superficial petrosal; the *Glosso-pharyngeal nerve* (9th) to the circumvallate papillæ at the base of the tongue to the surface behind them, and to the side of the tongue nearly as far forwards as the tip.

The Larynx.

The **Larynx** or organ of voice is closely connected with the hyoid bone and tongue. On tracing the mucous membrane from the dorsum of the tongue, it will be found to form three little *frœna* between the base of that organ and the prominent cartilage of the epiglottis; these are the *glosso-epiglottidean folds* (Fig. 255, 9). After being reflected over the epiglottis, the mucous membrane runs to the arytænoid cartilages and forms the two *arytæno-epiglottidean folds*, which bound the superior aperture of the larynx; and is then carried to the interior of the larynx and over its posterior surface into the œsophagus.

The **Superior Aperture of the Larynx** (Fig. 257) is bounded in front by the epiglottis, behind by the arytænoid cartilages, and on each side by the arytæno-epiglottidean folds. On looking through it will be seen the *Glottis* or *Rima Glottidis, i.e.*, the space between the two inferior or true vocal cords in front and the two arytenoid cartilages behind. The glottis varies, according to the movements of the arytænoid cartilages, from a mere chink to a wide triangular aperture with the apex forwards. Above the true vocal cords lie the less distinct *false cords*, and through the glottis may be seen the interior of the trachea. This view of the parts is of course reversed when reflected in the laryngoscope.

[The larynx is to be fastened upon a table by driving a nail or pin through the tongue and putting the trachea on the stretch with hooks, the anterior surface being exposed; the extrinsic muscles of the larynx, the sterno-hyoid, sterno-thyroid, thyro-hyoid, and inferior constrictor of the pharynx, are then to be carefully removed without injuring the crico-thyroid muscle or the external laryngeal nerve, which are now to be cleaned.]

Intrinsic Muscles of the Larynx.

The **Crico-thyroid Muscle** (Fig. 208, 22) *arises* from an oval surface on the side of the anterior aspect of the cricoid cartilage, and radiates to be *inserted* into the posterior part of the lower border and inner surface of the ala, and into the inferior cornu of the thyroid cartilage—some fibres joining those of the inferior constrictor. It is *supplied* by the external laryngeal branch of the superior laryngeal nerve (Fig. 258, 18).

[The preparation is to be turned over and the mucous membrane is to be dissected off the back of the larynx, the remnant of the œsophagus being removed. The crico-arytænoidei postici muscles on the back of the cricoid cartilage are readily dissected; but in order to clean the cross-fibres of the arytænoideus it will be necessary to over-distend the larynx so as to stretch the muscle; and this may be most readily done by the finger of an assistant.]

The **Arytænoideus** (Fig. 257, 4) is an example of a single muscle in the median line; its fibres crossing one another and being equally distributed on each side. It occupies the concave posterior surfaces of the two arytænoid cartilages, the fibres passing from one to the other. The superficial fibres cross obliquely from the apex of one cartilage to the base of the other, and *vice versâ*, so as to form an X, some turning around the outer border of the cartilage to join the arytæno-epigottideus or depressor of the epiglottis; whilst the deeper fibres pass transversely between the two cartilages, and constitute the arytænoideus proper. The arytænoideus is *supplied* by the inferior laryngeal nerve.

The **Crico-Arytænoideus Posticus** (Fig. 257, 10) *arises* from

Fig. 257.

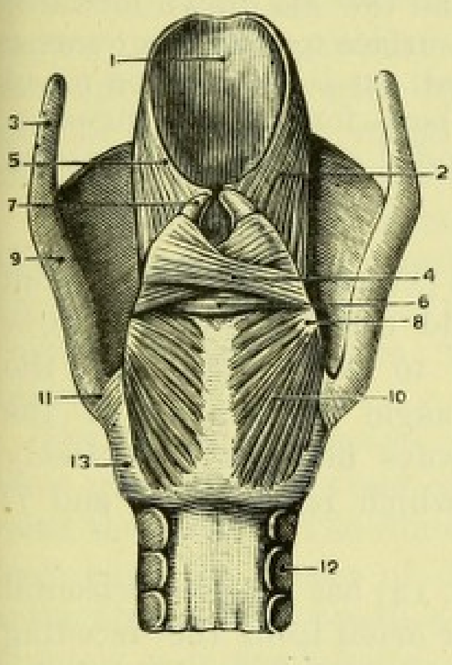


Fig. 258.

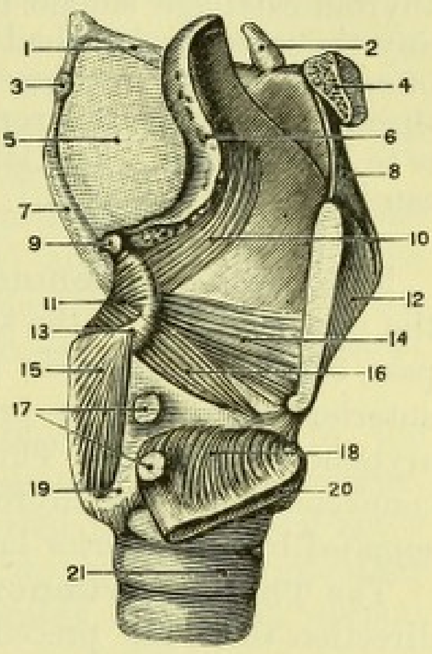


Fig. 257.—Posterior view of the larynx (from Sappey).

1. Epiglottis.
2. Arytæno-epiglottideus.
3. Superior cornu of thyroid.
4. Oblique fibres of arytænoideus.
5. Arytæno-epiglottidean fold.
6. Deep fibres of arytænoideus.
7. Tip of arytænoid cartilage.
8. External angle of base of arytænoid cartilage.
9. Thyroid cartilage.
10. Crico-arytænoideus posticus.
11. Articulation between inferior cornu of thyroid and cricoid.
12. Trachea.
13. Back of cricoid.

Fig. 258.—Side view of larynx, one ala of the thyroid cartilage partially removed, the lower part being turned down (from Sappey).

1. Great cornu of hyoid.
2. Small cornu of hyoid.
3. Cartilago triticea in thyro-hyoid ligament.
4. Body of hyoid bone.
5. Thyro-hyoid membrane.
6. Epiglottis.
7. Superior cornu of thyroid.
8. Front of thyro-hyoid membrane.
9. Cartilage of Santorini.
10. Arytæno-epiglottideus.
11. Arytænoideus.
12. Thyroid cartilage.
13. Outer angle of base of arytænoid cartilage.
14. Thyro-arytænoideus.
15. Crico-arytænoideus posticus.
16. Crico-arytænoideus lateralis.
17. Articulation between inferior cornu of thyroid and cricoid laid open.
18. Crico-thyroideus, turned down.
19. Cricoid cartilage.
20. Lower part of right ala of thyroid cartilage, turned down.
21. Trachea.

the corresponding half of the posterior surface of the cricoid cartilage, and its fibres converge obliquely upwards and outwards, to be *inserted* into the posterior aspect of the prominent outer angle of the base of the arytænoid cartilage. It is *supplied* by the inferior laryngeal nerve.

[To see the crico-arytænoideus lateralis and the thyro-arytænoideus muscles, the superior and inferior cornua of one half of the thyroid cartilage should be cut through and the ala drawn forward, any tissue being detached from its inner surface to within a quarter of an inch of the median line. A vertical cut is then to be made through it there with strong scissors or the bone-forceps, and the piece is to be removed. The larynx being distended as before, the muscles can be readily dissected.]

The **Crico-Arytænoideus Lateralis** (Fig. 258, 16) *arises* from the upper border of the side of the cricoid cartilage, and its fibres pass obliquely upwards and backwards to be *inserted* into the anterior aspect of the prominent outer angle of the base of the arytænoid cartilage. This muscle is always more or less closely connected with the thyro-arytænoideus, which is above it, and is *supplied* by the inferior laryngeal nerve.

The **Thyro-Arytænoideus** (Fig. 258, 14) has a more horizontal direction than the preceding muscle. It *arises* from the receding angle of the thyroid cartilage immediately external to the inferior or true vocal cord, and as far down as the crico-thyroid membrane, to which some of its fibres are attached. It passes backwards, the upper fibres more obliquely than the lower ones, and is *inserted* into the lower half of the rough antero-external surface of the arytænoid cartilage, external to the processus vocalis, and by some fibres into the outer surface of the vocal cord. It is *supplied* by the inferior laryngeal nerve.

[If a second larynx can be procured, a very satisfactory way of seeing the thyro-arytænoid muscle is to cut the thyroid cartilage horizontally at the level of the true vocal cords, when the muscles can be readily displayed immediately outside them.]

The *arytæno-epiglottideus* consists of a thin plane of fibres which *arise* from the upper part of the antero-external surface of the arytænoid cartilage, and after reinforcement by some of the superficial fibres of the arytænoideus, pass to be *inserted* into the side of the epiglottis. The inferior portion of the muscle passes in the mucous fold, forming the outer wall of the sacculus laryngis, and is known as the *compressor sacculi laryngis* of Hilton, or arytæno-epiglottideus inferior.

The *thyro-epiglottideus* is a small paired muscle *arising* from the receding angle of the thyroid cartilage above the thyro-arytænoideus, and *inserted* into the side of the epiglottis.

Actions of the Laryngeal Muscles.

The cartilages are moved upon one another by the several muscles, in such a manner as to alter either the tension of the vocal cords or the size of the glottis. The action of these muscles will be better understood, if it be remembered that the cricoid moves upon the thyroid, or *vice versâ*, around a transverse axis passing through the two crico-thyroid joints, while the arytænoids are capable of rotation round a nearly vertical axis, and of gliding movements from side to side and from before backwards.

The *Crico-thyroidei* rotate the cricoid cartilage upwards (or the thyroid cartilage downwards and forwards) and thus tighten the vocal cords by increasing the distance of the receding angle of the thyroid cartilage from the vocal processes of the arytænoid cartilages.

The *Thyro-arytænoidei* being parallel to, and attached to the same points as, the vocal cords, must necessarily by their contraction relax the cords. The fibres which are inserted into the vocal cords may have the power of dividing them into separately vibrating segments, and so produce a note considerably above the normal register, as in the falsetto.

The *Crico-arytænoidei postici* swing the arytænoid cartilages outwards, and thus separate the vocal processes and dilate the glottis. This can be easily shown by making traction upon the two muscles simultaneously with the points of a pair of forceps.

The *Crico-arytænoidei laterales* are antagonists to the postici, and approximate the vocal cords, thus narrowing or closing the glottis.

The *Arytænoideus* draws the arytænoid cartilages together, and thus, according to one view, constricts the glottis; but it may be doubted whether the more superficial fibres, which are inserted farthest out, would not tend to swing the cartilages upon their axes in such a manner as to widen the glottis. The most superficial fibres, which reinforce the arytæno-epiglottidei, aid the action of those muscles.

The *thyro-arytæno-epiglottidei* and the *arytænoideus* together approximate the sides of the upper aperture of the larynx and depress the epiglottis.

The *functions* of the laryngeal muscles are hence partly respiratory, partly vocal. In *respiration*, the glottis is widened by the crico-arytænoidei postici and narrowed by the crico-arytænoidei laterales and thyro-arytænoidei. In *vocalisation*, the preliminary approximation of the cords necessary for the production of sound having been effected by the two muscles just named, the cords may be made tense by the crico-thyroidei, or relaxed, as in the production of low notes, by the thyro-arytænoids, and the vibrating cords can probably be segmented by the contraction of the innermost fibres of the latter muscles and the note thus elevated above the usual register. The action of the arytænoideus is uncertain. The alteration of the position of the epiglottis is probably of service in modulating the sound, but the closure of the epiglottis in deglutition is mainly effected by the conjoint action of the retractors of the tongue and the elevators of the larynx.

[A side view of the interior of the larynx is now to be obtained by cutting away the crico-arytænoideus lateralis, with the vocal cords and mucous membrane of the same side, but the cricoid cartilage is to be left entire.]

On a Side-view (Fig. 259) of the interior of the larynx will be seen the horizontal projections of the mucous membrane, caused by the superior and inferior vocal cords. Between the two cords is a depression called the *ventricle* (7) of the larynx, and from the front of this a probe can be carried into a pouch, the *sacculus laryngis*, which projects upward between the upper cord and the thyroid cartilage. The mucous membrane is continued from the ventricle into the sac, and is there provided with numerous mucous glands which provide a secretion for the lubrication of the true vocal cords.

[The mucous membrane is to be dissected from the vocal cords, and their attachments are to be clearly shown.]

The **Vocal Cords** or **Thyro-arytænoid Ligaments** (Fig. 259) are four in number, two on each side of the larynx.

The *superior ligament* or *false cord* (5) has an arched direction, and is much more slender than the inferior ligament. It is attached in front to the receding angle of the thyroid cartilage, and behind to the projection on the upper part of the front of the arytænoid cartilage.

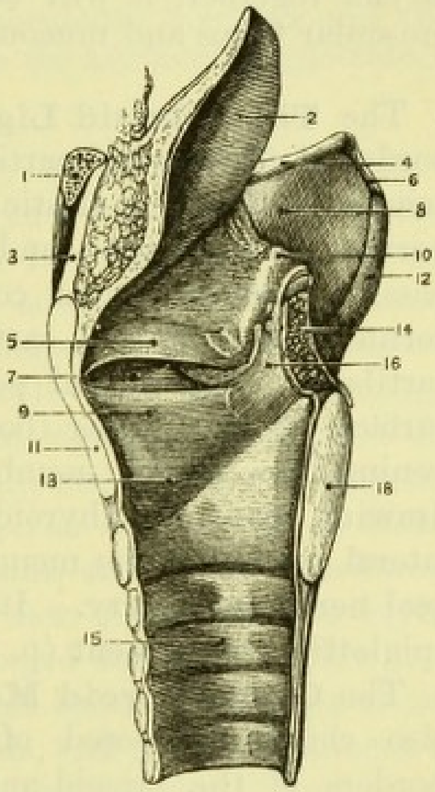
The *inferior ligament* or *true cord* (9), composed of yellow elastic fibrous tissue and horizontal in direction, is attached in front to the receding angle of the thyroid cartilage below the superior ligament, and behind to the prominent *processus vocalis* above the anterior angle of the base of the arytænoid cartilage, and is continuous laterally and below with the free upper edge of the crico-thyroid membrane.

The *glottis* or *rima glottidis* is the aperture bounded laterally by the true vocal cords in front, and the inter-arytænoid space behind.

The **Arteries** of the larynx are derived from the superior and inferior thyroid arteries.

The *superior laryngeal artery*, from the superior thyroid, enters the larynx through the thyro-hyoid membrane, occasionally through a foramen in the thyroid cartilage, and divides into ascending and descending branches, which supply the muscles and mucous membrane, and anastomose above with the dorsalis linguæ.

Fig. 259.



The *inferior laryngeal artery*, from the inferior thyroid, reaches the back of the cricoid cartilage, and anastomoses with the superior artery above and with the tracheal branches of the same vessel below. It completes the supply of the laryngeal structures.

The **Nerves** (Fig. 209) of the larynx are the superior and the inferior (or recurrent) branches of the pneumogastric.

The *superior laryngeal nerve* (9) has been seen to give a branch (*external laryngeal*) to the crico-thyroid and inferior constrictor muscles, and then to pierce the thyro-hyoid membrane with the superior laryngeal artery. It supplies the mucous membrane of the larynx and back of the tongue, and gives a communicating branch to the inferior laryngeal nerve.

The *inferior* or *recurrent nerve* (21) is the motor nerve of the larynx, and has been seen to take a different course on the two sides, winding around the subclavian artery on the right, and around the

Fig. 259.—Vertical section of larynx showing its ligaments (from Sappey).

1. Body of hyoid bone.
2. Epiglottis.
3. Front of thyro-hyoid membrane.
4. Great cornu of hyoid.
5. False vocal cord.
6. Thyro-hyoid ligament.
7. Ventricle of larynx.
8. Thyro-hyoid membrane.
9. True vocal cord.
10. Arytæno-epiglottidean fold and cartilage of Wrisberg.
11. Thyroid cartilage.
12. Superior cornu of thyroid.
13. Crico-thyroid membrane.
14. Arytænoideus muscle.
15. Trachea.
16. Arytænoid cartilage.
18. Cricoid cartilage.

aorta on the left side, but in the larynx the nerves are symmetrical. Each nerve, running up the side of the trachea, passes beneath the border of the inferior constrictor of the pharynx and within the ala of the thyroid cartilage, to end in branches to the muscles of the larynx. It supplies all the muscles of the larynx except the crico-thyroid.

[In order to see the ligaments which bind the several parts of the larynx together, it will be necessary to remove cautiously all the muscular fibres and mucous membrane.]

The **Thyro-hyoid Ligament** (Fig. 258, 5) connects the upper border of the thyroid cartilage with the hyoid bone. It is chiefly composed of yellow elastic tissue, and may be divided into a central portion or *membrane*, and two rounded lateral portions (3), each passing from the great cornu of the hyoid bone to the superior cornu of the thyroid cartilage, and often containing a nodule of cartilage. The central portion is attached above to the posterior surface of the upper border of the hyoid bone, a bursa intervening between the membrane and the bone. This allows of the drawing up of the thyroid cartilage behind the hyoid bone. The lateral portion of the membrane is perforated by the superior laryngeal nerve and artery. Its deep surface is in contact with the hyo-epiglottidean ligament (p. 565).

The **Crico-thyroid Membrane** or **Ligament** (Fig. 259, 13) is also chiefly composed of elastic tissue, and passes between the borders of the cricoid and thyroid cartilages mesially for about a third of an inch, but laterally is prolonged backwards to the arytænoid cartilages, and is continuous by the upper borders of these lateral portions with the true vocal cords. Laryngeal obstructions in connexion with or above the true cords may be relieved in adults by opening the crico-thyroid membrane (*laryngotomy*), but in children the crico-thyroid space is too narrow to make this operation available.

The **Crico-tracheal Ligament** is between the lower border of the cricoid cartilage and the upper ring of the trachea, and is a simple membrane like that between the several rings of the trachea.

Capsular Ligaments enclosing synovial membranes surround the articulations between the *cricoid* and the inferior cornua of the *thyroid cartilage ;* and between the *cricoid* and the bases of the two *arytænoid cartilages.*

The **Thyro - epiglottidean Ligament** connects the lower extremity of the epiglottis with the back of the thyroid cartilage, a little below the notch in its upper border.

The **Hyo-epiglottidean Ligament** is a fan-shaped band of yellow elastic tissue, passing behind the thyro-hyoid membrane from the attached extremity of the epiglottis to the upper border of the hyoid bone.

Cartilages of the Larynx.

[The large cartilages of the larynx, viz. the thyroid, cricoid, two arytænoid, and the cartilage of the epiglottis, are readily recognized, but two pairs of minute cartilages, the cornicula laryngis and the cuneiform cartilages, are to be looked for in the arytæno-epiglottidean folds of mucous membrane.]

The **Thyroid Cartilage** (Fig. 257, 9) (θυρεὸς εἶδος, like a shield) is the largest cartilage of the larynx, and consists of two halves or *alæ*, which meet at an angle in front and form a prominence, especially distinct in the male adult, called the *pomum Adami.* Each ala is quadrilateral in shape, and has a rounded *posterior border* into which fibres of the stylo- and palato-pharyngei muscles are inserted ; an *inferior border*, which gives attachment to the crico-thyroid muscle in its posterior half, and to the crico-thyroid membrane in its anterior half ; and a *superior* border which forms the V-shaped notch of the pomum Adami, and gives attachment to the thyro-hyoid membrane and a few fibres of the stylo-pharyngei. Its posterior border is prolonged above and below into *superior* and *inferior cornua.* The superior cornu, the longer of the two, runs upwards, backwards, and inwards, and gives attachment to the lateral thyro-hyoid ligament, while the inferior cornu passes downwards, forwards and inwards, to articulate with the facet in the side of the cricoid cartilage, and gives attachment to the crico-thyroid and inferior constrictor muscles.

On the *outer surface* of the ala is an *oblique ridge*, extending from a tubercle at the root of the superior cornu to another tubercle about the middle of the lower border of the cartilage. The ridge gives attachment to the sterno-thyroid and thyro-hyoid muscles, and the surface behind it to the inferior constrictor of the pharynx. The *inner surfaces* of the alæ are smooth, and in the receding angle formed by their junction are attached nine structures, viz. the thyro-epiglottidean ligament, the two pairs of thyro-arytænoid ligaments (false and true vocal cords), the two thyro-epiglottidei muscles, and the two thyro-arytænoid muscles, the last just external to the inferior ligaments or true cords.

The **Cricoid Cartilage** (Fig. 258, 19) (κρίκος εἶδος, like a ring) is a ring of cartilage, shallow *in front*, where it is connected with the thyroid cartilage by a membrane, and has the crico-thyroideus attached to its outer surface; but deep behind, where it fills up a part of the space left between the posterior borders of the thyroid. Its upper border looks obliquely forwards, while its lower border is horizontal. The *upper border* presents two oval articular surfaces for the arytænoid cartilages, at the sides of the deep portion, and more anteriorly gives origin to the crico-arytænoidei laterales. The *lower border* is connected by a ligament with the first tracheal ring.

On each side, and near the lower border of the cartilage, is a small facet for articulation with the inferior cornu of the thyroid cartilage, and below this is the attachment of the lowest fibres of the inferior constrictor. The deep *posterior surface* is divided in the middle line by a vertical ridge, to which are attached some of the fibres of the œsophagus, the concave surface on each side giving origin to the crico-arytænoidei postici muscles.

The **Arytænoid Cartilages** (Fig. 259, 16) (ἀρυταίνα, a pitcher*) are two in number, and are of a pyramidal shape. The base of each cartilage is triangular, and articulates near its outer angle with the upper border of the cricoid cartilage; above its anterior angle is a sharp projection, the *processus vocalis*, which gives attachment to the true vocal cord; and its external angle forms the prominent *processus muscularis*, into which are inserted the crico-arytænoideus posticus and crico-arytænoideus lateralis. The apex is curved backwards and inwards, and is surmounted by the cornicula laryngis. The posterior surface is smooth and concave, and gives attachment to the arytænoideus muscle; the antero-external surface is rough for the origin of the thyro-arytænoideus and arytæno-epiglottideus muscles; and the internal surface, the narrowest, is smooth and is covered with mucous membrane.

The **Cornicula Laryngis** or **Cartilages of Santorini** are two pairs of small conical cartilages, connected with the apices of the arytænoid cartilages and with the arytæno-epiglottidean folds.

The **Cuneiform Cartilages** or **Cartilages of Wrisberg** are two small rod-like bodies developed in the arytæno-epiglottidean folds of mucous membrane, but are sometimes wanting. These and the last are composed of yellow fibro-cartilage, while the thyroid, cricoid, and arytænoid cartilages are of the hyaline variety.

The **Epiglottis** (Fig. 259, 2) also composed of yellow fibro-cartilage, is shaped like a cordate leaf, and has been seen to be con-

* This derivation has reference to the appearance of both cartilages taken together and covered by mucous membrane. In animals, which were the principal subjects of dissection among the ancients, the opening of the larynx, with the arytænoid cartilages, bears a curious resemblance to the mouth of a pitcher with a large spout (Wilson).

nected by ligaments with the thyroid cartilage and the hyoid bone. The upper third of its anterior (buccal) surface and the whole of its posterior (laryngo-pharyngeal) surface are covered with mucous membrane. The cartilage is excavated, especially on its posterior aspect, by numerous depressions, in which mucous glands are lodged. The *posterior* surface is larger than the upper aperture of the larynx, and may be divided into a lower or respiratory portion covered with ciliated epithelium and presenting in the middle line a little prominence, the *cushion ;* and an upper or gustatory portion covered with squamous laminated epithelium and forming a part of the digestive tract. The free portion of the *anterior* surface is connected to the back of the tongue by three glosso-epiglottic folds, and the narrow extremity is attached to the hyoid bone by the hyo-epiglottidean ligament, and to the thyroid cartilage by the thyro-epiglottidean ligament. The *lateral borders* give attachment to the arytæno-epiglottidean folds, the thyro-epiglottidei, arytæno-epiglottidei, and some fibres of the stylo-pharyngei muscles.

The large cartilages of the larynx are very apt to undergo calcareous degeneration in advanced life, and the epiglottis is not unfrequently thickened by disease or injured by ulceration.

Ligaments of the Cervical Vertebræ.

The ligaments uniting the cervical vertebræ together are, except in the case of the first two, similar to those found in other parts of the spinal column, and their description will be found at the end of that of the thorax. The student would do well to refer to this description in order to observe the slight differences between these ligaments in the cervical and dorsal regions.

Ligaments of the Atlas, Axis, and Occiput.

[In order to examine the special ligaments of the first two cervical vertebræ and the occipital bone, it will be convenient to separate the whole of the cervical from the dorsal spine.]

The ligaments of the first two vertebræ and the occipital bone may be conveniently divided into (1) those external to, and (2) those internal to, the vertebral canal. The external ligaments more or less resemble the ligaments common to the vertebral column, but the internal ligaments have special relation to the movements of nutation and rotation, which are peculiar to this region.

1. The *External ligaments* are the Anterior, Posterior, and Lateral Occipito-Atlantal, and the Anterior and Posterior Atlanto-axial ligaments ; besides Capsular ligaments for the articular processes of the vertebræ and the condyles of the occipital bone.

The **Anterior Occipito-Atlantal Ligament** (Fig. 260) consists of a superficial and a deep portion. The superficial portion (1) is narrow and mesial, and is attached to the basilar process of the occipital bone above, and the anterior tubercle of the atlas below. The deep portion (2) is broad and membranous, and is attached to the occipital bone close to the foramen magnum above, and to the upper margin of the anterior arch of the atlas below.

Fig. 260.

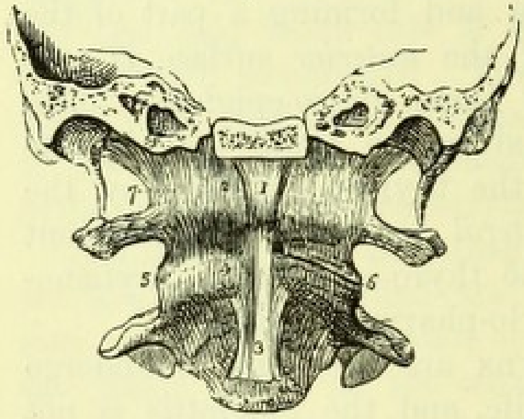
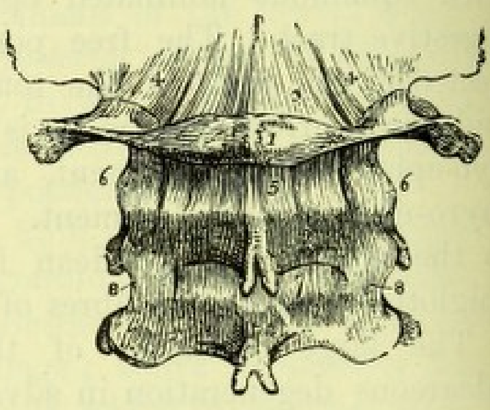


Fig. 261.



The **Posterior Occipito-Atlantal Ligament** (Fig. 261, 3) resembles the ligamenta subflava, but is composed of white fibrous

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Fig. 260.—Anterior view of the ligaments connecting the atlas, axis, and occipital bone (from Wilson).

1. Anterior round occipito-atlantal ligament.
2. Anterior broad occipito-atlantal ligament.
3. Commencement of the anterior common ligament.
4. Anterior atlanto-axial ligament, continuous inferiorly with the commencement of the anterior common ligament.
5. One of the atlanto-axial capsular ligaments; that on the opposite side has been removed to show the approximated surfaces of the articular processes (6).
7. One of the occipito-atlantal capsular ligaments. The most external of these fibres constitute the lateral occipito-atlantal ligament.

Fig. 261.—Posterior ligaments of the occipito-atlantal and atlanto-axial articulations (from Wilson).

1. Atlas.
2. Axis.
3. Posterior occipito-atlantal ligament.
4, 4. Capsular and lateral occipito-atlantal ligament.
5. Posterior atlanto-axial ligament.
6, 6. Its capsular ligaments.
7. The first pair of ligamenta subflava.
8, 8. Capsular ligaments of the 2nd and 3rd vertebræ.

tissue. It is thin and membranous, and is attached above to the posterior margin of the foramen magnum, and below to the posterior arch of the atlas. On each side, this ligament is perforated by the vertebral artery and suboccipital nerve, over which some of its fibres arch.

The **Lateral Occipito-Atlantal Ligaments** (Fig. 261, 4) are short strong bands, passing between the roots of the transverse processes of the atlas and the jugular processes of the occipital bone. They serve to strengthen the **capsular ligaments** uniting the condyles of the occipital bone with the corresponding articular facets on the upper surface of the atlas.

The **Anterior Atlanto-Axial Ligament** (Fig. 260, 4) resembles the anterior occipito-atlantal ligament, and consists of a superficial and a deep portion. The superficial portion is round, and is continuous with the anterior common ligament, being attached to the anterior tubercle of the atlas and the body of the axis. The deep portion is broad and thin, and extends from the anterior arch of the atlas to the body of the axis.

The **Posterior Atlanto-Axial Ligament** (Fig. 261, 5) resembles the posterior occipito-atlantal ligament, and is composed of white fibrous tissues, lined by a layer of yellow elastic tissue. It extends between the posterior arch of the atlas and the laminæ of the axis.

The **Capsular Atlanto-Axial** ligament is sufficiently loose to allow free rotation of the atlas around the odontoid process of the axis.

2. The *Internal Ligaments* are the Occipito-Axial, the Cruciform, and the Odontoid ligaments.

[To expose these ligaments it will be necessary to saw through the occipital bone obliquely on each side of the foramen magnum. The posterior part of the bone being removed, the arches of the atlas and axis are to be cut through on each side and taken away, and any remains of the spinal cord dissected off with the dura-mater, when the occipito-axial ligament will be exposed.]

The **Occipito-Axial Ligament** (Fig. 262, 5) (apparatus ligamentosus colli) is continuous with the posterior common ligament. It is attached below to the back of the body of the axis, and superiorly to the basilar groove of the occipital bone, above the posterior margin of the foramen magnum.

[The occipito-axial ligament is to be divided and turned up and down, when the cruciform ligament of the atlas and axis will be brought into view, and immediately above the transverse portion will be seen the two oblique odontoid ligaments.]

The **Cruciform Ligament** (Fig. 263) consists of a strong transverse ligament and two small vertical slips. The *Transverse Ligament* is attached to a tubercle on the inner surface of each lateral mass, and thus forms with the anterior arch of the atlas a ring in which the odontoid process of the axis is firmly held. The *vertical slips* of the cruciform ligament pass from the transverse ligament to the basilar process of the occipital bone and the body of the axis

Fig. 262.

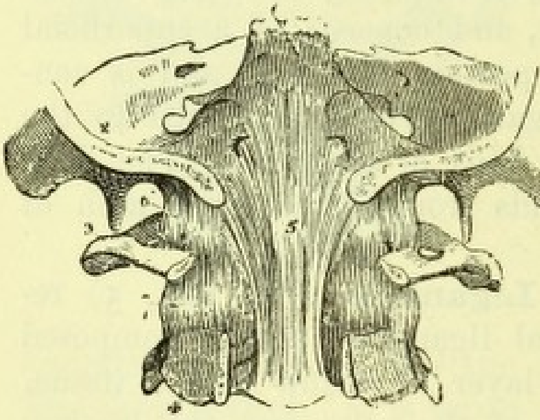
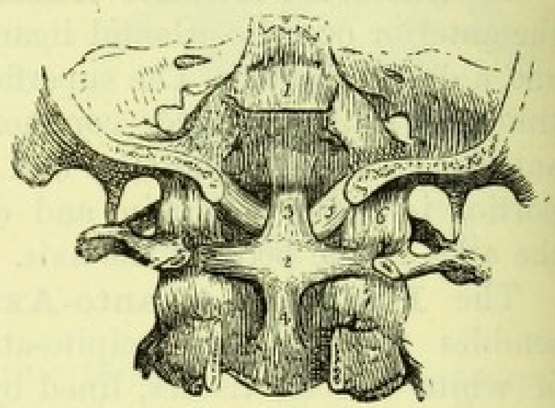


Fig. 263.



respectively, and by detaching the upper one the odontoid ligaments will be fully seen.

The **Odontoid** or **Check Ligaments** (Fig. 263, 5) are two strong bands of fibres, which pass obliquely from the sides of the head

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Fig. 262.—The occipito-axial ligament (from Wilson).

1. Basilar portion of the sphenoid bone.
2. Section of the occipital bone.
3. Atlas, its posterior arch removed.
4. Axis, its posterior arch removed.
5. Occipito-axial ligament, rendered prominent at its middle by the projection of the odontoid process.
6. Lateral and capsular ligament of the occipito-atlantal articulation.
7. Capsular ligament of the articular process of the atlas and axis.

Fig. 263.—Posterior view of the ligaments connecting the atlas, axis, and occipital bone (from Wilson).

1. Superior part of the occipito-axial ligament, which has been cut away in order to show the ligaments beneath.
2. Transverse ligament of the atlas.
3, 4. Ascending and descending slips of the transverse ligament, which complete the cruciform arrangement.
5. One of the odontoid ligaments, the fellow ligament is seen on the opposite side.
6. One of the occipito-atlantal capsular ligaments.
7. One of the atlanto-axial capsular ligaments.

of the odontoid process to the margin of the foramen magnum on each side, and thus check the rotation of the cranium and atlas upon the odontoid process. Between these is a weak *central odontoid ligament* (*ligamentum suspensorium dentis*), passing vertically between the margin of the foramen magnum and the top of the odontoid process.

On cutting all the ligaments of the articulation except the transverse ligament of the atlas, the odontoid process will be found to be still firmly held in position, owing to the fact that the transverse ligament grasps the contracted neck of the odontoid process. There are two *synovial membranes* in connection with the odontoid process, one in front, between it and the posterior surface of the atlas; the other behind, between it and the transverse ligament.

TABLE X.—MUSCLES OF THE HEAD AND NECK

Muscle.	Origin.	Insertion.	Nerve.
Occipito-frontalis	Superior curved line of occipital bone, outer $\frac{2}{3}$	Fibres of orbicularis palpebrarum and pyramidalis nasi	Facial (7th).
Auricularis superior	Aponeurosis of occipito-frontalis	Helix of pinna	Facial (7th).
Auricularis anterior	Aponeurosis of occipito-frontalis	Front of helix	Facial (7th).
Auricularis posterior	Mastoid process	Back of concha	Facial (7th).
Levator palpebræ sup.	Margin of optic foramen	Upper tarsal cartilage	Third.
Obliquus superior	Margin of optic foramen	Eyeball, sup. ext. quadrant behind meridian	Fourth.
Rectus superior	Margin of optic foramen	Eyeball, upper side	Third.
Rectus internus	Margin of optic foramen	Eyeball, inner side	Third.
Rectus inferior	Margin of optic foramen	Eyeball, lower side	Third.
Rectus externus	Common origin and sphenoidal fissure Upper part of optic foramen	Eyeball, outer side	Sixth.
Obliquus inferior	Superior maxilla behind lacrymal groove	Eyeball, sup. ext. quadrant behind meridian	Third.
Orbicularis palpebrarum	Frontal, inner angle; tendo oculi; superior maxilla, nasal process	Skin; malar bone and external tarsal ligament	Facial (7th).
Corrugator supercilii	Frontal, superciliary ridge	Orbicularis palpebrarum	Facial (7th).
Pyramidalis nasi	Orbicularis palpebrarum	Blends with compressor nasi	Facial (7th).
Levator labii superioris alæque nasi	Superior maxilla, nasal process	Alar cartilage; upper lip	Facial (7th).
Compressor nasi	Back of alar groove	Fascia over bridge of nose	Facial (7th).
Depressor alæ nasi	Superior maxilla, myrtiform fossa	Columna and ala nasi	Facial (7th).
Orbicularis oris	Septum nasi; alveoli of both jaws	Surrounds the mouth	Facial (7th).
Levator labii proprius	Sup. maxilla and malar, above infra-orb. foramen	Orbicularis oris	Facial (7th).
Levator anguli oris	Sup. maxilla below infra-orbital foramen	Orbicularis oris	Facial (7th).
Zygomaticus major	Malar bone	Orbicularis oris	Facial (7th).
Zygomaticus minor	Malar bone internal to last	Levator labii superioris	Facial (7th).
Depressor anguli oris	Lower jaw, oblique line below mental foramen	Orbicularis oris	Facial (7th).

Depressor labii inferioris	Lower jaw, oblique line near symphysis	Orbicularis oris	Facial (7th).
Levator menti	Lower jaw, incisive fossa	Skin of chin	Facial (7th).
Platysma	Front of clavicle; fascia	Lower jaw, skin and fascia	Facial (7th).
Sterno-cleido-mastoid	Manubrium, front; clavicle, inner $\frac{1}{3}$	Mastoid process; occipital line, outer $\frac{1}{2}$	Spinal-accessory (11th).
Sterno-hyoid	Manubrium, back; clavicle	Hyoid bone, body	Descendens cervicis.
Sterno-thyroid	Manubrium, back; 1st costal cartilage	Thyroid cartilage, oblique line	
Thyro-hyoid	Thyroid cartilage, oblique line	Hyoid bone, body, and great cornu	Hypoglossal (12th).
Omo-hyoid	Scapula, upper margin and transverse ligament.	Hyoid bone, body	Descendens cervicis.
Digastricus	Groove on inner side of mastoid process	Lower jaw, close to symphysis, central tendon to hyoid bone, body	Facial (7th). Mylo-hyoid (5th).
Stylo-hyoid	Styloid process, outer side	Hyoid bone, side of body	Facial (7th).
Masseter	Zygomatic arch and superior maxilla	Lower jaw, angle and ramus, outer surface	3rd division of 5th.
Temporal	Temporal fossa and fascia	Lower jaw, coronoid process and ramus	3rd division of 5th.
Pterygoideus externus	Pterygoid plate, tuberosity of palate and maxilla Great wing of sphenoid	Lower jaw, front of neck; interarticular cartilage	3rd division of 5th.
Pterygoideus internus	Pterygoid plate, tuberosity of palate and maxilla	Lower jaw, inner surface of angle	3rd division of 5th.
Buccinator	Maxillæ, alveolar borders opposite molars; pterygo-maxillary ligament	Orbicularis oris	7th and 3rd div. of 5th.
Mylo-hyoid	Ridge on inner side of lower jaw	Hyoid bone, body; median raphe	Inferior dental (5th).
Hyo-glossus	Hyoid bone, body and cornua	Tongue, side of	Hypoglossal (12th).
Stylo-glossus	Styloid process, tip; stylo-maxillary ligament	Tongue, side of	
Stylo-pharyngeus	Styloid process, root	Pharynx; thyroid cartilage and epiglottis	Glosso-pharyngeal (9th).
Genio-hyoid	Lower mental tubercle	Hyoid bone, body; above mylo-hyoid	Hypoglossal (12th).
Genio-glossus	Upper mental tubercle	Tongue, median line, sometimes hyoid bone, above last	
Scalenus anticus	1st rib, scalene tubercle	Cervical vertebræ, 3, 4, 5, 6, anterior transverse (costal) processes	Brachial nerves.
Scalenus medius	1st rib, upper surface behind groove for subclavian artery	Cervical vertebræ, lower 6, posterior transverse processes	Cervical anterior.
Scalenus posticus	2nd rib	Cervical vertebræ, lower 3, posterior transverse processes	
Rectus capitis anticus major	Cervical vertebræ, 3, 4, 5, 6, anterior transverse processes	Occipital, basilar process	1st cervical, anterior.

TABLE X.—MUSCLES OF THE HEAD AND NECK—*continued.*

Muscle.	Origin.	Insertion.	Nerve.
Rectus capitis anticus minor	Atlas, lateral mass and transverse process	Occipital, basilar process	1st cervical, anterior.
Rectus capitis lateralis	Atlas, transverse process	Occipital, jugular process	
Longus colli	*a.* Dorsal vertebræ, 2, 3, bodies *b.* Cervical vertebræ, 3, 4, 5, transverse processes *c.* Cervical vertebræ, 6, 7, dorsal, 1, 2, bodies	*a.* Cervical vertebræ, 5th and 6th transverse processes *b.* Atlas, anterior tubercle *c.* Cervical vertebræ, 2, 3, 4, bodies	Cervical anterior.
Inferior constrictor	Cricoid cartilage; thyroid cartilage, inf. cornu and ala behind oblique line	Median raphe, sometimes basilar process	Pharyngeal plexus, recurrent and external laryngeal.
Middle constrictor	Hyoid bone, greater and lesser cornua; stylo-hyoid ligament	Median raphe	Pharyngeal plexus.
Superior constrictor	Internal pterygoid plate and hamular process; pterygo-maxillary ligament; mylo-hyoid ridge; soft palate; tongue	Median raphe; basilar process	
Tensor palati	Scaphoid fossa: Eustachian tube	Soft palate and palatine ridge	3 Div. of 5th and otic ganglion.
Levator palati	Petrous bone; Eustachian tube	Soft palate	Facial through Meckel's ganglion.
Azygos uvulæ	Posterior nasal spine of palate	Uvula	
Palato-glossus	Soft palate	Side of tongue	Spinal-accessory and vagus through pharyngeal plexus.
Palato-pharyngeus	Soft palate; Eustachian tube (Salpingo-pharyngeus)	Pharynx; thyroid cartilage	
Crico-thyroideus	Cricoid cartilage, front of ring	Thyroid cartilage, lower border and cornu	External laryngeal.
Arytænoideus	Arytænoid cartilages, concave posterior surfaces	Decussating fibres	Recurrent laryngeal.
Crico-arytænoideus posticus	Cricoid cartilage, posterior surface	Arytænoid, base, posterior outer angle	
Crico-arytænoid. lat.	Cricoid cartilage, superior lateral border	Arytænoid, base, anterior outer angle	
Thyro-arytænoideus	Thyroid cartilage, receding angle	Arytænoid, anterior surface	
Arytæno-epiglottideus	Side of epiglottis	Arytænoid, anterior surface above last	
Thyro-epiglottideus	Thyroid cartilage, receding angle	Side of epiglottis	

TABLE XI.—THE ARTERIES OF THE HEAD AND NECK.

A. *Innominate.* Branching into right common carotid and right subclavian opposite the upper border of the right sterno-clavicular joint.

B. *Common carotid.* Branching into external and internal carotid opposite upper border of thyroid cartilage.

C. *External carotid.*

I. *Superior thyroid.* Arising close to origin of external carotid.
1. Inferior hyoid.
2. Superior laryngeal.
3. Crico-thyroid.
4. Sterno-mastoid.
5. Terminal glandular.

II. *Lingual.* Arising below greater cornu of hyoid bone.
1. Superior hyoid.
2. Dorsalis linguæ.
3. Sublingual.
4. Ranine or terminal.

III. *Facial.* Arising opposite greater cornu of hyoid bone.

1. Ascending palatine	From submaxillary stage.
2. Tonsillar	
3. Submaxillary	
4. Submental	
5. Inferior labial	From facial stage.
6. Inferior coronary	
7. Superior coronary	
8. Lateralis nasi	
9. Muscular (several)	
10. Angular or terminal	

IV. *Occipital.* Arising opposite facial.
1. Sterno-mastoid (inconstant).
2. Auricular.
3. Posterior meningeal.
4. Princeps cervicis.
5. Cranial or terminal.

V. *Posterior auricular.* Arises beneath posterior belly of digastricus.
1. Stylo-mastoid.
2. Auricular.
3. Occipito-temporal.

VI. *Sterno-mastoid.* Inconstant. May be replaced by the sterno-mastoid branch of the occipital. Arises below occipital.

VII. *Ascending pharyngeal.* Arising usually half an inch or more above bifurcation of common carotid.
1. External or neuro-muscular.
2. Internal or pharyngeal.
3. Ascending or meningeal.

VIII. *Parotid* and *masseteric.* Arising below terminal bifurcation.

IX. *Temporal.* A terminal branch. Arising with the next on the substance of the parotid gland.
1. Orbital.
2. Transverse facial.

TABLE XI.—THE ARTERIES OF THE HEAD AND NECK—*continued.*

C. *External carotid—continued.*

IX. *Temporal—continued.*

3. Middle temporal.
4. Anterior auricular.
5. Articular, muscular, and parotid.
6. Anterior temporal } terminal.
7. Posterior temporal } terminal.

X. *Internal maxillary.*

1. Tympanic 2. Middle meningeal 3. Small meningeal 4. Inferior dental (mylo-hyoid, dental, and mental branches)	First stage from origin to anterior border of long internal lateral ligament.
5. Deep temporal, 2 branches 6. Pterygoid 7. Masseteric 8. Buccal 9. Alveolar (dental and antral branches) 10. Infra-orbital (temporo-malar, orbital, antral and dental branches)	Second stage to pterygo-maxillary fissure (9 and 10 sometimes regarded as branches of 3rd stage).
11. Descending palatine 12. Vidian 13. Pterygo-palatine 14. Spheno-palatine or nasal	Third stage in spheno-maxillary fossa.

D. *Internal carotid.*

I. Tympanic.

II. Receptacular.

III. Anterior meningeal.

IV. Ophthalmic . 1. Lacrymal; 2. Retinal; 3. Ciliary (short, long and anterior); 4. Supra-orbital; 5. Ethmoidal (anterior and posterior); 6. Frontal; 7. Palpebral; 8. Nasal; 9. Muscular (several).

V. Anterior cerebral VI. Middle cerebral VII. Posterior communicating VIII. Anterior choroid	See special section—Brain.

E. *Subclavian.* Divided into three stages in neck. Second stage behind scalenus anticus, first and third stages internal and external to the muscle.

I. *Vertebral* (first stage). Unites with fellow in skull to form basilar.

1. Spinal 2. Muscular	In neck.
3. Posterior meningeal 4. Anterior spinal 5. Posterior spinal 6. Posterior inferior cerebellar	In cranium before junction with its fellow.
7. Transverse, several 8. Auditory 9. Anterior inferior cerebellar. 10. Superior cerebellar 11. Posterior cerebral	In cranium, from *Basilar artery.* See special section—Brain.

TABLE XI.—THE ARTERIES OF THE HEAD AND NECK—*continued.*

E. *Subclavian artery—continued.*
- II. *Thyroid axis* (first stage). Trifurcates into α, β and γ.
  - α. *Inferior thyroid.*
    1. Laryngeal.
    2. Tracheal.
    3. Œsophageal.
    4. Ascending cervical.
  - β. *Supra-scapular* (Transversalis humeri).
    1. Acromial.
    2. Subscapular.
    3. Supra-spinous.
    4. Infra-spinous.
  - γ. *Transversalis Colli.*
    1. Superficial cervical.
    2. Posterior scapular (may arise from 3rd stage of subclavian).
- III. *Internal mammary* (first stage).
  8 branches in chest. See 'Thorax' section.
- IV. *Superior intercostal* (first stage left, second stage right).
  1. Profunda cervicis.
  2. Intercostal (see Thorax).

TABLE XII.—THE NERVES OF THE HEAD AND NECK.

CRANIAL NERVES.

I. *Olfactory* to nasal mucous membrane.

II. *Optic* to retina.

III. *Oculo-motor* to levator palpebræ, superior, internal and inferior recti, and inferior oblique; ganglionic to ciliary ganglion from last.

IV. *Trochlear* (or pathetic) to superior oblique of eyeball.

V. *Trifacial.* Motor and sensory portions. The latter developes the Gasserian ganglion. United nerve breaks up into α, β and γ.
- α. *Ophthalmic* division.
  1. Recurrent meningeal.
  2. Lacrymal. Glandular and palpebral branches.
  3. Frontal. Supra-orbital and supra-trochlear branches.
  4. Nasal. Ganglionic (ciliary), long ciliary, infra-trochlear and nasal (external and internal) branches.

  Ciliary or *lenticular ganglion* gives off short ciliary.
- β. *Superior maxillary* division.
  1. Orbital. Temporal and malar branches.
  2. Spheno-palatine or ganglionic (Meckel).
  3. Superior dental, posterior, middle, and anterior.
  4. Infra-orbital. Palpebral, nasal, and labial branches

  Spheno-palatine or *Meckel's ganglion.* Branches are (1) Orbital; (2) Nasal and naso-palatine; (3) Three palatine nerves (large, small and external); (4) Vidian and (5) Pterygo-palatine or pharyngeal.

TABLE XII.—THE NERVES OF THE HEAD AND NECK—*continued.*

CRANIAL NERVES—*continued.*

V. *Trifacial—continued.*

γ. *Inferior maxillary* division.

I. *Recurrent branch* through foramen spinosum.

II. *Smaller* or '*motor' division* (contains some sensory filaments).

1. Deep temporal (two or three).
2. Masseteric.
3. Buccal (sensory) to buccinator, skin and mucous membrane.
4. Internal pterygoid. To internal pterygoid, tensor palati, and tensor tympani.
5. External pterygoid. To muscle.
6. Ganglionic to otic ganglion.
7. Recurrent meningeal (through foramen spinosum).

III. *Larger* or '*sensory' division* (contains some motor filaments).

1. *Auriculo-temporal.* Ganglionic (to otic ganglion), articular, mental, parotid, auricular, and temporal branches.
2. *Lingual* (gustatory) joined by chorda tympani.
   Ganglionic to submaxillary ganglia.
   Communicating to hypoglossal nerve.
   Sensory to mucous membrane of tongue and mouth.
   Muscular to inferior lingualis.
3. *Inferior dental.*
   Mylo-hyoid (motor).
   Inferior dental (posterior and anterior).
   Mental.

Otic ganglion. Branches are (1) *Communicating* to the inferior maxilla, Jacobson's (glosso-pharyngeal), facial, auriculo-temporal, and sympathetic (middle meningeal plexus); (2) *Muscular*, joining nerve to tensor tympani and tensor palati.

Submaxillary ganglion. (1) Communicating to lingual, chorda tympani, and sympathetic (on facial artery); (2) Glandular to salivary and mucous glands.

VI. *Abducens.* To external rectus.

VII. *Facial.*

α. *Branches of communication.*

In petrosa. With (1) Auditory; (2) Meckel's ganglion (through petrosal); (3) Otic ganglion and chorda tympani (through small petrosal); (4) middle meningeal plexus (through external petrosal).

Near base of skull (after escape from stylo-mastoid foramen). With (1) Glosso-pharyngeal; (2) Vagus; (3) Carotid plexus.

In parotid region. With auriculo-temporal and great auricular.

On face. With the three divisions of the fifth.

β. *Branches of distribution.*

In petrosa. Tympanic to stapedius.

In neck. Posterior auricular, digastric and stylo-hyoid.

On face. Temporo-facial division: temporal, malar, infraorbital. Cervico-facial division: buccal, supra-maxillary, infra-maxillary.

VIII. *Auditory.*

α. Branches of communication to facial.

β. Branches of distribution to membranous labyrinth.

TABLE XII.—THE NERVES OF THE HEAD AND NECK—*continued.*

CRANIAL NERVES—*continued.*

IX. *Glosso-pharyngeal.*
1. *Branches of communication* with (1) Vagus; (2) Superior cervical ganglion.
2. *Tympanic* or *Jacobson's* nerve. (1) Three, to lining of tympanum, Eustachian tube, and fenestræ; (2) Three, to carotid plexus, greater petrosal, and small petrosal.
3. *Pharyngeal* to pharyngeal plexus.
4. *Tonsillar.*
5. *Muscular* to stylo-pharyngeus.
6. *Lingual* (anterior and posterior divisions).

X. *Pneumogastric* or *Vagus.*
1. *Branches of communication* with (1) Glosso-pharyngeal; (2) Superior cervical ganglion; (3) Hypoglossal; (4) First and second cervical nerves.
2. *Auricular* or *Arnold's nerve.* Communicating with facial and its posterior auricular branch. Cutaneous to back of pinna.
3. *Pharyngeal* to pharyngeal plexus.
4. *Superior laryngeal.* (1) External laryngeal to crico-thyroid, inferior constrictor, pharyngeal plexus, and superior cardiac nerve; (2) Sensory to mucous membrane of larynx; (3) Communicating to inferior laryngeal.
5. *Cervical cardiac* (superior and inferior).
6. *Inferior laryngeal.* (1) Cardiac; (2) Œsophageal; (3) Tracheal; (4) Laryngeal (to all muscles except crico-thyroid); (5) To superior laryngeal.

(For Thoracic and Abdominal Branches see special sections.)

XI. *Spinal-accessory.*
1. Communicating with (1) Vagus; (2) Superior cervical ganglion, (3) 1st and 2nd cervical nerves; (4) 2nd, 3rd and 4th cervical nerves of cervical plexus.
2. Muscular to sterno-mastoid and trapezius.

XII. *Hypoglossal.*
1. Communicating with (1) Vagus; (2) Superior cervical ganglion; (3) 1st and 2nd cervical nerves; (4) Lingual.
2. Descendens cervicis (1) To sterno-hyoid; (2) To sterno-thyroid; (3) To omo-hyoid; (4) Communicans cervicis to 2nd and 3rd cervical nerves.
3. Muscular to thyro-hyoid.
4. Muscular to genic-hyoid.
5. Muscular to hyo-glossus, stylo-glossus, genio-glossus and intrinsic muscles.

(2, 3 and 4 probably derived from cervical communication.)

SPINAL NERVES.

Anterior divisions.

Cervical plexus formed by first four cervical nerves.

Superficial	1. Small occipital	2nd and 3rd.
	2. Great auricular	
	3. Superficial cervical .	
	4. Sternal............	3rd and 4th.
	5. Clavicular	
	6. Acromial	

TABLE XII.—THE NERVES OF THE HEAD AND NECK—*continued.*

SPINAL NERVES—*continued.*

Anterior divisions—continued.

Cervical plexus—continued.

Muscular ....
1. To sterno-mastoid, 2nd.
2. To levator anguli scapulæ, 3rd.
3. To recti antici and lateralis (three branches).
4. To scalenus medius and longus colli.
5. To trapezius, 3rd and 4th.
6. To diaphragm (phrenic), 3rd, 4th and 5th.

Communicating
1. To glosso-pharyngeal
2. To pneumogastric ..
3. To hypoglossal......
   Loop between 1st and 2nd.
4. To communicans noni, 2nd and 3rd.
5. Intercommunicating from 1st, 2nd and 3rd to succeeding.
6. To brachial plexus, 4th nerves.

Brachial plexus. Branches above clavicle.
1. To rhomboids, 5th.
2. To phrenic (phrenic communicating), 5th or 5th and 6th.
3. To supra and infra spinati (supra-scapular), 5th and 6th.
4. To subclavius, 5th and 6th. Usually communicates with phrenic.
5. To serratus magnus (posterior thoracic, nerve of Bell), 5th and 6th, or 5th, 6th, and 7th.
6. To scaleni and longus colli, 5th, 6th, 7th and 1st dorsal.

SYMPATHETIC NERVES.

Superior cervical ganglion.

Internal.. *Carotid plexus.* On outer edge of internal carotid artery. To (1) Tympanic plexus (Jacobson's); (2) Vidian; (3) Gasserian ganglion; (4) Sixth nerve; (5) Arterial wall.

Ascending. *Cavernous plexus.* On inner side of artery. To (1) Third; (2) Fourth; and (3) Ophthalmic division of fifth nerves; (4) Lenticular ganglion; (5) Arterial wall.

External.. *Communicating* with ninth, tenth, eleventh, and twelfth cranial nerves and first four cervical nerves.

Internal ..
Pharyngeal, join pharyngeal plexus.
Laryngeal, join superior laryngeal nerve.
Superior cardiac. Left to superficial cardiac plexus, right to deep plexus

Anterior.. *External carotid plexus* to external carotid artery and its branches. The facial plexus joins the submaxillary ganglion, the middle meningeal plexus joins the otic ganglion and the facial nerve (external petrosal).

Descending. To middle ganglion.

Middle cervical ganglion.

External. To 5th and 6th cervical nerves.

Internal
Thyroid to thyroid body and external laryngeal nerve.
Middle cardiac to deep plexus.

Ascending and descending. Communicating with superior and inferior ganglia.

Inferior cervical ganglion.

External
To 7th and 8th cervical.
To vertebral artery.

Internal. Inferior cardiac to deep plexus.

Ascending and descending to middle cervical and 1st dorsal ganglia.

PART V.

THE THORAX.

[The axilla having been completed, the dissectors of the thorax should detach the remains of the pectorales, the serrati, and the abdominal muscles from the outer surfaces of the ribs and their cartilages, and dissect the external intercostal muscles.]

The **External Intercostal Muscles** (Fig. 124, 4), eleven in number on each side, are placed between the ribs, and are attached to the lower and upper borders and outer surfaces of the adjacent bones, the fibres running obliquely downwards and forwards. They extend from the tubercles of the ribs to the line of junction with the costal cartilages; and beyond this point, prolonged to the anterior extremities of the intercostal spaces, is a thin fascia, the fibres of which take the same direction as those of the external intercostals.

[By removing the external intercostal in one space, the outer surface of the internal intercostal muscle will be exposed, and the intercostal artery will be found with its accompanying vein and nerve. The artery lies at first at the lower border of the rib bounding the space above, and ends by anastomosing with the corresponding intercostal branch of the internal mammary, which runs outwards in the substance of the internal intercostal muscle. A small collateral branch of the artery will be found at the lower part of each space between the muscles, anastomosing with a corresponding branch of the internal mammary.

The **Internal Intercostal Muscles** (Fig. 124, 5) take a direction opposite to that of the external muscles, and can now be seen only in front, where the external muscles are wanting, but will be fully exposed from within the thorax.

Each muscle in the typical spaces extends from the angles of the ribs to the anterior extremity of the space. It is attached to the superior border of the lower rib, close to the attachment of the external intercostal, and to the inner margin of the vascular groove of the upper rib, encroaching upon the inner surfaces of both bones. It should be noted that both external and internal intercostals are attached to the outer border of the first rib.

[The knife is to be carried through the cartilages of all the true ribs except the first, as near the bones as possible, and then along the intercostal space between the 5th and 6th ribs to the lower part of the sternum. The sternum having been sawn across between the 1st and 2nd ribs, and between the 5th and 6th ribs, the intervening part is to be removed with the triangularis sterni and the internal mammary vessels, which are necessarily divided in two places, the pleuræ being cut near the median line so as to preserve the anterior mediastinum.]

The **Triangularis Sterni Muscle** (Fig. 266, 3) lies at the back of the sternum, but when it has been damaged by the incision made for injecting the subject, another specimen should be examined on a fresh sternum from the post-mortem room. It *arises* from the inner surface of the ensiform cartilage and lower part of the meso-sternum, and from the cartilages of the last two or three true ribs; and is *inserted* into the cartilages of the 2nd, 3rd, 4th, 5th and 6th ribs. Its digitations, which appear to be continuous with those of the transversalis, pass behind the internal mammary vessels. It acts as a muscle of expiration by depressing the ribs, and is *supplied* by the intercostal nerves.

[The internal mammary arteries may now be dissected by removing the triangularis sterni.]

The **Internal Mammary Artery** (Fig. 266, 2) passes downwards behind the cartilages of the ribs, about half an inch from the margin of the sternum, superficially to the triangularis sterni, as far as the 7th costal cartilage, where it divides into its terminal branches the superior epigastric and the musculo-phrenic.

a. The *superior epigastric branch*, after passing between the sternal and costal origins of the diaphragm, enters the fibres of the rectus abdominis muscle, and anastomoses with the deep epigastric branch of the external iliac, thus establishing a communication which becomes of great importance in any case of obstruction of the abdominal aorta or iliac arteries.

b. The *musculo-phrenic branch* runs outwards between the lower rib cartilages and the diaphragm, and after perforating the latter opposite the 8th or 9th cartilage, supplies it, anastomosing with the lower intercostal arteries, and with the phrenic branches of the abdominal aorta.

The other branches of the internal mammary are (*c*) *comes nervi phrenici*, a small branch accompanying the phrenic nerve; (*d*) *mediastinal* and (*e*) *pericardiac* branches, from which small twigs pass to form the 'sub-pleural mediastinal plexus' (Turner); (*f*) *anterior intercostals*, two to each of the upper six intercostal spaces, running outwards at first beneath the internal intercostal muscle, then between the two intercostals, and anastomosing with the posterior intercostal branches; and (*g*) *perforating* branches to the pectoral muscles and to the mamma and the skin.

The *venæ comites* of the internal mammary artery unite to open into the corresponding innominate vein.

On opening the thorax as directed, the lungs will be exposed by the necessary division of the pleuræ, and, unless attached by old adhesions, have probably fallen back so as to show the pleura pericardii and its plicæ adiposæ. The great vessels of the heart will be seen emerging from the upper part of the pericardium, and if the pericardium has been opened to allow of the injection of the body, a portion of the heart may be visible, but for the present the opening may be advantageously closed with a stitch.

Sub-pleural Connective Tissue. (Fig. 264). Between the parietal pleura and the chest-wall may be seen a well-marked layer of connective tissue, which is prolonged in a more attenuated form beneath the diaphragmatic and pericardiac pleura, and into the neck over the pleural domes. It is continuous with the abundant mediastinal areolar tissue surrounding the vessels and nerves, and passes into the neck and axillæ chiefly in the form of vascular and nervous sheaths, and through the aortic opening to join the subperitoneal tissue; in certain positions it becomes the seat of abundant fatty deposits, as over the front of the pericardium, where it forms large adipose folds which extend on to the adjacent part of the diaphragm. It is difficult to demonstrate beneath the visceral layer of the pleura, but is nevertheless present and invests the pulmonary lobules. Over the root of the lung it is found in considerable quantity, and there serves to bind the component elements together.

The **Pleuræ** (Fig. 266) are two shut sacs of serous membrane lining the thorax and covering the lungs, but have been opened in removing the sternum. One of the lungs is to be drawn forward, when its pleura can be readily traced over the inner surface of the sternum and ribs (costal portion) to the back of the root of the lung, forming the lateral boundary of the posterior mediastinum (mediastinal portion); thence around the lung (pulmonary portion) to the front of the root, from which it passes on to the pericardium (pericardial layer), and is carried forward to about the middle of the sternum, where it becomes continuous with the costal portion. If the lung is drawn forward, below its root will be seen a fold of pleura called the *ligamentum latum pulmonis*, connecting the lower lobe with the side of the pericardium and diaphragm. The pleura is reflected upon the upper surface of the diaphragm below (diaphragmatic layer), and prolonged in a conical form above the first rib, where it may be felt behind the subclavian artery (cervical layer or dome). The *visceral* layer of the pleura is that which covers the lung ; the *parietal* layer includes the costal layer as well as that part which covers the diaphragm and the sides of the pericardium, and enters into the formation of the mediastina and dome. The right pleura is shorter but wider than the left, because the diaphragm rises higher on the right side owing to the presence of the liver, and the heart has a direction to the left.

The position of the anterior and inferior reflections of the pleuræ should be carefully studied. The *anterior reflection* of the right pleura passes a little beyond the mid-line of the sternum, that of the *left* pleura extends to the mid-line down to the fourth costal cartilage, but from that point it diverges more or less towards the left. In about eleven subjects out of twelve it does not pass outside the left sternal border, and consequently leaves only a very narrow mediastinal space, while the whole of the pericardium opposed to the left costal cartilages and intercostal spaces is separated from these parietal structures by the pleura, and cannot be reached in the operation of paracentesis except through the pleural cavity.

The *inferior reflection* extends in a slightly ascending course from the neck of the 12th rib around the thorax to the sternal end of the 7th costal cartilage, crossing the 11th, 10th, 9th, and 8th ribs in succession.

The **Mediastinum** is the space between the pleuræ. For convenience of description it is divided into two parts, superior and inferior, the latter being subdivided into three segments, anterior, middle and posterior.

The *Superior Mediastinum* is *bounded* in front by the manubrium sterni, behind by the bodies of the upper four dorsal vertebræ, above by the oblique plane of the upper aperture of the thorax, and below by a nearly horizontal plane drawn through the lower surface of the body of the fourth dorsal vertebra and the junction of the manubrium with the body of the sternum. It *contains* the trachea ; the œsophagus ; the thoracic duct ; the horizontal part of the arch of the aorta and its three great branches; the innominate veins, with their tributaries; part of the superior vena cava; the phrenic, pneumogastric, left recurrent laryngeal, and cardiac nerves; lymphatic glands; the remains of

Fig. 264.

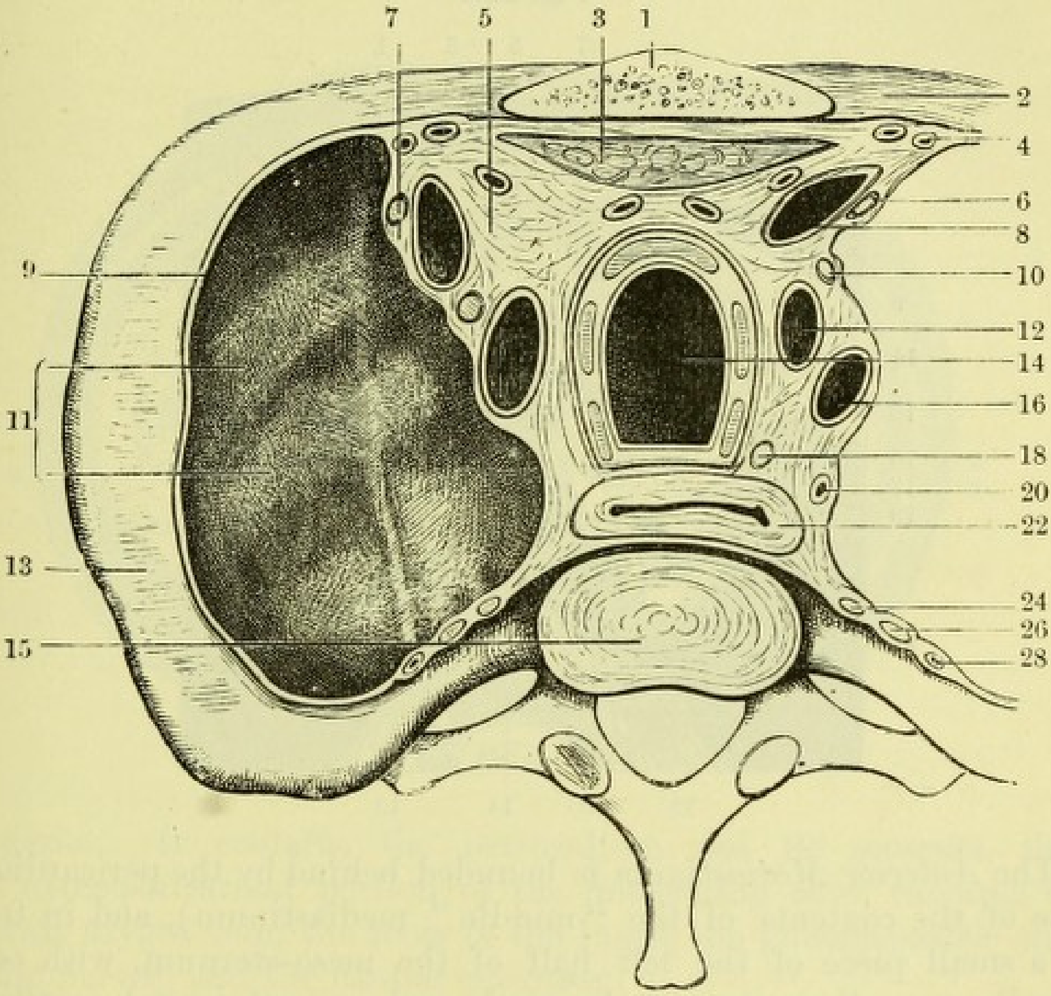


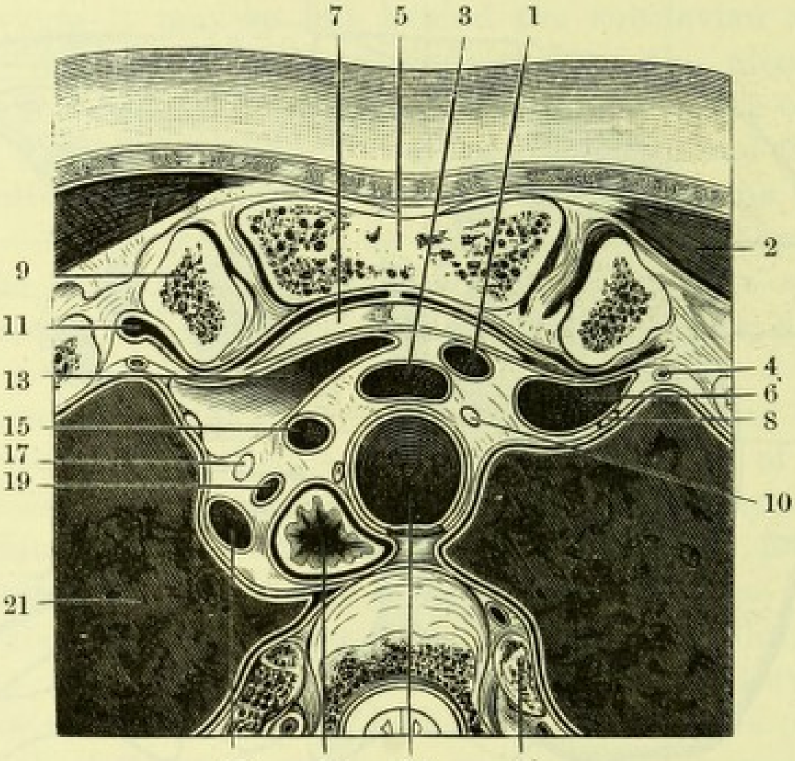
Fig. 264.—Oblique section of superior mediastinum below first rib and first dorsal vertebra (Anderson and Makins) from beneath. The pleura has been removed.

1. Sternum.
2. 1st costal cartilage.
3. Remains of thymus.
4. Internal mammary vessels.
5. Visceral portion of subpleural tissue.
6. Right phrenic nerve.
7. Left phrenic nerve.
8. Innominate vein.
9. Parietal lamina of subpleural tissue.
10. Left vagus.
11. Dome of subpleural tissue.
12. Left carotid.
13. Under surface of 1st rib.
14. Trachea.
15. Under surface of 1st dorsal vertebra.
16. Left subclavian.
18. Left recurrent laryngeal nerve.
20. Thoracic duct.
22. Œsophagus.
24. 1st dorsal nerve.
26. Sympathetic.
28. Superior intercostal artery.

the thymus ; and a large quantity of connective tissue investing these structures.

The *Inferior portion of the great mediastinal space*, by an unnecessary and somewhat perplexing convention, is divided into *three* parts, anterior, middle and posterior.

Fig. 265.



The *Anterior Mediastinum* is bounded behind by the pericardium, (one of the contents of the "middle" mediastinum), and in front by a small piece of the left half of the meso-sternum, with occasionally a small portion of the sixth and seventh costal cartilages and the fifth and sixth intercostal spaces. It contains only a little

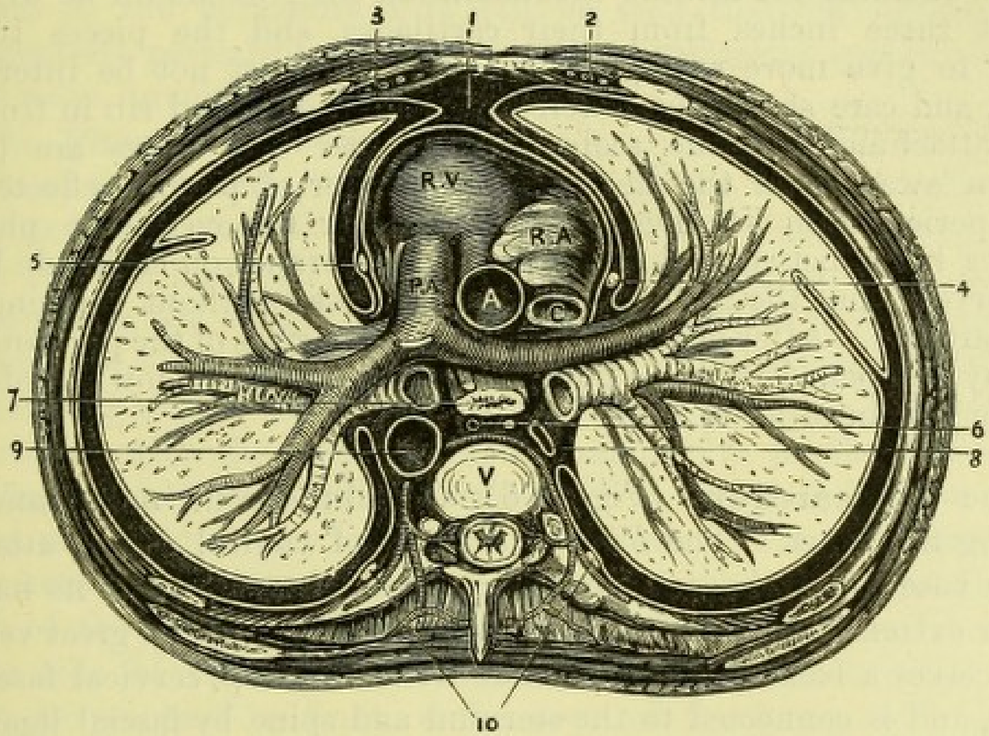
Fig. 265.—Horizontal section of superior mediastinum through 3rd dorsal vertebra from above (after Braune).

1. Inferior thyroid vein.
2. Pectoralis major.
3. Innominate artery.
4. Internal mammary artery.
5. Sternum.
6. Right innominate vein.
7. Remains of thymus (line passes through sterno-thyroid).
8. Right phrenic.
9. Clavicle.
10. Right vagus.
11. Sterno-hyoid.
12. Neck of 5th rib.
13. Left innominate vein.
14. Trachea, with recurrent laryngeal nerve on left side.
15. Left internal carotid.
16. Œsophagus.
17. Left vagus.
18. Left subclavian.
19. Left vertebral (arising here from aorta).
21. Lung.

cellular tissue continuous with the subpleural tissue, and some lymphatics (the triangularis sterni and internal mammary vessels being regarded as parietal structures).

The *Middle Mediastinum* is not bounded in front or behind, unless the anterior and posterior mediastina can be regarded as

Fig. 266.



boundaries. It contains the pericardium and its contents, the small extra-pericardial portion of the descending cava, the arch of the great azygos vein, the roots of the lungs, the pneumogastric and phrenic nerves, and the cardiac plexuses.

The *Posterior Mediastinum*, bounded in front by the pericardium,

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Fig. 266.—Diagram of a transverse section of the thorax (altered from Wilson and Carter, by J. T. Gray).

1. Anterior mediastinum.
2. Internal mammary vessels.
3. Triangularis sterni muscle.
4. Right phrenic nerve between pleura and pericardium.
5. Left phrenic nerve between pleura and pericardium.
6. Thoracic duct in posterior mediastinum.
7. Œsophagus with left vagus in front and right vagus behind.
8. Vena azygos major.
9. Thoracic aorta, giving off intercostal arteries.
10. Gangliated cord of sympathetic.

R. V. Right ventricle. R. A. Right auricle of heart in middle mediastinum.
P. A. Pulmonary artery.
A. Aorta.
C. Vena cava superior.
V. Dorsal vertebra.

and behind by the dorsal vertebræ below the fourth, will be afterwards dissected; it contains the descending part of the arch, with the descending thoracic aorta and its branches, the œsophagus, the pneumogastric nerves, the azygos veins, the thoracic duct, the splanchnic nerves, some lymphatic glands, and a quantity of connective tissue investing the aorta and other structures in the space.

[To examine the middle mediastinum, the ribs should be divided about three inches from their cartilages, and the pieces turned back to give more room, but the first rib must not be interfered with, and care should be taken to divide the second rib in front of the attachment of the scalenus posticus. The lungs are to be drawn away from the heart, and the layer of pleura reflected on the pericardium is then to be carefully removed (the phrenic nerves lying between the two serous membranes on each side being preserved), and the roots of the lungs cleaned without injuring the pericardium. After observing the external surface of the pericardium, it may be opened by an oblique incision from above downwards and to the left, in order to study its interior.]

The **Pericardium** (Fig. 266) is a fibro-serous membrane enclosing the heart. The *Fibrous layer* is of conical shape, attached by its base to the thoracic surface of the diaphragm, while its narrow upper extremity becomes lost upon the adventitia of the great vessels. It receives a band of fibrous tissue from the deep cervical fascia in front, and is connected to the sternum and spine by fascial ligamentous processes. Its outer surface gives attachment in the greater part of its extent to the pleuræ, which leave a mesial posterior mediastinal space uncovered behind, and a very narrow anterior mediastinal space to the left of the middle line in front. The latter usually lies behind the lower third of the left side of the meso-sternum.

The *Serous layer* resembles other serous membranes in having parietal and visceral reflections. The *parietal* lamina covers the inner surface of the fibrous layer, and the cardiac area of the diaphragm; the *visceral* layer invests the heart and the roots of all the great vessels, extending as a common tube for the aorta and pulmonary artery for a distance of about two inches from their origin. It also surrounds the pulmonary veins and superior vena cava, but covers the inferior vena cava only on its anterior half, the posterior half of the vessel blending with the fibrous pericardium just before piercing the diaphragm. It forms a number of pouches between the great vessels. Two of these are specially noteworthy, the *oblique sinus*, between the inferior left pulmonary vein and the inferior vena cava; and the *transverse sinus*, a complete tunnel between the conjoined arterial trunks (aorta and pulmonic) in front, and the venous trunks behind and below.

The fibrous layer and the parietal portion of the serous pericardium are supplied by branches from the aorta, the intercostals, the phrenics, and the internal mammary arteries. The visceral pericardium is supplied by twigs of the coronary arteries.

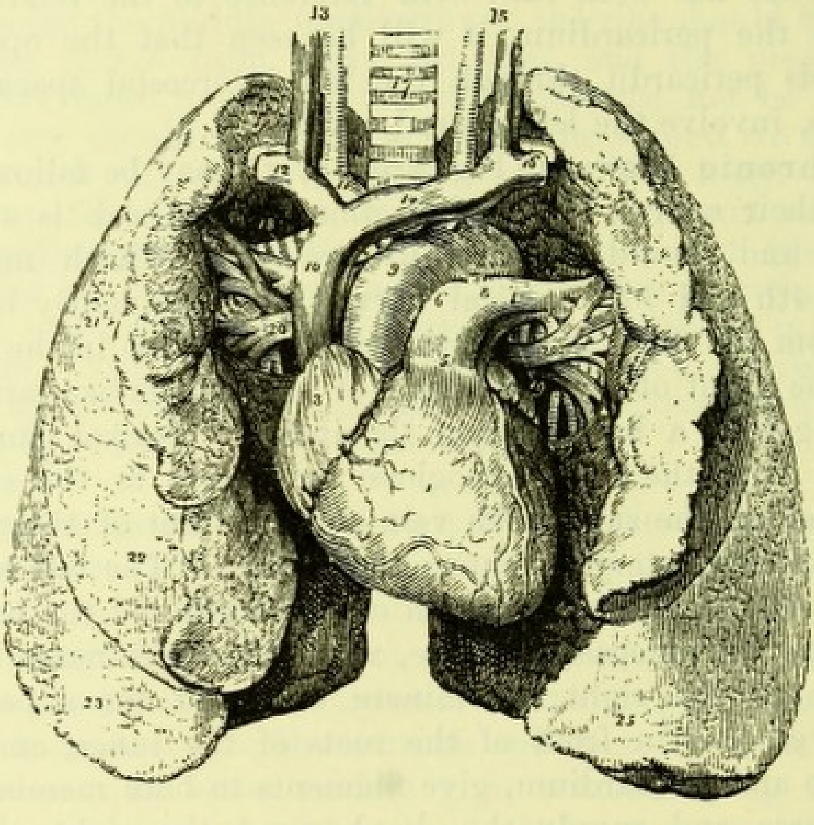
From what has been said with reference to the relation of the pleuræ to the pericardium, it will be seen that the operation of paracentesis pericardii through the left intercostal spaces will, in most cases, involve the left pleural cavity.

The **Phrenic Nerves** (Fig. 266, 4, 5) may be followed in the whole of their course, if the dissection of the neck is sufficiently advanced, and should be carefully preserved. Each nerve arises from the 4th and 5th cervical nerves, and frequently by a small branch from the 3rd, it crosses the scalenus anticus in the neck, and reaches the front of the first stage of the subclavian artery, communicating with a branch from the inferior cervical ganglion and sometimes with the ansa hypoglossi and nerve to the subclavius. Passing behind the subclavian vein and in front of the root of internal mammary artery, it enters the thorax. The left nerve then runs between the horizontal arch of the aorta and the left lung in front of the pneumogastric nerve, while the right nerve lies to the outer side of the right innominate vein and the superior cava. Both nerves pass in front of the roots of the lungs, and between the pleuræ and pericardium, give filaments to both membranes, and finally pierce and supply the diaphragm ; the right also giving branches to the capsule of the liver ; the left communicating with the solar plexus. The left nerve is longer than the right, partly because of the deflection of its course by the projection of the heart to the left, partly on account of the lower level of the diaphragm on this side. Accompanying each nerve may be seen a small *comes nervi phrenici* artery from the internal mammary.

[The pericardium is to be dissected from the roots of the lungs and entirely removed from the great vessels, except a small piece which should be left to mark the point at which it was attached to the aorta. In doing this care must be taken of the left phrenic and left pneumogastric nerves, as well as of some small cardiac nerves and the left superior intercostal vein, all of which cross the arch of the aorta.]

The **Roots of the Lungs** (Figs. 266 and 267) are each formed by a pulmonary artery, two pulmonary veins, and a bronchus, with small bronchial vessels, the anterior and posterior pulmonary plexuses of the pneumogastric and sympathetic nerves, and some lymphatics, all bound together by connective tissue continuous with the mediastinal and subpleural tissue and invested by a fold of pleura. The order of the three principal structures from before backwards is the same on both sides of the body, viz. veins, artery,

Fig. 267.



and bronchus; from above downwards on the right side the order is the reverse, viz. bronchus, artery, veins; but on the left side it is artery, bronchus, veins. The reason of this difference is, that a large eparterial branch is given off from the right bronchus to the

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Fig. 267.—The heart and lungs (from Wilson).

1. Right ventricle.
2. Left ventricle.
3. Right auricle.
4. Left auricular appendix.
5. Pulmonary artery.
6. Right pulmonary artery.
7. Left pulmonary artery.
8. Remains of the ductus arteriosus.
9. Arch of the aorta.
10. Superior vena cava.
11. Innominate artery, and in front of it the right innominate vein.
12. Right subclavian vein, and behind it, the corresponding artery.
13. Right common carotid artery and jugular vein.
14. Left innominate vein.
15. Left carotid artery and jugular vein.
16. Left subclavian vein and artery.
17. Trachea.
18. Eparterial branch of right bronchus.
19. Left bronchus.

20, 20. Pulmonary veins.

21. Superior lobe of the right lung.
22. Middle lobe.
23. Inferior lobe.
24. Superior lobe of the left lung.
25. Inferior lobe.

upper lobe of the lung, while the branch to the corresponding lobe of the left lung is hyparterial (see p. 631).

The *right root* is related in *front* to the superior vena cava and the phrenic nerve, *behind* to the vena azygos major and the vagus nerve, and the vena azygos major curves over it *above* to terminate in the superior cava.

The *left root* has in *front* the phrenic nerve ; *behind*, the descending arch of the aorta and vagus nerve ; and *above*, the horizontal arch of the aorta and the recurrent laryngeal nerve.

The **Lungs** (Fig. 267) vary very much in condition in different bodies. They are somewhat contracted, but if perfectly healthy their surfaces are smooth, and the tissue is elastic and crepitant throughout. They are of a pinkish white colour, marbled and mottled, in the adult with lines of bluish black pigment, which may be greatly exaggerated in residents in large towns. Their united weight averages about 43 ounces, of which about 22 belong to the right lung, and their specific gravity varies from 0·345 to 0·746.

Each lung is divided into two principal segments by an oblique fissure, and the upper segment of the right is intersected by a second fissure. These fissures extend down to the roots and subdivide the lungs into lobes, superior and inferior on the left side, and superior, middle and inferior on the right. The superior lobe of the right lung receives a large eparterial bronchial tube, which passes above the right pulmonary artery; all the other tubes of both lungs being hyparterial.

The pulmonic pleura is intimately adherent to the lung tissue, and is prolonged into the fissures.

Each lung may be described as having a base, an apex, an external or parietal surface, an internal or mediastinal surface, and anterior, posterior and inferior margins.

The *base* is concave, with sharp margins, and rests upon the diaphragm. The *apex* is rounded and projects only to a small extent above the oblique plane of the upper opening of the thorax, but it reaches about an inch and a half above the horizontal level of the first costal cartilage, and lies behind the subclavian vessels. The *outer surface,* moulded to the inner surface of the thoracic wall, is strongly convex and marked by oblique ridges corresponding to the intercostal spaces, and by a long oblique fissure running from a little below the apex at the back to the lower part of the anterior border in the front. In the right lung the portion of the organ above this fissure is subdivided by a second deep fissure, passing almost horizontally forwards from the middle of the oblique fissure to the anterior margin. The *inner surface* may be divided into

Fig. 268.

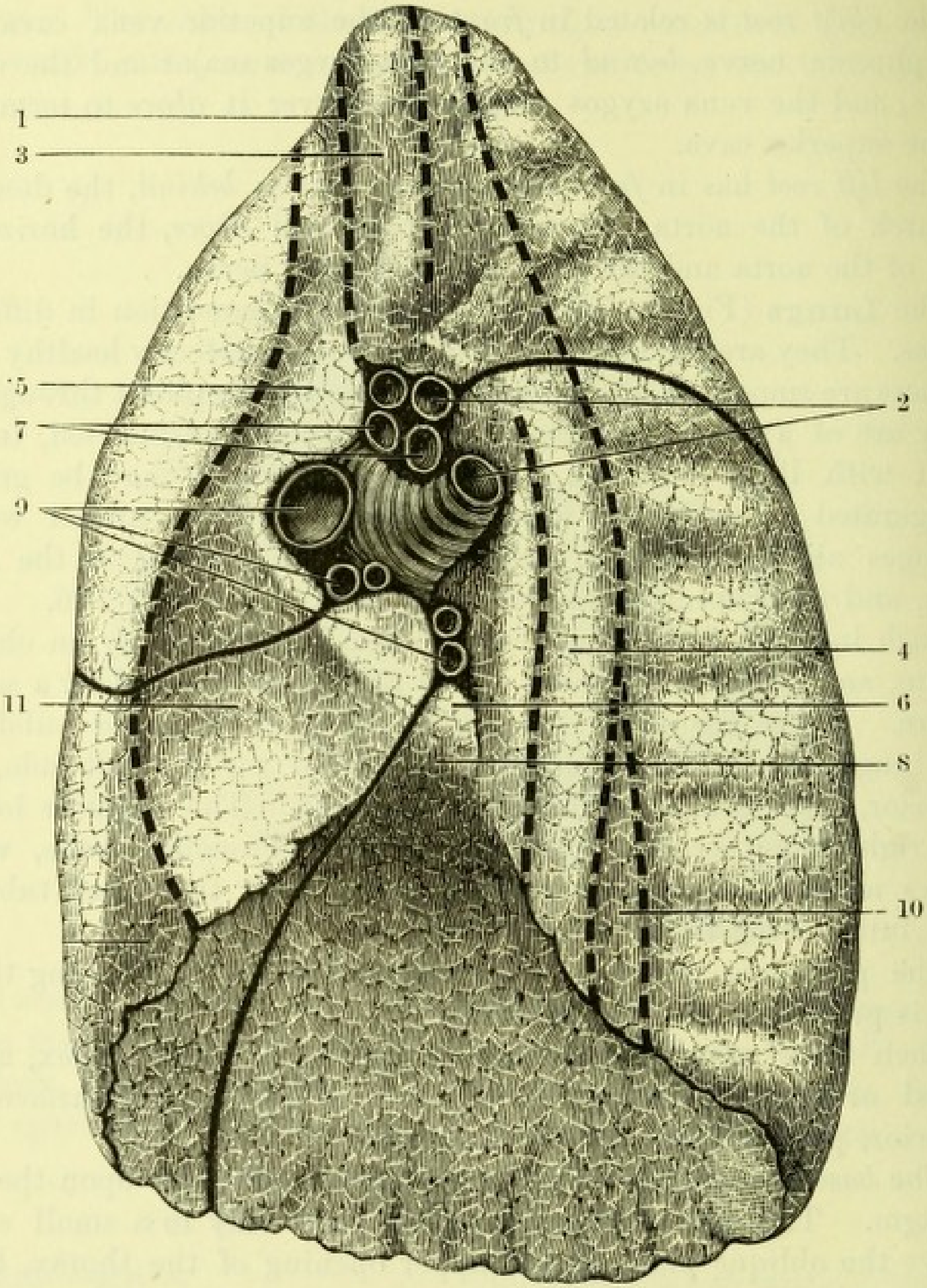


Fig. 268.—The inner aspect of the right lung, showing its relations to the mediastinal structures. (From the model of His.)

1. For right innominate vein.
2. Bronchi.
3. For trachea.
4. For œsophagus (the position is indicated above, but there is no distinct impression above the hilum).
5. For lower end of vena cava superior.
6. For left auricle.
7. Veins.
8. For vena cava inferior.
9. Arteries.
10. For aorta.
11. For right auricle and right ventricle (latter below).

Fig. 269.

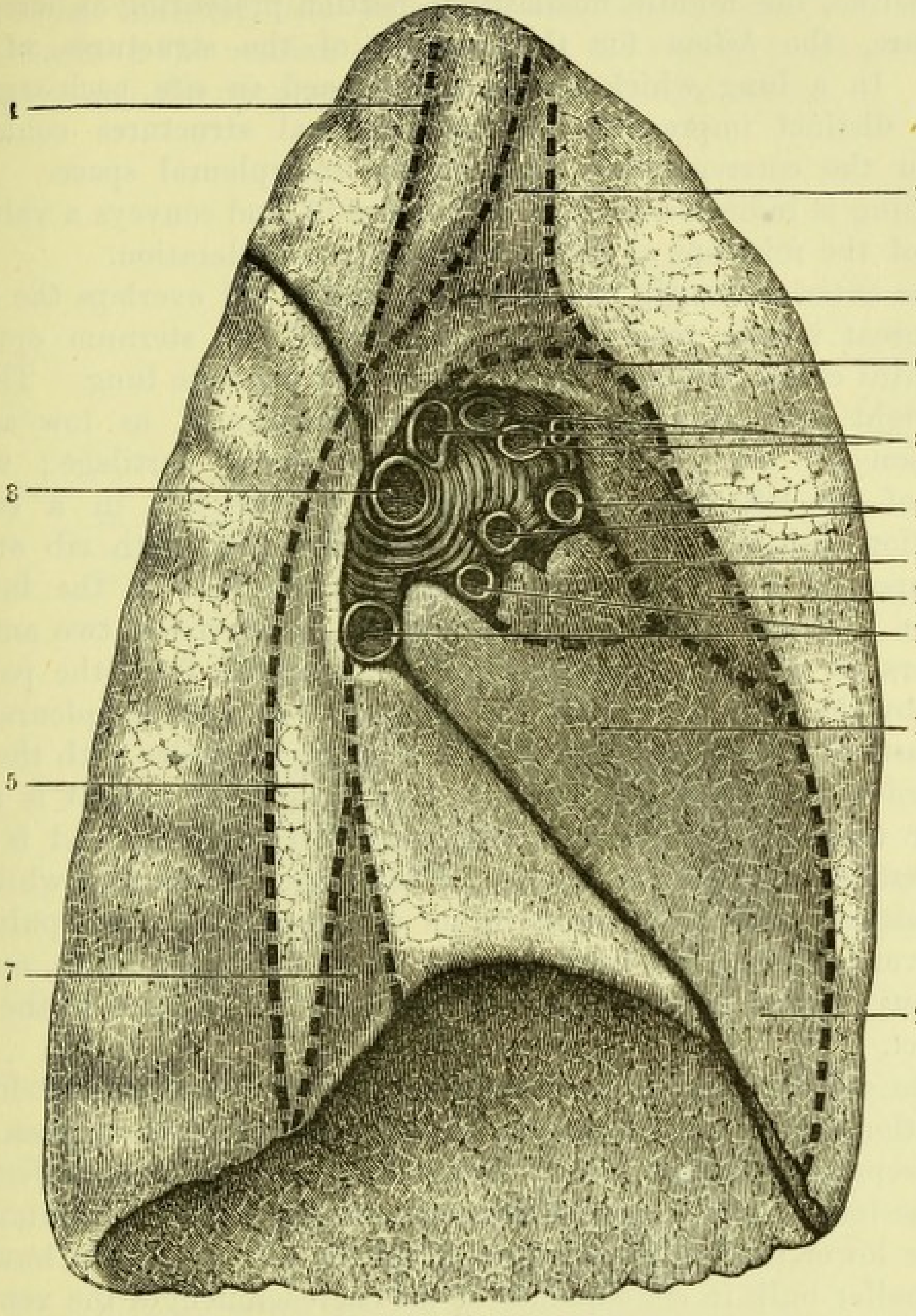


Fig. 269.—The inner aspect of the left lung, showing its relations to the mediastinal structures. (Drawn from the model of His.)

1. Position of œsophagus and trachea (no impression).
2. For left common carotid artery.
3. Bronchus.
4. For arch of aorta.
5. For dorsal aorta.
6. For pulmonary artery.
7. For œsophagus.
8. Veins.
10. Arteries.
12. For right auricular appendage.
14. For right ventricle and pulmonic sinus arteriosus.
16. Arteries.
18. For left ventricle.
20. For cardiac apex.

three portions, corresponding to the superior, middle and posterior mediastina, the middle mediastinal portion presenting an irregular aperture, the *hilum* for the passage of the structures of the root. In a lung which has been hardened *in situ*, each segment bears distinct impressions of the principal structures contained within the corresponding part of the interpleural space. This moulding is indicated in Figs. 268 and 269, and conveys a valuable idea of the relations of the surface under consideration.

The anterior margin of each lung is sharp and overlaps the heart and great vessels, reaching the mid-line of the sternum opposite the third costal cartilage, and meeting the opposite lung. That of the right lung then passes vertically downwards as low as the junction of the gladiolus with the ensiform cartilage; whilst that of the left lung passes outwards to the left in a curved direction behind the fifth costal cartilage and sixth rib around the apex of the heart, and finally inwards to join the inferior border. There is hence an interspace between the two anterior borders, in which the pericardium is separated from the parietes only by the inner portion of the left pleura and the subpleural and mediastinal connective tissue. This space coincides with the *area of cardiac dulness* of physicians. It will be seen that it is much larger than the "anterior mediastinum" (Fig. 266), and is very different in outline. It should be remembered also that while the mediastinal area is constant in its dimensions, the interpulmonic area varies during life with the amount of air in the lungs, and for obvious reasons may be greatly widened when exposed in the dead subject.

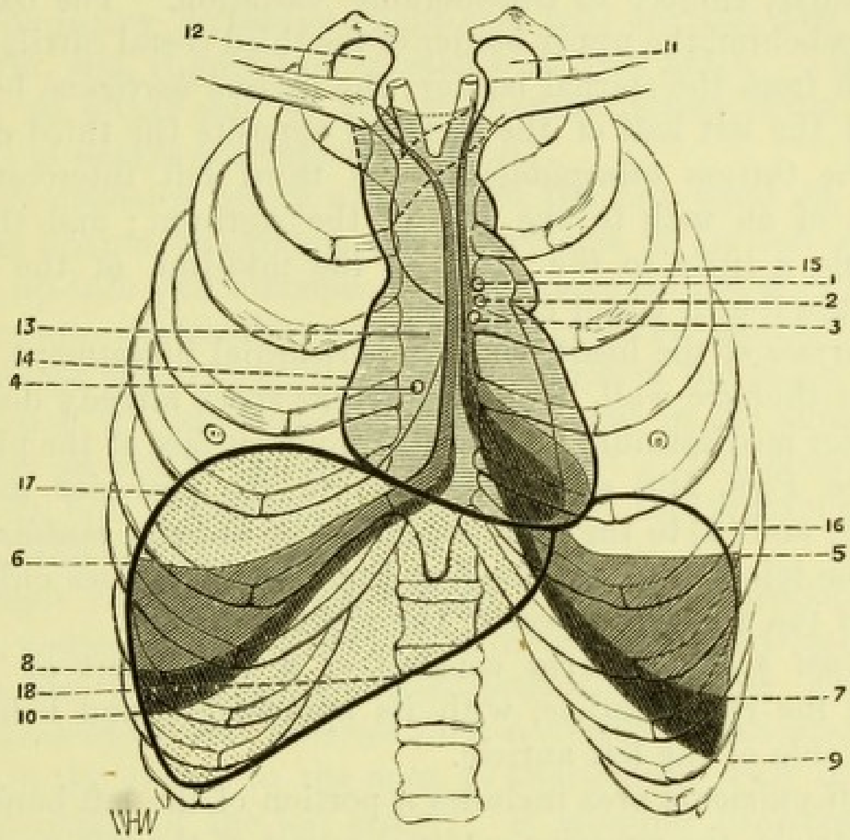
The *inferior margin* is sharply defined and follows the line of reflection of the pleura, but never reaches quite so low, even after the deepest inspiration.

The left lung is somewhat longer vertically than the right, owing to the lower level of the diaphragm on the left side; it is, however, of smaller bulk in consequence of the encroachment of the ventricular portion of the heart upon that side of the thoracic cavity.

The **Heart** (Fig. 270) is placed obliquely between the lungs, and rests on the diaphragm, with its base directed backwards and to the right, and the apex to the left side. The base lies opposite to the 6th, 7th and 8th dorsal vertebræ, and the apex beats between the 5th and 6th ribs, about 3 inches from the middle line below and to the inner side of the nipple. A *median sagittal section* of the body (Fig. 277) leaves, on the right side, a portion of both auricles, with all the venous orifices except those of the left pulmonary veins, and a small portion of the anterior part of the right ventricle.

On the left are the whole of the left ventricle, nearly the whole of the right ventricle, the pulmonic and aortic orifices (the latter sometimes in the median line, rarely to the right), portions of both auricles, and the openings of the left pulmonary veins.

Fig. 270



The *right border* of the heart is situated an inch and a half from the middle line, the *apex*, which for purposes of auscultation is described as being about two inches below the male nipple and one to the sternal side, lies three inches from the middle of the sternum;

Fig. 270.—Diagram of the relations of the thoracic viscera to the walls of the chest.

1. Situation of pulmonary orifice.
2. Left auriculo-ventricular orifice.
3. Orifice of aorta.
4. Right auriculo-ventricular orifice.
5. Limit of the anterior and inferior border of left lung in complete expiration.
6. Ditto, of right lung.
7. Limit of left lung in inspiration.
8. Ditto of right lung in inspiration.
9. Limit of left pleura. (This more often keeps within the costal margin down to the 7th rib).
10. Limit of left pleura.
11. Superior cul-de-sac of left lung.
12. Ditto of right lung.
13. Right auricle.
14. Right auricular appendage.
15. Left auricle.
16. Limit of diaphragm in complete expiration.
17. Ditto, ditto.
18. Ditto, ditto, in complete inspiration.

the *base* reaches as high as the upper border of the third costal cartilage ; and the lower or *left border* is marked by a line drawn from the 7th right chondro-sternal articulation to the apex of the heart.

The positions of the central points of the *arterial* and *auriculo-ventricular orifices*, according to Braune, are as follows, but these are, of course, subject to considerable variation. The *Ostium pulmonale* lies behind the upper border of the third costal cartilage, a fifth of an inch from the sternal border; the *Ostium aorticum*, behind the middle of the left half of the sternum opposite the third costal cartilage; the *Ostium bicuspidale*, in the third left intercostal space, two-fifths of an inch to the left of the sternum ; and the *Ostium tricuspidale*, a little to the right of the mid-line of the sternum, opposite the fourth costal cartilage.

The *surface* of the heart, with its pericardial investment, is related (1) to the thoracic wall, in the triangular space already described as the anterior mediastinum ; (2) to the inner surface of the pleuræ and lungs (see Figs. 268 and 269) ; (3) to the posterior mediastinal structures, and (4) to the diaphragm. The *anterior mediastinal area* lies on the left side of the median line and comprises only a small portion of the anterior aspect of the right ventricle.

The *right pulmonic area* consists of a small part of the right ventricle, the right auricle, with its appendages, and behind these the right side of the left auricle.

The *left pulmonic area* includes a portion of the left border of the right ventricle, the superior external aspect of the left ventricle, the left side of the left auricle, with its appendage, the anterior inter-ventricular furrow, and part of the auriculo-ventricular furrow.

The *Diaphragmatic area* consists of portions of the right and left ventricles, with the posterior inter-ventricular septum ; and a portion of the right auricle, with the inferior caval orifice.

The *posterior Mediastinal area* consists of the posterior part of the base of the heart, with the pulmonic veins.

The weight of the healthy heart averages 11 oz. in the male and 9 oz. in the female.

The anterior aspect of the heart is convex, and is formed almost entirely by the right ventricle and auricular appendage, but a small portion of the right auricle is seen at the right side, and a part of the left ventricle at the apex and the left border, while the irregular border of the left auricular appendage appears to the left of the pulmonary artery. The postero-inferior surface of the heart, which rests for the most part upon the diaphragm, is flattened, and is formed by part of the right auricle, and by the left auricle and ventricle, which last forms the apex of the heart. Each surface of the heart is grooved by the divisions between the auricles and ventricles. The *anterior inter-ventricular groove* is near the left border of the heart, whilst the *posterior inter-ventricular groove* lies a little to the right, their positions indicating the oblique direction of the septum. In these grooves will be seen the descending branches of the coronary vessels.

The **Coronary Arteries** (right and left) are the first branches of the aorta, and supply the substance of the heart. They are to be found on either side of the pulmonary artery, with a plexus (*coronary*) of nerves accompanying each.

The *left coronary artery* arises from the left sinus of Valsalva, and passes behind the pulmonary artery and to its left side, there breaking up into two branches, (1) *auriculo-ventricular*, which runs in the auriculo-ventricular groove on the posterior aspect of the heart to anastomose with the corresponding branch of the Right Coronary Artery ; and (2) *inter-ventricular*, which runs in the anterior inter-ventricular groove to the apex of the heart. The artery supplies branches to both ventricles, the left auricle, the pulmonary artery, the aorta, and the septum.

The *right coronary artery* springs from the anterior sinus of Valsalva, courses from left to right in the auriculo-ventricular groove, and opposite the posterior inter-ventricular furrow divides into *auriculo-ventricular* and *posterior inter-ventricular* branches, the latter running in the groove to the apex to anastomose with the anterior inter-ventricular of the left artery. It supplies branches to both ventricles, the right auricle, the aorta, and the pulmonary artery.

The **Veins** of the heart do not correspond precisely to the arteries. The *great cardiac vein* runs up the anterior inter-ventricular groove with the descending branch of the left coronary artery, but leaves it to pass along the horizontal auriculo-ventricular groove to the back of the heart, where it becomes considerably enlarged, and terminates by forming the *coronary sinus*, between the left auricle and ventricle. It receives the *posterior cardiac veins* from the back of the heart, the *middle cardiac vein* which follows the inter-ventricular groove behind, the *right coronary vein* which enters it near the termination, and small branches from the auricles, including the *oblique vein* of Marshall, which runs downwards and inwards over the back of the left auricle, and probably represents the remains of the fœtal left superior vena cava. Finally it opens by means of the coronary sinus into the back of the right auricle.

Some small *anterior cardiac veins*, and other small veins called the *venæ minimæ cordis*, pass directly into the right auricle.

The *superficial cardiac plexus* of the sympathetic is situated immediately in front of the arch of the aorta, and gives branches to the front and back of the heart. To it may be traced the left superior cardiac nerve of the sympathetic, the left inferior cardiac branch from the recurrent laryngeal (vagus), and branches from the deep cardiac plexus.

The *deep cardiac plexus* lies behind the aorta, and is formed by all the cardiac nerves of the right side and the middle and inferior left cardiac of the sympathetic and left superior vagus cardiac.

The **Great Vessels of the Heart** (Fig. 276) have the following positions. The vena cava superior lies to the right, the pulmonary artery to the left, and between them is the arch of the aorta. The inferior vena cava can be seen piercing the diaphragm at the back of the heart, by drawing the organ upwards; and the right and left pulmonary veins pass outwards from the back of the left auricle to join the roots of the lungs.

The **Cavities** of the heart are to be opened *in situ,* and in the order in which the blood enters them.

[The right auricle is to be opened by one incision from the superior to the inferior vena cava, and another at right angles to it into the auricular appendage.]

Right Auricle (Fig. 271, 1).—The interior of the auricle consists of a main cavity, the *atrium* or *sinus venosus*, and the diverticulum of the *auricular appendage.* It is smooth internally, except on its anterior wall and in the appendix, where the muscular fibres form prominent bands, for the most part running parallel to each other like the teeth of a comb, and hence called *musculi pectinati.* The *endocardium*, or lining membrane, is seen to be continuous with the lining membrane of the veins.

The large openings into the right auricle are those of the *superior vena cava* (3), entering at the upper and anterior part; the *inferior vena cava* (4), entering at the lower and back part; and the *coronary sinus* (7), lying between the *inferior caval* and the *auriculo-ventricular* (9) openings and below the Eustachian valve.

The *foramina Thebesii* are numerous small openings which are found in the wall of the auricle, corresponding to the anterior cardiac veins and the venæ cordis minimæ. Similar but still smaller apertures may be found in the other cavities.

The *tubercle of Lower* is a projection occasionally found in the wall of the auricle, between the superior and inferior venæ cavæ. It depends upon a subserous deposit of fat.

The *coronary valve* (8) (valve of Thebesius) is a thin imperfect endocardial fold at the orifice of the coronary sinus.

The *Eustachian valve* (6) is a semilunar fold placed in front and to the left of the opening of the vena cava inferior, extending between this orifice and the lower border of the annulus ovalis immediately

Fig. 271.

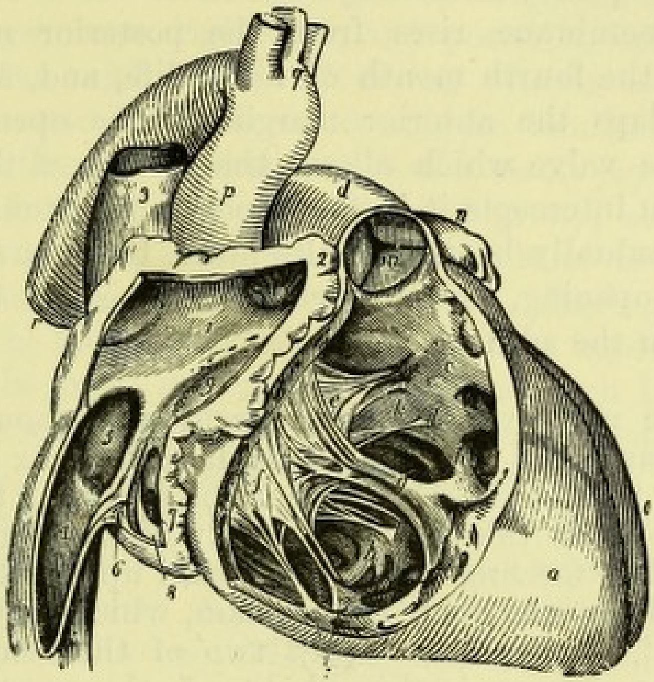


Fig. 271.—Right side of the heart laid open (from Wilson).

1. Cavity of right auricle.
2. Auricular appendix: in its cavity are seen the musculi pectinati.
3. Superior vena cava, opening into the upper part of the right auricle.
4. Inferior vena cava.
5. Fossa ovalis; the prominent ridge surrounding it is the annulus ovalis.
6. Eustachian valve.
7. Opening of the coronary sinus.
8. Coronary valve.
9. Entrance of the auriculo-ventricular opening. Between the figures 1 and 9, two or three foramina Thebesii are seen.

a. Right ventricle.
b. Cavity of right ventricle.
c. Conus arteriosus or infundibulum.
d. Pulmonary artery.
e, f. Tricuspid valve; *e* is placed on the left curtain, *f* on the anterior curtain.
g. One of the musculi papillares, to the apex of which the anterior and right curtains are connected by chordæ tendineæ.
h. Columnæ carneæ.
i. Two musculi papillares of the right curtain.
k. Attachment by chordæ tendineæ of the left limb of the anterior curtain.
l, l. Chordæ tendineæ.
m. Semilunar valves of the pulmonary artery.
n. Apex of left auricular appendix.
o. Left ventricle.
p. Ascending aorta.
q. Its transverse portion, with the three arterial trunks which arise from the arch.
r. Descending aorta.

above the opening of the coronary sinus. In the fœtus it directs the current of blood from the inferior vena cava through the foramen ovale, but in the adult is generally cribriform and very imperfect.

The *fossa ovalis* and *annulus ovalis* (5) are also remains of fœtal structures, found on the inner wall of the right auricle.

The *annulus ovalis* is a muscular ring surrounding the shallow fossa ovalis, and representing the margin of the foramen ovale of the fœtus. The *fossa ovalis* is a thin membranous portion of the inter-auricular septum, formed by the fœtal valve of the foramen ovale. This membrane rises from the posterior margin of the foramen about the fourth month of fœtal life, and, as it developes, gradually overlaps the anterior margin of the opening, so as to form a complete valve which allows the passage of the blood from right to left, but intercepts it in the opposite direction. After birth the aperture gradually becomes obliterated, but not unfrequently a small oblique opening, through which a probe can be introduced, will be found in the adult.

[To open the right ventricle, its flaccid wall should be grasped with the left hand, and the scalpel made to transfix it about half-way down, and well to the right side of the septum ; the knife being then carried towards the apex, the cavity of the ventricle will be opened. The left forefinger is to be passed up into the pulmonary artery, and will serve to guide the incision, which is to be prolonged into that vessel, if possible, *between* two of the semilunar valves. All clots being removed, the whole of the ventricle will be displayed.]

The **Right Ventricle** (Fig. 271, *a*) consists of a main cavity, the walls of which show columnar projections formed by the muscular substance of the heart; and of a smooth funnel-shaped portion (*infundibulum* or *conus arteriosus*) leading upwards and to the left into the pulmonary artery. The projections on the wall of the ventricle are called *columnæ carneæ* (*h*) ; of these four varieties may be described ; one in which the column merely stands out in relief, being attached to the wall of the ventricle in its whole length ; a second in which the column is attached at both ends but is free in the middle, so that a probe may be passed between it and the wall ; a third, called *musculi papillares* (*g*), which project into the cavity of the ventricle and give attachment by their extremities to *chordæ tendineæ*, or fibrous cords passing to the flaps of the auriculo-ventricular valve ; and a fourth variety consisting of bands which pass from one fleshy column to another, or to the ventricular wall. One of these latter, running from the base of the anterior papillary muscle to the septum, is called the *moderator band,* a structure which is largely developed in the ox and some other of the lower animals.

The right auriculo-ventricular or *tricuspid* valve (*e*) is formed by a reduplication of the *endocardium* or lining membrane of the heart, and between its layers are some tendinous and muscular fibres, the former being continuous with the chordæ tendineæ. The entire valve is attached above to a fibrous ring (*zona tendinosa*), which bounds the auriculo-ventricular opening, and is divided below into three *larger cusps*, right, left, and posterior, and three *smaller cusps* alternating with these, all giving attachment by their free borders and ventricular surfaces to chordæ tendineæ. The *chordæ tendineæ* are connected to three groups of *musculi papillares*, anterior, posterior, and internal or septal—the last group, however, are very imperfectly developed, and some of the cords of the posterior cusp may be attached directly to the septal wall. Each group of chordæ tendineæ will be found attached to the adjacent borders of two larger cusps and to the small intervening cusp, and each large cusp hence receives its chordæ tendineæ from two sets of musculi papillares.

The left cusp of the valve is the largest and is in contact with the anterior wall, the right cusp lies against the right wall, and the posterior is opposed to the back part of the septum ventriculorum. The left or *infundibular* flap shuts off the infundibulum from the general cavity of the ventricle, but does not form a part of the infundibulum.

The auricular surface of the tricuspid valve is extremely smooth, for the purpose of facilitating the flow of blood into the ventricles.

The tricuspid valve acts during contraction of the ventricle (systole), and prevents the regurgitation of blood into the auricle ; but even in health there is said to be a slight reflux, which has been termed the 'safety-valve action.' The infundibular division of the tricuspid valve serves to prevent the blood from flowing into the pulmonary artery until the ventricle is fully distended and able to contract forcibly on its contents.

The *pulmonary artery* is attached to a fibrous ring, which intervenes between it and the muscular substance of the heart, and the lining membrane of the artery is continuous with that of the ventricle.

The *semilunar valves* (*m*) of the pulmonary artery are three reduplications of the lining membrane, strengthened by fibrous tissue which is collected principally at the attached border of each valve. The attached border is semicircular, and is fixed to the wall of the artery ; the free border is sub-divided into two slightly concave portions by a little fibro-cartilaginous body, called the *corpus Arantii.* On each side of the corpus Arantii is a crescentic portion, the lunula, which is more transparent than the rest of the valve owing to the absence of the fibrous elements. Two of the valves are anterior (right and left) and one posterior, and the arterial wall is dilated opposite each valve to form the *sinus of Valsalva.*

The semilunar valves act during dilatation of the ventricle (diastole), and prevent the regurgitation of the blood from the pulmonary artery.

The blood, which is venous or dark-coloured, is carried by the pulmonary artery to its bifurcation, and then by the right and left pulmonary arteries to the lungs, where it is aerated ; and is brought back to the heart by the four pulmonary veins as arterial or red blood. The pulmonary veins open into the left auricle.

[The left auricle is to be opened by one vertical incision on its posterior aspect, midway between the pulmonary veins, and another into the auricular appendage. The heart must be drawn well upwards and to the right side to expose the cavity properly.]

The **Left Auricle** (Fig. 272, 1) resembles the right auricle, but the sinus venosus is free from musculi pectinati, and the auricular appendix is longer and thinner and more "crenate." The openings into it are those of the pulmonary veins, two on each side, and the left auriculo-ventricular orifice, which is much smaller than that on the right side.

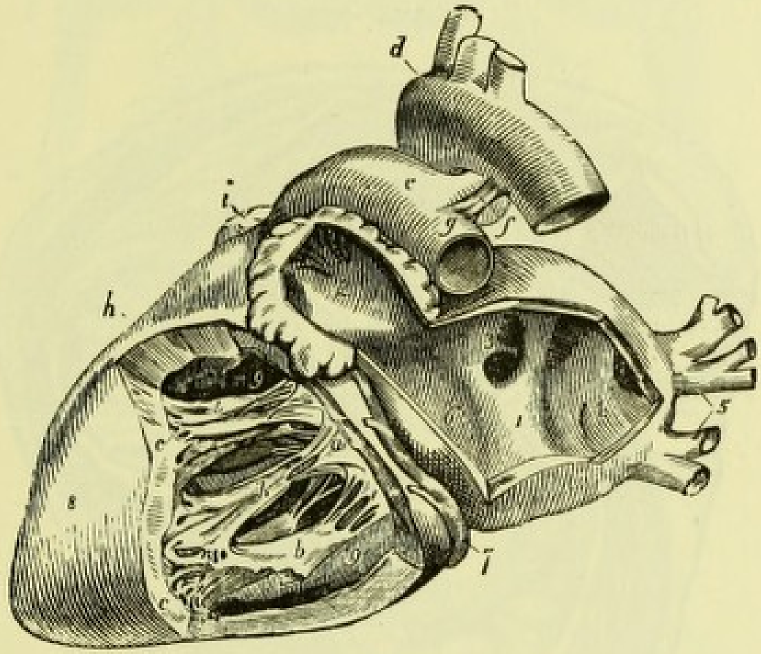
The *musculi pectinati* of the auricular appendix are like those of the right side but smaller. On the septum of the auricle may be indistinctly visible the *annulus ovalis* and *fossa ovalis,* and the free edge of the valve of the foramen ovale may be seen as a little semilunar furrow outside the upper and anterior portion of the annulus. It is here that a persistent communication may sometimes be found between the two auricles.

[To open the left ventricle, the left forefinger should be introduced through the auriculo-ventricular opening, and the knife thrust through the wall of the ventricle near the apex to meet it. The knife is then guided upwards between the flaps of the mitral valve, and an incision made through the front of the ventricle into the auriculo-ventricular opening. The finger is next to be passed from below into the aorta, followed by the knife, which is to be carried through the front wall of the ventricle close to the septum, thus isolating the right flap of the mitral valve. The incision is to be prolonged into the aorta between two of the semilunar valves, and it will be found to be necessary to divide the pulmonary artery, which lies in front of the aorta, but care should be taken to do so above the pulmonary semilunar valves.]

The **Left Ventricle** (Fig. 272, 8) resembles the right, but its wall is at least three times as thick, and its cavity reaches to the apex of the heart. The *columnæ carneæ* and *chordæ tendineæ* bear a resemblance to those of the right side.

The endocardium of the left cavities of the heart is thicker and more opaque than that of the right cavities.

Fig. 272.



The left auriculo-ventricular, *mitral*, or *bicuspid* valve, is similar in construction and connections to that of the right side, but presents only two principal cusps with two small intermediate cusps.

Fig. 272.—Left side of the heart laid open from behind (from Wilson).

1. Cavity of the left auricle.
2. Cavity of the appendix auriculæ, near the apex of which are seen musculi pectinati.
3. Opening of the two right pulmonary veins.
4. The sinus, into which the left pulmonary veins sometimes open.
5. Left pulmonary vein.
6. Auriculo-ventricular opening.
7. Coronary sinus, lying in the auriculo-ventricular groove.
8. Left ventricle.

9, 9. Cavity of the left ventricle; the figures rest on the septum ventriculorum.

a. Mitral valve; its flaps are connected by chordæ tendineæ to *b*, *b*, musculi papillares.

c, *c*. Fixed columnæ carneæ, forming part of the internal surface of the ventricle.

d. Arch of the aorta.

e. Pulmonary artery.

f. Obliterated ductus arteriosus.

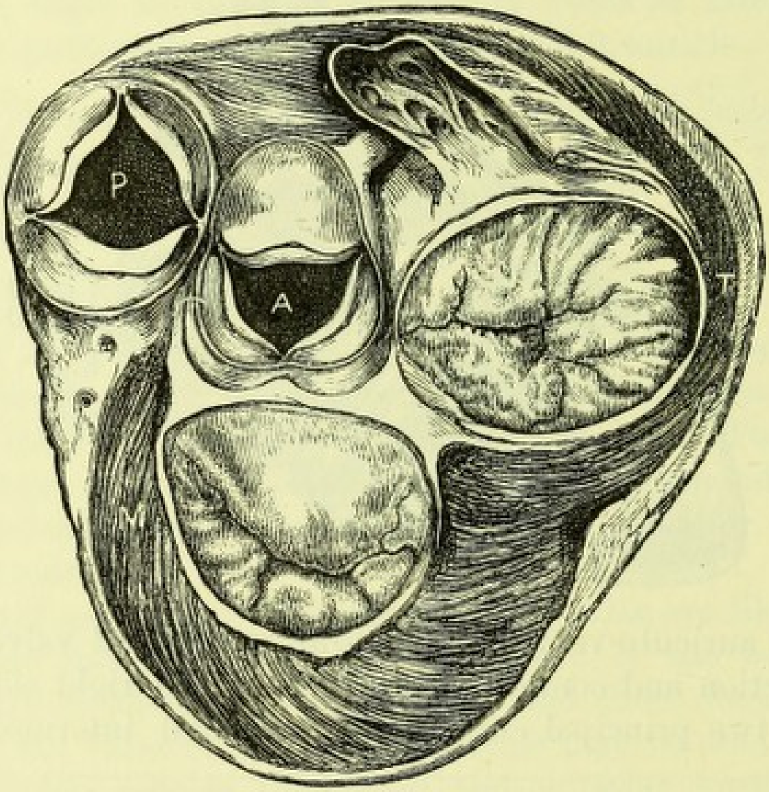
g. Left pulmonary artery.

h. Right ventricle.

i. Apex of the appendix of right auricle.

The larger cusp is in front and to the right of its fellow, and is peculiar in forming a part of the conus arteriosus. It is smooth on both surfaces, and is separated from the aortic valves by a small space with aponeurotic walls—the *intervalvular space* of Sibson—which receives the aortic valves when distended in 'diastole.' The *musculi papillares* are in two groups, and are much larger than those of the right ventricle, and the rest of the carneæ columnæ are more numerous and more complex in the arrangement than on the right side. The auriculo-ventricular ring is about five-sixths of the dimensions of that of the tricuspid opening.

Fig. 273.



The mitral valve acts during contraction of the ventricle (systole), and prevents the regurgitation of blood into the auricle. The anterior division of the mitral valve prevents the blood from flowing into the aorta until the ventricle is fully distended and able to contract forcibly on its contents ; and the pressure of the blood in the intervalvular space, on the anterior flap of the mitral valve,

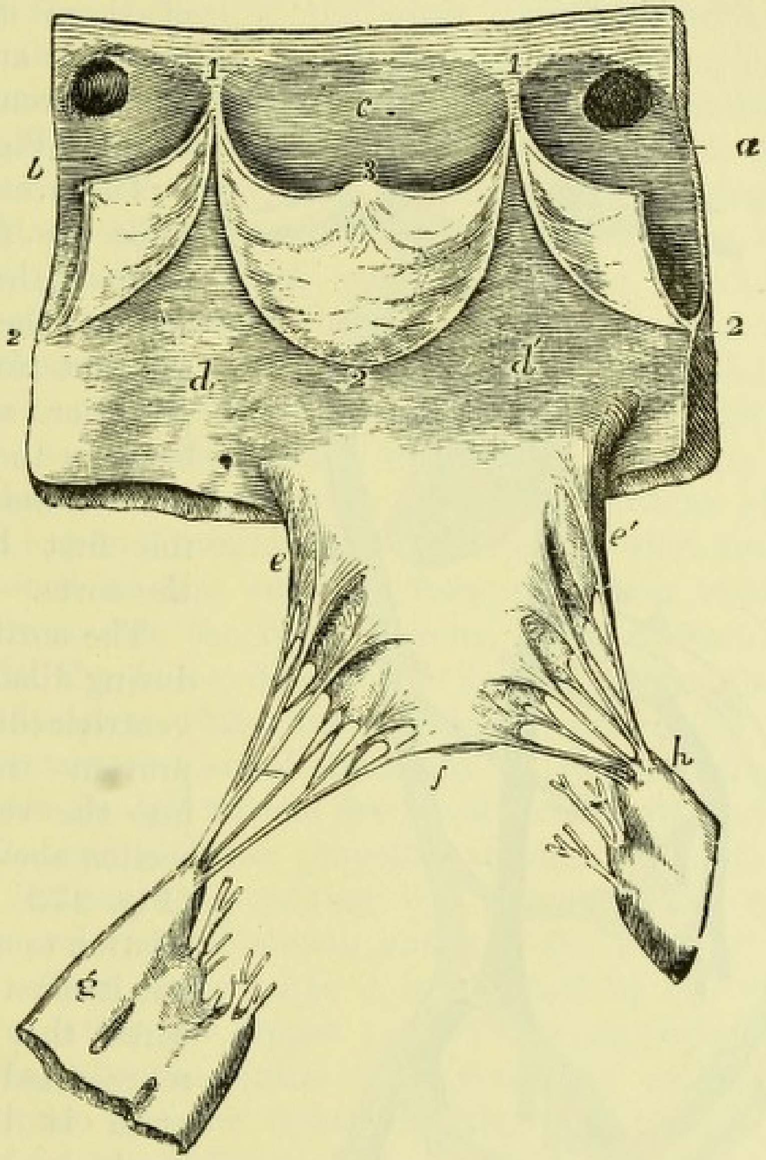
Fig. 273.—A section of the heart at the level of the valves, seen from above (from Sibson's Medical Anatomy).

P. Pulmonary artery.
A. Aorta.
M. Mitral valve.
T. Tricuspid valve.

keeps the latter closed up to the end of the 'systole' or contraction of the ventricle.

The shortening of the musculi papillares during the contraction of the ventricle, compensates for the approximation of their ventricular attachments to the auriculo-ventricular ring, and prevents the valve-

Fig. 274.



flaps from being driven into the auricle by the upward pressure of the blood-stream during the ventricular systole.

A fibrous ring intervenes between the muscular tissue of the

Fig. 274.—Portion of the wall of the ventricle *d*, *d'*, and aorta *a*, *b*, *c*; showing attachments of one flap of the mitral and the aortic valves.

a, *b*, *c*. Sinuses of Valsalva (*a* and *b* with openings of coronary arteries). 1, 2. Attached border of semilunar valve; 3. Corpus Arantii in the middle of the free border of the valve. The lunulæ are seen on either side of 3.

g and *h*. Musculi papillares. *e*, *e'*, *f*. Attachment of the chordæ tendineæ.

heart and the aorta, and the lining membrane of the vessel is here continuous with the endocardium. This arterial ring is about a tenth part smaller than that of the pulmonic artery.

The *Aortic semilunar valves* resemble those of the pulmonary artery but are more fully developed, and the *corpora Arantii* are better seen than on the right side. The aortic valves occupy a position the converse of those of the pulmonary artery, viz., one in front and two behind (Fig. 273).

The *sinuses of Valsalva* are deeper than those on the right side, and at the bottom of the anterior and left posterior sinuses will be seen the orifices of the *coronary arteries*, the first branches of the aorta.

The aortic valves act during dilatation of the ventricle (diastole), and prevent regurgitation into the ventricle. A section above the valves (Fig. 273) shows their relation to one another; but it must be remembered that the aspect represented in the diagram is directed upwards, backwards, and to the right, and that the pulmonary would occupy the highest and

Fig. 275.

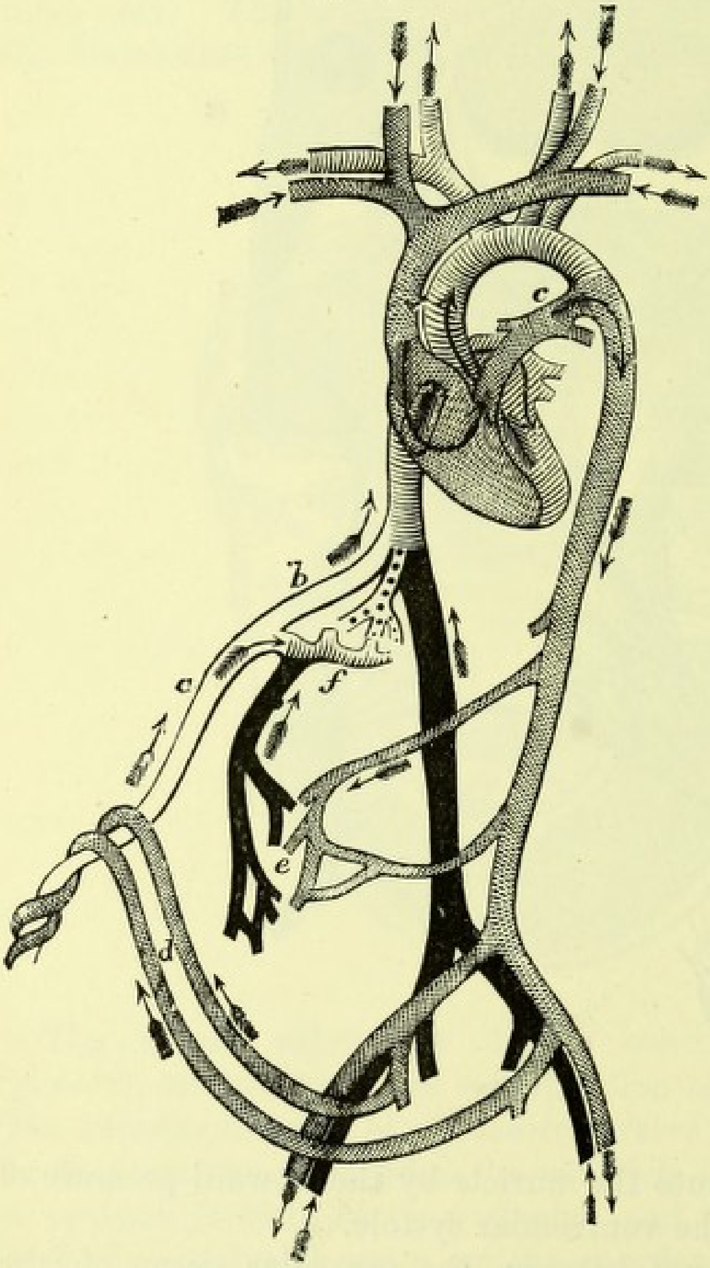


Fig. 275.—Fœtal circulation (from Wilson).

a. Umbilical vein.
b. Ductus venosus.
c. Ductus arteriosus.
d. Hypogastric arteries.
e. Termination of visceral arteries and commencement of portal system.
f. Portal vein.

The arrows show the course of the blood-current.

most anterior position of the four orifices, well on the left of the middle line of the body; the aortic orifice is a little below it, nearer to, and sometimes touching, the mesial plane; the mitral orifice lies at a still lower level and on the left; and the tricuspid orifice, slightly lower than the last, is the only one on the right of the mid-line.

The **Fœtal Circulation** (Fig. 275).—This will be the best opportunity for contrasting the adult circulation with that of the fœtus. In the fœtus the blood is brought from the placenta by the *umbilical vein*, which, entering the body at the umbilicus, passes upwards to the longitudinal fissure of the liver, and at the transverse fissure divides into three branches, two joining the portal vein, the other, called the *ductus venosus*, joining the inferior vena cava. The placental blood hence enters the inferior vena cava in two streams; the larger through the hepatic veins after having circulated through the liver, where it undergoes partial depuration by the excretion of bile, and ministers to the storage of amyloid matter in the hepatic cells; the smaller through the ductus venosus, which serves as a safety pipe in conditions of embarrassment of the portal circulation. In the inferior vena cava the blood is joined by that returned from the lower extremities, and is then poured into the right auricle. The Eustachian valve, of large size in the fœtus, directs the current across the auricle to the patent foramen ovale, and the blood enters the left auricle, where it meets with a small admixture of impure blood from the lungs. From the left auricle the blood necessarily passes into the left ventricle, and is thence propelled through the aorta to the head and upper extremities, touching but probably not intermingling with the superior caval stream entering the aorta by the ductus arteriosus. From these parts it is returned by the superior vena cava, which enters the upper part of the right auricle, and the blood is joined by the cardiac blood from the coronary sinus and descends at once into the right ventricle, thus taking a course at right angles to, and in front of, the inferior caval stream, probably without admixture with it. From the right ventricle the blood is propelled into the pulmonary artery, and a small portion reaches the lungs through the right and left pulmonary arteries to return to the left ventricle, but by far the larger portion passes through the *ductus arteriosus* (a short tube connected with the pulmonary artery close to the bifurcation), and enters the arch of the aorta immediately beyond the origin of the left subclavian artery. Through the aorta passes the blood supplying the trunk and viscera; and then entering the iliac arteries, a small portion only is conveyed by the external iliacs to the lower extremities, but the greater part enters the internal iliacs to reach the *hypogastric arteries*, two vessels which run to the umbilicus and then wind round the umbilical vein to the placenta, under the name of *umbilical arteries.*

It will be seen that the fœtal circulation comprises two main streams, which keep almost wholly distinct from each other except at one point: the well oxygenated *placental stream* supplying the heart, head, neck, and upper extremities; and the relatively impure superior *caval stream* which, in part, goes to supply the lungs, abdominal viscera, and lower extremities, and returns to contaminate the placental stream in the inferior vena cava; and in part passes to the placenta for restoration of its vitalizing elements. The liver is of very large proportionate size in the fœtus, and appears to serve the double purpose of depuration and storage of nutrient material.

The **Pulmonary Artery** (Fig. 276, 28) is about two inches long; it has already been seen to arise from the right ventricle and there to lie in front, and a little to the left, of the aorta, having in contact with it the two coronary arteries and the auricular appendages. It passes backwards and upwards to the left side of the aorta, lying in front of the left auricle, and, after reaching the hollow of the aortic arch, it bifurcates opposite the 6th dorsal vertebra into the right and left pulmonary arteries. These go to their respective lungs; the right being the longer of the two and necessarily passing beneath the arch of the aorta, and the left crossing the descending aorta. The position of each of the arteries in the root of the lung has been already seen, the right being below and the left above the bronchi passing to the upper lobes of the corresponding lungs.

Connecting the left pulmonary artery with the descending portion of the arch of the aorta immediately beyond the origin of the subclavian artery is a fibrous cord, the *ligamentum arteriosum*, which is the relic of the obliterated *ductus arteriosus* of the fœtus. Around this winds the left recurrent laryngeal nerve.

The **Pulmonary Veins** are four in number, two to each lung. Their positions in the roots of the lungs have been seen, and they have been traced to the left auricle of the heart. The right veins are the longer and pass beneath the arch of the aorta, the left veins crossing the descending aorta. Occasionally the two veins of either side unite to form a single trunk before opening into the auricle.

The **Arch of the Aorta** (Fig. 276, 26).—The aorta arises from the left ventricle, and at first takes a course upwards and to the right side, then backwards and slightly to the left, over the root of the left lung and around the left side of the trachea. For convenience of description the arch is divided into three portions—ascending, horizontal, and descending.

The *ascending* or *ventral aorta* arises usually behind the left half of the sternum at the level of the third costal cartilage, passes upwards, forwards, and somewhat to the right, a portion of its breadth crossing the middle line; finally, curving again to the left, it becomes continuous with the horizontal portion at the level of the upper border of the second costal cartilage. This is perhaps the typical arrangement, but the examination of different subjects will show many variations, the most common of which is the encroachment of the origin of the aorta upon the middle line, the mesial sagittal plane cutting the left or even the anterior sinus of Valsalva. The portion of the vessel which projects towards the right, sometimes called the *great sinus of the aorta*, almost invariably lies in the right half of the body (Fig. 277, 7).

The ascending aorta, with the pulmonary artery, is almost entirely enclosed in the serous pericardium. It is related *in front* to the root of the pulmonary artery, the right auricular appendage, the edges of both pleuræ and lungs, the lower portion of the thymus, and more superficially the left half of the sternum ; *behind* to the left auricle, the right deep cardiac nerves, and the root of the right lung ; on the *left* to the trunk of the pulmonary artery and branches of the superficial cardiac nerves ; and on the *right* to the superior vena cava and right auricle.

Its branches are the two coronary, which have already been traced (p. 597).

The *horizontal aorta* (transverse aorta, transverse portion of the arch of the aorta) commences behind the left half of the sternum, occasionally in the middle line, and thence runs backwards, inclining slightly to the left to terminate on the left side of the intervertebral disc between the 4th and 5th dorsal vertebræ. It describes a double curve in its course, with one concavity downwards corresponding to the root of the left lung, and another to the right corresponding to the trachea.

It will be seen that the course of this portion of the great arterial trunk from the front to the back of the thorax is almost directly antero-posterior, hence its principal relations, usually described as anterior and posterior, are rather left and right.

On the *left* side are the left lung and pleura, the left vagus and phrenic nerves, the superficial cardiac plexus, and the origin of the left recurrent laryngeal nerve. On the *right* side, the right lung and pleura, the trachea, the œsophagus, the thoracic duct, the left recurrent laryngeal nerve, the deep cardiac plexus, and the left side of the disc between the 4th and 5th dorsal vertebræ. *Above*

Fig. 276.

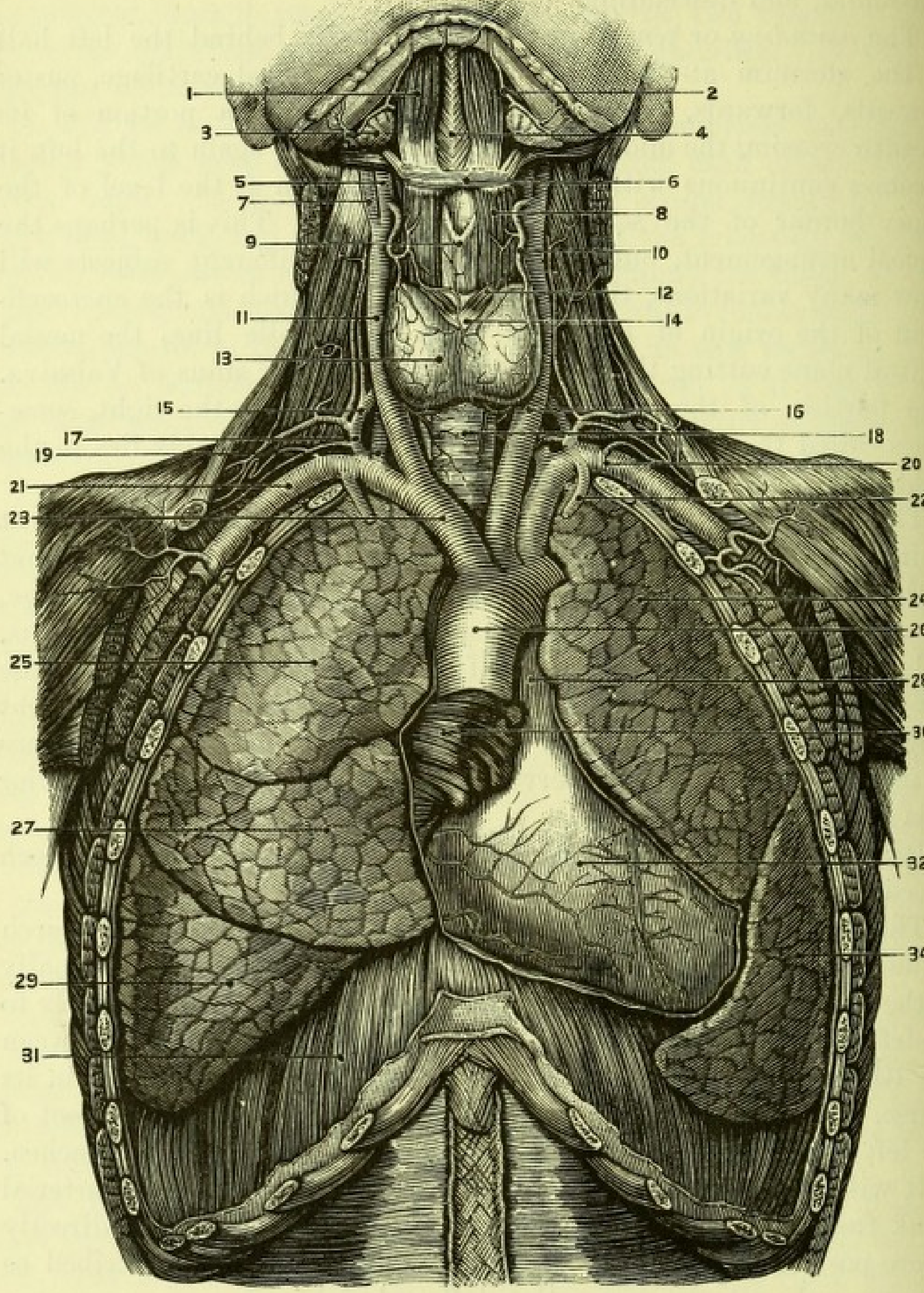
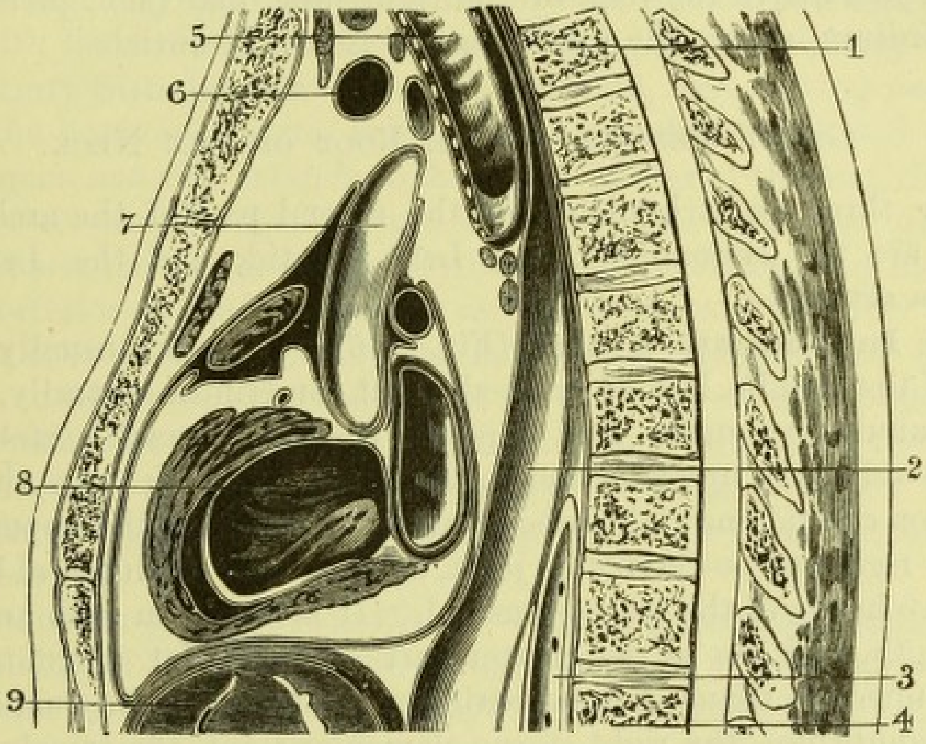


Fig. 276.—Heart and large vessels (from Bonamy and Beau).

1. Digastric.
2. Submental artery (facial).
3. Submaxillary gland.
4. Mylo-hyoid.
5. External carotid.
6. Hyoid bone.
7. Internal carotid.
8. Thyro-hyoid.
9. Thyroid cartilage.
10. Superior thyroid artery.
11. Right common carotid.
12. Crico-thyroid.

are its three great branches, innominate, left carotid and left subclavian, arising in the order named from before backwards and from right to left. *Below* are the left bronchus, the bifurcation of the pulmonary artery, the ductus arteriosus, the recurrent laryngeal nerve, and some lymphatic glands. The *branches* have been named: in the majority of cases, all lie to the left of the median line at their origin, the innominate crossing to the right side a little above its commencement; but in some cases the root of the latter vessel is cut by the mesial sagittal plane.

Fig. 277.



13. Thyroid body.
14. Cricoid cartilage.
15. Inferior thyroid artery.
16. Left common carotid.
17. Thyroid axis.
18. Trachea.
19. Vertebral artery.
20. Left subclavian artery.
21. Right subclavian artery.
22. Internal mammary artery.
23. Innominate artery arising from horizontal aorta.
24. Left lung (upper lobe).
25. Right lung (upper lobe).
26. Ascending arch of aorta.
27. Right lung (middle lobe).
28. Pulmonary artery.
29. Right lung (lower lobe).
30. Right auricle.
31. Diaphragm.
32. Front of right ventricle.
34. Left lung (lower lobe).

Fig. 277.—Median sagittal section of thorax (after Braune).

1. Body of third dorsal vertebra.
2. Œsophagus.
3. Descending aorta.
4. Body of tenth dorsal vertebra.
5. Trachea.
6. Left innominate vein, with the innominate artery behind.
7. Sinus of ascending aorta, with the right auricular appendage in front, and the right pneumogastric artery behind.
8. Right auricle. In front of this is seen the right ventricle, and behind, the left auricle.
9. Liver.

The name *descending portion of arch of aorta* has been given to the part of the vessel that lies by the left side of the 5th dorsal vertebra (in the older text books it was said to rest against the 4th or even the 3rd vertebra). On the *left* side and *behind* it is invested by the left pleura ; in *front* are the vagus nerve and the root of the left lung ; and on the right side it is related to the vertebral column, the œsophagus, and the thoracic duct.

The **Vena Cava Superior** (Fig. 267, 10) is formed by the junction of the right and left brachio-cephalic or innominate veins, on the right of the innominate artery. It receives the vena azygos major just above the root of the right lung, and then, piercing the pericardium, enters the upper part of the right auricle.

Great Vessels of the Root of the Neck.

The three great branches of the second part of the arch of the aorta are the Innominate, the Left Carotid, and the Left Subclavian arteries.

The **Innominate Artery** (Fig. 276, 23) begins usually on the left of the middle line of the body, but sometimes centrally, behind the manubrium sterni and opposite the 4th dorsal vertebra. It passes obliquely upwards and to the right, dividing into the right common carotid and right subclavian arteries behind the upper border of the right sterno-clavicular joint, and opposite the interval between the two heads of the sterno-mastoid. It is about an inch and a half in length, and lies in the greater part of its extent surrounded by the connective tissue of the superior mediastinum. *In front* of it are the manubrium, the right sterno-clavicular joint, the remains of the thymus gland, and the origins of the sterno-hyoid and sterno-thyroid muscles ; and it is crossed nearly at right angles by the left innominate vein and obliquely by the right inferior thyroid vein. *Behind* it, near its origin, are the trachea and the root of the left common carotid artery, afterwards the prolongation of the right pleura into the neck. To the *right* side are the right pleura and lung, the right innominate vein and right phrenic nerve ; to the *left* side, the inferior thyroid veins and, at its bifurcation, the trachea. The origin of the left common carotid lies somewhat to the left as well as behind.

The innominate artery ordinarily gives off no branch, but occasionally a small vessel, the *thyroidea ima,* arises from it or from the aorta close to it, and runs up the front of the trachea to the thyroid body.

The **Left Common Carotid Artery** (Fig. 276, 16) leaves the arch on the left of the middle line, and runs upwards and to the left side, at a level anterior to that of the left subclavian artery. Above the left sterno-clavicular articulation its relations correspond to those of the right carotid artery (p. 444).

The *thoracic portion* has *in front* the manubrium, with the remains of the thymus gland, the origins of the left sterno-hyoid and sterno-thyroid muscles, the root of the innominate artery and the commencement of the left innominate vein. *Behind* it lie the root of the subclavian artery, the trachea, and at a higher point the left border of the œsophagus and the thoracic duct; to its *right* are the innominate artery, the inferior thyroid vein, the trachea and the left recurrent laryngeal nerve; to its *left* side, the left pneumo-gastric nerve with its cardiac branches, and the left pleura and lung.

The **Left Subclavian Artery** (Fig. 276, 20), arising near the end of the horizontal aorta, behind and somewhat to the left of the left common carotid, extends to the lower border of the first rib, and may be conveniently divided into a thoracic and a cervical portion. The *Thoracic* portion is nearly vertical in its direction, and lies in a plane posterior to that of the left carotid artery and slightly to the left. It is crossed *in front* by the left innominate vein and cardiac nerves; to the *inner* side and *behind* are the trachea, the œsophagus, the left recurrent laryngeal nerve, the thoracic duct, and the spine with the longus colli muscle; on the *outer* side it is related to the left vagus and the left pleura and lung. The *Cervical* portion has been described.

Irregularities of the Great Vessels.—The number and position of the branches of the arch of the aorta are subject to variation. The commonest irregularity is for the *left* carotid to arise from the innominate, thus reducing the branches to two; but there may be *four* large branches, owing to the right carotid and subclavian arising separately, or in rare cases to the *right* subclavian arising from the extreme left of the arch, and passing to the right side in front of or behind the œsophagus. The left vertebral artery not unfrequently arises from the aorta between the left carotid and left subclavian; and the thyroidea ima may occasionally spring from the arch.

The **Right Innominate Vein** (Fig. 267) commences at the inner end of the clavicle by the junction of the subclavian and internal jugular veins, and then descends on the outer side of the innominate artery to join the vein of the opposite side, the union of the two forming the vena cava superior opposite the lower border of the first costal cartilage or first intercostal space. It is closely invested by the right pleura, and has the phrenic nerve on its outer side and the vagus behind.

The **Left Innominate Vein** (Fig. 267), longer and more nearly horizontal than the right vein, commencing at a corresponding point

Fig. 278.

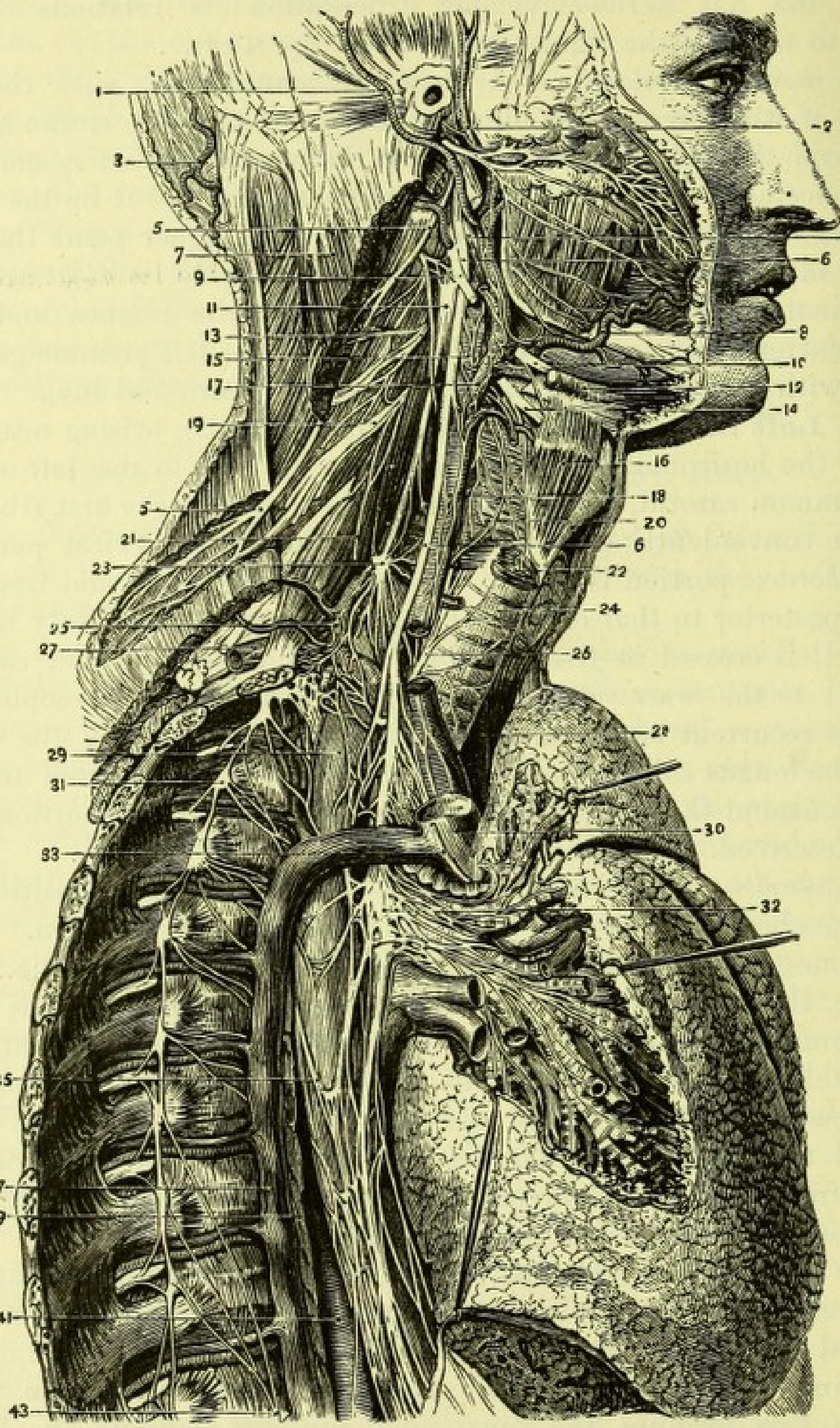


Fig. 278.—Distribution of the right pneumogastric nerve (from Hirschfeld and Leveillé).

1. Posterior auricular artery.
2. Temporal artery.
3. Occipital artery.
4. Glosso-pharyngeal nerve.
5, 5. Spinal-accessory nerve.
6, 6. Pneumo-gastric nerve.

on the left side and in the same way, in front of the left common carotid artery, and runs obliquely downwards and to the right, lying above the level of the arch of the aorta. It crosses the mesial plane in front of the three great branches of the aorta to unite with the right innominate vein behind the right half of the sternum, and the innermost part of the first intercostal space.

Tributaries.—Each innominate vein receives the internal mammary, the inferior thyroid, and the vertebral veins. The left vein receives, in addition, small thymic and pericardiac tributaries and the left superior intercostal (the right ending in the vena azygos major). In some cases both inferior thyroid veins pass to the left innominate.

[The ascending portion of the arch of the aorta and the two venæ cavæ are to be divided, and the remains of the heart removed with the pulmonary vessels, which are to be cut close to the lungs. The arch of the aorta is to be held to one side by hooks, and the bifurcation of the trachea with the deep cardiac plexus dissected out.]

The **Deep Cardiac Plexus** (Fig. 278) is situated behind and to the left of the horizontal aorta, and in front of the trachea close to its bifurcation. The *right half* of the plexus receives all the cardiac nerves of that side, viz., three cardiac nerves from the three cervical ganglia of the sympathetic, the cardiac branches of the pneumo-gastric, and the cardiac branch of its recurrent laryngeal nerve. The branches of this half of the plexus are distributed to the right side of the heart and the right lung, and many of them have been necessarily destroyed. The *left half* (Fig. 279) of the plexus receives all the cardiac nerves of the left side, with the exception of the superior cardiac branch of the sympathetic and the inferior cardiac branch of the pneumo-gastric, which have been already traced to the superficial cardiac plexus (p. 598).

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7. Sterno-mastoid (cut).
8. Facial artery.
9. Hypoglossal nerve with communication from 2nd cervical nerve.
10. Lower end of ditto.
11. Superior cervical ganglion of sympathetic.
12. Digastric.
13. Third cervical nerve.
14. Superior laryngeal nerve.
15. Internal carotid.
16. Thyro-hyoideus.
17. External carotid.
18. Common carotid.
19. Fourth cervical nerve.
20. Inferior constrictor of pharynx.
21. Phrenic nerve on scalenus anticus.
22. Crico-thyroideus.
23. Middle cervical ganglion.
24. Trachea.
25. Thyroid axis.
26. Recurrent laryngeal nerve.
27. Subclavian artery.
28. Innominate artery.
29. Œsophagus.
30. Vena cava superior (cut).
31. Gangliated cord of sympathetic.
32. Posterior pulmonary plexus.
33. Phrenic nerve (cut).
35. Œsophageal plexus.
37. Vena azygos major.
39. Thoracic duct.
41. Thoracic aorta.
43. Great splanchnic nerve.

Fig. 279.

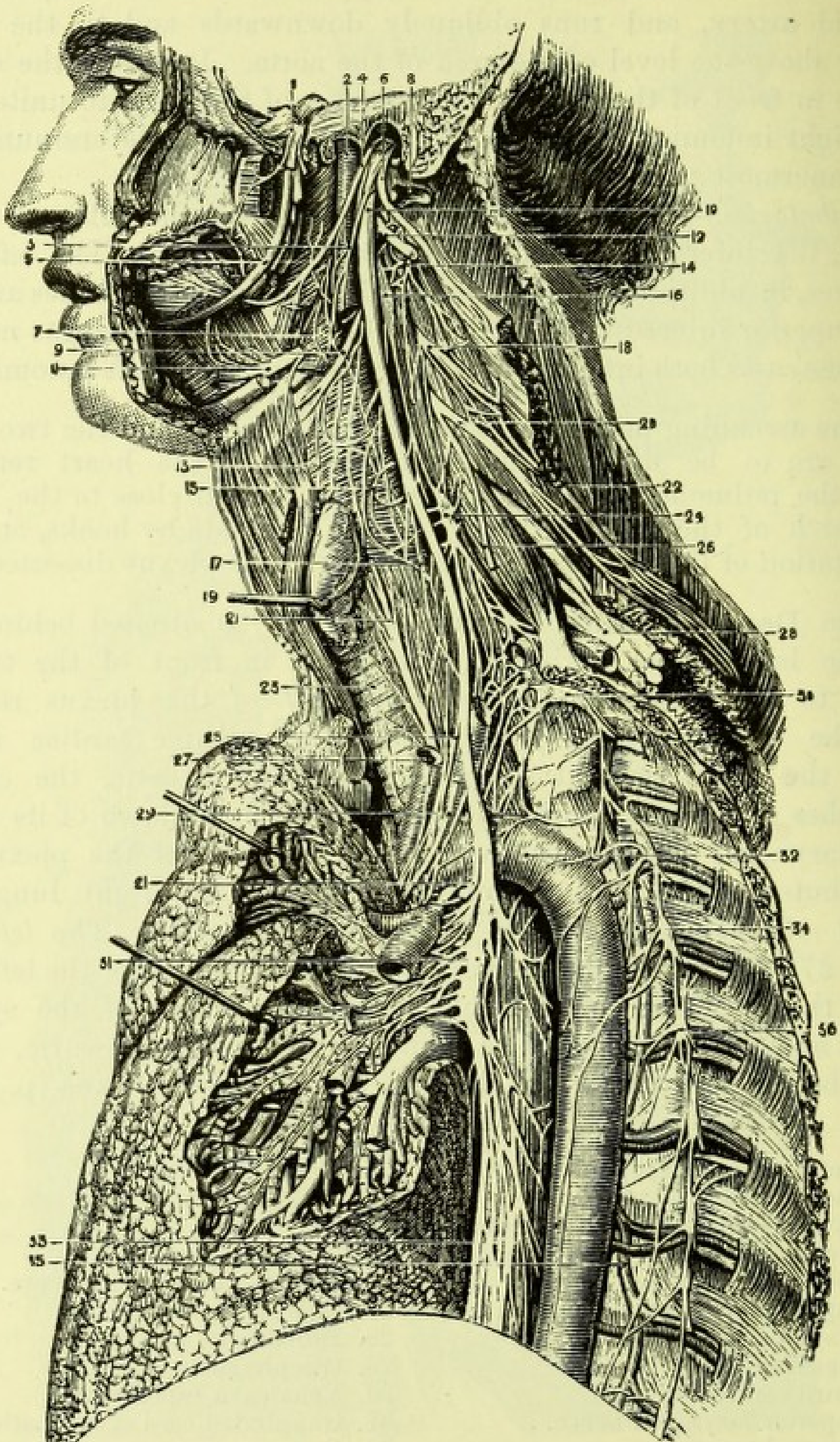

Fig. 279.—Distribution of the left pneumogastric nerve (from Hirschfeld and Leveillé).

1. Gasserian ganglion of fifth nerve. 2. Internal carotid artery.

Its branches are distributed to the left side of the heart and the left lung, and communicate with the superficial cardial plexus.

The **Trachea** (Fig. 276, 18) in the thorax has *in front* of it the sternum, the remains of the thymus gland, the inferior thyroid veins, the deep cardiac nerves, the anterior portion of the horizontal aorta, the lower part of the innominate and left common carotid arteries, and the left innominate vein. *Behind* it lies the œsophagus. On the *right* side are the right pleura and lung, the right vagus, and a lymphatic gland. On the *left*, the tracheal curve of the horizontal aorta, the left carotid and subclavian arteries, the left vagus, the left recurrent laryngeal nerve, and the deep cardiac nerves. It bifurcates into the right and left bronchi opposite the upper border of the 5th dorsal vertebra, the septal portion of its last cartilage lying slightly to the left of the median line, so that the right branch is more likely to admit a foreign body than the left. The angle of bifurcation is about 100°—110°. It is difficult to say whether the right bronchus is more horizontal or more vertical in its direction than the left, on account of the asymmetry caused by the origin of the large eparterial branch from the former tube; hence, perhaps, the discrepancy in the statements of different authorities.

The **Right Bronchus** (Fig. 278) is larger than the left. At a distance of about one inch from its origin is given off a large *eparterial* branch to the upper lobe of the lung. The right pulmonary artery passes backwards beneath this branch to reach the posterior surface of

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3. Pharyngeal branch of pneumogastric.
4. Glosso-pharyngeal nerve.
5. Lingual nerve (5th).
6. Spinal-accessory nerve.
7. Middle constrictor of pharynx.
8. Internal jugular vein (cut).
9. Superior laryngeal nerve.
10. Ganglion of trunk of pneumogastric nerve.
11. Hypoglossal nerve on hyo-glossus.
12. Ditto communicating with eighth and first cervical nerve.
13. External laryngeal nerve.
14. Second cervical nerve looping with first.
15. Pharyngeal plexus on inferior constrictor.
16. Superior cervical ganglion of sympathetic.
17. Superior cardiac nerve of pneumogastric.
18. Third cervical nerve.
19. Thyroid body.
20. Fourth cervical nerve.
21, 21. Left recurrent laryngeal nerve.
22. Spinal-accessory, communicating with cervical nerves.
23. Trachea.
24. Middle cervical ganglion of sympathetic.
25. Middle cardiac nerve of pneumogastric.
26. Phrenic nerve (cut).
27. Left common carotid artery.
28. Brachial plexus.
29. Phrenic nerve (cut).
30. Inferior cervical ganglion of sympathetic.
31. Posterior pulmonary plexus of pneumo-gastric.
32. Thoracic aorta.
33. Œsophageal plexus.
34. Vena azygos superior.
35. Vena azygos minor.
36. Gangliated cord of sympathetic.

the lower part of the main bronchus (Fig. 286). The vena azygos major hooks over the right bronchus to open into the superior vena cava.

The **Left Bronchus** (Fig. 279) runs beneath the arch of the aorta, crossing the œsophagus and the descending aorta. Its undivided portion is nearly twice as long as that of the right bronchus, because the branch to the upper lobe of the lung comes off at a lower level than the eparterial branch on the right side. The pulmonary artery passes *above* it before breaking up into its branches. (See also p. 631.)

[The right lung is to be drawn forward, and the pleura divided where it is reflected from the lung to the wall of the thorax, and the parts in the posterior mediastinum are to be cleaned.

The muscular œsophagus will be at once seen, and the right pneumo-gastric nerve is to be traced to it and to the back of the right bronchus. On displacing the œsophagus, the side of the descending thoracic aorta will come into view, but it will be better seen in the dissection of the left side.

The vena azygos major appears to the right of the aorta, and between the two will be found the slender and collapsed thoracic duct. The intercostal vessels will be seen crossing the back of the space, and near the diaphragm the splanchnic nerves from the sympathetic chain enter the mediastinum, but the chain of gangiia lies behind the pleura.]

The **Posterior Mediastinum** (Fig. 266) is the interpleural space behind the pericardium. It is bounded *behind* by the dorsal vertebræ below the 4th, in *front* by the pericardium, and on *each side* by the reflection of the pleura. Its *contents* are the dorsal aorta, the vena azygos major, the pneumogastric and splanchnic nerves, the œsophagus, the thoracic duct, lymphatics and connective tissue. It communicates above with the neck through the superior mediastinum, and below with the retroperitoneal space in the abdomen through the aortic opening in the diaphragm.

The **Œsophagus** (Fig. 278, 29) is a muscular tube continuous with the pharynx. It begins opposite the lower border of the 6th cervical vertebra, and lies slightly to the left side of the median line in the neck as it passes through the superior aperture of the thorax. About the 5th dorsal vertebra it regains the middle line, and then follows the curve of the spine down to the level of the 10th dorsal vertebra, at which point it bends forward and to the left to pass through the œsophageal opening in the diaphragm, terminating in the stomach opposite the lower border of the same vertebra. In *front* of it, in the chest, lie the trachea, the right pulmonary artery, the left common carotid artery, the left recurrent laryngeal and left vagus nerves, the pericardium, and some bronchial lymphatic glands. *Behind* are the dorsal vertebra, the longi colli, the thoracic duct, the hemi-azygos veins, the vena azygos major (slightly overlapped), the right intercostal arteries, the right vagus, and the aorta (below). To the *right* are the right pleura and lung and some bronchial glands; to the *left* the posterior part of the horizontal aorta and the upper part of the dorsal aorta, the left subclavian artery, the left vagus, the left pleura and lung, and the thoracic duct (above).

Its relations in the neck are given at p. 464. In the abdomen it lies in a notch in the back of the left lobe of the liver, close to the lobus Spigelii, and is invested by peritoneum.

It is supplied by the inferior thyroid artery, the aorta and the gastric artery. Its veins join the inferior thyroids, the vena azygos and the gastric. Its nerves come from the œsophageal plexus of the vagi and from the first dorsal ganglion.

The œsophagus is from nine to ten inches in length and consists of an outer connective tissue coat, beneath which are two layers of *muscular* fibres, the outer longitudinal and the inner circular, both of the striped variety in the upper part, but unstriped in the lower part of the tube. The muscular coat is lined by a layer of submucous tissue with a muscularis mucosæ, and a simple *mucous membrane* with papillæ and stratified epithelium, which is thrown into longitudinal folds when the œsophagus is not distended with food. The glands in the mucous membrane are of the compound racemose variety. The long meshes of nerve fibres upon the œsophagus are derived from the two pneumo-gastrics, and form the *plexus gulæ*.

The **Thoracic Duct** (Fig. 280, 15) is a delicate tube about eighteen inches long, embedded in loose tissue between the aorta and the vena azygos major. By cutting away the remains of the diaphragm carefully, if the abdomen has been dissected, it may be traced from the *receptaculum chyli* (33) opposite the second lumbar vertebra, and will be found to pass behind the right renal artery, and through the aortic opening to the right side of the aorta. In the thorax it continues to the right of the aorta, lying between it and the vena azygos major and superficial to the intercostal arteries, as high as about the fourth dorsal vertebra; then crossing obliquely to the left of the spine above the arch of the aorta, it runs along the left side of the œsophagus through the superior aperture of the thorax. In the neck the duct usually terminates in the left subclavian vein, close to its junction with the left internal jugular (6) (*vide* p. 458); but occasionally rises higher in the neck, and opens into the jugular at the junction of the vein with some irregular tributary. It has valves at various points, and near its entrance into the vein may be found a pair, which prevent the reflux of blood into the duct.

The thoracic duct receives the whole of the lymphatics of the body except those of the right pleura and lung, the right side of the

Fig. 280.

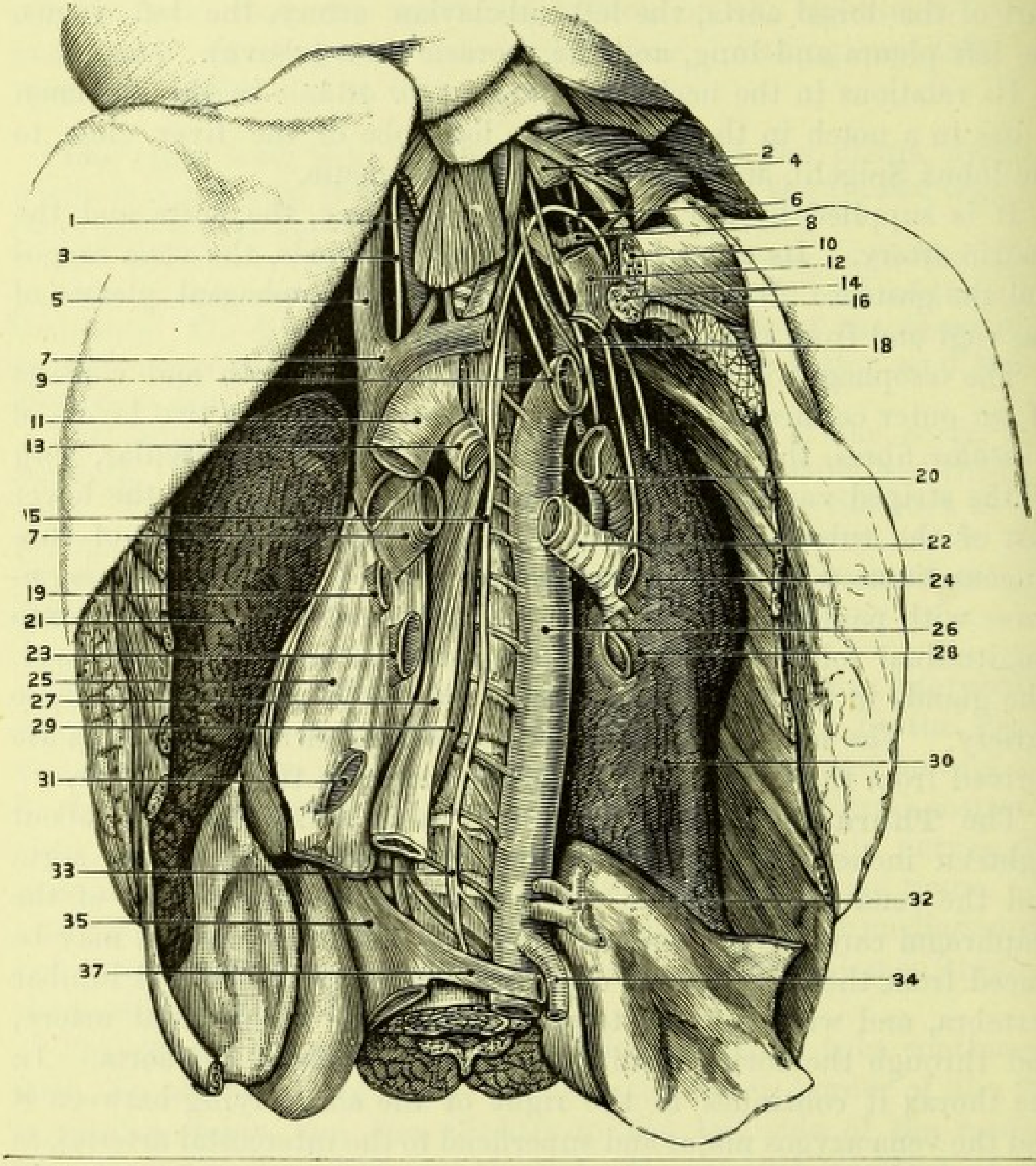


Fig. 280.—The thoracic duct (drawn by H. E. Browne). Seen from the front.

1. Right common carotid.
2. Left internal jugular vein (cut).
3. Right vagus.
4. Left omohyoid.
5. Right innominate vein.
6. Thoracic duct.
7. Commencement of superior cava.
8. Left thyroid axis.
9. Left recurrent laryngeal nerve.
10. Clavicle.
11. Arch of aorta.
12. Junction of left internal jugular and subclavian veins.
13. Commencement of left bronchus.
14. Left first rib.
15. Thoracic duct.
16. Pectoralis major.
17. Right pulmonary artery.

heart, the right side of the head and neck and the right upper extremity, all of which are drained by the right lymphatic trunk.

Between the ribs close to the vertebræ may be found some intercostal *lymphatic glands*, the efferent vessels of which open into the duct. Œsophageal and bronchial glands may also be seen in connection with the tubes of the same name.

The **Vena Azygos Major** (Fig. 281, 15) usually commences in the right ascending lumbar vein, and is to be traced through the aortic orifice of the diaphragm. It lies to the right of the thoracic duct upon the vertebræ, crossing the right intercostal arteries, and receiving directly or indirectly all the right intercostal veins, except the first. About the level of the seventh dorsal vertebra, it receives the *inferior hemi-azygos vein* (18), passing from the left side behind the aorta, and very generally a vertebra or two higher receives the *superior hemi-azygos vein* (16), also from the left side. It then arches forward over the right bronchus, and after receiving the *right superior intercostal vein* and the *right bronchial vein*, opens into the superior vena cava just outside the pericardium. The left superior intercostal vein opens into the left innominate vein. The veins of the intercostal spaces of the right side hence all terminate in one trunk, while those of the left side usually end in three different trunks; all, however, but those of the first and second spaces on the left side, eventually communicating with the vena azygos major.

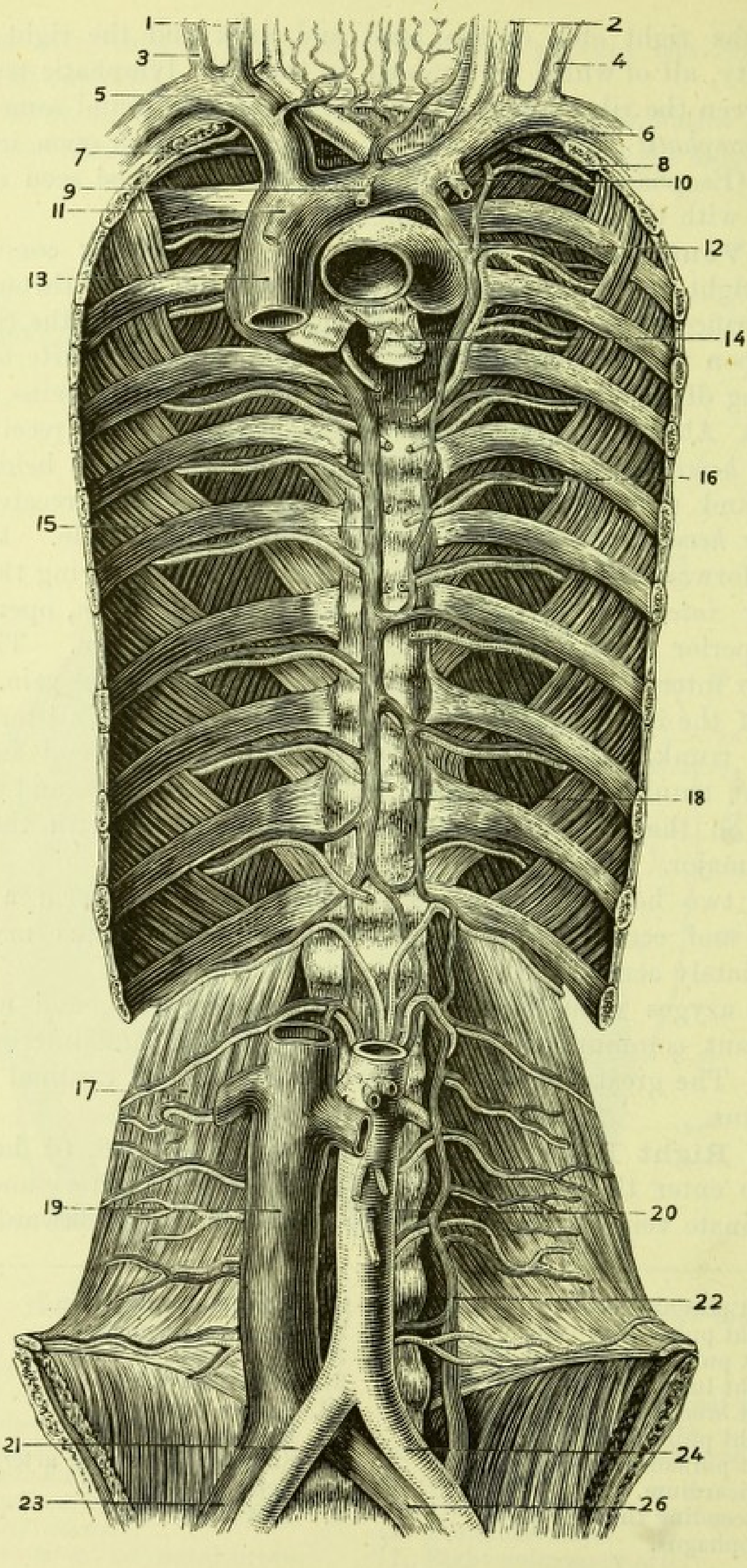
The two hemi-azygos veins sometimes join to form a single trunk, and occasionally some of the intercostal veins may pass immediately across to the great azygos vein.

The azygos veins contain some imperfect valves, and form an important communication between the superior and inferior venæ cavæ. The great azygos vein represents the right cardinal vein of the fœtus.

The **Right Pneumo-Gastric Nerve** (Fig. 278, 6) has been seen to enter the thorax between the subclavian artery and right innominate vein (p. 459). It may now be traced backward to the

18. Left phrenic nerve.
19. Right pulmonary vein.
20. Left pulmonary artery.
21. Right lung.
22. Left bronchus.
23. Right pulmonary vein.
24. Left pulmonary vein.
25. Pericardium.
26. Descending thoracic aorta.
27. Œsophagus.
28. Left pulmonary vein.
29. Vena azygos major.
30. Left lung.
31. Vena cava inferior.
32. Cœliac axis.
33. Receptaculum chyli.
34. Superior mesenteric artery.
35. Vena cava inferior.
37. Left renal vein.

Fig. 281.



right side of the trachea, towards the bifurcation, giving off the *anterior pulmonary plexus*, then passing behind the root of the lung to break up into the *posterior pulmonary plexus*, which receives communicating branches from the last cervical and four upper dorsal nerves. From this position it runs by the side of the œsophagus, then behind it, dividing into branches, which unite with branches of the left pneumo-gastric to form the *plexus gulæ* around the tube. Finally the nerve passes, with the œsophagus, through the opening in the diaphragm and is distributed to the back of the stomach.

Cardiac branches arise from the trunk of the nerve in the thorax, and join the deep cardiac plexus.

[The left lung is now to be drawn forward, and the pleura removed in the same manner as on the right side. The œsophagus with branches from the left pneumo-gastric will be seen near the diaphragm, and upon displacing it, the descending thoracic aorta will be brought into view, with the left splanchnic nerves and hemi-azygos veins.]

The **Left Pneumo-Gastric Nerve** (Fig. 270, 31) enters the thorax between the left carotid and subclavian arteries, and behind the left innominate vein. It descends between the horizontal arch and the left lung, giving off its *recurrent laryngeal* branch and the *anterior pulmonary* plexus, and passes behind the root of the left lung and in front of the descending aorta, there giving off the *posterior pulmonary* plexus. It then reaches the front of the œsophagus, and joins in the formation of the *plexus gulæ ;* finally passing through the œsophageal opening in the diaphragm. The *recurrent laryngeal branch* runs below the remains of the ductus arteriosus, and upwards on the right of the horizontal aorta, ascending to the neck in the

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Fig. 281.—Veins of the trunk and neck (from Cruveilhier).

1. Right internal jugular vein.
2. Left internal jugular vein
3. Right external jugular vein.
4. Left external jugular vein.
5. Right innominate vein.
6. Left innominate vein.
7. Right superior intercostal vein.
8. Left superior intercostal artery.
9. Thymic vein.
10. Left internal mammary vein.
11. Right internal mammary vein.
12. Left superior intercostal vein, joining superior hemi-azygos vein.
13. Vena cava superior, receiving the vena azygos major.
14. Left bronchus.
15. Vena azygos major.
16. Vena azygos superior.
17. Quadratus lumborum.
18. Inferior hemi-azygos vein.
19. Vena cava inferior.
20. Abdominal aorta.
21. Right common iliac artery.
22. Ascending lumbar vein.
23. Right common iliac vein.
24. Left common iliac artery.
26. Left common iliac vein.

sulcus between the trachea and œsophagus. It gives off *cardiac nerves* to the deep cardiac plexus.

The **Dorsal** or **Descending Thoracic Aorta** (Fig. 280, 26) is the continuation of the arch of the aorta, and extends from the lower border of the fifth dorsal vertebra to the lower border of the twelfth dorsal vertebra, opposite which it passes through the aortic opening in the diaphragm to become the abdominal aorta. In its course it lies at first to the left, but afterwards in front of the bodies of the vertebræ, and crosses the hemi-azygos veins. It is crossed by the root of the left lung and by the œsophagus; the latter at first lying to the right side, but afterwards passing in front and then a little to the left side of the vessel, close to the diaphragm. The pericardium also touches it in front. The thoracic duct and the vena azygos major keep to its right side, and it is closely invested by the pleura on the left. The *descending portion of the arch*, which lies in contact with the body of the fifth dorsal vertebra, is sometimes described as a part of the descending thoracic aorta (page 612).

Branches.—From the front of the aorta are given off *pericardiac*, *left bronchial*, *œsophageal*, and *mediastinal* branches. From the back part of the aorta arise the right and left *intercostal* arteries, which will be afterwards traced.

a. The *pericardiac* branches are small and irregular.

b. The *left bronchial* arteries, two in number, run on the posterior surface of the bronchus, and supply blood to the tissues of the lungs. The *right bronchial* artery usually arises from the first aortic intercostal of that side, but sometimes from the main trunk. A *bronchial vein* accompanies each artery; the right opening into the vena azygos major, and the left into the left superior intercostal vein.

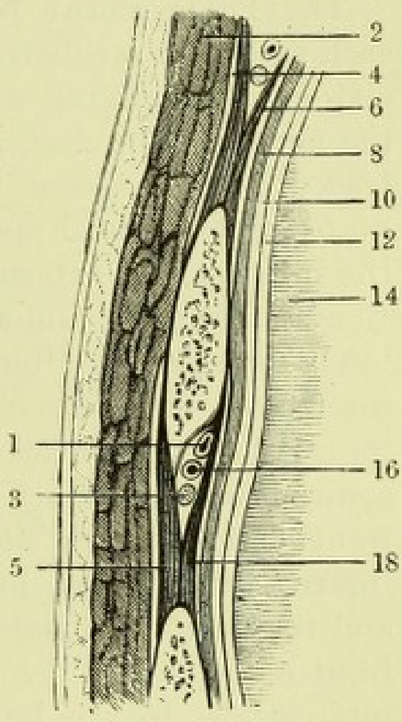
c. The *œsophageal* arteries are four or five small branches to the gullet, anastomosing above with the inferior thyroid, and below with the gastric arteries.

d. The *mediastinal* arteries are small twigs to the cellular tissue and glands of the posterior mediastinum. They anastomose with the pericardiac and œsophageal arteries, and form part of the subpleural mediastinal plexus of Turner.

[The trachea is to be cut just above the bifurcation, and the lungs are then to be removed from the chest and kept for subsequent examination. The intercostal vessels, the azygos veins, and the gangliated cord of the sympathetic, with its branches, are now to be dissected out by removing the pleuræ, and opportunity may be taken to follow out the thoracic duct, if this was not done satisfactorily before.]

The **Aortic Intercostal Arteries** (Fig. 281), nine or ten in number on each side, arise from the back part of the aorta, and supply the nine or ten lower intercostal spaces, anastomosing with the superior intercostal artery above. The arteries of the right side are necessarily longer than those of the left, owing to the position of the aorta to the left side of the median line. The upper arteries ascend to reach their proper intercostal spaces, but the lower vessels run transversely, passing beneath the œsophagus, thoracic duct, vena azygos major, and gangliated cord of the sympathetic on the right side; and beneath the hemi-azygos veins and the gangliated cord of the sympathetic on the left side.

Fig. 282.



Each artery gives off close to the vertebræ a *Posterior branch*, which passes backwards between the transverse processes, dividing into a *muscular* branch to the muscles of the back, and a small *spinal* branch to supply the spinal cord and the body and arch of each vertebra (Fig. 266).

The intercostal arteries lie at first against the external intercostal muscles, and are covered only by the pleuræ. A vein and nerve are in relation with each artery, the vein being highest and the nerve lowest in most of the spaces, but the artery lies below the nerve in the three or four upper spaces (Fig. 282). The artery then disappears beneath the internal intercostal, and gives off its collateral branch, which follows the upper border of the lower rib of the space, and like the terminal branch, anastomoses with the intercostal branches of the internal mammary.

The **Intercostal Veins** (Fig. 281), with the exception of those from the upper two or three spaces on the left side, receive spinal

Fig. 282.—Section of an intercostal space. The collateral intercostal vessels at the upper border of the rib are omitted in the cut.

1. Vein.
2. Pectoral muscle.
3. Nerve.
4. External intercostal fascia.
5. External intercostal muscle.
6. Internal intercostal fascia.
8. Subpleural tissue.
10. Parietal pleura.
12. Visceral pleura.
14. Lung.
16. Artery.
18. Internal intercostal muscle.

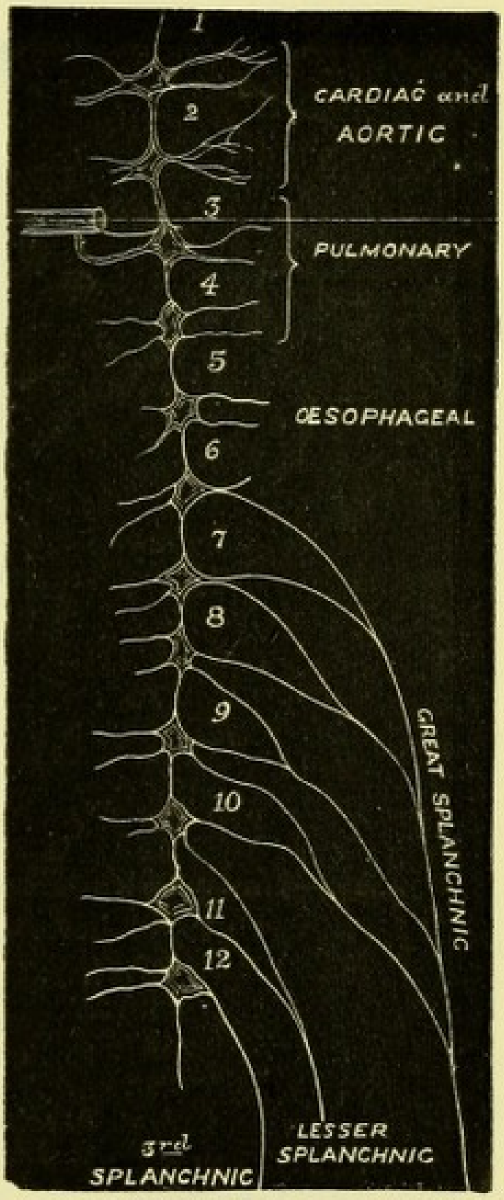
and muscular tributaries, and open into the azygos veins on each side. The vena azygos major of the right side has been already seen.

The **Inferior Hemi-Azygos Vein** (Fig. 281, 18), commencing in the left lumbar veins or in the renal vein, pierces the left crus of the diaphragm and receives the lower intercostal veins of the left side ; it has been seen to pass behind the aorta and open into the vena azygos major. The upper intercostal veins of the left side form the superior intercostal and superior hemi-azygos trunks, the termination of which has been described (page 458).

The **Intercostal Nerves** (Fig. 279) are eleven in number on each side, and are distributed to the front and sides of the chest and abdomen, supplying muscular and cutaneous branches. Each of the nerves of the *2nd, 3rd, 4th, 5th and 6th interspaces,* if carefully traced, will be seen to lie at first between the pleura and the posterior intercostal aponeurosis, then to enter the interval between the internal and external intercostal muscles, and run in this relation as far as the mid-axillary line, where it gives off a *lateral cutaneous branch ;* it afterwards dips into the fibres of the internal intercostal, and piercing these about the junction of the rib with its cartilage, it reaches the deep surface of the internal intercostal, again lying in contact with the pleura. Finally, after passing in front of the internal mammary vessels, it turns forward, pierces the internal intercostal muscle, the external intercostal aponeurosis, and the pectoralis major, and ends by supplying the skin of the front of the chest. It gives *muscular branches* in its course to both intercostals, to the levatores costarum, serratus posticus superior, and triangularis sterni. The *lateral cutaneous* branches of the 3rd, 4th, 5th and 6th nerves pierce the external intercostal muscles and the intervals between the digitations of the serratus magnus, and break up into anterior and posterior divisions, which are distributed to the skin over the lateral aspect of the thorax. The first nerve usually receives a communicating twig from the second (Cunningham) but gives only a small branch to the first intercostal space ; it then passes through the superior aperture of the thorax, across the neck of the first rib, lying externally to the superior intercostal artery and first thoracic ganglion, and joining the eighth cervical nerve it helps to form the brachial plexus. The lateral branch of the *second* does not break up into anterior and posterior thoracic divisions, but passes to the arm, where it joins the lesser internal cutaneous nerve (see upper extremity).

The intercostal nerves *below the sixth* follow an analogous course, but on escaping from the intercostal spaces, they run forwards between the internal oblique and transversalis muscles to enter the rectus abdominis, and, emerging from this muscle near the middle line, they terminate in the superjacent integument. Their *muscular* branches supply the intercostals, levatores costarum, serratus posticus inferior, obliqui, transversalis, and rectus. The *lateral cutaneous* branches divide like those of the upper intercostals, and end in the skin of the abdomen over the interval between the rectus and erector spinæ. It is from these that the twigs to the external oblique are derived. The *last dorsal nerve* lies below the last rib, and is distributed to the outer part of the buttock.

Fig. 283.



The **Gangliated Cord of the Sympathetic** (Fig. 278, 31) is placed over the heads of the ribs on each side of the thorax, just outside the posterior mediastinum and beneath the pleura, and is connected above with the inferior cervical ganglion, which should now be dissected on the neck of the first rib. The thoracic ganglia are generally said to correspond to the ribs in number, but the first ganglion often blends with the inferior cervical ganglion ; and occasionally two of the lower ganglia are united. Each ganglion gives off *ascending* and *descending branches* of communication with the ganglia above and below, *external branches* (usually two) to the thoracic spinal nerves, and *internal branches* of distribution (Fig. 283).

The *internal branches* from the five or six upper ganglia are given to the vertebræ and their ligaments, the œsophagus, and the posterior pulmonary and aortic plexuses. From the internal branches of the six or seven lower ganglia arise the splanchnic nerves and branches to the aortic plexus.

Fig. 233.—The sympathetic chain in the thorax (from Wilson).

Splanchnic Nerves (Fig. 278, 43). The *great splanchnic nerve* is derived from five ganglia (6th, 7th, 8th, 9th, 10th) by separate fibres. It runs inwards in the posterior mediastinum and, after

Fig. 284.

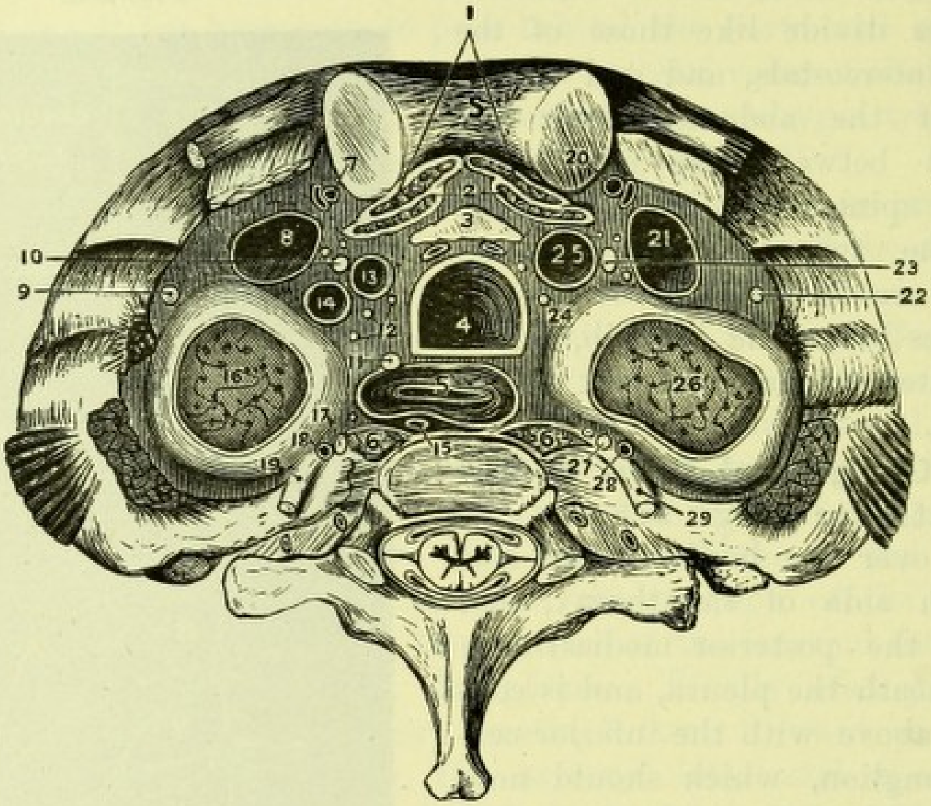


Fig. 284.—The superior aperture of the thorax (drawn by G. E. L. Pearse).

MEDIAN LINE.

1. Sterno-hyoid muscles.
2. Sterno-thyroid muscles.
3. Remains of thymus gland.
4. Trachea.
5. Œsophagus.
6. Longi colli muscles.

LEFT SIDE.	RIGHT SIDE.
7. Internal mammary artery.	20. Internal mammary artery.
8. Innominate vein.	21. Innominate vein.
9. Phrenic nerve.	22. Phrenic nerve.
10. Pneumo-gastric nerve.	23. Pneumo-gastric nerve.
11. Recurrent laryngeal nerve.	
12. Cardiac nerves.	24. Cardiac nerves.
13. Left carotid artery. } 14. Left subclavian artery. }	25. Innominate artery.
15. Thoracic duct.	
16. Apex of lung and pleura.	26. Apex of lung and pleura.
17. Sympathetic.	27. Sympathetic.
18. Superior intercostal artery.	28. Superior intercostal artery.
19. First dorsal nerve.	29. First dorsal nerve.

piercing the crus of the diaphragm, joins the semilunar ganglion and the renal and supra-renal plexuses in the abdomen.

The *lesser splanchnic nerve* is derived from the 10th and 11th ganglia, and also pierces the crus of the diaphragm to join the solar, renal, and supra-renal plexuses.

The *least splanchnic nerve* is derived from the 12th ganglion, and goes to the renal plexus.

The **Internal Intercostal Muscles** (Fig. 281) can be seen beneath the pleuræ without any further dissection. Beginning at the sternum the muscles reach as far as the angles of the ribs, behind which points are visible the intercostal vessels and nerves lying against the external intercostals. Their fibres take a direction contrary to that of the external intercostal fibres, *i.e.*, they run forwards and upwards.

The **Subcostales** consist of planes of muscular fibre passing from one rib to the second or third rib below, in the direction of the internal intercostals.

The relation of the parts passing through the **Superior Aperture of the Thorax** can be now fully understood, and will be found in the accompanying table (p. 628) and the diagram taken from nature (Fig. 284).

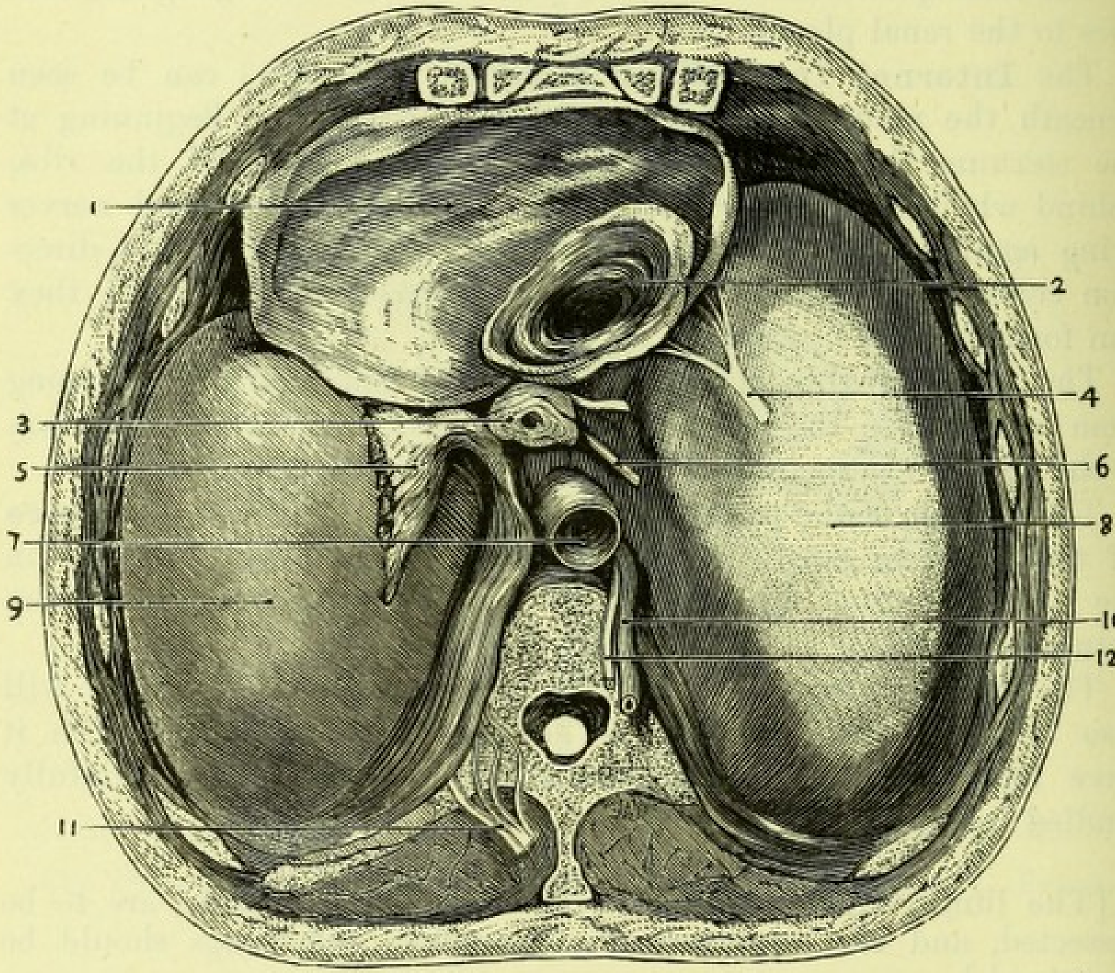
The **Upper Surface of the Diaphragm** (Fig. 285) will also be thoroughly exposed. The structures in relation with it have been already dissected, but these should again be carefully studied in connection with the muscle.

[The lungs, which have been removed and laid aside, are to be dissected, and the structure of the trachea and lungs should be examined.]

The **Trachea** (Fig. 286, 1) extends from the lower border of the 6th cervical vertebra to that of the 4th dorsal vertebra. It is about four inches and a half in length, convex in front, but flattened posteriorly, and is composed of a series of incomplete cartilaginous rings, the extremities of which are connected behind by fibrous and muscular tissue. There are from sixteen to twenty cartilages, each measuring about two lines in depth, but decreasing in this dimension from above downwards: the last is peculiar in being cut obliquely on each side, so as to be adapted to the commencement of the two bronchi. The cartilages are connected together by elastic fibrous tissue, and the first is similarly connected to the cricoid cartilage.

On dissecting away the fibrous tissues at the back of the trachea, together with numerous mucous glands, transverse involuntary muscular fibres (*trachealis muscle*) will be seen connecting the extremities of the cartilaginous rings. Within this is a longitudinal layer of elastic fibres, closely connected with the submucous

Fig. 285.



tissue. The epithelium of the mucous membrane is columnar and ciliated.

On looking into the lower end of the trachea, a septum will be seen between the two bronchi, but placed a little to the left of the

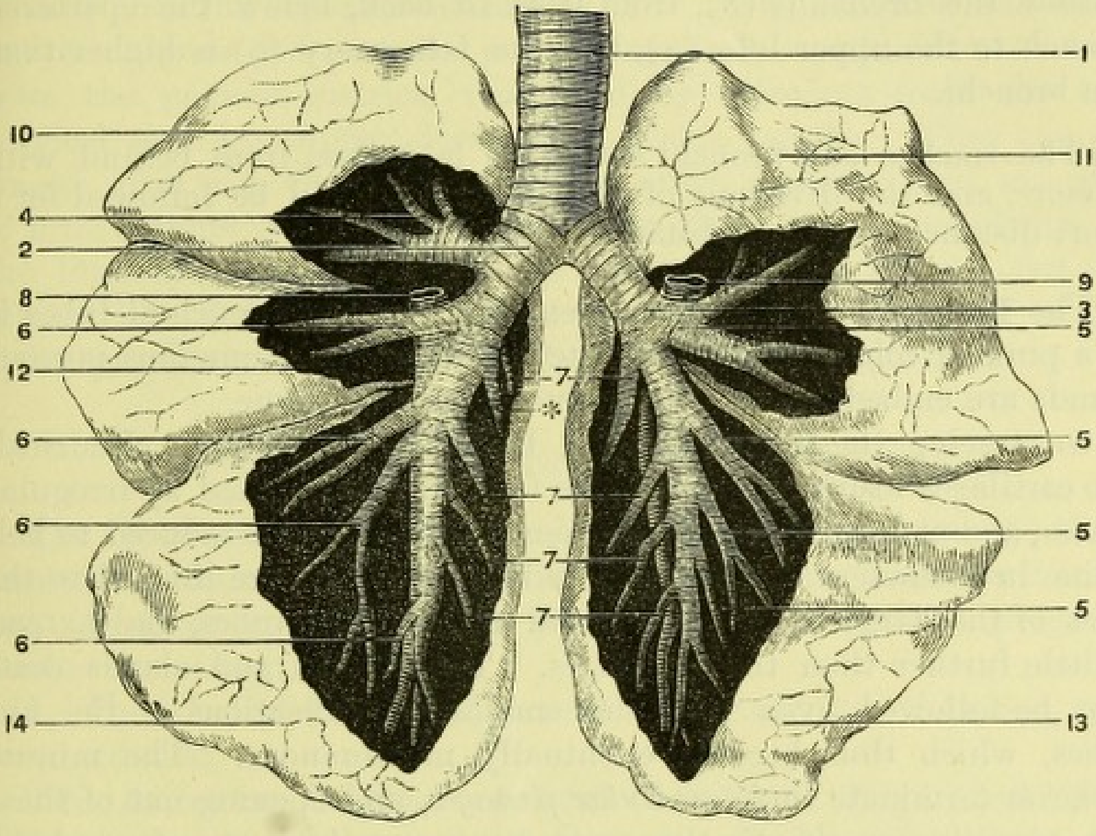
Fig. 285.—The upper surface of the diaphragm (from University College Museum).

1. Pericardium.
2. Vena cava inferior opening into right auricle.
3. Œsophagus with left pneumo-gastric nerve in front.
4. Right phrenic nerve (left nerve hidden by the pericardium).
5. Ligamentum latum pulmonis.
6. Right pneumo-gastric nerve.
7. Aorta.
8. Tendinous centre of right muscle.
9. Pleura, covering left muscle.
10. Vena azygos major.
11. Sympathetic with splanchnics.
12. Thoracic duct.

median line; this favours the passage of foreign bodies into the right bronchus, the orifice of which is larger than that of the left.

If the bronchi be traced into the lung by dissecting off the pulmonary tissue, it will be found that each main bronchus extends

Fig. 286.



to the base of the lung, the left (3) forming a sigmoid curve round the heart. They give off lateral branches in two series, dorsal and ventral (5, 6, 7), besides others less regular in arrangement; and the right gives off in addition a large *eparterial branch* (Fig. 286, 4), which passes above the pulmonary artery to the upper lobe of the

Fig. 286.—Trachea and bronchi seen from the front (modified from Aeby).

1. Trachea.
2. Right bronchus.
3. Left bronchus.
4. Eparterial bronchus to right upper lobe, above pulmonary artery; no corresponding branch on left side.

5, 5, 5, 5. Left ventral branches, four in number, the upper going to upper lobe.

6, 6, 6, 6. Right ventral branches four in number.

7, 7, 7, 7. Dorsal branches, right and left, four in number, the upper going to the middle lobe.

* A branch found only on the right side, corresponding to that going to the azygos lobe of most animals.

8. Right pulmonary artery.
9. Left pulmonary artery.
10. Right upper lobe.
11. Left upper lobe.
12. Right middle lobe.
13. Left lower lobe.
14. Right lower lobe.

lung, and an *azygos branch* (Fig. 286, *) corresponding to the branch going to the azygos lobe in the monkey and other animals. The branches of the pulmonary artery lie in immediate contact with the back of the bronchi and follow their course accurately; those of the pulmonary veins lie for the most part on the ventral aspect, and are not quite so regular. The right pulmonary artery crosses the bronchus (8), from front to back, below the eparterial branch to the upper lobe (4), but the left artery (9) is higher than the bronchi.

[The trachea and bronchi are to be laid open from behind with scissors, and the divisions of the bronchi should be followed for a short distance into the substance of the lungs.]

The **Lungs.**—The mucous membrane of the bronchial tubes is of a pinkish colour, and has ciliated epithelium. Numerous mucous glands are embedded in the submucous areolar tissue.

On tracing the tubes they will be found to become cylindrical, the cartilages losing their ring-like form are represented by irregular plates, and at length disappear when the *bronchia* are reduced to half a line in diameter. The muscular fibres, which were limited to the back of the large bronchi, surround the smaller tubes, and extend a little further than the cartilages. The fibrous and elastic coats may be followed even into the smallest ramifications of the air-tubes, which thus become eventually membranous. The minute *bronchia* terminate in *intercellular passages*, and opening out of these are *air-cells*, or *alveoli*, the septa between which are formed by reduplications of the lining membrane. The air-cells average about $\frac{1}{100}$th of an inch in diameter, and are lined with squamous epithelium.

The air-cells and intercellular passages collected around the extremity of each minute bronchial tube form a *lobule* or *infundibulum*, and these aggregated together constitute the substance of the lung, but the air-cells of one lobule have no connection with those of another.

The *pulmonary artery* subdivides like the bronchus it accompanies, and gives a branch to each lobule. It ends in a plexus of capillaries distributed beneath the mucous membrane of the air-cells and their septa and on the walls of the intercellular passages, anastomosing with the terminal branches of the bronchial arteries, but not with the capillaries of the adjacent lobules.

The *pulmonary veins* convey the arterialised blood from the lobules, and correspond to the branches of the arteries. They have no valves, and the veins of different lobules anastomose freely.

The *bronchial arteries*, arising on the right side from the intercostal artery, on the left from the thoracic aorta, may be traced upon the bronchial tubes for some distance. They supply the substance of the lung, and their blood is returned partly by the bronchial veins and partly by the pulmonary veins. The *bronchial veins* of the right side open into the vena azygos major, and on the left usually into the superior intercostal vein. The *nerves* of the lungs are the anterior and posterior pulmonary plexuses, which are derived from the pneumo-gastrics, reinforced by filaments from the last cervical and four upper dorsal sympathetic ganglia. They can be traced upon the bronchial tubes for some distance, and are said to have minute ganglia developed upon them. The *lymphatics* of the lung are connected with the *bronchial glands* found about the bifurcation of the trachea. Those of the right lung pass to the right lymphatic trunk, those of the left to the thoracic duct.

Articulation of the Ribs with the Vertebræ.

The ligaments of the ribs may be divided into two sets, (1) those connecting the ribs with the bodies of the vertebræ (costo-vertebral), and (2) those connecting the ribs with the transverse processes (costo-transverse).

1. The Costo-vertebral ligaments are Anterior, Capsular, and Inter-articular.

The **Anterior Costo-vertebral** or **Stellate Ligament** (Fig. 287, 2) consists of three short fasciculi, which radiate from the anterior surface of the head of the rib. The *superior* fasciculus passes to the vertebra above; the *middle* fasciculus to the intervertebral substance; the *inferior* fasciculus to the vertebra below. The whole ligament is closely connected with the anterior common ligament of the vertebræ. In the case of the first, tenth, eleventh, and twelfth ribs, which articulate each with a single vertebra, the stellate ligament is attached principally to that vertebra, but sends a few fibres to the vertebra above.

The **Capsular Ligament** is a thin layer of fibres surrounding the articulation where the anterior ligament is wanting.

The **Interarticular Ligament** (Fig. 289, 4) is seen by removing the stellate ligament, and is a short band passing between the ridge on the head of the rib and the intervertebral substance, and dividing the articulation into two parts, each with a separate *synovial membrane.* It is absent from the articulations of the tenth, eleventh, and twelfth ribs, which have each a single synovial membrane.

2. The costo-transverse ligaments are Anterior, Posterior, and Middle.

The **Anterior Costo-transverse Ligament** (Fig. 287, 3) is attached to a rough ridge on the upper border of the neck of each of the ribs, except in the case of the first, and ascends to the lower border of the transverse process of the vertebra above. It separates the anterior from the posterior division of the intercostal nerves.

Fig. 287.

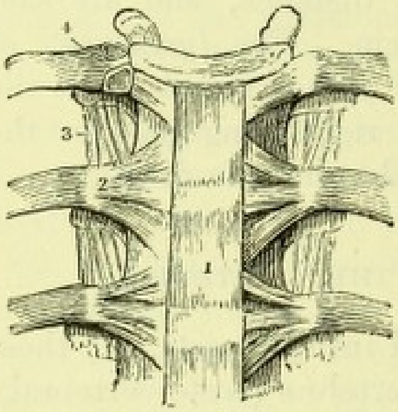
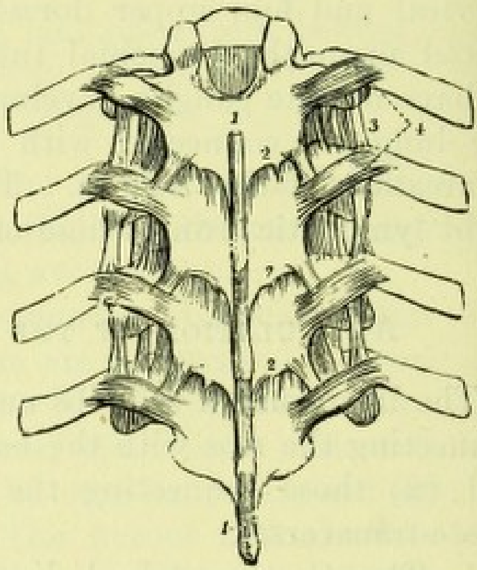


Fig. 288.



The **Posterior Costo-transverse Ligament** (Fig. 288, 4) is a short thick band passing outwards from the apex of the transverse process of the vertebra to the rough non-articular portion of the tubercle of the rib (Fig. 289, 5).

[In order to see the middle costo-transverse ligament, it will be necessary to make a horizontal section through the transverse process

Fig. 287.—Anterior ligament of the vertebræ, and ligaments of the ribs (from Wilson).

1. Anterior common ligament.
2. Anterior costo-vertebral or stellate ligament.
3. Anterior costo - transverse ligament.
4. Interarticular ligament connecting the head of the rib to the intervertebral substance, and separating the two synovial membranes of this articulation.

Fig 288.—Posterior view of part of the dorsal vertebral column, showing the ligaments connecting the vertebræ with each other, and the ribs with the vertebræ (from Wilson).

1, 1. Supraspinous ligament.
2, 2. Ligamenta subflava, connecting the laminæ.
3. Anterior costo-transverse ligament.
4. Posterior costo - transverse ligament.

of a vertebra and the neck of the corresponding rib, when the short ligament will be found between the two.]

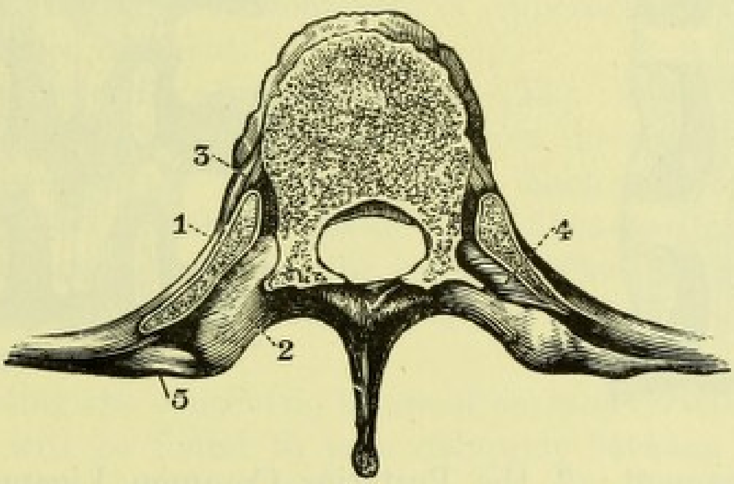
The **Middle Costo-transverse Ligament** (Fig. 289, 4) consists of short strong fibres, passing between the posterior surface of the neck of the rib and the anterior surface of the corresponding transverse process.

A *synovial membrane* exists between the facet upon each of the transverse processes of the ten upper dorsal vertebræ and the articular tubercle of the corresponding rib.

The anterior extremity of each rib has a hollow into which the costal cartilage fits, the two structures being firmly united by the periosteum.

Chondro-Sternal Articulation.—The cartilages of the true ribs fit into depressions on the side of the sternum, and are

Fig. 289.



attached by *anterior* and *posterior* ligaments. A band attaching the seventh rib to the xiphoid cartilage is called the costo-xiphoid ligament.

The fifth, sixth, seventh, eighth, ninth and tenth cartilages are connected to each other by fibrous bands.

Synovial Membranes.—The first costal cartilage is continuous with the sternum, and has no synovial cavity. The second and third cartilages have a double synovial membrane, owing to the existence of an interarticular ligament. The fourth, fifth, sixth,

Fig. 289.—Transverse section of dorsal vertebra and ribs (from Quain).

1. Head of rib.
2. Transverse process of vertebra.
3. Anterior costo-vertebral or stellate ligament.
4. Middle costo-transverse ligament.
5. Posterior costo-transverse ligament.

and seventh cartilages have each a single synovial membrane at the external articulation, and there are additional synovial membranes between the sixth and seventh, seventh and eighth, and eighth and ninth costal cartilages.

Ligaments of the Vertebræ.

[The ligaments of the spinal column are to be examined by removing all the remaining muscular fibres.]

The ligaments of the *Bodies* of the vertebræ are—1, the Anterior

Fig. 290.

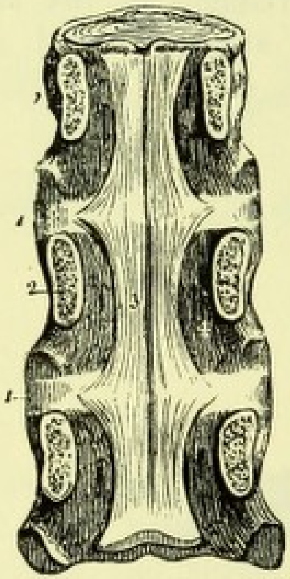
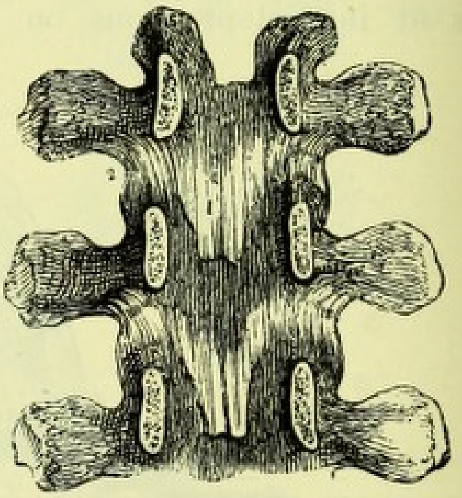


Fig. 291.



Common Ligament; 2, the Posterior Common Ligament; and 3, the Intervertebral Substance or Fibro-cartilage.

The **Anterior Common Ligament** (Fig. 287, 1) is a broad band of fibres extending down the front of the vertebral column, from the axis to the sacrum. The fibres are attached principally to the intervertebral substances, and slightly to the upper and lower margins of the vertebræ; the deep fibres passing between the adjacent bones, while the superficial cross three or more vertebræ. The ligament, when divided, will be seen to be thicker

Fig. 290.—Posterior ligament of the vertebræ (from Wilson).

1, 1. Intervertebral substances. 3. Posterior common ligament.
2. Pedicles of vertebræ sawn through.

Fig. 291.—Internal view of the arches of three vertebræ (from Wilson).

1. One of the ligamenta subflava. 2. The capsular ligament of one side.

opposite the bodies of the vertebræ than on the intervertebral substances; and it is broader in the lumbar than in the cervical and dorsal regions.

[To see the posterior common ligament it will be necessary to remove the spinal cord, if this has not been already done. The saw is to be applied over the pedicles of, say, six dorsal vertebræ, and these being divided on each side, the remains of the spinal cord can be removed, when the posterior ligament will be seen on the backs of the bodies of the vertebræ. The ligamenta subflava can be dissected upon the vertebral arches which have been sawn away.]

The **Posterior Common Ligament** (Fig. 290, 3) is found upon the posterior aspect of the bodies of the vertebræ from the axis to the sacrum. Unlike the anterior common ligament it is broad opposite the intervertebral substances, with which it is closely connected, and narrow opposite the bodies of the vertebræ; and is broader in the cervical than in the lumbar region, and thickest in the dorsal region. It is composed of superficial and deep fibres like the anterior ligament.

The **Intervertebral Substances** (Fig. 290, 1) are found between the bodies of all the vertebræ from the axis to the sacrum, and are largest in the lumbar region. Each disc is composed of concentric layers of fibrous tissue and fibro-cartilage externally, with a soft elastic material in the centre. The discs are deepest in front in the cervical and lumbar regions, and the reverse in the dorsal region.

On dissecting the concentric layers of an intervertebral substance, their fibres will be found to pass obliquely between the adjacent vertebræ, taking opposite directions by alternate layers. By cutting through the attachment to one of the vertebræ with a strong knife, a pulpy material in the centre will be seen to expand considerably above the level of the fibro-cartilaginous rings around it: this is probably a relic of the chorda dorsalis of the embryo.

The *Articular Processes* are surrounded by **Capsular Ligaments** (Fig. 291, 2), which are looser in the cervical than in the dorsal and lumbar regions; they permit a simple gliding movement between the processes. Each joint has a simple synovial membrane.

The *Arches* are united by the **Ligamenta Subflava** (Fig. 291, 1). These are to be seen on the internal surfaces of the arches which have been removed, and will be found to consist of a series of yellow elastic ligaments, extending between the laminæ of the vertebræ on each side of the middle line, from the axis to the sacrum. Owing to the overlapping of the laminæ, the ligaments are attached to the posterior surface of the arch below and to the anterior surface of the arch above (Fig. 288, 2).

The *Spinous Processes* are united by (1) the Interspinous and (2) the Supraspinous ligaments, both of which give attachment to muscles.

The **Interspinous Ligaments** are placed between the spinous processes of the vertebræ, extending from the root to the tip of each. They are stronger in the lumbar than in the dorsal, and in the dorsal than in the cervical region.

The **Supraspinous Ligament** (Fig. 288, 1) is a fibrous cord extending along the tips of the spinous processes, from the last cervical vertebra to the sacrum. It is continuous with the *ligamentum nuchæ*, and is thicker in the lumbar than in the dorsal region. It is composed of superficial and deep fibres, which have the same arrangement as those of the anterior and posterior common ligaments.

The *Transverse Processes* are connected by **Intertransverse Ligaments**, which are round and thick in the dorsal, and thin and membranous in the lumbar region. They are frequently absent in the cervical region.

PART VI.

DISSECTION OF THE BACK AND SPINAL CORD.

In dissecting the back it is customary for the owners of the arms to take the first two layers of muscles, while the dissectors of the head and neck claim such of the superficial muscles as are contained in their part, and complete the dissection of the remainder of the region, including the spinal cord.

[An incision is to be made from the occiput to the sacrum in the median line, and another along each crest of the ilium at right angles to it. The dissectors should then raise the skin with all the subcutaneous tissues down to the superficial muscles, through which the cutaneous nerves appear. On the left side of the subject, the arm is to be drawn forward so as to put the latissimus dorsi on the stretch, and the dissector should begin to clean the lower part of that muscle, and work upwards to the trapezius. On the right side the arm should be pulled down at first, and the head drawn over to the opposite side with hooks, to put the upper fibres of the trapezius on the stretch, and the dissector must begin at the upper border of that muscle (already exposed in the posterior triangle) and work downwards to the latissimus dorsi. On both sides, the arm and scapula will require to be moved from time to time to stretch the different sets of fibres in turn.]

The **Cutaneous Nerves** (Fig. 295) are derived from the posterior divisions of the spinal nerves, and are mostly of small size; but the upper dorsal nerves reach the shoulder, and the lumbar the buttock. The cervical and upper six dorsal cutaneous nerves pierce the trapezius close to the spine, the second and sometimes a branch of the third cervical turning up to the occiput (the smallest occipital nerve from the third being much smaller than the great occipital from the second, and lying internally to it). There is no cutaneous branch from the 1st; and those of the 6th, 7th, and 8th cervical nerves are of small size. The lower six dorsal and three lumbar nerves appear near the angles of the ribs, and pierce the latissimus dorsi along the oblique line at which the muscular fibres commence ; and the sacral nerves give usually two small branches through the tendinous expansion near the spine.

Fig. 292.

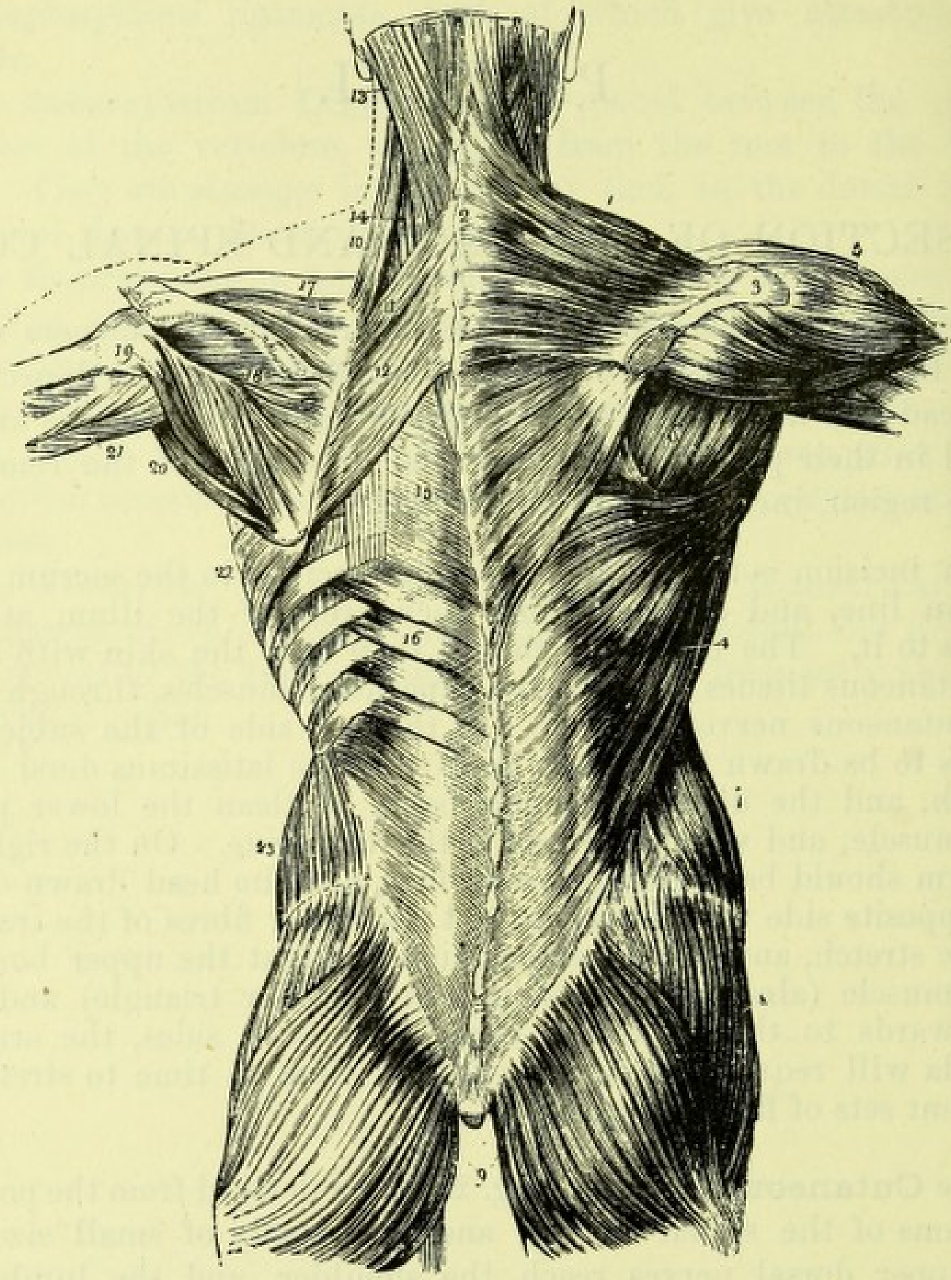


Fig. 292.—First, second, and part of the third layer of muscles of the back ; the first layer occupies the right ; the second the left side (from Wilson).

1. Trapezius.
2. Ligamentum nuchæ.
3. Acromion process and spine of the scapula.
4. Latissimus dorsi.
5. Deltoid.
6. Muscles of the dorsum of the right scapula: infraspinatus, teres minor, and teres major.
7. Obliquus externus.
8. Gluteus medius.
9. Glutei maximi.
10. Levator anguli scapulæ.
11. Rhomboideus minor.
12. Rhomboideus major.
13. Splenius capitis ; the muscle internal to, and overlaid by, the splenius, is the complexus.

The **First Layer of Muscles** (Fig. 292) consists of the Trapezius and Latissimus Dorsi. The Trapezius partially overlaps the latissimus, but between them and the base of the scapula is a small triangular interval, in which the lower fibres of the rhomboideus major can be seen, and, below that muscle, the posterior surfaces of two or three ribs and their intercostal muscles.

The **Trapezius** (Fig. 292, 1) of one side is triangular, but the two muscles together resemble a trapezium. It *arises* from the external occipital protuberance and inner third of the superior curved line of the occipital bone; from the ligamentum nuchæ and the seventh cervical spinous process; and from the spinous processes of all the dorsal vertebræ and the supraspinous ligaments. The fibres converge to be *inserted* into the outer third of the posterior border of the clavicle, and into the inner border of the acromion process and the upper border of the spine of the scapula, as far as the tubercle at the outer angle of the basal triangle. This bony eminence receives the insertion of a tendon, which glides over the basal triangle (and is separated from it by a bursa) and receives the lower two-thirds of the dorsal fibres of the muscle. The fibres thus have different directions, and the action of the muscle upon the scapula varies according to the portion brought into use. The action of the entire muscle is to draw the scapula towards the spine, and thus the two trapezii throw back the shoulders. The upper fibres, acting alone, elevate the shoulder girdle, the lower fibres depress and retract it. When the scapulæ are fixed by other muscles, the two trapezii extend the head and neck, or one muscle acting by itself would draw the head and spine to the same side.

It should be noticed that a large oval tendinous aponeurosis (*speculum rhomboideum*), divided into two symmetrical halves by the spine, separates the bellies of the two muscles opposite the last cervical and three or four upper dorsal vertebræ—a substitution of tendon for muscle that probably has reference, as suggested by Mr. Davies Colley, to the comparatively small range of movement of the scapula backwards at this point.

The trapezius has been seen to be *supplied* by the spinal-accessory nerve and branches of the 3rd and 4th cervical nerves. It is

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14. Splenius colli, partially seen: the common origin of the splenius is seen attached to the spinous processes below the origin of rhomboideus major.
15. Vertebral aponeurosis.
16. Serratus posticus inferior.
17. Supra-spinatus.
18. Infra-spinatus.
19. Teres minor.
20. Teres major.
21. Long head of triceps.
22. Serratus magnus.
23. Obliquus internus.

doubtful whether it receives branches from the posterior divisions of the nerves which pierce it.

The *Ligamentum Nuchæ* is a band of white fibrous tissue, which extends from the prominent spinous process of the seventh cervical vertebra to the external occipital protuberance and crest, and is connected by small slips with the spines of the intervening vertebræ. It intervenes between, and gives origin to, the muscles of the two sides of the neck. In some of the lower animals, it is of large development and composed of yellow elastic tissue, and gives an important support to the head.

The **Latissimus Dorsi** (Fig. 292, 4) *arises* by a tendinous origin from the posterior half of the outer lip of the crest of the ilium, and the upper sacral spines ; from all the lumbar and the six lower dorsal spines ; and from the outer surfaces of the three or four lower ribs, interdigitating with the external oblique muscle of the abdomen. The broad muscular fibres become collected together as they wind round the inferior angle of the scapula, to which they sometimes have a slight attachment, and then pass forward and upward, at first behind, then below, and finally in front of the teres major, to be *inserted* into the bottom of the bicipital groove of the humerus. The fibres of the muscle are so twisted that those which were highest at their origin are lowest at the insertion, and *vice versâ*. At its insertion the tendon is separated from that of the teres major by a bursa (*v.* p. 25).

The latissimus dorsi, when taking its fixed point below, extends, adducts, and rotates the humerus inwards, drawing it behind the back, and at the same time draws back the shoulder girdle (acting upon the sterno-clavicular joint) ; or if the arm is raised the muscle would depress it. When the humerus is fixed, the muscle would pull up the trunk, as in climbing, or might act upon the lower ribs as an extraordinary muscle of inspiration. It is *supplied* by the long subscapular nerve, and perhaps also by the dorsal nerves which pierce it.

[The trapezius is to be divided by a vertical incision near the spine, care being taken not to cut the subjacent tendinous origins of the rhomboidei in the cervical region. In reflecting the muscle, its tendon will be seen to glide over the smooth triangular surface at the inner end of the spine of the scapula. Care must be taken of the spinal-accessory nerve and the accompanying branches of the superficial cervical artery. The posterior surface of the levator anguli scapulæ and rhomboidei muscles is now to be cleaned.]

Second Layer of Muscles consists of the levator anguli scapulæ and the rhomboidei.

The **Levator Anguli Scapulæ** (Fig. 292, 10) *arises* from the posterior tubercles on the transverse processes of the upper four cervical vertebræ, and is *inserted* into the base of the scapula opposite the supra-spinous fossa. The surface of this muscle has been seen in the posterior triangle of the neck, where it covers the splenius colli.

The **Rhomboideus Minor** (Fig. 292, 11) is a narrow muscle, *arising* from the ligamentum nuchæ, and from the spines of the seventh cervical and first dorsal vertebræ. It is *inserted* into the base of the scapula opposite the spine.

The **Rhomboideus Major** (Fig. 292, 12) *arises* from the spinous processes of the upper four or five dorsal vertebræ below the first, and the interspinous ligaments. It is *inserted* into the base of the scapula opposite the infra-spinous fossa, the middle fibres being usually attached to a fibrous arch, which is unconnected with the bone.

The three muscles of the second layer act upon the scapula, drawing it upwards and inwards towards the spine. Acting in association with other muscles they tend to rotate the scapula at the acromio-clavicular joint, and to make the glenoid cavity look downwards.

The superficial cervical artery passes over the outer surface of the levator anguli scapulæ, and the posterior scapular artery runs beneath this muscle to reach the hinder margin of the scapula, between the attachments of the rhomboids and serratus magnus.

The levator anguli scapulæ is supplied by branches from the 3rd and 4th cervical nerves, the rhomboids by branches from the 5th cervical.

[The posterior belly of the omo-hyoid is to be traced out to the scapula, and the levator anguli scapulæ, rhomboidei, and the upper half of the latissimus dorsi are then to be divided, when the scapula can be drawn away from the ribs, and the inner surface of the serratus magnus muscle, with a quantity of loose cellular tissue between it and the ribs, will be brought into view. This muscle is to be divided by a vertical incision, and the clavicle being sawn through (if this has not already been done), the arm will be attached only by the vessels and nerves, which may be cut and the limb removed. Between the rhomboidei and the serratus will be seen the posterior scapular artery, and more externally the supra-scapular artery runs above the ligament of the notch while the nerve passes beneath it. The attachment of the omo-hyoid muscle to the upper border of the scapula will also be exposed. The dissector of the arm will proceed at once with the dissection of the scapular muscles. The tendinous origin of the latissimus is then to be removed, and the serrati postici superior and inferior are to be defined.]

The **Third Layer of Muscles** (Fig. 292) consists of the Serrati postici superior and inferior, and the Splenius capitis et colli. They are all *supplied* by the external branches of the posterior divisions of the cervical nerve.

Cf. Rhomb. Min.

The **Serratus Posticus Superior** *arises* from the lower part of the ligamentum nuchæ, the spinous processes of the seventh cervical and upper two dorsal vertebræ, and the corresponding interspinous ligament; it passes downwards to be *inserted* into the superior borders of the second, third, fourth, and fifth ribs, (4 externally to their angles.

The **Serratus Posticus Inferior** (Fig. 292, 16) *arises* from the spinous processes of the last two dorsal and upper two lumbar vertebræ and the interspinous ligaments; it passes upwards to be *inserted* into the lower borders of the last four ribs, externally to their angles.

The serratus posticus superior raises the ribs, and is therefore a muscle of inspiration; the serratus inferior has a contrary action.

[The serrati are to be divided and turned aside, and the splenius capitis and splenius colli are to be cleaned, when the posterior portion of the *fascia* covering the deeper muscles, and united more or less with the origins of the latissimus dorsi and serratus posticus inferior, as well as with the subjacent muscles, will be seen. The name of *vertebral aponeurosis* has been given to the continuation of this structure beneath the serratus posticus superior and the splenius, and over the deep muscles; this is to be defined, and afterwards must be removed.]

The **Splenius** (Fig. 292) is single at its *origin* but is divided into two parts at its insertion. It arises from the lower half of the ligamentum nuchæ, and from the spinous processes of the seventh cervical and upper six dorsal vertebræ.

The *splenius capitis* (13), or upper portion, passes upwards and inwards to be *inserted* into the mastoid process and into the outer third of the superior curved line of the occipital bone, immediately beneath the sterno-mastoid muscle.

The *splenius colli* (14), or lower portion, is *inserted* into the posterior tubercles on the transverse processes of the upper three or four cervical vertebræ, beneath the levator anguli scapulæ.

The splenii of both sides acting together draw the head and neck backward. One muscle acting alone, draws the head backwards, lateralises it towards the corresponding shoulder, and rotates the face towards the same side.

The splenius capitis was seen in the posterior triangle of the neck, above the levator anguli scapulæ, but the splenius colli was hidden by this muscle. At the upper border of the splenius may appear the nearly vertical fibres of the complexus, running to the interspace between the two curved lines of the occipital bone.

[The splenius must be reflected in order to show the complexus, which lies beneath it. In order to define the connections of the erector spinæ, an interval is to be sought opposite the last rib, separating the muscular mass into two parts. The *outer segment* is to be turned outwards and its attachment to the ribs and cervical transverse processes noted ; it consists of the sacro-lumbalis continued upwards by the accessorius, and the cervicalis ascendens. The *inner segment* when separated from a few muscular and tendinous bands called the spinalis dorsi, passing between some of the dorsal and lumbar spines, and will be found to consist of the longissimus dorsi prolonged upwards into the neck by the complexus and transversalis colli. The aponeurosis covering the erector spinæ is to be divided by an oblique incision, following the line of separation between the muscles. In making this dissection the inner branches of the posterior divisions of the intercostal vessels and nerves will be found internal to the longissimus dorsi, and the external branches between the longissimus dorsi and the sacro-lumbalis. The occipital artery will also be shown in the neck.]

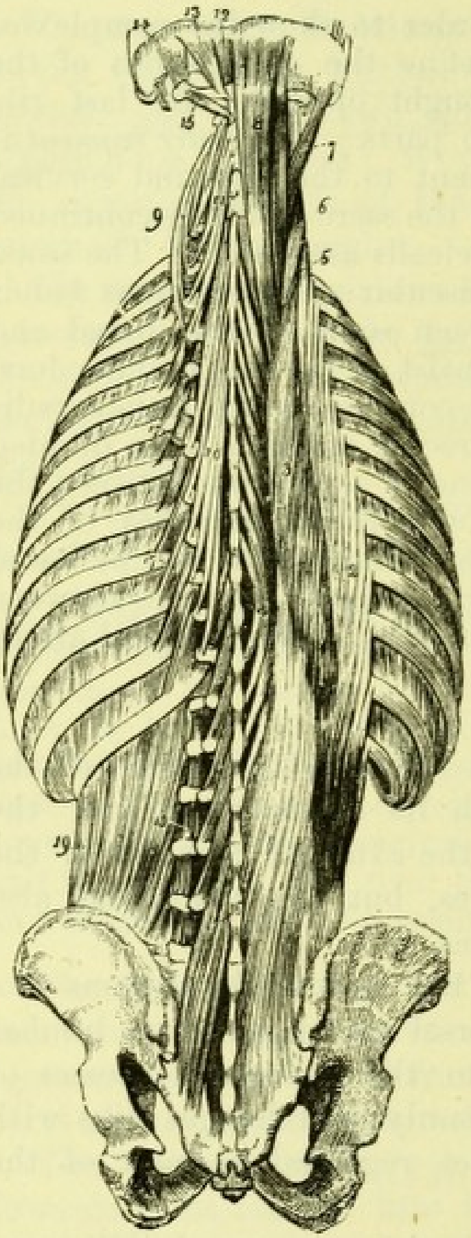
The **Fourth Layer of Muscles** (Fig. 293) consists of the Spinalis dorsi, the Erector spinæ with its subdivisions, and the Complexus. They are all *supplied* by the external branches of the posterior divisions of the spinal nerves, but the complexus also receives twigs from the internal branches.

The **Spinalis Dorsi** (Fig. 293, 4) lies close to the spinous processes, *arising* from the lower two dorsal and upper two lumbar spinous processes, and is *inserted* into the spinous processes of the upper six dorsal vertebræ. It commonly interchanges slips with the longissimus dorsi, and is sometimes regarded as part of the erector spinæ.

The **Erector Spinæ** (Fig. 293, 1) is the great muscle filling up the hollow at the back of the sacrum and lumbar vertebræ. It *arises* from the posterior fifth of the inner lip of the crest of the ilium, from the posterior surface of the sacrum, from the spinous processes of the three or four lower lumbar vertebræ ; and from the aponeurosis covering the muscle. It divides before its insertion into the sacro-lumbalis and longissimus dorsi muscles. In the loins its aponeurosis blends with the 'fascia lumborum' or posterior segment of the tendon of the transversalis abdominis muscle (*v.* p. 262).

The **Sacro-Lumbalis** (Fig. 293, 2) the smaller and more external of the two divisions, passes upwards and outwards to be *inserted* into the angles of the six lower ribs, and is directly prolonged upwards by the two following muscles.

Fig. 293.



The **Accessorius** (musculus accessorius ad sacro-lumbalem), consisting of muscular slips which pass *from* the angles of the six lower ribs internal to the insertion of the sacro-lumbalis, *to* the angles of the six upper ribs.

The **Cervicalis Ascendens** (Fig. 293, 5), *arising* from the angles of the upper five ribs, internal to the insertion of the accessorius, and being *inserted* into the posterior tubercles on the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ.

The **Longissimus Dorsi** (Fig. 293, 3), the inner division of the Erector spinæ, has two sets of insertions; an *inner*, by tendinous slips into the transverse processes of all the dorsal vertebræ, and into the articular tubercles of the lumbar vertebræ; and an *outer*, by fleshy slips into the ten lower ribs between their tubercles and angles, and into the transverse processes of the lumbar vertebræ. It is prolonged to the neck and head by two muscles, the **transversalis capitis et colli** and the **complexus,** both of which

Fig. 293.—Fourth and fifth, and part of the sixth layer of the muscles of the back (from Wilson).

1. Common origin of the erector spinæ.
2. Sacro-lumbalis.
3. Longissimus dorsi.
4. Spinalis dorsi.
5. Cervicalis ascendens.
6. Transversalis cervicis.
7. Trachelo-mastoideus.
8. Complexus.
9. Transversalis cervicis, showing its origin.
10. Semispinalis dorsi.
11. Semispinalis colli.
12. Rectus posticus minor.
13. Rectus posticus major.
14. Obliquus superior.
15. Obliquus inferior.
16. Multifidus spinæ.
17. Levatores costarum.
18. Intertransversales.
19. Quadratus lumborum.

arise from the transverse processes of the five or six upper dorsal vertebræ and the articular processes of the four lower cervical vertebræ.

The **Transversalis Capitis et Colli** is divided into two portions, the higher, called *transversalis capitis* or *trachelo-mastoid*, being inserted into the mastoid process under cover of the fore part of the splenius; the lower, called *transversalis colli*, passing to the posterior tubercles of the transverse processes of the 3rd, 4th, 5th, and 6th cervical vertebræ, internally to the cervicalis ascendens.

The **Complexus,** having the same origin as the transversalis, but lying to the inner side of it, is inserted into the space between the superior and inferior curved lines, on the inner side of the area for the superior oblique. It is pierced by the great occipital and third occipital nerves.

The most internal and superficial part of the complexus has been called the **Biventer Cervicis,** from the fact that it consists of two fleshy portions or bellies with an intervening tendon.

The erector spinæ, with its continuations upwards, extends the entire spine and head if the muscles of the two sides act together. Acting singly, they lateralise and rotate the vertebræ.

Occipital Artery (Fig. 294, 3).—The second portion of the occipital artery is now exposed in its course between the muscles attached to the occipital bone. It has been seen to pass under the posterior belly of the digastricus, and disappear beneath the sterno-mastoid, splenius capitis, and trachelo-mastoid, to reach its groove in the mastoid portion of the temporal bone internally to the digastric groove. Finally it crosses the superficial aspect of the superior oblique and complexus, and passes to the back of the scalp between the attachments of the sterno-mastoid and trapezius. The great occipital nerve, which has a similar distribution, pierces the complexus and trapezius to reach the occiput. The branches of the artery are (1) *Muscular* to the sterno-mastoid, splenius, trachelo-mastoid, and digastricus; (2) *Auricular* to the back of the auricle, anastomosing with the posterius auricular of the external carotid; (3) *Meningeal*, through the foramen lacerum posterius; (4) *Mastoid*, piercing the mastoid foramen to supply the mastoid cells and dura mater; (5) *Princeps Cervicis*, which runs downwards between the complexus and semispinalis, supplying both and anastomosing with the posterior branches of the vertebral and the deep cervical branch of the superior intercostal. It gives off a small *superficial cervical* twig which runs superficially to the complexus, supplying the trapezius and anastomosing with the *superficial cervical* branch of the transversalis colli; (6) *Suboccipital*, anastomosing with muscular branches of the vertebral in the suboccipital triangle; and (7) *Terminal* to the occipital portion of the scalp, anastomosing with the temporal, and giving a small parietal twig through the parietal foramen.

The *Occipital* vein usually passes deeply beneath the complexus to anastomose with the vertebral and deep cervical veins. Before leaving the cranium it communicates with the lateral sinus through the mastoid foramen.

[The complexus is to be divided transversely, at the point where the great occipital nerve pierces it, so as to preserve the nerve uninjured, and the muscle should be dissected up from the condensed cellular tissue beneath it and turned outward. The small muscles, with the vessels and nerves, of the suboccipital region are then to be dissected out, together with the semispinalis muscle, which fills the vertebral groove in the cervical and dorsal regions. All vessels and nerves are to be carefully preserved.]

Fifth Layer of Muscles (Fig. 294) consists of the two Posterior Recti, the two Obliqui, and the Semispinalis muscles. The recti and obliqui are *supplied* by the suboccipital nerves, and the inferior oblique also by a twig from the posterior division of the third cervical. The semispinalis is supplied by the internal branches of the posterior divisions of the spinal nerves.

The **Rectus Capitis Posticus Major** (Fig. 294, 8) *arises* from the spinous process of the axis, and passes obliquely upward and outward beneath the cranial attachment of the superior oblique, to be *inserted* into the outer part of the inferior curved line of the occipital bone, and into a small portion of the space below it.

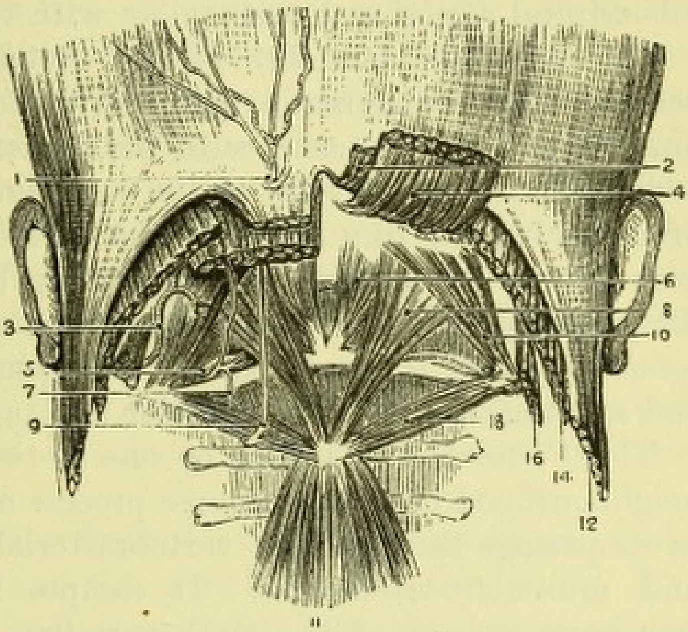
The **Rectus Capitis Posticus Minor** (Fig. 294, 6) is placed close to the median line, and is slightly overlapped by the preceding muscle. It *arises* from the posterior tubercle of the atlas, and is *inserted* by fleshy fibres into the space below the inferior curved line on the occipital bone, close to the median line and to its fellow muscle of the opposite side.

The **Obliquus Inferior** (Fig. 294, 18) *arises* from the spinous process of the axis, and is *inserted* into the posterior part of the extremity of the transverse process of the atlas. The great occipital nerve turns upwards around its lower border.

The **Obliquus Superior** (Fig. 294, 10) *arises* from the transverse process of the atlas, and is *inserted* into the outer part of the interspace between the superior and inferior curved lines of the occipital bone, the attachment being separated from that of the complexus by an oblique ridge joining the two curved lines. The muscle overlaps the rectus major above, and the occipital artery runs along its upper border. It is less oblique in direction than the rectus major.

Both recti muscles and the superior oblique, acting with their fellows of the opposite side, extend the head at the occipito-atlantal joint, and the rectus major, owing to its oblique direction, is also a rotator of the atlanto-axial joint, and slightly of the occipito-atlantal joint when acting singly. The inferior oblique is essentially a rotator of the atlanto-axial joint; and the superior oblique extends the head at the occipito-atlantal, and may give rise to very limited movements of rotation and lateral inclination at the same articulation. It must be remembered that the motion of the atlanto-axial joint is purely rotatory, while that of the occipito-atlantal joint is mainly in the direction of flexion and extension, with a small range of rotation and lateral flexion.

Fig. 294.



The **Suboccipital Triangle** (Fig. 294) is a narrow space covered in by the complexus, and bounded on its three sides by the Rectus Capitis Posticus Major, and the two Obliqui; its floor being formed by the posterior arch of the atlas and the posterior occipito-atlantal and atlanto-axial ligaments. It *contains* the vertebral artery with a small vein, the suboccipital nerve, and branches of these.

The **Vertebral Artery** (Fig. 294, 5) ascends through the foramina in the transverse processes of the six upper cervical

Fig. 294.—Suboccipital region (drawn by J. T. Gray).

1. Occipital artery and nerve piercing trapezius.
2. Trapezius.
3. Occipital artery.
4. Complexus.
5. Vertebral artery.
6. Rectus capitis posticus minor.
7. Suboccipital nerve.
8. Rectus capitis posticus major.
9. Great occipital nerve.
10. Obliquus superior.
11. Semispinalis colli.
12. Sterno-mastoideus.
14. Splenius capitis.
16. Trachelo-mastoideus.
18. Obliquus inferior.

vertebræ, and, having perforated the atlas, is seen in the sub-occipital triangle, running horizontally inwards in the groove behind the superior articular process of that bone, and piercing the posterior occipito-atlantal ligament to ascend into the skull through the foramen magnum. It gives small *muscular* and *spinal* branches in the intervals between the transverse processes, and its horizontal portion usually gives off a branch to supply the muscles in the suboccipital region and anastomose with the occipital artery.

The *Muscular* branches of the vertebral artery will be found between the semispinalis and complexus, supplying the adjacent muscles, and anastomosing with the princeps cervicis of the occipital and the profunda cervicis of the superior intercostal. The *Spinal* branches behave like those of the intercostal and lumbar arteries, each giving off anterior and posterior branches (*rami canalis*) to the osseo-ligamentous spinal canal, and a medullary branch (*ramus spinalis*) which is conducted to the spinal cord by the nerve-root and anastomoses with the anterior and posterior spinal arteries.

The *Vertebral vein* begins by one or two small tributaries in the neighbourhood of the transverse process of the atlas, and gains size in its passage through the vertebrarterial canal by receiving spinal and muscular tributaries. It escapes from the foramen in the transverse process of the sixth vertebra, and ends in the subclavian vein. An accessory vertebral vein usually occupies the foramen in the transverse process of the seventh vertebra.

The posterior division of the **Suboccipital Nerve** (Fig. 294, 7) (1st cervical) emerges between the occiput and atlas, and generally beneath the vertebral artery. It is of small size, and supplies branches to the recti and obliqui muscles, one to the complexus, and a communicating branch to the great occipital.

The **Great Occipital Nerve** (Fig. 294, 9) is the internal branch of the posterior division of the second cervical nerve, and leaves the vertebral canal between the atlas and axis. It winds below the inferior oblique, giving a branch to the complexus, and communicating with the suboccipital nerve; it then turns upward to pierce the complexus and trapezius muscles, and supply the skin of the occipital region as far as the lambdoid suture. The *external* branch of the posterior division of the second nerve supplies the splenius, complexus, and trachelo-mastoid muscles.

The *posterior division of the third nerve* often gives an *internal* branch, the *third occipital*, which takes the same direction as the great occipital nerve, but runs to the inner side of this and communicates with it. The *external* branch joins and is distributed with the corresponding branch of the second nerve. The posterior divisions of the remaining cervical nerves divide into external and internal branches. The *external* branches supply the cervicalis ascendens and transversalis capitis et colli : the *internal* are distributed to the deeper and more internal muscles, and give off cutaneous filaments (those from the 4th and 5th of large size) to the integument over the posterior spinal muscles.

The **Deep Cervical Artery** lies upon the semispinalis colli muscle, and is exposed when the complexus is reflected. It is the posterior branch of the superior intercostal artery (p. 458), and reaches the back of the neck by passing between the transverse process of the last cervical vertebra and the neck of the first rib. It supplies the deep muscles, anastomosing with the muscular branches of the vertebral, and with the princeps cervicis of the occipital artery. There is thus established between the carotid and subclavian arteries a communication which would enlarge after ligature of the common carotid artery.

The **Semispinalis** (Fig. 293) is divided into the semispinalis colli and semispinalis dorsi, and lies between the complexus and the multifidus spinæ.

Semispinalis colli (11) *arises* from the transverse processes of the six upper dorsal vertebræ and the articular processes of the four lower cervical vertebræ, and is *inserted* into the spines of the cervical vertebræ from the 2nd to the 5th inclusive.

Semispinalis dorsi (10) *arises* from the transverse processes of the dorsal vertebræ from the sixth to the tenth inclusive, and is *inserted* into the spinous processes of the lower two cervical and upper four dorsal vertebræ. Both segments are supplied by the posterior divisions of the cervical nerves.

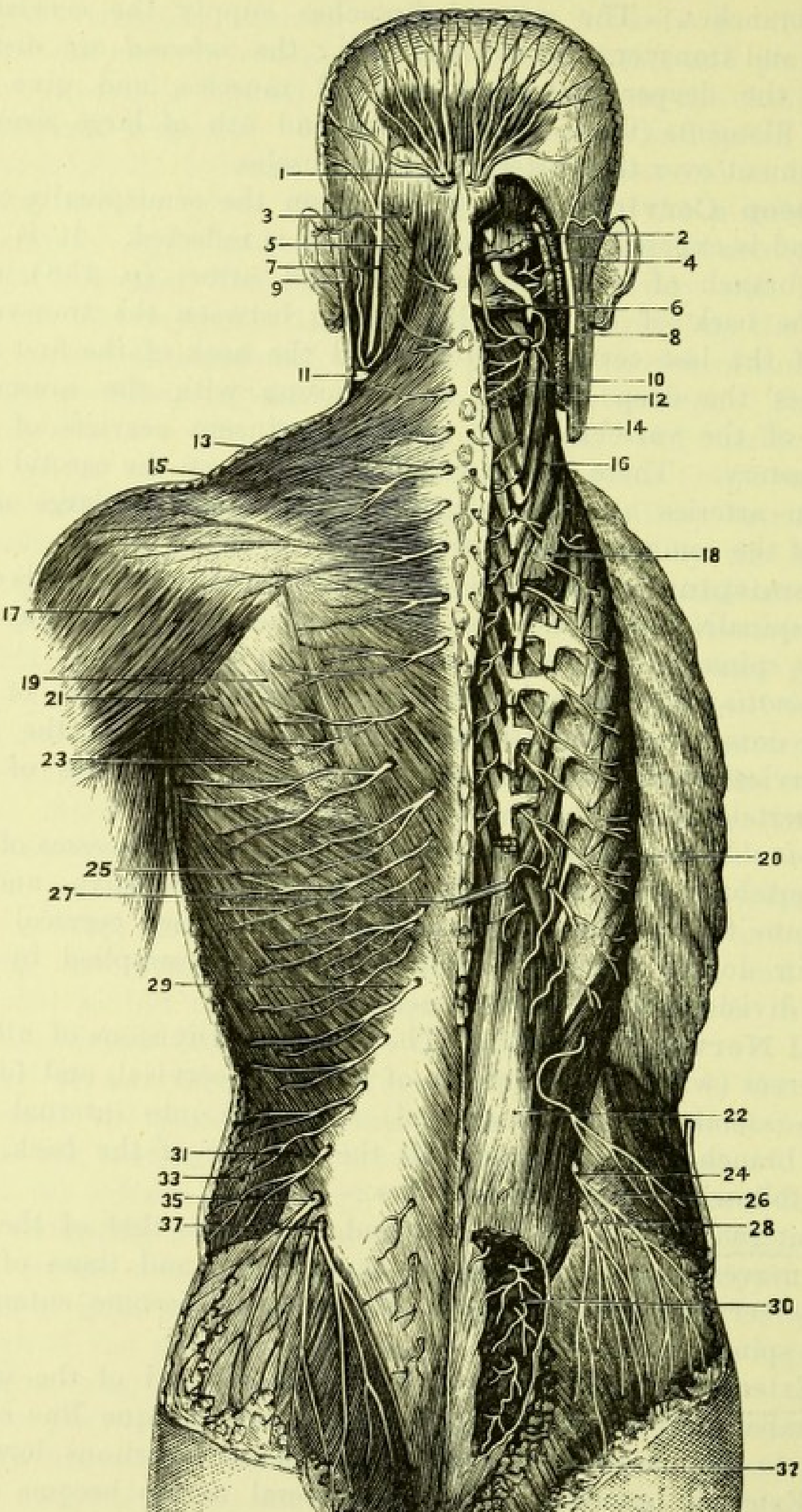
Spinal Nerves (Fig. 295).—The Posterior Divisions of all the spinal nerves (with the exception of the first cervical, and fourth and fifth sacral, and the coccygeal) subdivide into internal and external branches, which supply all the muscles of the back, and give the following cutaneous branches :—

The Internal branch of the 2nd and sometimes that of the 3rd cervical nerves supply the skin of the occiput, and those of the lower five cervical and upper six dorsal nerves become cutaneous near the spinous processes.

The External branches of the lower six dorsal and of the upper three lumbar nerves become cutaneous at an oblique line corresponding to the margin of the aponeurosis of the latissimus dorsi.

The External branches of the upper sacral nerves become cutaneous near the median line. The fourth and fifth sacral nerves are very small and join with the coccygeal nerve.

Fig. 295.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The *Coccygeal nerve* emerges from the lower end of the vertebral canal and is distributed over the coccyx.

The Posterior Divisions of the **Intercostal and Lumbar Arteries** divide like the nerves into spinal and muscular branches, and the latter into internal and external branches, which accompany the nerves to the muscles of the back.

The *Spinal branches* supply the spinal canal by anterior and posterior *rami canalis;* and the spinal cord and its membranes by the medullary twigs or *rami spinalis.* The latter reach the cord by accompanying the nerve-roots, and hence follow a course which becomes longer and more vertical as the organ approaches the lower end of the column, a fact that may help to explain the occasional development of spinal paraplegia in old persons, when the *vis a tergo* of circulation is impaired.

The **Sixth Layer of Muscles** (Fig. 293) consists of the Interspinales, Intertransversales, Multifidus Spinæ, Levatores Costarum, and, in the dorsal region, the Rotatores Spinæ. These are all *supplied* by the internal branches of the posterior division of the spinal nerves.

The position of the Interspinales and Intertransversales is sufficiently indicated by their names. They are double in the cervical region, but are ill-marked in the dorsal region.

The **Multifidus Spinæ** (16) fills up the vertebral groove beneath the erector spinæ. It *arises* from the articular processes of the cervical and lumbar vertebræ, and from the transverse processes of the dorsal vertebræ and sacrum ; and is *inserted* into the spinous processes of all the vertebræ except the atlas. Its fibres extend, lateralise, and rotate the cervical and dorsal vertebræ; but only extend and lateralise in the lumbar region.

Fig. 295.—The nerves of the back (from Hirschfeld and Leveillé).

1. Great occipital nerve.
2 & 3. Complexus muscle.
4 & 5. Splenius capitis.
6. Great occipital nerve.
7 & 8. Small occipital nerve.
9. Sterno-mastoideus.
10. Semispinalis colli.
11. Superficial cervical nerve.
12. Levator anguli scapulæ (cut).
13. Eighth cervical nerve.
14. Sterno-mastoid (cut).
15. Trapezius.
16. Trachelo-mastoideus.
17. Deltoid.
18. Transversalis colli.
19. Infra-spinatus.
20. Sacro-lumbalis.
21. Teres minor.
22. Erector spinæ.
23. Teres major.
24. Lateral cutaneous of last dorsal.
25. Latissimus dorsi.
26. Obliquus internus.
27. Longissimus dorsi.
28. Lateral cutaneous of first lumbar.
29. Posterior division of first lumbar.
30. ,, ,, of sacral nerves.
31. ,, ,, of fifth lumbar.
32. Gluteus maximus.
33. Obliquus externus.
35. Lateral cutaneous of last dorsal.
37. ,, ,, of first lumbar.

The *Rotatores Spinæ* consist of deep fibres beneath the multifidus in the dorsal region; they pass from the root of each transverse process to the lamina of the vertebra above. There appears to be no advantage in regarding them as distinct from the multifidus.

The *Levatores Costarum* are fan-shaped muscles one to each rib, each passing between the extremity of the transverse process of the vertebra above and the upper border of the rib below, externally to the tubercle. They are muscles of inspiration.

THE SPINAL CORD AND MEMBRANES.

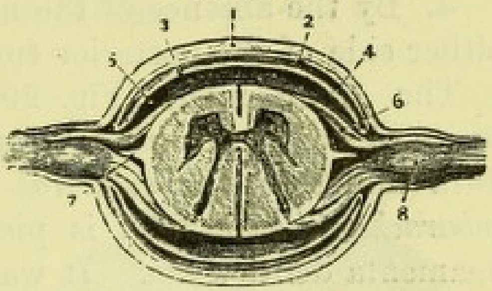
[To open the spinal canal, the remains of the muscles of the back should be cleared away as far as possible, when some part of the plexus of *dorsi-spinal veins* may be seen upon the vertebræ. A block then being placed beneath the thorax so as to make the dorsal region prominent, a cut is to be made with the saw on each side of the middle line, so as to divide the laminæ of the vertebræ as far out as possible. Two or three of the arches being now removed with the chisel, the point of a spine-chisel or rachet is to be introduced into the canal, and the instrument carefully hammered through the arches of the vertebræ for the whole length of the spine, except the upper two cervical vertebræ. The operation being repeated on the opposite side, the arches can be removed with the bone-forceps, and the canal will be thoroughly opened. On the inner surface of the arches will be seen the *ligamenta subflava*, which are described with the other vertebral ligaments, (p. 637).]

Upon opening the Spinal Canal some loose tissue and fat will be seen, together with a plexus of veins.

The **Spinal Veins** correspond to the intra-cranial sinuses, and consist of vessels which surround the theca vertebralis, occupying a space between the dura mater and periosteum of the spinal canal, and communicating through the intervertebral foramina, with the vertebral veins in the neck, the intercostal in the back, the lumbar, ilio-lumbar and sacral in the loins and sacral region. They may be divided into two intercommunicating sets, anterior and posterior, the *posterior* mainly longitudinal in direction, the *anterior* consisting of two longitudinal trunks joined together opposite the middle of the body of each vertebra by a transverse branch which receives the *vena basis vertebræ*. They receive the *medulli-spinal* veins which surround the cord between the pia mater and arachnoid, and they are continuous above at the foramen magnum with the occipital sinuses.

The **Dura Mater of the Cord** is a fibro-serous membrane like and continuous with that of the brain, but differs from it (1) in not serving as a periosteum to the bones in which it lies, (2) in the absence of venous sinuses between its laminæ, and (3) in not sending prolongations into the fissures of the nerve centre. It is connected to the pia mater by fine filaments of connective tissue, and by lateral tooth-like processes (*ligamenta denticulata*), which are attached to the sides of the cord opposite the interval between the anterior and posterior roots of each nerve (Fig. 296, 7).

Fig. 296.



The dura mater is continuous above with that of the brain at the foramen magnum, and terminates below in a cul de sac about the middle of the sacrum, but is continued to the coccyx as a fibrous cord.

By removing the transverse processes of two or three of the dorsal vertebræ, tubes of dura mater may be traced upon each of the nerve roots to the intervertebral foramina. They are attached by connective tissue to the margins of the foramina, and eventually become lost upon the perineurium.

[By opening one of the tubes of dura mater, the position of the ganglion upon the posterior root in the intervertebral foramen will be seen. The cord is next to be removed by carrying the knife along the outside of the dura mater so as to divide the nerves as far out as possible; those which have been thoroughly exposed by the dissection being severed beyond the ganglion. The cord attaching the dura mater to the coccyx is to be divided, and the sacral nerves cut as long as possible, and lastly the dura mater divided transversely at the level of the axis. The cord when removed is to be laid out on a table with the posterior surface uppermost, and the opportunity may be taken of examining the anterior spinal veins in the vertebral canal.]

The anterior surface of the spinal cord, when removed from the body, may be distinguished from the posterior by the following characters:—

1. By a bright shining cord (*linea splendens*) running opposite the anterior median fissure.

Fig. 296.—Transverse section of the spinal cord and its membranes (from Hirschfeld and Leveillé).

1, 2. Dura mater, fibrous and serous layers.
3. Arachnoid.
4. Subdural space.
5. Subarachnoid space.
6. Anterior root of nerve.
7. Ligamentum denticulatum.
8. Ganglion on posterior root of nerve.

2. By the presence of a single spinal artery, instead of two as on the posterior surface.

3. By the smaller and non-ganglionic anterior nerve roots.

4. By the absence of the narrow median columns of Goll, seen on either side of the posterior surface in the upper part of the cord.

The **Arachnoid** (Fig. 296, 2) is a delicate transparent membrane of connective tissue, separated from the inner surface of the dura mater by the *subdural space*, and from the pia mater by the *subarachnoid space*. It is pierced by the nerve roots and by the ligamenta denticulata. It was formerly described as consisting of a parietal and a visceral layer. The parietal layer, lining the inner surface of the dura mater, is now regarded as the epithelium of that membrane ; the arachnoid proper loosely invests the spinal cord, and gives sheaths to the several nerves. The space between the two layers of the arachnoid, or rather between the dura mater and the arachnoid, was formerly called the *sac of the arachnoid*, but is now usually described as the *subdural space*.

The **Subarachnoid Space** (Fig. 296, 5) lies between the visceral layer of the arachnoid and the pia mater of the spinal cord, and is of considerable extent ; it can be shown by lifting up the arachnoid with forceps, or by inserting a blow-pipe and forcing air beneath the membrane. This space is filled with fluid and crossed by fine trabeculæ and membranous expansions of delicate connective tissue. It communicates with the serous spaces of the brain by three openings, one in the posterior serous wall of the fourth ventricle (foramen of Monro), and one in each lateral recess of the same space ; and by this means the cerebral fluid may escape into the spinal canal when the intracranial pressure is increased.

[The cord is to be turned over so as to expose its anterior surface, and an incision is to be made through the dura mater to expose the arachnoid and subarachnoid space, as was done behind. The pia mater is then to be examined both on the front and back of the cord.]

The **Pia Mater** encloses the spinal cord, giving prolongations upon the roots of the nerves. It is continuous with the pia mater of the brain, but is less vascular. It sends processes into the anterior and posterior median fissures of the cord, and at the termination of the spinal cord is prolonged upon the *filum terminale*. It is thickened opposite the anterior median fissure to form the *linea splendens*.

The **Ligamenta Denticulata** (Fig. 297, 16) are found on each side of the cord, between the anterior and posterior roots of the nerves. They comprise a series of twenty-one or twenty-two serrations, connected with the pia mater between the anterior and posterior nerve roots, and with the inner surface of the dura mater midway between the apertures of exit for the nerves, each denticulation being covered by a funnel-shaped sheath of arachnoid. They serve to sling the cord and secure it from shocks.

The *Anterior Spinal Artery* and the two *Posterior Spinal Arteries* may be traced upon the cord, if well-injected. They are branches of the vertebral arteries, the anterior being formed by the junction of a branch from each side (p. 664). The arteries ramify in the pia mater, anastomosing with the spinal branches of the vertebral, intercostal, lumbar, ilio-lumbar and sacral vessels, which enter the vertebral canal through the intervertebral foramina, and pass to the cord along the nerve roots.

The *Veins* of the cord (*medulli-spinal*) are small and tortuous, forming an irregular network, but one branch larger than the rest accompanies the anterior spinal artery. They communicate with the spinal veins by branches that run with the nerves to the intervertebral foramina, and above join the inferior cerebellar vein or the inferior petrosal sinus.

The **Spinal Cord** (Figs. 297,

Fig. 297.

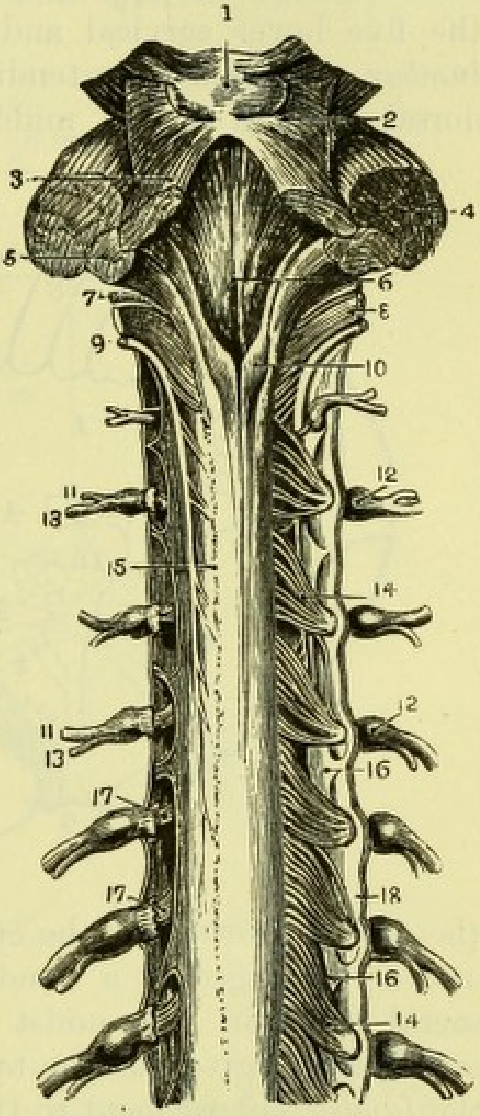


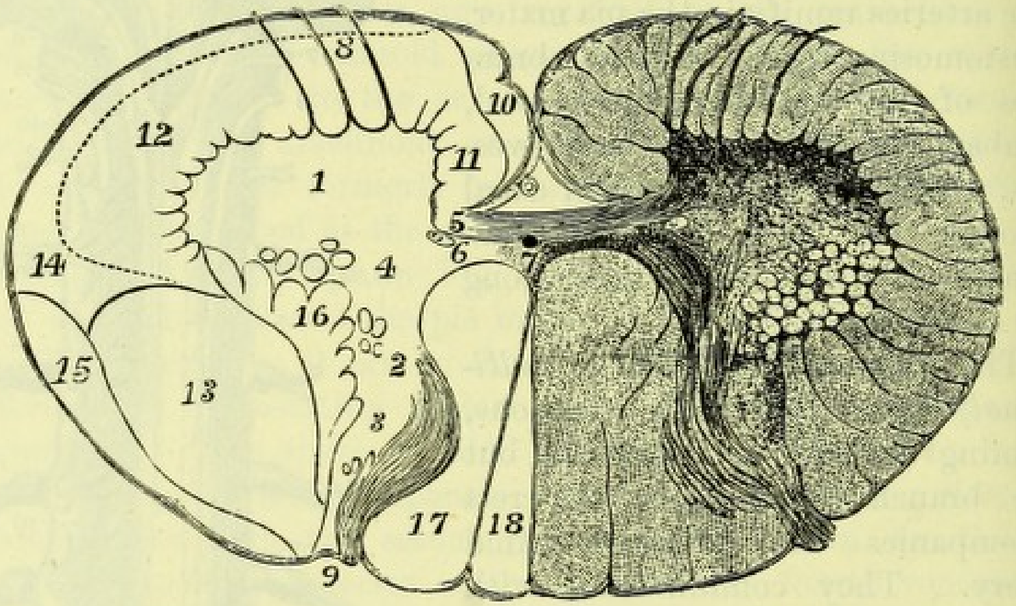
Fig. 297.—Fourth ventricle and upper part of spinal cord and membranes. The posterior roots of the nerve are removed on the left side (from Hirschfeld and Leveillé).

1. Corpora quadrigemina.
2. Fillet of the olivary body.
3. Processus a cerebello ad testem.
4. Processus a cerebello ad pontem.
5. Processus a cerebello ad medullum.
6. Anterior wall of fourth ventricle.
7. Glosso-pharyngeal nerve.
8. Pneumo-gastric nerve.
9. Spinal-accessory nerve.
10. Processus clavatus continuous below with column of Goll.

11, 11. Anterior divisions of spinal nerves.
12, 12. Ganglia of nerves.
13, 13. Posterior divisions of spinal nerves.
14, 14. Posterior roots of spinal nerves.
15. Line of origin of posterior roots of left side. Within this lies the column of Burdach, and in the upper part of the cord, the column of Goll.
16, 16. Ligamentum denticulatum.
17, 17. Anterior roots of spinal nerves.
18. Dura mater.

300) is a continuation of the medulla oblongata into the spinal canal, and extends from the foramen magnum to the lower border of the first lumbar vertebra. It is from 16 to 18 inches long, and weighs about an ounce and a half. In shape it is sub-cylindrical, and presents two enlargements, both flattened somewhat from before backwards :—the upper, or *brachial enlargement*, corresponding to the five lower cervical and first dorsal vertebræ; and the lower, or *lumbar enlargement*, extending from the upper border of the 10th dorsal vertebra to the middle of the first lumbar vertebra, where

Fig. 298.



the cord narrows, like the end of a cigar, into the *conus terminalis*, and is prolonged as a slender thread, the *filum terminale*, into the sacral canal in the midst of the cauda equina. The *brachial* enlargement gives origin to the nerves of the upper extremities, the *lumbar* enlargement to those of the lower extremities.

The cord presents an *anterior median fissure*, which extends into

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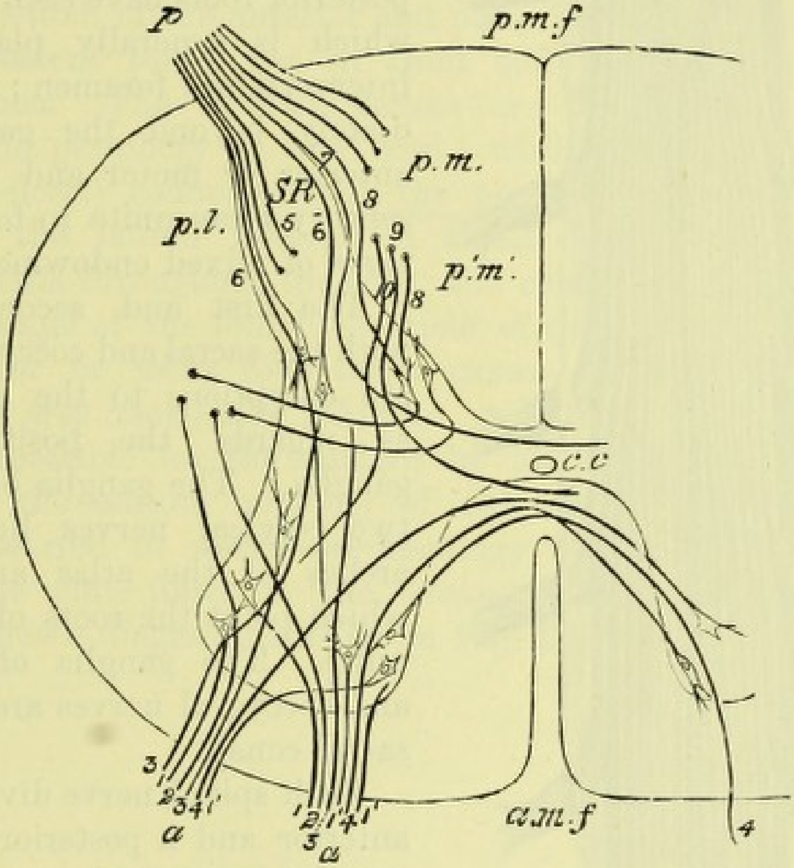
Fig. 298.—Diagram of the tracts and columns of the spinal cord in the cervical region (Gowers).

1. Anterior horn of grey matter.
2. Posterior horn.
3. Caput cornu posterioris.
4. Central grey matter.
5. Anterior (white) commissure.
6. Posterior (grey) commissure.
7. Central canal.
8. Anterior nerve root.
9. Posterior nerve root.
10. Direct pyramidal tract } Anterior column.
11. Anterior root zone.... }
12. Mixed zone.......... } Lateral column.
13. Crossed pyramidal tract }
14. Superficial sensory tract }
15. Direct cerebellar tract. }
16. Lateral reticular formation .... }
17. Tract of Burdach. Postero-lateral column.
18. Tract of Goll. Postero-mesial column.

it for about one-third of its thickness, and can be opened up; a *posterior median fissure*, somewhat deeper, which also admits a prolongation of pia mater, but cannot be opened; and on each side an *antero-lateral* line and a *postero-lateral groove* corresponding respectively to the line of attachment of the anterior and posterior roots of the spinal nerves, and dividing each half of the cord into *anterior*,

Fig. 299.



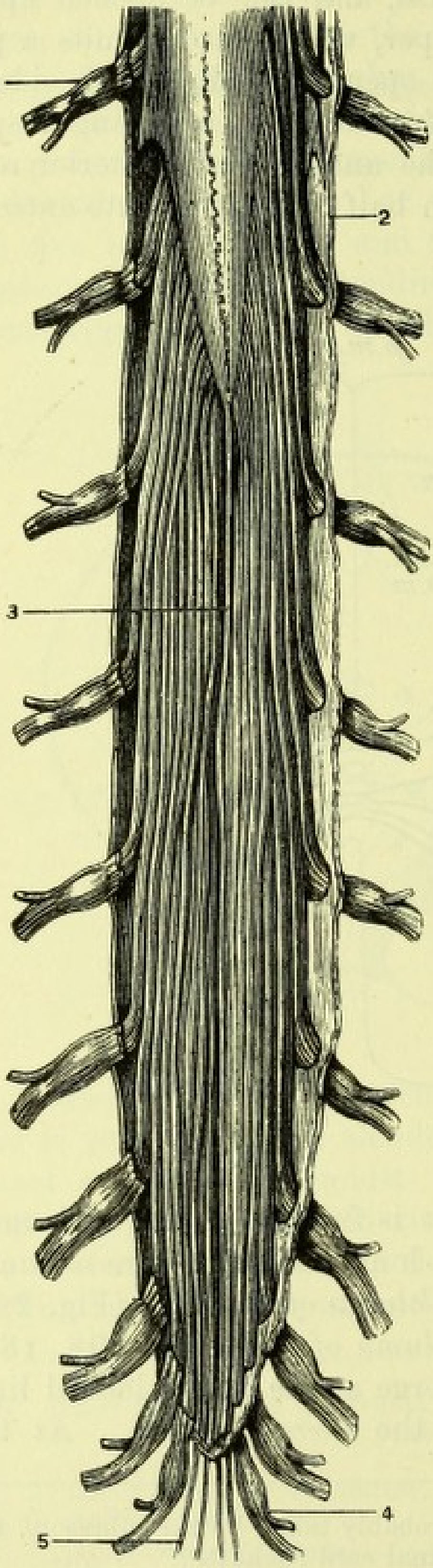
lateral and *posterior columns*. The last is further sub-divided, most distinctly in the cervical region, by a longitudinal fissure of small depth into a *postero-lateral column*, or *Column of Burdach* (Fig. 298, 17), and a *postero-mesial column* or *Column of Goll* (Fig. 298, 18).

The anterior roots of the nerves emerge at the antero-lateral line, marking off the *anterior* column from the *lateral* column. At the

Fig. 299.—Diagram illustrating the paths probably taken by the fibres of the nerve-roots on entering the spinal cord (Schäfer).

a.m.f. Anterior median fissure.
p.m.f. Posterior median fissure.
c.c. Central canal.
S.R. Substantia gelatinosa of Rolando.
a.a. Funiculi of anterior nerve root.
p. Funiculus of posterior root of a nerve. By following the fibres 1, 2, 3, &c. their course through the grey matter of the spinal cord may be traced.

Fig. 300.



bottom of the median fissures are the anterior and posterior *commissures.*

The **Spinal Nerves** (Fig. 297) are thirty-one in number on each side of the cord. Each nerve has been seen to arise by two roots, the posterior (except in the first nerve) being larger than the anterior. The posterior roots have each a ganglion, which is generally placed in the intervertebral foramen; and immediately beyond the ganglion, the anterior or motor and posterior or sensory roots unite to form a *spinal nerve* of mixed endowments.

The first and second cervical, with the sacral and coccygeal nerves, are exceptions to the general rule as regards the position of the ganglia. The ganglia of the upper two cervical nerves lie upon the arches of the atlas and axis, at which point the roots of the nerves unite. The ganglia of the sacral and coccygeal nerves are within the sacral canal.

Each spinal nerve divides into an anterior and a posterior trunk, the anterior being the larger throughout, except in the 1st and 2nd cervical nerves, where they are of smaller size than the posterior. The majority of the spinal nerves divide just outside the intervertebral foramina, but in the first cervical, the last sacral, and the coccygeal nerves, the division takes place within the dura mater; and the upper

Fig. 300.—The cauda equina, seen from behind (from Hirschfeld and Leveillé).

1. Root of 12th dorsal nerve.
2. Dura mater laid open.
3. Filum terminale.
4. Fourth sacral nerve.
5. Fifth and sixth sacral nerves.

four sacral nerves divide inside the sacral canal, the anterior and posterior trunks emerging at the anterior and posterior sacral foramina. Each anterior branch is connected to the sympathetic chain by one or two slender filaments.

In a transverse section (Fig. 296) the spinal cord will be found to consist of white nervous matter, enclosing two symmetrical grey crescents. The convexities of these are turned towards one another and connected together by two slender *commissures*, which lie at the bottom of the anterior and posterior median fissures.

Each crescent terminates in front and behind by expansions called cornua. The *anterior cornua* are the larger, but do not reach to the periphery of the cord; while the slender *posterior cornua* are closely connected with the posterior roots of the spinal nerves in the lateral fissure. A small *central canal* (canal of Stilling) exists throughout the cord, and communicates above with the lower angle of the fourth ventricle of the brain (Fig. 298, 7). The anterior or *white commissure* passes in front of this, the posterior or *grey commissure* behind.

It is impossible for the student in his ordinary dissection to investigate the minute anatomy of the spinal cord, and he is therefore referred to works on histology for fuller details. The tracts of the white fibres in the cord, as recognised by physiologists, are shown diagrammatically in Fig. 299.

PART VII.

DISSECTION OF THE BRAIN.

Before dissecting the Membranes or Vessels of the Brain, it will be well to recognise the several parts of the Encephalon, as this will assist the student in following the description.

The Encephalon consists of the *Cerebrum*, the *Mid-Brain*, the *Cerebellum*, and the *Medulla Oblongata*; connected together by a commissural structure called the *Pons Varolii*. The *Cerebrum* forms the greater part of the mass of the Encephalon, and is incompletely divided by a vertical median fissure into two symmetrical hemispheres, which are united by a large transverse commissure called the *corpus callosum*. The *Mid-Brain* lies between the cerebrum and the pons Varolii, and comprises the *crura cerebri* and *corpora quadrigemina*. The *Cerebellum* lies beneath the hinder part of the Cerebral hemispheres, and is attached by peduncles to the Cerebrum and Medulla Oblongata. The *Medulla Oblongata* forms a kind of stem to the Cerebrum and Cerebellum, and passes downwards to the vertebral canal to become continuous with the spinal cord. The *Pons Varolii* consists of a set of transverse fibres, commissural between the two halves of the cerebellum, and a set of longitudinal fibres passing between the medulla and the rest of the encephalon. These parts will be readily recognised by referring to Fig. 305.

The average weight of the brain in the adult is 48 ounces, in the female 43½ ounces (Boyd). The proportion to the rest of the body averages 1 to 36·5, and is practically the same in the two sexes.

[The brain is to be placed in a plate with the base upward, for the examination of the membranes and the dissection of the vessels.]

The **Membranes of the Brain** are the Dura Mater, the Arachnoid, and the Pia Mater.

The **Dura Mater** has been already seen as a fibro-serous membrane lining the skull, supporting the meningeal vessels, forming the rigid walls of the venous sinuses, and giving off processes separating the hemispheres of the brain from each other, and the hinder part of the cerebrum from the cerebellum (p. 403).

The **Arachnoid** is a serous membrane, which was formerly described as consisting of two layers—*parietal* and *visceral.* The term 'Arachnoid' is now limited to the latter, and the former is regarded as the epithelial layer of the dura mater.

The *Arachnoid* is a connective tissue membrane more or less closely related to the subjacent pia mater, but differing from it in passing from one convolution to another without dipping into the sulci. It is prolonged into the great longitudinal fissure between the hemispheres of the cerebrum, nearly as far as the corpus callosum, and may be traced over the base of the cerebrum, to the cerebellum and medulla oblongata, ensheathing the various cranial nerves, and becoming continuous with the arachnoid of the spinal cord at the foramen magnum.

The arachnoid presents minute villous processes, some of which tend to undergo hypertrophy and to cause absorption of the superjacent dura mater and bone; they are then known as *Pacchionian bodies.* It is separated from the dura mater by the subdural space, and from the pia mater by the subarachnoid space, but is connected with both membranes by delicate fibrous trabeculæ.

The **Subarachnoid Space** is occupied by a considerable quantity of cerebro-spinal fluid, and communicates with the cerebral ventricles and the subarachnoid space of the cord. It is largest at the base of the brain, in front of and behind the pons Varolii, and serves as a kind of water cushion to the nerve centres.

The *Anterior Subarachnoid Space* (diamond-shaped space) is immediately in front of the pons Varolii, and is formed by the stretching of the arachnoid from one temporo-sphenoidal lobe of the cerebrum to the other, as far forward as the optic commissure.

The *Posterior Subarachnoid Space* will be found behind the pons and beneath the cerebellum. This is continuous with the subarachnoid space of the spinal cord, and communicates with the interior of the brain by means of a central aperture in the fourth ventricle, the foramen of Magendie, and two lateral apertures, one at each lateral recess of the same ventricle.

The **Pia Mater** is a vascular membrane closely investing the surface of the brain, passing into the sulci between the convolutions, and is continued into the interior through the transverse fissure in the form of a triangular fold called the *velum interpositum,* which will be subsequently examined. It becomes more tough and fibrous as it approaches the spinal cord, and while investing the latter its vascularity almost entirely disappears.

[The arachnoid is to be removed from the arteries at the base of the brain, and these are to be cleaned and their branches followed. It will now be possible to show the longitudinal fissure between the two frontal lobes of the cerebrum more clearly than before, and also the fissure of Sylvius between the frontal and temporo-sphenoidal lobes of each side.]

The **Arteries of the Brain** (Fig. 301) are derived from four great trunks—the two vertebral and the two internal carotid arteries.

The **Vertebral Artery** (1) has been seen as a branch of the subclavian artery, and has been traced through the transverse processes of the cervical vertebræ to the atlas. The artery pierces the posterior occipito-atloid ligament and the dura mater between the occiput and the atlas, and enters the skull through the foramen magnum by the side of the medulla oblongata. At the lower border of the pons Varolii the two vertebrals unite to form the **Basilar Artery** (6), which passes along the middle line of the pons to bifurcate at its anterior border into the right and left *posterior cerebral arteries* (8).

The *Branches* of the *Vertebral Artery* are :—

1. A small *Posterior Spinal artery* (3), running down the posterior surface of the spinal cord, and separated by a small interval from its fellow of the opposite side.

2. A small *Anterior Spinal artery* (2), joining its fellow of the opposite side to form a mesial vessel running down the anterior surface of the spinal cord. These spinal arteries supply the cord, and anastomose with the rami spinales of the vertebral, intercostal, lumbar, and sacral arteries.

3. A small *Posterior Meningeal artery* (4) to the dura mater.

4. The *Posterior Inferior Cerebellar artery* (5), passing backward to the posterior part of the inferior surface of the cerebellum, and anastomosing with the other cerebellar arteries.

The *Branches* of the *Basilar Artery* are :—

1. The *Anterior Inferior Cerebellar arteries*, a pair of small vessels passing to the anterior part of the inferior surface of the cerebellum on each side, and anastomosing with the other cerebellar arteries.

2. *Transverse arteries of the Pons*, four or five on each side, supplying the pons Varolii.

3. The *Auditory artery*, arising with the transverse arteries but accompanying the auditory nerve into the temporal bone.

4. The *Superior Cerebellar arteries* (7), arising close to the bifurcation, and separated from the posterior cerebral arteries by the third pair of nerves. Each artery winds around the crus cerebri, parallel to the fourth nerve, to reach the upper surface of the cerebellum, where it anastomoses with its fellow and with the inferior cerebellar arteries. It supplies the cerebellum and sends twigs to the optic lobes and choroid plexus.

5. The *Posterior Cerebral arteries* (8), are the terminal branches

of the basilar trunk. Each artery winds around the crus cerebri, parallel to the superior cerebellar artery but separated from it by the third nerve, and is distributed to the under surface of the posterior part of the cerebrum, where it anastomoses with the middle cerebral artery. It is connected to the internal carotid artery by the posterior communicating artery, shortly after its origin. Its branches may be divided into cortical and medullary. The *cortical* branches supply the internal and inferior part of the temporo-occipital region of the cerebrum, the temporo-sphenoidal and occipital convolutions, the cuneate lobule, and the dentate convolution; and the *medullary* branches (*postero-median, postero-lateral*, and *posterior choroid*) are distributed to the optic thalamus, third ventricle, velum interpositum, and choroid plexus. The largest of these is the *posterior choroid*, which passes through the transverse fissure. The *postero-median* branches are several fine twigs which pierce the posterior perforated spot.

The **Internal Carotid Artery** (Fig. 301, 10) has been traced to the anterior clinoid process of the sphenoid bone, where it was divided in removing the brain. The artery reaches the base of the brain on the outer side of the optic commissure, and at once breaks up into three branches—the anterior and middle cerebral, the posterior communicating, and the anterior choroid arteries.

1. The *Anterior Cerebral artery* (13) runs forward in the longitudinal fissure, and, turning round the genu of the corpus callosum, is distributed to the anterior part of the cerebrum, reaching as far back in the longitudinal fissure as the parieto-occipital sulcus. The arteries of the two sides are united at the commencement of the fissure by a short transverse branch, the *anterior communicating artery* (14). At its origin the anterior cerebral artery sends a few medullary branches (*antero-median* and *antero-lateral*) through the lamina cinerea and anterior perforated spot to the 5th ventricle and front of the corpus striatum; and its terminal cortical branches are distributed to the frontal, para-central, and parieto-occipital convolutions, and to the corpus callosum. The *Anterior Communicating Artery* gives off some *antero-median* branches which pass through the lamina cinerea, with associated twigs from the middle cerebral.

2. The *Middle Cerebral artery* (12), a larger branch than the last, runs in the fissure of Sylvius between the frontal and temporo-sphenoidal lobes, and divides into four or five large cortical branches, which lie between the convolutions of the Island of Reil, and are distributed to the island and to the frontal, temporo-sphenoidal and parietal convolutions. Medullary branches are given off before the division to supply the caudate and lenticular nuclei of the corpus striatum and the internal capsule; and some small twigs

arising near its commencement run with companion branches from the anterior cerebral artery to pierce the *locus perforatus anticus* on their way to the corpus striatum. The left middle cerebral artery is peculiarly liable to disease.

Fig. 301.

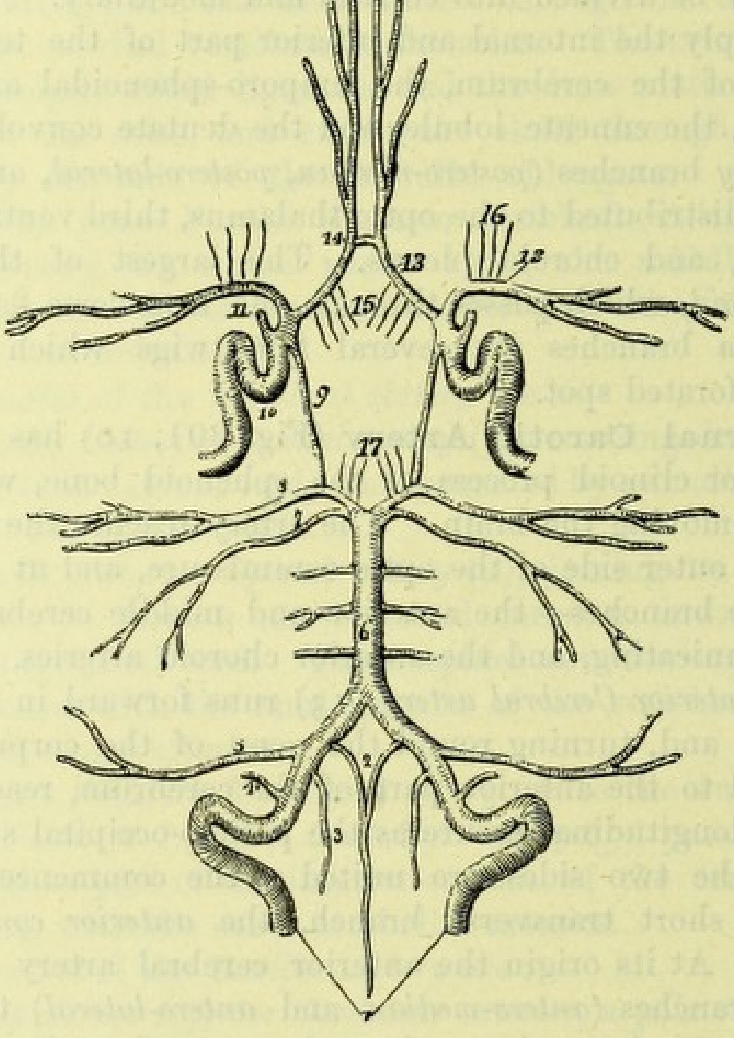


Fig. 301.—Arteries of the brain and circle of Willis (from Wilson). The arteries being symmetrical have references on one side only.

1. Vertebral arteries.
2. Anterior spinal branches uniting to form a single vessel.
3. Posterior spinal artery.
4. Posterior meningeal artery.
5. Posterior inferior cerebellar artery.
6. Basilar artery giving off transverse branches.
7. Superior cerebellar artery.
8. Posterior cerebral artery (postero-lateral medullary branches omitted).
9. Posterior communicating branch of the internal carotids.
10. Internal carotid artery, showing its curves within the skull.
11. Ophthalmic artery divided across.
12. Middle cerebral artery.
13. Anterior cerebral arteries connected by—
14. Anterior communicating artery (anterior perforating branches omitted).
15. Antero-median medullary branches of anterior cerebral artery.
16. Antero-lateral medullary branches of middle cerebral artery.
17. Postero-median medullary branches of posterior cerebral artery.

3. The *Posterior Communicating artery* (9) is a long slender branch, which runs backward to join the posterior cerebral artery.

4. An *Anterior Choroid artery* is given off by either the carotid or

Fig. 302.

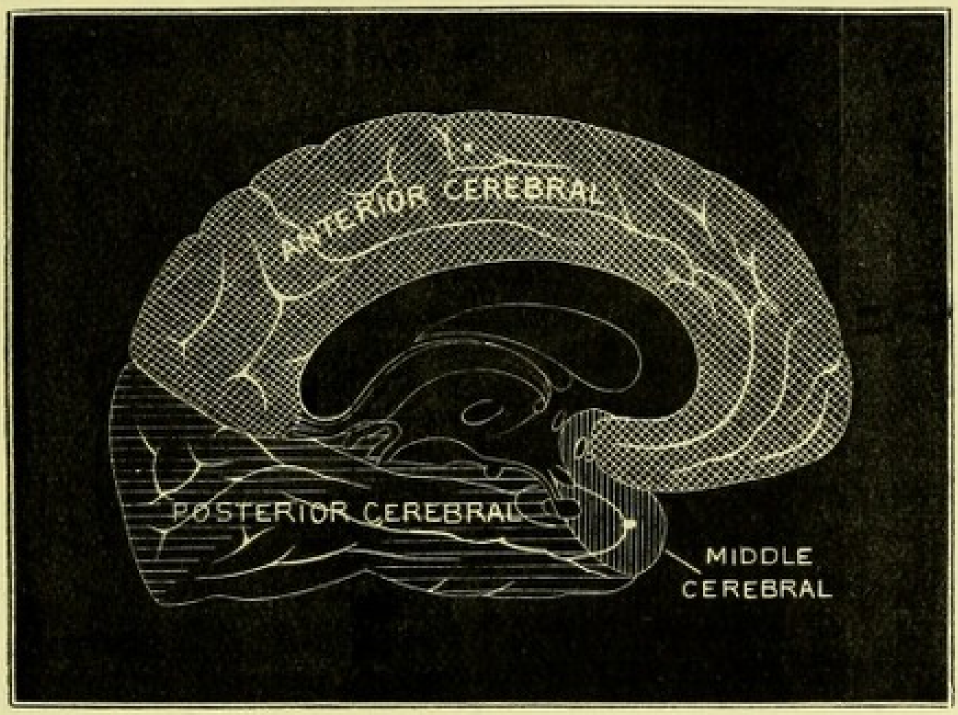


Fig. 303.

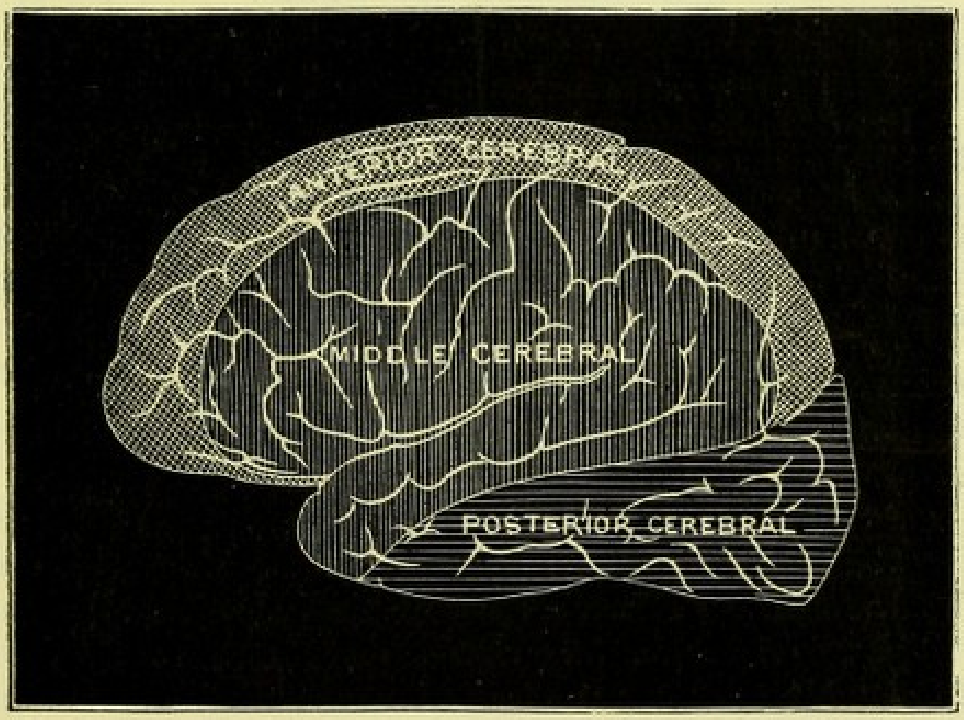


Fig. 302.—Scheme of distribution of cortical branches of cerebral arteries on the mesial surface of the brain.

Fig. 303.—Scheme of distribution of cortical branches of cerebral arteries on the calvarial surface of the brain.

the middle cerebral artery, and winds round the crus cerebri to the choroid plexus of the lateral ventricle.

The **Circle of Willis** (Fig. 301) is the name given to the communication between the arteries at the base of the brain, and may be traced on either side from before backward as follows :—Anterior communicating, anterior cerebral, and internal carotid arteries ; posterior communicating, posterior cerebral, and basilar arteries. This free anastomosis is of importance in carrying on and equalising the circulation of the blood in the brain, when an obstruction arises in one of the main trunks.

Various irregularities of the vessels forming the circle of Willis may be met with, one or other of the arteries being much above or below its normal size ; but the direct communication between the trunks is almost constant.

The **Veins** of the brain open into the sinuses of the skull, which have been examined (p. 404).

The *superior cerebral* veins enter the superior longitudinal sinus ; the *inferior cerebral* end in the inferior longitudinal, lateral, cavernous, superior petrosal and superior longitudinal sinuses, and the venæ Galeni ; the *superior cerebellar* veins enter the venæ Galeni ; and the *inferior cerebellar* veins pass to the occipital or sigmoid sinus.

The Base of the Brain.

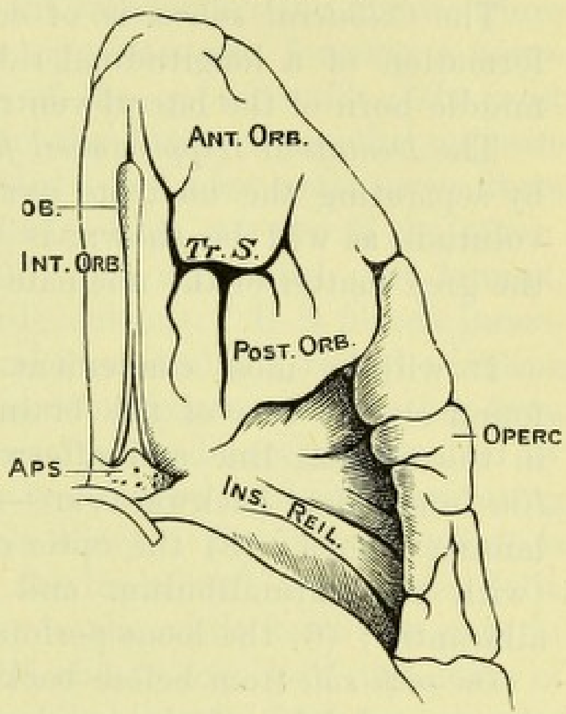
[The arachnoid and pia mater are to be carefully dissected from the base of the brain, care being taken not to detach any of the nerves. It should be noticed that the pia mater disappears between the splenium of the corpus callosum and the mid-brain, at the commencement of the *great transverse fissure* of the brain (p. 691). The pia mater upon the cerebellum and posterior part of the cerebrum should be left undisturbed, so that the velum interpositum may not be damaged.]

The convolutions of the under surface of the great brain or *Cerebrum* are divided into an anterior and a posterior group by the Sylvian fissure.

The *anterior group*, representing the under surface of the frontal lobe, is subdivided into the *straight* and the *supra-orbital convolutions* by the *olfactory sulcus*, a straight fissure which runs parallel to the longitudinal fissure. The *straight convolution* lies on the inner side of the olfactory sulcus and is continuous with the antero-inferior extremity of the marginal convolution of the mesial aspect of the brain. The *supra-orbital convolutions* lie over the orbital plate of the frontal bone, and are divided into *anterior*, *posterior*, and *internal* groups by a fissure, which breaks up into three or more branches, and is called the *triradiate sulcus*. The *olfactory sulcus* lodges the olfactory peduncle and bulb.

The *Fissure of Sylvius* appears on the base of the brain as a deep sulcus of curved form, between the supra-orbital convolutions and the under surface of the temporo-sphenoidal lobe. Its opening (*Vallecula Sylvii*) lies on the outer side of the anterior perforated space and root of the olfactory nerve. From this point it runs outwards to reach the lateral aspect of the hemisphere, where it will be traced further.

Fig. 304.



The convolutions behind the fissure of Sylvius are called *temporo-occipital*, and represent the under surface of the temporo-sphenoidal and occipital lobes. The posterior half of these convolutions are concealed by the cerebellum.

The temporo-occipital region is divided by a fissure, the *collateral sulcus*, into *internal* and *external temporo-occipital* convolutions, the former of which is better known as the *uncinate gyrus* on account of the hook-like curvature of its anterior extremity, or as the *hippocampal gyrus* from its connexion with the hippocampus major.

The *Uncinate* or *Hippocampal gyrus* is closely related to the crus cerebri and the fourth nerve. The fissure which separates it from the crus will afterwards be traced into the transverse and dentate fissures. It is divided posteriorly into two limbs by the intrusion of a fissure, the *calcarine*: the upper limb becoming continuous with the fornicate convolution around the splenium of the corpus callosum, while the lower limb is continued back beneath the calcarine fissure, and is sometimes called the *lingual lobule*, or *fifth temporal*

Fig. 304.—Orbital surface of the Frontal lobe, and Island of Reil (after Turner). The tip of the temporo-sphenoidal lobe is removed.

TR. S. Triradiate sulcus.
ANT. ORB. Anterior orbital gyrus.
INT. ORB. Internal ,, ,,
POST. ORB. Posterior ,, ,,
OPERC. Operculum.
OB. Olfactory bulb occupying the olfactory sulcus.
APS. Anterior perforated spot.
INS. REIL. Island of Reil with its three limiting sulci.

gyrus (the fourth being the external temporo-occipital convolution). The *hook*, or *uncus*, is situated at its anterior extremity in contact with the side of the crus cerebri, and is crossed by a delicate greyish band, the *band of Giacomini*, continuous with the dentate convolution.

The *Collateral sulcus* is of considerable depth, and leads to the formation of a longitudinal ridge, the *eminentia collateralis*, in the middle horn of the lateral ventricle.

The *Dentate* or *Hippocampal fissure* and *convolution* may be exposed by separating the uncinate gyrus from the crus cerebri. The convolution, as will be shown, is really formed by the free border of the grey matter of the uncinate convolution.

It will be most convenient to examine the several structures found on the base of the brain in front of the pons Varolii, first in the median line and afterwards on each side. *In the median line* from before backwards are—(1) the longitudinal fissure ; (2) the lamina cinerea ; (3) the optic commissure ; (4) the tuber cinereum (with the infundibulum and pituitary body) ; (5) the corpora albicantia ; (6) the locus perforatus posticus.

On each side from before backwards are—(1) the under surface of the frontal lobe of the cerebrum, with (2) the olfactory bulb and its peduncle resting in the olfactory sulcus ; (3) the optic nerve (in front of the commissure), and (4) the optic tract (behind the commissure) ; (5) the locus perforatus anticus, at the root of the olfactory nerve and close to the commencement of (6) the fissure of Sylvius ; (7) the crus cerebri diverging from its fellow, with the commencement of the transverse fissure to its outer side ; (8) the third nerve, appearing between the divergent crura ; (9) the fourth nerve winding round the outer side of the crus ; (10) the temporo-occipital convolutions.

The **Longitudinal Fissure** (Fig. 305, 1) divides the cerebrum into the two hemispheres. The portion now seen separates the frontal lobes of the cerebrum, and, if these are drawn apart, a white body, the *corpus callosum*, will be seen at the bottom of the fissure. The anterior part of the corpus callosum, around which the anterior cerebral artery turns, is known as the *genu*, and the portion continued backwards and downwards from this into the lamina cinerea is termed the *rostrum*.

The **Lamina Cinerea** (Fig. 305, 4) is a thin grey layer, continuous superficially with the rostrum of the corpus callosum and prolonged to the margin of the optic commissure. It is almost vertical in direction, and forms part of the anterior wall of the third ventricle. It is pierced by small *anterior perforating* twigs from the anterior cerebral and anterior communicating arteries.

The **Optic Commissure** or **Chiasma** (Fig. 305, 7) is the point of communication between the two optic nerves. The fibres are said to have the following arrangement :—The outermost fibres of the tract pass to the optic nerve of the same side ; the middle fibres mostly decussate with those of the opposite side, forming a figure of X, and pass to the optic nerve of the opposite side ; the most posterior fibres are reflected back to the brain along the opposite optic tract behind the cross arrangement ; and a few optic nerve fibres pass in the front part of the commissure from one eye to the other.

The **Tuber Cinereum** (Fig. 305, 8) is a rounded grey lamina, forming part of the floor of the third ventricle. It is placed immediately behind the optic chiasma, and is continuous with the lamina cinerea over the dorsal aspect of the commissure. Projecting from it is the *Infundibulum*, a hollow funnel shaped process, attached by its narrow extremity to the pituitary body below, and communicating by its cavity with the third ventricle above. The *Pituitary body* is usually torn off in the removal of the brain and left in the Sella Turcica. In the fœtus it is hollow ; in the adult it will be seen (if left attached to the brain) to be solid and to consist of two lobes of a reddish colour : an anterior larger, and oblong in shape ; a posterior lobe small and rounded. These are of different morphological significance ; the anterior lobe being developed from the epiblast of the upper end of the primitive buccal cavity ; while the posterior lobe originates, with the infundibulum, as a hollow process from the anterior cerebral vesicle, but in the higher vertebrates degenerates into a solid mass of connective tissue with scattered cells and pigmented corpuscles.

The relation of the infundibulum and pituitary body to the tuber cinereum will be better understood by referring to the vertical section of the brain (Fig. 317, 20).

The **Corpora Albicantia** or **Mammillaria** (Fig. 305, 10) are two white bodies resembling small peas, which are placed between the two crura cerebri and immediately behind the tuber cinereum. They are formed by the anterior crura of the *fornix* which, as will be afterwards seen, descend to the base of the brain and there twist upon themselves, the points of reflection appearing at the surface on each side of the middle line. Upon section grey matter will be found in the interior of each mammillary body.

The **Locus Perforatus Posticus** (Fig. 305, 12) is placed behind the corpora albicantia in the angle between the two crura cerebri. It is composed of grey matter, and is perforated by numerous small vessels going to the thalamus opticus from the posterior cerebral artery.

The several structures which have been enumerated in the median line, viz., lamina cinerea, optic chiasma, tuber cinereum, corpora albicantia, and locus perforatus posticus, are all included within the area of the circle of Willis, and also form parts of the anterior wall and floor of the third ventricle of the brain (see vertical section, Fig. 317).

The *Interpeduncular space* is the lozenge-shaped interval between the optic commissure and tracts in front, and the crura cerebri and pons Varolii behind. It contains the tuber cinereum, the infundibulum, the corpora albicantia, the posterior perforated spot, and the third pair of nerves.

The **Olfactory Peduncle** (First nerve) (Fig. 305, 3) is of a prismatic shape, very soft, being destitute of neurilemma, and held in its place only by a reflection of the arachnoid. It has three *roots*, two white and one grey. The external root (white) passes in front of the anterior perforated space to the fissure of Sylvius, and may be traced to the corpus striatum ; the internal root (white) goes to the inner side of the frontal lobe ; the middle root (grey) passes to the papilla of grey matter in the olfactory sulcus.

The **Olfactory Bulb** (Fig. 305, 3) is a small lobe of grey matter formed upon the extremity of the olfactory peduncle, and from it arise the branches of the olfactory nerve, which descend to the nose. It is oval in shape, and rests upon the cribriform plate of the ethmoid bone.

The **Optic** or **Second Nerve** (Fig. 305, 7) passes from the optic commissure to the eye-ball, where it is lost in the retina. It is round and firm, and is invested by a sheath composed of dura mater, arachnoid and pia mater. It has been shown that each optic nerve has fibres derived from the opposite as well as from the corresponding eye and side of the brain, and others connecting it with its fellow.

The **Optic Tract** (Fig. 305) is a flattened band connecting the optic commissure with the brain. It can be seen passing around the crus cerebri to disappear beneath the uncinate gyrus, and will be afterwards traced to the *corpora geniculata*, to the *optic thalamus*, and to the *corpora quadrigemina*.

The **Locus Perforatus Anticus** (Fig. 305, 6) is situated close behind the olfactory nerve, and at the inner end of the fissure of Sylvius. It is composed of grey nervous matter, and is perforated by numerous small branches to the corpus striatum from the middle cerebral artery.

The **Fissure of Sylvius** (Fig. 305, 5) runs outwards between the supra-orbital and temporo-sphenoidal convolutions, and is occupied by the middle cerebral artery. It corresponds to the margin of the lesser wing of the sphenoid bone when the brain is *in situ*, and on

Fig. 305.

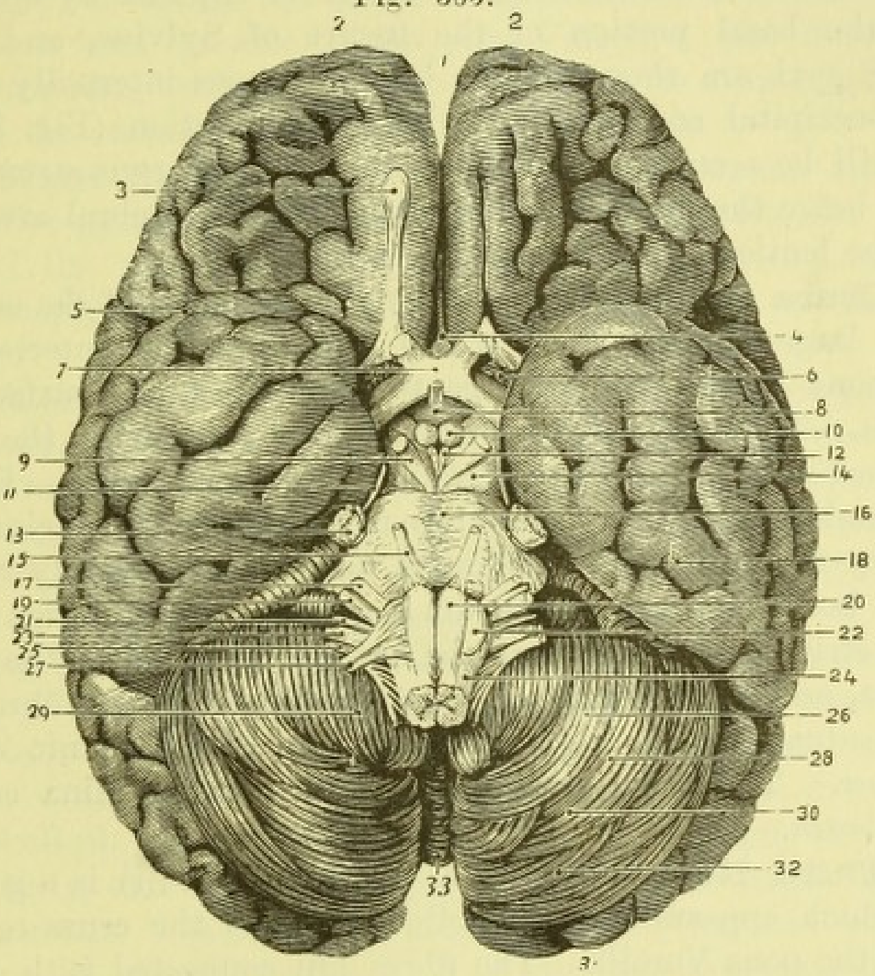


Fig. 305.—The base of the brain (from Hirschfeld and Leveillé).

1. Longitudinal fissure.
2, 2. Frontal lobe of cerebrum.
3. Olfactory peduncle and bulb.
4. Lamina cinerea.
5. Fissure of Sylvius.
6. Locus perforatus anticus.
7. Optic commissure.
8. Tuber cinereum and infundibulum.
9. Third nerve.
10. Corpus albicans.
11. Fourth nerve.
12. Locus perforatus posticus.
13. Fifth nerve.
14. Crus cerebri.
15. Sixth nerve.
16. Pons Varolii.
17. Portio dura of 7th.
18. Temporo-sphenoidal lobe of cerebrum.
19. Portio mollis of 7th.
20. Anterior pyramid.
21. Glosso-pharyngeal nerve.
22. Olivary body.
23. Pneumo-gastric nerve.
24. Lateral tract.
25. Spinal accessory nerve.
26. Digastric lobe.
27. Hypoglossal nerve.
28. Cerebellum.
29. Amygdala.
30. Slender lobe.
31. Posterior lobe of cerebrum.
32. Posterior inferior lobe.
33. Inferior vermiform process.

the outer aspect of the brain divides into two branches, which will be subsequently traced.

The **Island of Reil, Insula,** or **Central Lobe** (Fig. 304), is a group of five convolutions (*gyri operti*) radiating from a point a little external to the anterior perforated spot, and bounded by *anterior*, *posterior* and *external limiting sulci*. It is exposed by opening up widely the basal portion of the fissure of Sylvius, and its two posterior gyri are then seen to be continuous internally with the temporo-occipital convolutions. In frontal section (Fig. 313) the insula will be seen to be closely related to the corpus striatum, and its sulci lodge the main branches of the middle cerebral artery, from which the lenticulo-striate vessels arise.

The **Crura Cerebri** (Fig. 305, 14) (peduncles of the cerebrum) are two large white bodies, which appear at the anterior border of the pons Varolii and diverge to enter the under surface of the cerebrum. They are mainly formed by the columns of the medulla and spinal cord transmitted through the pons Varolii. Each crus is surrounded and overlapped externally by the gyrus uncinatus, and crossed by the optic tract and fourth nerve, and is closely related to the free border of the tentorium cerebelli. Its inferior aspect is coarsely striated by fibres from the anterior pyramid of the medulla oblongata, and is known as the *crusta*, while the deeper fibres, called the *tegmentum*, enclose a pigmented group of ganglionic cells, the *locus niger*. The crura with the corpora quadrigemina constitute the *mid-brain*.

The **Third Nerve** (Fig. 305, 9) (motor oculi) is a good-sized nerve, which appears with its fellow between the crura cerebri in front of the pons Varolii. The fibres are connected with the grey substance of the crus (locus niger), and may be traced to the anterior wall of the aqueduct of Sylvius.

The **Fourth Nerve** (Fig. 305, 11) (trochlearis vel patheticus) is the smallest of the cranial nerves, and winds round the outer side of the crus cerebri. It will be afterwards traced to the valve of Vieussens and to the anterior wall of the aqueduct of Sylvius below the third.

The **Pons Varolii** or **Tuber Annulare** (Fig. 305, 16, and Fig. 311) is the large white body immediately behind the crura and in front of the medulla oblongata. It is more or less convex from side to side, but is slightly grooved along the middle line by the basilar artery. Its transverse fibres are prolonged on each side as a round thick process of white fibres, passing obliquely outwards and backwards to the cerebellum, and forming the *middle cerebellar peduncle* or *processus a cerebello ad pontem*. Its longitudinal fibres, divided into two parts by a deep bundle of transverse fibres, pass from the medulla through the crura to the cerebral hemispheres. Emerging from the side of the pons is seen the fifth nerve.

The **Fifth Nerve** (Fig. 305, 13) (trifacial, trigeminal) is the largest of the cranial nerves, and consists of two portions, motor and sensory, of which the motor is the anterior and smaller. The nerve arises from the side of the pons Varolii, a few fibres of the pons intervening between the two roots ; but its deep origin will be traced to the anterior wall of the fourth ventricle.

The **Sixth Nerve** (Fig. 305, 15) (abducens oculi) arises from the anterior pyramid of the medulla oblongata close to the posterior border of the pons, and slightly from the pons itself. It may be traced deeply to a nucleus in the anterior wall of the fourth ventricle.

The **Medulla Oblongata** (Fig. 305) is the upper part of the spinal cord, and extends from the lower border of the foramen magnum to the lower border of the pons. It is about an inch in length, larger above than below, somewhat flattened from before backwards, and runs almost vertically downwards, with a slight inclination backwards, resting upon the basilar groove of the occipital bone; but when the brain is removed the medulla often assumes an almost horizontal direction, and errors of nomenclature have arisen from this change of position. It contains all the elements of the spinal cord, continued through it to the cerebrum and cerebellum, and has, in addition, a special ganglionic structure, the olivary body, and a number of grey nuclei for the origin of nerves.

The anterior aspect of the medulla is all that can be seen at this stage of the dissection. It is divided into two halves by the *anterior median fissure.* This fissure is continuous below with the anterior median fissure of the cord ; it terminates above in a small depression called the *foramen cæcum*, and is partially obliterated below by the decussation of the crossed pyramidal tracts.

On either side of the fissure is the rounded *anterior pyramid*, continuous with the anterior column and the opposite lateral column of the cord. Its fibres pass through the pons Varolii, between the superficial and deep transverse fibres, to form the crusta of the crus.

The *Olive* or *Olivary body* (22) is an ovoid projection, on the outer side of the anterior pyramid and immediately below the pons. It is separated from the anterior pyramid by the hypoglossal sulcus or anterior lateral furrow, and the emerging filaments of the twelfth nerve ; and from the funiculus of Rolando by a posterior lateral furrow pierced by fibres of the ninth, tenth and eleventh nerves.

On section it will be found to contain a plicated capsule of grey matter, open above, and giving origin by its inner surface to a bundle of fibres that join those surrounding the capsule, and derived from the lateral column of the cord. Some white fibres of deep origin, the *superficial arciform fibres*, are seen arching below and over the olivary body.

The *Funiculus of Rolando* is continuous superficially with the lateral column of the spinal cord, but corresponds to a mass of grey matter (*substantia gelatinosa of Rolando*) continuous with the head of the posterior horn of grey matter of the cord. At the lower part of the medulla it is broad, and lies between the anterior pyramid and the restiform body, but at the upper part it is narrowed and pushed aside by the projection of the olivary body between it and the anterior pyramid. It may be traced as a slight prominence outside the olive, and a few longitudinal fibres may sometimes be seen in front of this body.

The funiculus gracilis and funiculus cuneatus of the medulla, continued upwards from the posterior median and postero-lateral columns of the cord, will be seen later.

The **Seventh** and **Eighth Nerves** (Fig. 305) (Facial and Auditory), are closely connected at their origins, the facial being anterior and the auditory posterior; and running between the two is a minute nerve called the *pars intermedia*.

The *Facial* (17) is rounder and smaller than the auditory; it arises from the lateral tract of the medulla oblongata, between the olive and restiform body, and slightly from the pons Varolii. The deep origin can be traced to the anterior wall of the fourth ventricle.

The *Auditory* (19) is flattened and very soft, owing to the absence of neurilemma. It lies in close contact with the last, and arises partly from two nuclei in the lower part of the anterior wall of the fourth ventricle, partly from a nucleus in the restiform body, and derives a few fibres from the striæ acusticæ.

The **Ninth, Tenth** and **Eleventh Nerves** (Glosso-pharyngeal, Pneumo-gastric, and Spinal-accessory) (Fig. 305) lie close together in that order from above downwards, and spring from the side of the medulla between the olivary body and funiculus of Rolando.

The *Glosso-pharyngeal nerve* (21) is the smallest of the three nerves, and arises by five or six roots below the eighth nerve.

The *Pneumo-gastric* or *Vagus nerve* (23) arises below the glosso-pharyngeal, by a number of fibrillæ which unite to form a single nerve. This lies parallel to the glosso-pharyngeal nerve and to the inner side of a small lobe of the cerebellum, called the *flocculus* or *lobe of the pneumo-gastric.*

The *Spinal-accessory nerve* (25) springs partly from the medulla and partly from the spinal cord. The upper part (accessory to the vagus) arises by fine fibrillæ, below the origin of the pneumo-gastric, for the whole length of the medulla. The spinal portion (Fig. 297, 9) originates in a similar way from the side of the spinal cord, between the ligamentum denticulatum and the posterior roots of the spinal nerves, reaching as low as the sixth cervical nerve.

The deep origins of the ninth, tenth and eleventh nerves may be traced to special nuclei in the lower part of the anterior wall of the fourth ventricle. The spinal fibres of the eleventh are connected with the grey matter of the spinal cord.

The **Twelfth or Hypoglossal Nerve** (Fig. 305, 27) arises superficially by numerous fibrillæ from the groove between the anterior pyramid and the olivary body. The nerve roots unite into two bundles, which pierce the dura mater separately. The deep fibres may be traced to a special nucleus at the lower part of the fourth ventricle.

[By slicing down the pons Varolii, the arrangement of its transverse and longitudinal fibres may be seen. These are in alternate layers, the transverse being continuous with the crura cerebelli, and the longitudinal with the fibres of the cord and the crura cerebri. The superficial fibres are transverse, beneath these is a longitudinal layer which is succeeded by a deep layer of transverse and a still deeper layer of longitudinal fibres. The longitudinal fibres are continued up into the crus cerebri on each side ; and, on making a deep long cut into this structure, it will be seen that a grey nucleus of dark colour, the *locus niger*, occupies the interval between the superficial and deep fibres. The posterior aspect of the pons and medulla forms the anterior wall of the fourth ventricle.]

The Exterior of the Brain.

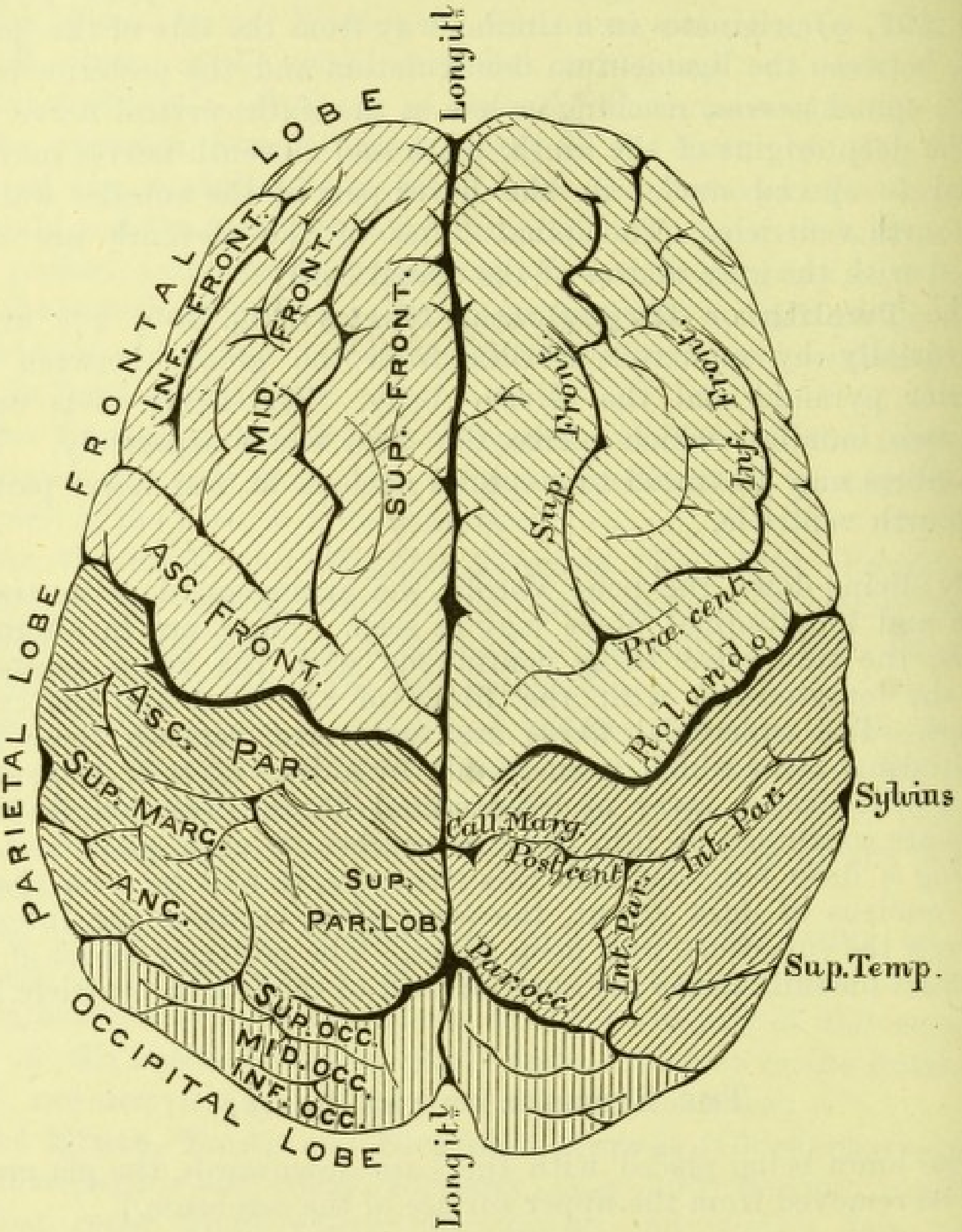
[The brain being placed with the base downwards, the pia mater is to be removed from the upper surface of the cerebrum.]

The exterior of each hemisphere of the brain has three surfaces, Calvarial, Basal and Mesial. It is subdivided by fissures of varying depth into prominences called convolutions, and these are grouped by natural and arbitrary boundary lines into lobes, lobules and regions. The convolutions and fissures vary considerably in different brains and even on different sides of the same brain, but within certain limits their arrangement is fairly constant.

The *Basal surface* has already been described (p. 668).

The *Calvarial surface* (Figs. 306 and 307), moulded to the form of the inner surface of the vault of the cranium, is subdivided by

Fig. 306.



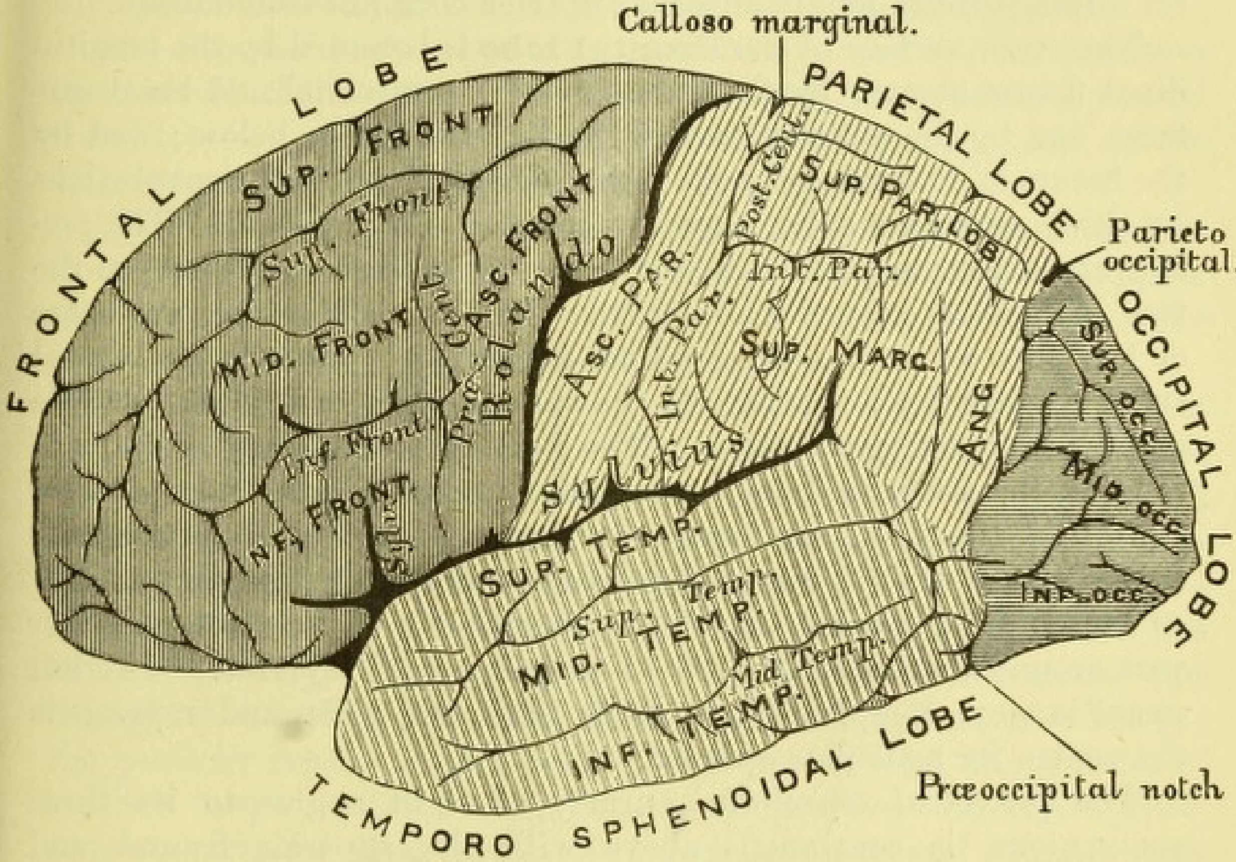
means of three important fissures, the fissure of Sylvius, the fissure of Rolando, and the external Parieto-occipital fissure, into four lobes, frontal, parietal, temporo-sphenoidal and occipital. A fifth lobe, the

Fig. 306.—Upper surface of the central hemispheres (modified after Dalton). The Convolutions are marked on the left side and the Sulci on the right.

Central lobe or Island of Reil, is concealed at the bottom of the fissure of Sylvius (p. 674).

The *Fissure of Sylvius*, the commencement of which was seen on the basal surface, winds on to the calvarial surface, and running obliquely upwards and backwards, divides after a short course into two branches, the *anterior* or vertical, which ascends for a short

Fig. 307.



distance into the inferior convolution of the frontal lobe, and the *posterior* or horizontal, which continues the direction of the main fissure backwards and upwards for about three inches, and then usually turns somewhat abruptly upwards for about an inch, terminating in the supra-marginal fissure of the parietal lobe. The point at which its course is changed is called the *angle*.

The *Fissure of Rolando* or *Central fissure* commences above close to the longitudinal fissure, about half an inch behind the central point of this, and runs downwards and forwards in a sinuous course at an angle of about 65° with the longitudinal fissure, to end a little

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Fig. 307.—Lateral view of the convolutions of the brain (after Thane).

The references to the Convolutions and the Sulci are distinguished by differences in type. The convolution in the fore part of the occipital lobe behind the angular is now called the post-temporal.

above the posterior branch of the fissure of Sylvius, and about an inch behind the anterior limb of the same fissure.

The *External parieto-occipital* fissure is continuous with the *Internal parieto-occipital* fissure, which will be found on the mesial surface of the hemisphere. It runs outwards and forwards for about an inch, starting from the longitudinal fissure about midway between the upper end of the fissure of Rolando and the hinder extremity of the brain, and ends above the first annectant gyrus between the supra-parietal lobule and the superior occipital convolution.

The outer surface of the **Frontal lobe** is bounded by the longitudinal fissure above; by the junction of the calvarial and basal surfaces, and by the anterior part of the Sylvian fissure below; and by the fissure of Rolando behind. It is subdivided into four convolutions by three secondary sulci, superior, inferior and precentral. The *precentral sulcus* runs parallel to the fissure of Rolando, and between the two lies the *precentral convolution.* The *superior sulcus* runs more or less parallel to the longitudinal fissure, and joins the precentral sulcus posteriorly: it separates the superior or *first* from the middle or *second* frontal convolution. The *inferior sulcus,* often difficult to localise, lies about midway between the superior fissure and the lower border of the lobe, ending in or near the precentral sulcus, and separates the middle from the inferior or *third* convolution.

The *Inferior frontal convolution* describes a curve at its posterior part around the anterior limb of the fissure of Sylvius. The left gyrus is more complicated in form than the right, and represents the centre for articulate speech.

The *precentral convolution*, nearly at right angles to its three companions, is continuous above with the superior frontal and post-central convolutions, and below with the inferior frontal and post-central convolutions.

The under surface of the Frontal lobe, lying upon the orbital plate of the frontal bone and lesser wing of the sphenoid, has been described. Its internal surface is formed by the mesial convolutions in front of the quadrate lobule (Fig. 304).

The outer surface of the **Parietal lobe** is bounded in front by the fissure of Rolando; above by the longitudinal fissure; below by the posterior limb of the Sylvian fissure, and an imaginary line continuing its course onwards from the *angle* of the latter; and behind by the external parieto-occipital fissure, and an imaginary line drawn from this towards the preoccipital notch at the base of the temporo-sphenoidal lobe, cutting the arbitrary line running backwards from the angie of the Sylvian fissure. Its internal surface is represented by the quadrate lobule on the mesial surface of the hemisphere.

Its external surface is subdivided by two sulci, the intra-parietal and the superior post-central, into three segments, the post-central convolution, the supra-parietal lobule, and the infra-parietal lobule. The *Intra-parietal sulcus* commences above the posterior limb of the fissure of Sylvius, and runs upwards parallel to the lower part of the Rolandic fissure (*pars ascendens inferior* or *inferior post-central*), then bends backwards and courses in a direction nearly parallel to the longitudinal fissure into the occipital lobe, between the first and second annectant convolutions (*pars horizontalis*).

The *Superior Post-central sulcus* may be regarded as a continuation upwards of the ascending portion of the last, but is often separated from it by a convolution. It runs parallel to the upper half of the Rolandic fissure nearly to the longitudinal fissure.

The *Post-central* (or ascending parietal) *convolution* is parallel to the precentral convolution. It is bounded in front by the Rolandic fissure, and behind by the superior post-central sulcus and the ascending portion of the intra-parietal sulcus.

The *Superior parietal convolution* or *Supra-parietal lobule* lies above the longitudinal portion of the intra-parietal sulcus, between the superior post-central and internal parieto-occipital fissures. It is continuous below the latter with the first annectant convolution, and at the longitudinal fissure with the quadrate lobule on the mesial surface of the hemisphere. The *Infra-parietal lobule* lies below the longitudinal portion of the intra-parietal sulcus, and behind its ascending portion. Three fissures terminate in it below: the *posterior branch of the fissure of Sylvius* in front, the *parallel* or *superior temporo-sphenoidal* fissure in the middle, and the *inferior temporo occipital* (2nd temporal) sulcus behind: and around each of these arches a convolution: the *supra-marginal* over the Sylvian fissure, the *angular* convolution over the parallel fissure, and the *post-parietal* over the inferior temporo-occipital. The latter convolution is continuous with the second and third annectant gyri.

The **Temporo-Sphenoidal or Temporal Lobe** occupies the middle fossa of the cranium. It lies below the fissure of Sylvius and the imaginary line connecting the angle of the latter with the parieto-occipital boundary line, and it is separated from the lower part of the occipital lobe by the continuation of that boundary line to the pre-occipital notch, at the angle of junction between the calvarial and basal surfaces. Its under surface is represented by portions of the gyrus uncinatus and external temporo-occipital convolutions (4th and 5th temporal gyri) seen on the basal aspect of the hemisphere. Its outer surface is divided by two fissures, the *superior* or *parallel,* and the *inferior,* into three convolutions, superior, middle and inferior. The *parallel fissure* is parallel to the posterior branch of the Sylvian fissure, and ends in the angular convolution; the *inferior fissure,* parallel to the last, ends in the post-temporal gyrus. The *superior* and *middle* or *first* and *second convolutions* become continuous with the supra-marginal, angular and post-temporal gyri; the *inferior* or *third convolution* passes above the preoccipital notch to the occipital lobe by means of a *lateral annectant gyrus,* and is continuous inferiorly with the external temporo-occipital convolution of the basal surface. The upper surface of this lobe is concealed within the fissure of Sylvius and closely related to the Island of Reil. It presents two or three *transverse* temporal gyri, the largest and most anterior of which lies behind the posterior limiting sulcus of the insula.

The **Occipital Lobe** lies behind the parietal and temporo-sphenoidal lobes. Its outer surface has been arbitrarily divided into *superior, middle* and *inferior convolutions* by *superior* and *inferior occipital fissures,* but these are almost impossible to recognise on most brains. The parieto-occipital sulcus has been seen to pass into the occipital lobe: it usually joins a transverse furrow, the *anterior occipital sulcus,* and below and in front of the latter is an oblique *lateral occipital sulcus.* These divide the outer surface of the lobe into an *anterior gyrus,* between the anterior sulcus and the upturned end of the lateral sulcus; and a *posterior gyrus* behind the upturned end of the lateral sulcus (Schäfer).

The occipital annectant gyri are four in number. The first *annectant gyrus* unites the superior occipital convolution with the supra-parietal lobule, the *second,* the middle occipital with the angular convolution. The *third,* the middle occipital with the lower part of the post-parietal convolution; and the *fourth,* the lower occipital with the lower temporo-sphenoidal.

The name of *opercular* has been applied to those parts of the inferior frontal, ascending frontal, ascending parietal and superior marginal convolutions, which form a kind of operculum or lid over the fissure of Sylvius and conceal the Island of Reil.

The Mesial Surface of the Brain.

For purposes of description it will be convenient to classify the appearances presented on the mesial aspect of the brain into (I.) those structures which cross the middle plane and are divided in a sagittal section through the longitudinal fissure, and (II.) those which lie close to the line of section but are not divided.

I. The structures cut through are as follows (Fig. 317) :—

(1.) The *Corpus callosum*, with its rostrum and genu in front, its splenium behind, and its body in the middle (p. 685).

(2.) The *Fornix*, connected behind and above with the corpus callosum, and arching downwards and forwards to form the corpora albicantia at the base.

(3.) The *Septum lucidum*, including between its layers the *Fifth ventricle*, and connecting the under surface of the body of the corpus callosum with the upper surface of the rostrum and fornix.

(4.) The *Velum interpositum*, a fold of pia mater entering the brain at the transverse fissure of Bichat, below the corpus callosum (splenium) and fornix.

(5.) The basal structures forming the anterior wall and floor of the third ventricle, viz. the *lamina cinerea*, the *optic chiasma*, the *tuber cinereum*, the *infundibulum* and the *pituitary body*, the commissural fibres between the two corpora albicantia and adjacent parts of the anterior pillars of the fornix, the *posterior perforated spot*, and the junction of the crura cerebri.

(6.) The commissural structures crossing the third ventricle, viz. the *anterior* and *posterior* white commissures and the *middle* grey commissure.

(7.) The corpora quadrigemina and pineal body, overlying the mesial aqueduct of Sylvius.

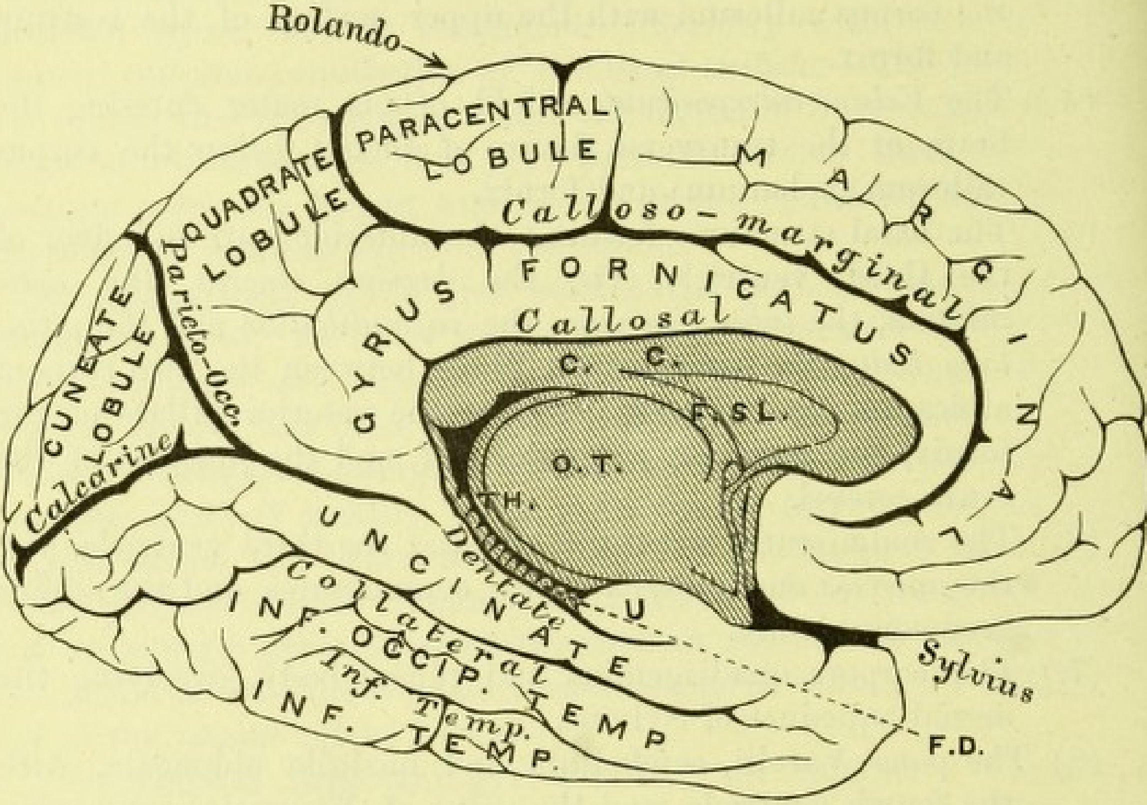
(8) The pons Varolii, cerebellum and medulla oblongata, with the fourth ventricle, and the valve of Vieussens connecting the superior cerebellar peduncles.

II. The undivided bilateral structures seen on the mesial surface consist of the convolutions and sulci in front of, behind and above, the corpus callosum; and the optic thalami, forming the lateral walls of the third ventricle. Below the third ventricle lie the temporo-occipital convolutions, which belong to the basal surface, and are best exposed after removal of the pons, cerebellum, and medulla by section of the crura cerebri (Fig. 308).

The **principal fissures of the mesial surface** are three in number: (1) the *calloso-marginal*, (2) the *internal parieto-occipital*, and (3) the *calcarine;* and by means of these **the convolutions** may be divided into four groups, (1) the gyrus fornicatus, (2) the marginal convolutions, (3) the quadrate lobule, and (4) the cuneate lobule.

The *Calloso-marginal* fissure commences a little below the rostrum of the corpus callosum, and curves forwards around the genu and backwards above the body, finally running upwards opposite the splenium to the margin of the longitudinal fissure. The *Calcarine* fissure runs from near the lower part of the hinder extremity of the hemisphere forwards to a point a little below the splenium of the corpus callosum, dividing the posterior extremity of the uncinate gyrus into two parts. It corresponds to a projection called the hippocampus minor in the posterior horn of the lateral ventricle.

Fig. 308.



The *Internal Parieto-occipital* fissure is continuous above with the external parieto-occipital fissure of the calvarial surface, and runs downwards and forwards to join the calcarine fissure near its middle.

The *Marginal Convolutions* lie between the calloso-marginal fissure and the margin of the longitudinal fissure. They are subdivided by many secondary fissures (the most constant of which, the *sulcus marginalis*, subdivides the middle of the gyrus into superior and inferior parts) and about an inch and a half of their posterior extremity, partly cut off by a vertical fissure and corre-

Fig. 308.—The inner and under surface of a cerebral hemisphere showing the convolutions and sulci (modified after Thane).

C. C.	Corpus callosum.	O. T.	Optic thalamus.
S. L.	Septum lucidum.	T. H.	Tænia hippocampi.
F.	Fornix.	F. D.	Fascia dentata.

The Convolutions and Sulci are distinguished by differences in type.

sponds to the pre and post-central gyri of the outer surface, is sometimes termed the *paracentral lobule.*

The *Gyrus fornicatus* (Convolution of the Corpus Callosum) arches around the rostrum, genu, body and splenium of the corpus callosum, and is continuous behind with the quadrate lobule and the upper limb of the posterior end of the uncinate gyrus. It is separated from the marginal convolutions by the calloso-marginal fissure. This and the uncinate gyrus together form around the corpus callosum and crus cerebri, a kind of ellipse (*limbic lobe*), which is complete except at one point, opposite the anterior perforated spot.

The *Quadrate lobule*, representing the inner surface of the parietal lobe, lies between the terminal portion of the calloso-marginal fissure and the internal parieto-occipital fissure, and is continuous below with the hinder part of the fornicate gyrus.

The *Cuneate lobule* is a wedge-shaped group of convolutions between the parieto-occipital and calcarine fissures.

The Interior of the Brain.

[A slice of brain substance about an inch thick is to be taken from the top of the right hemisphere, the knife being carried through the calloso-marginal sulcus; the centrum ovale minus will thus be exposed.]

The name *Centrum Ovale* is given to the white substance of the cerebrum as seen on horizontal sections at different levels. It appears as a white mass of somewhat oval shape surrounded by the plicated grey matter of the convolutions. It is dotted by minute red or dark points, the *puncta vasculosa,* corresponding to divided blood vessels.

[By slicing off one hemisphere a little above the level of the corpus callosum, a side view of the upper part of the opposite hemisphere will be obtained, but the convolutions of the inner surface can be thus only very imperfectly observed. The removal of the upper parts of both hemispheres a little above the level of the corpus callosum displays the centrum ovale majus.]

The **Corpus Callosum** (Fig. 308, C. C), the great transverse commissure of the brain, consists of fibres passing transversely from one hemisphere to the other, and forms the floor of the middle portion of the longitudinal fissure and the anterior wall and roof of the lateral ventricles. It is nearer the anterior than the posterior extremity of the brain, and is slightly arched from before backwards. In a median sagittal section its anterior extremity will be seen to bend abruptly backwards and downwards to the base of the brain, forming the *genu* and *rostrum*, while posteriorly it ends in a thick free border, termed the *splenium*, which forms the upper boundary of the transverse fissure of Bichât and lies in contact with the velum interpositum. Beneath, it is connected with the *septum lucidum*, and further back with the *fornix* (Fig. 317).

The *Rostrum* has been seen to become continuous superficially at the base of the brain with the lamina cinerea, and to give off two *peduncles* which extend outwards, one on each side, to the beginning of the Sylvian fissure.

On the upper surface of the corpus callosum in the middle line is a mesial longitudinal furrow, the *raphe*, on either side of which are two white bands, the *striæ obtectæ* or *nerves of Lancisi*, and outside these are other longitudinal lines (*lateral striæ*), overlapped by the gyrus fornicatus. The longitudinal elements are crossed by transverse markings called the *lineæ transversæ*, which indicate the course of the fibres of the structure. The anterior callosal fibres curve forwards on entering the hemispheres, the posterior backwards (*forceps major*), and the intermediate fibres (*tapetum*) pass directly outwards.

The Corpus Callosum is about four inches in length from splenium to genu, and extends to within an inch and a half of the anterior extremity of the brain, and two inches and a half of the posterior extremity.

The Lateral Ventricles.

[To open the lateral ventricle in each hemisphere, the corpus callosum is to be carefully cut through about half an inch from the middle line, until the delicate membrane (*ependyma ventriculorum*) lining the ventricle is seen; the handle of the scalpel should then be used to reflect the brain substance and expose the cavity.]

The **Lateral Ventricle** (Fig. 309) consists of a *central cavity* or *body*, and three *cornua*, anterior, posterior, and middle or descending. The *Anterior* cornu turns forwards and outwards into the front of the hemisphere, and offers nothing of importance for notice. The *Posterior* cornu curves backwards and then inwards into the hinder part of the brain, and presents on its inner wall two ridge-like elevations, one, the *forceps major*, due to a bundle of fibres continuous with the splenium of the corpus callosum and curving backwards into the occipital lobe; the other, called the *hippocampus minor* or *calcar avis* (Fig. 310, 7), corresponding to the bottom of the calcarine fissure. The *Middle horn* commences at the same point as the posterior horn, but turns downwards behind and beneath the optic thalamus to reach the base of the hemisphere. It will be traced in a subsequent dissection. The *Body* of the ventricle is bounded superiorly by the corpus callosum, and its *floor*, which slopes downwards and forwards in front, is formed by the following parts, from before backwards—1. Corpus striatum ; 2. Tænia semicircularis ; 3. Optic thalamus ; 4. Choroid plexus ; 5. Fornix.

The **Corpus Striatum** (Fig. 309, 3) or *superior ganglion of the hemisphere* appears as a grey pyriform body in the floor of the ventricle, its greater end being directed forwards and its narrow extremity or tail backwards and outwards. When cut transversely it will be seen to consist of two grey portions, an *intraventricular* or *caudate nucleus* corresponding to the surface exposed on the floor of the ventricle, and a larger *extraventricular* or *lenticular nucleus* which corresponds in position with the Island of Reil. The two nuclei are separated by a layer of white substance, called the *internal capsule*, consisting of fibres prolonged from the crus cerebri and, in their passage through the grey nuclei, causing the striated appearance from which the name of the body is derived. A thin layer of grey substance called the *claustrum* is found outside the lenticular nucleus, and is separated from it by a band of white fibres, called the *external capsule*, which joins the internal capsule below the nucleus ; and from the grey matter of the Island of Reil by a second and unnamed layer of white matter (Fig. 313). The two corpora striata are separated behind by the two optic thalami.

The **Tænia Semicircularis** or **Stria terminalis** (Fig. 309, 6) is a narrow band of white matter lying superficially between the corpus striatum and the optic thalamus ; it joins the anterior pillar of the fornix in front, terminating in a grey mass called the nucleus amygdalæ ; and posteriorly it becomes lost in the middle horn of the ventricle. A vein (vena corporis striatæ) is often found beneath it, and one or two small tributaries of the choroid plexus usually cross its upper surface.

The **Thalamus Opticus** (Fig. 309, 7) is here seen as a white body, overlapped by the fornix and choroid plexus. At its anterior end is a prominence, called the *anterior tubercle*, corresponding to a grey nucleus ; posteriorly it forms the anterior and superior boundary of the middle horn, and is surrounded by the lateral portion of the great transverse fissure. It will be further exposed in a later dissection.

The **Choroid Plexus** (Fig. 309, 8) is a vascular fringe lying upon the surface of the thalamus, and continued into the descending cornu of the lateral ventricle. It will subsequently be seen as the fringed edge of a process of pia mater (velum interpositum), which enters at the transverse fissure and lies beneath the fornix. By drawing gently upon the choroid plexus of one side it may be shown to be connected with that of the opposite side through the *foramen of Monro* (5) (p. 695).

[To see the fornix thoroughly, the remnant of the corpus callosum in the middle line should be cut through transversely about its centre, and the posterior part is to be carefully dissected away from the subjacent fornix.]

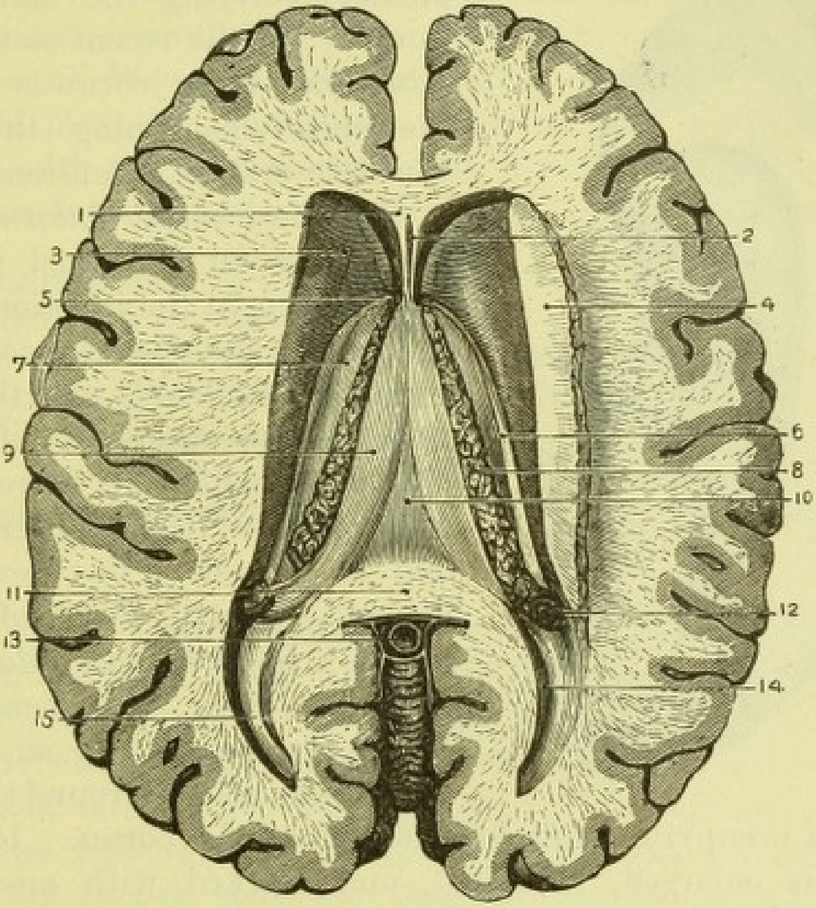
The **Fornix** (Fig. 309, 10) is a thin white body, of triangular shape, placed in the middle line beneath the corpus callosum. It is narrow in front and there divides into two *anterior crura* or *pillars*, which pass to the base of the brain and become twisted on themselves to form the *corpora albicantia* (p. 671). Posteriorly it is incorporated with the splenium of the corpus callosum, and gives off on each side a *posterior pillar*, which passes into the middle horn, fusing with the hippocampus major and tænia hippocampi. The angle of divergence between these posterior pillars is occupied by the transverse fibres of the corpus callosum, which give rise to the appearance called the *lyra of the fornix*. Its superior surface is connected in the middle line with the septum lucidum, and forms on each side a part of the floor of the lateral ventricle: its inferior surface is separated from the third ventricle and optic thalami by the velum interpositum; and its lateral borders are in contact with the choroid plexuses. The fissure on each side, between its anterior pillar and the anterior extremity of the optic thalamus, is converted by the lining membrane of the ventricle (*ependyma*) into a serous canal, the *foramen of Monro*, which opens below into the third ventricle. The choroid plexus does not pass through this canal but outside it.

The lateral ventricles are separated from one another by the **Septum Lucidum**, a very thin double layer of cerebral matter, grey externally and white within, enclosing a shut sac called the fifth ventricle, and extending between the anterior part of the corpus callosum and the fornix. It is deeper in front than behind (Fig. 317, 8).

The **Fifth Ventricle** (Fig. 309, 2) can be shown by cutting through the septum lucidum with a pair of scissors close to the remains of the corpus callosum. It lies between the two layers of the septum lucidum, and is deepest in front. In the fœtus it formed a part of the great longitudinal fissure, but is subsequently cut off from the fissure by the development of the corpus callosum.

[To see the descending cornu, the side of the brain should be freely cut away opposite the point at which the choroid plexus disappears. The choroid plexus being taken as a guide, the horn can be opened along its side, and the cavity exposed by drawing the parts asunder.]

Fig. 309.



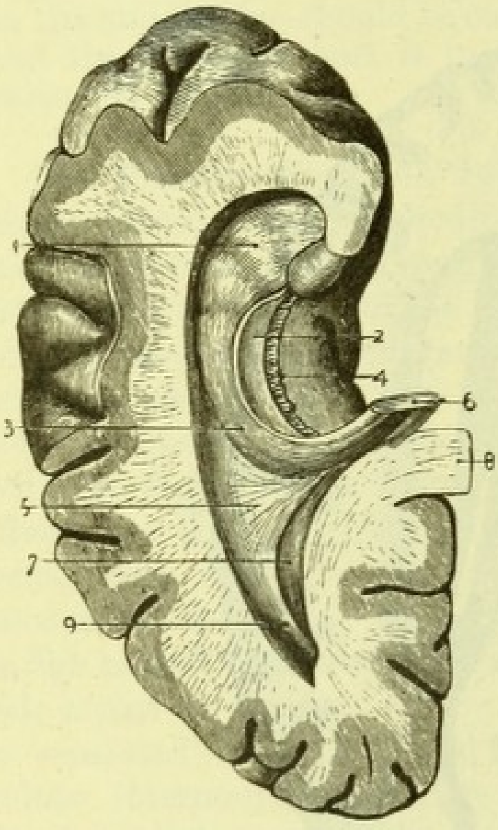
The **Descending** or **Middle Cornu** (Fig. 310) takes a curved course downward, behind and then beneath the optic thalamus. Its direction is at first slightly backwards and then outwards, downwards, forwards, and inwards; opening at the base of the dissected

Fig. 309.—Lateral ventricles of the brain (from Hirschfeld and Leveillé).

1. Septum lucidum.
2. Fifth ventricle.
3. Corpus striatum.
4. Corpus callosum, reflected.
5. Foramen of Monro.
6. Tænia semicircularis.
7. Thalamus (opticus).
8. Choroid plexus.
9. Corpus fimbriatum.
10. Fornix.
11. Posterior extremity of corpus callosum.
12. Commencement of descending cornu.
13. Vena Galeni.
14. Hippocampus minor.
15. Posterior cornu of lateral ventricle.

brain through the lateral part of the transverse fissure of Bichât between the gyrus uncinatus and crus cerebri (Fig. 305). It contains the following structures from without inwards—(1) the *Eminentia collateralis;* (2) the *hippocampus major*, terminating below and in front in the *pes hippocampi;* (3) the *fimbria* or *tænia hippocampi;* (4) the *Dentate Convolution;* (5) the *Dentate fissure;* (6) the grey matter of the upper surface of the uncinate gyrus; (7) the choroid plexus overlying the tænia hippocampi. In the recent state the termination of the cornu is closed by the ependyma lining the lateral ventricle and its extensions.

Fig. 310.



The *Eminentia Collateralis* (Fig. 310, 5) is an elongated projection commencing at the junction between the middle and posterior cornua, and running downwards into the middle horn on the outer side of the hippocampus major. It corresponds to the bottom of the collateral fissure, and its greater or less development depends upon the depth of this.

The *Hippocampus Major* (Fig. 310, 3) is a prominent convex body corresponding to an unfolding of cerebral matter around the *dentate fissure*, and occupying the whole length of the cornu. Its anterior extremity is enlarged, lobulated, and marked with more or less distinct transverse grooves, and has received the name *Pes Hippocampi* (1) from its fancied resemblance to the foot of an animal. It has a thin layer of white fibres on the surface, but consists principally of grey matter continuous with that of the uncinate gyrus, by the folding of which it is developed (Fig. 311).

Fig. 310.—Middle and posterior cornua of the lateral ventricle of brain (from Hirschfeld and Leveillé).

1. Pes hippocampi.
2. Tænia hippocampi.
3. Hippocampus major.
4. Dentate convolution with opening of dentate fissure on its inner side, and the upper surface of the uncinate gyrus internal to the fissure
5. Eminentia collateralis.
6. Posterior pillar of fornix (cut).
7. Hippocampus minor (the forceps major is seen on the inner side of this in continuity with the splenium).
8. Splenium of corpus callosum (cut).
9. Posterior cornu.

At the anterior border of the hippocampus major is a thin band of white cerebral matter continuous with the posterior pillar of the fornix, known as the *Fimbria* or *Tœnia Hippocampi* (Fig. 310, 2). By lifting this up with the handle of the scalpel and turning it aside, the dissector exposes the *Dentate Convolution*, or Fascia Dentata, a border of grey matter which receives its name from the toothed aspect given to it by the passage of small vessels across it at regular intervals. This is the free edge of the *uncinate gyrus*. The *Dentate Fissure* lies between the dentate convolution and the upper surface of the uncinate convolution (Figs. 308, 311).

The *Choroid Plexus* of the descending cornu is continuous with the choroid plexus of the lateral ventricle, and is now seen to be connected with the border of the fold of pia mater which enters the brain through the transverse fissure of Bichât.

[The fornix should be cut through opposite the foramen of Monro, and reflected with the handle of the scalpel. The transverse markings called the *Lyra* will then be seen between its posterior pillars; and the velum interpositum beneath will be brought into view. By carefully scraping away the brain substance with the handle of the knife, the continuity of the velum interpositum with the pia mater through the great transverse fissure may be easily demonstrated.]

The **Velum Interpositum** (Fig. 312, 5) is a double fold of membrane, of triangular form, inflected into the interior of the brain at the transverse fissure from the pia mater over the upper surface of the cerebellum and the occipito-temporal convolutions of the under surface of the cerebrum. Between its layers, near the middle line, are the two veins of Galen passing to the straight sinus, the veins of the corpus striatum, and the choroid branches of the cerebral arteries, which enter it laterally. Its upper surface is in contact with the corpus callosum and fornix; its under surface forms the roof of the 3rd ventricle, and rests upon the optic thalami laterally; its borders are fringed by the choroid plexuses of the lateral ventricles, and the choroid plexus of the third ventricle depends from its inferior surface.

The **Great Transverse Fissure** or **Fissure of Bichât** (Fig. 311) which is now opened, is the slit by which the velum interpositum enters the brain. It is exposed on the undissected brain by opening up the interspace between the cerebrum and cerebellum, and removing the pia mater. It will then be seen as a wide fissure, nearly horizontal in the middle, but strongly curved downwards and inwards at the sides. Its central portion lies between the corpus callosum in front and the corpora quadrigemina and upper surface of the optic thalamus below; while its extremities bend each around the corresponding optic thalamus, at first external to, and then beneath it, to terminate in the interval between the crus cerebri and the uncinate gyrus at the base of the brain. It opens into the middle horn of the lateral ventricle over

Fig. 311.

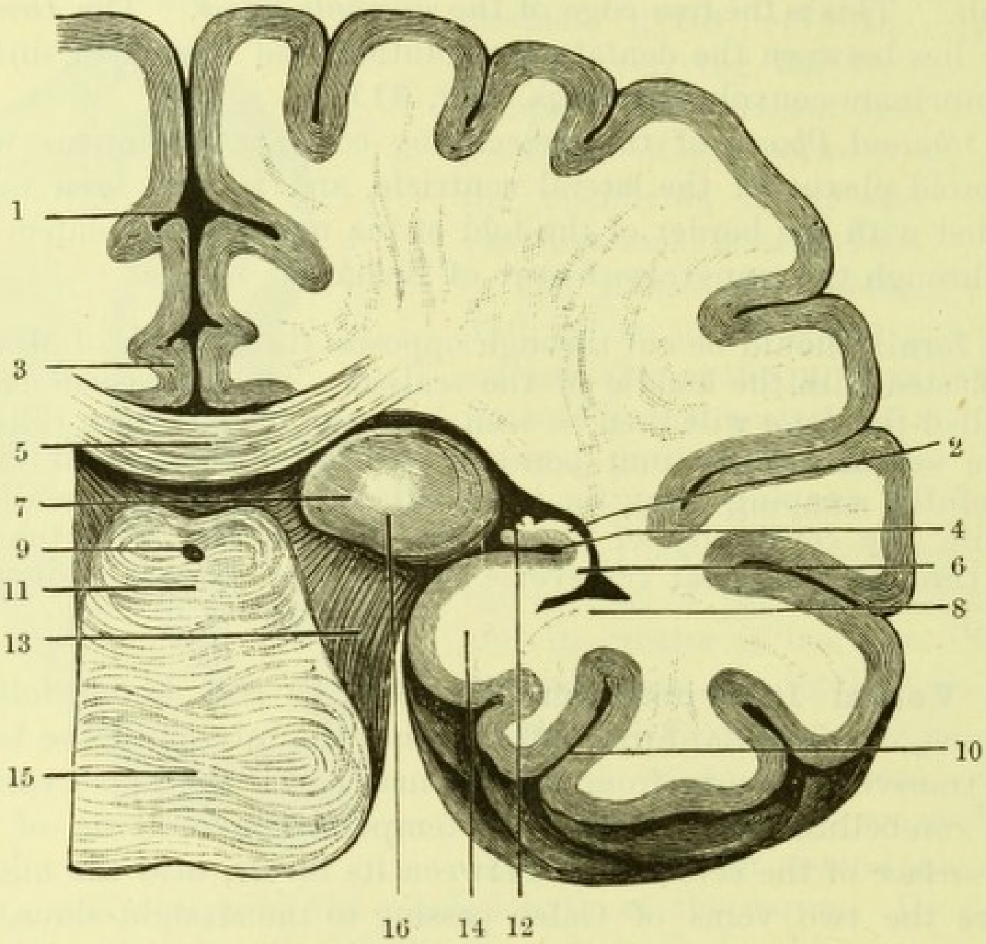


Fig. 311.—Frontal section of the brain through the transverse fissure (W. A.). The velum interpositum and choroid plexus removed.

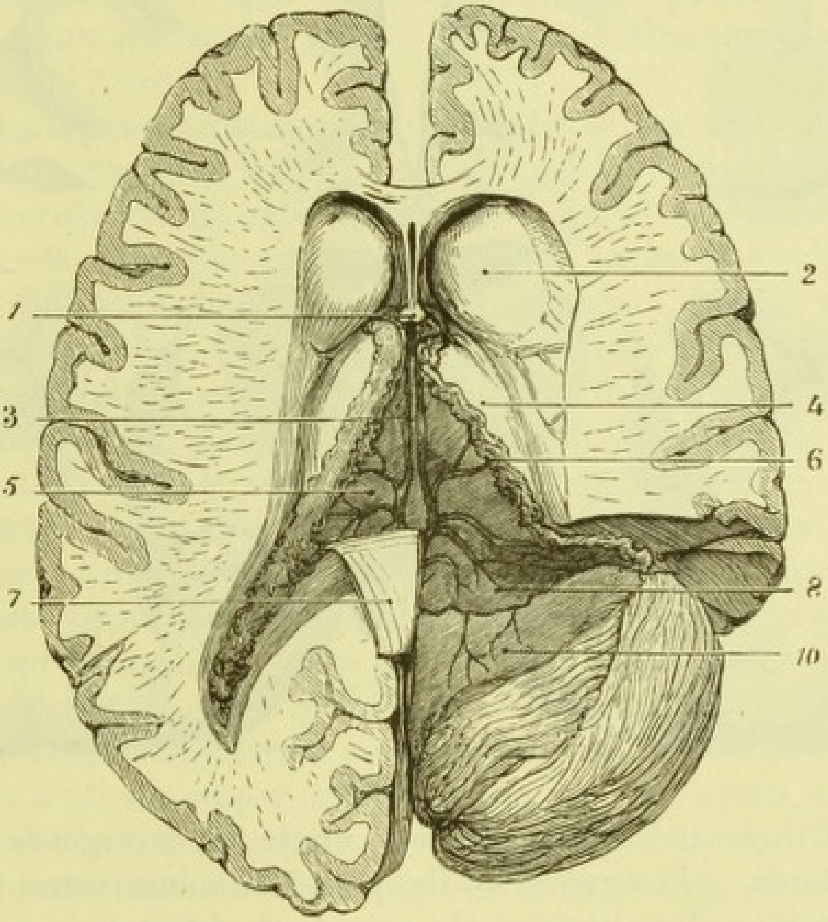
The fissure is seen between the corpus callosum and corpora quadrigemina in the middle line, and curving on each side around the posterior extremity of the optic thalamus to end opposite the crus cerebri, between the thalamus and the gyrus uncinatus. It is continuous with the middle horn of the ventricle over the hippocampus major.

1. Longitudinal fissure.
2. Superficial white matter of hippocampus major, terminating in the fimbriæ.
3. Gyrus fornicatus.
4. Dentate fissure.
5. Splenium of corpus callosum (cut).
6. Hippocampus major.
7. Posterior extremity of optic thalamus.
8. Eminentia collateralis.
9. Aqueduct of Sylvius.
10. Collateral fissure.
11. Corpora quadrigemina.
12. Dentate convolution.
13. Crus cerebri.
14. Gyrus uncinatus.
15. Pons Varolii.
16. Posterior tubercle of optic thalamus.

the hippocampus major on the outer side of the thalamus, when the ependyma closing the cornu in this situation is broken down.

[The velum interpositum is to be reflected, and the two small *choroid plexuses of the third ventricle* will be seen on its under surface near the middle line. The third ventricle is now exposed, and behind it the corpora quadrigemina and the pineal gland. The latter is very liable to be removed with the velum interpositum, unless it is carefully dissected.]

Fig. 312.



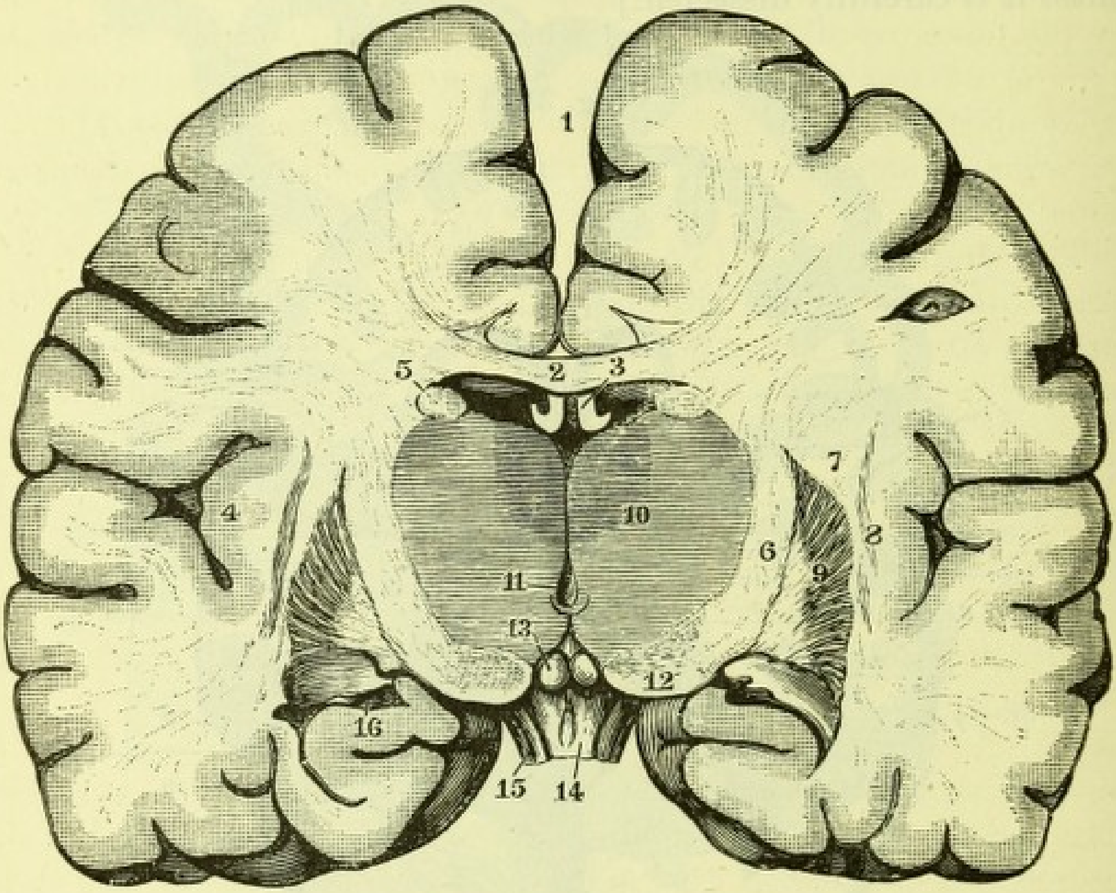
The **Third Ventricle** (Fig. 314) is the mesial interspace between the two optic thalami: these, with the peduncles of the pineal gland, forming its *lateral* boundaries. Its *roof* is formed by the

Fig. 312.—The velum interpositum, showing its continuity with the pia mater (from University College Museum).

1. Fornix divided and reflected.
2. Corpus striatum.
3. Venæ Galeni.
4. Thalamus opticus.
5. Velum interpositum.
6. Choroid plexus.
7. Left half of fornix reflected, showing lyra.
8. Pia mater on under surface of cerebrum, continuous with
10. Pia mater on upper surface of cerebellum.

fornix and velum interpositum. Its *floor* corresponds to the optic chiasma, tuber cinereum, infundibulum, corpora albicantia, the upper surface of the crura cerebri, and the locus perforatus posticus (from before backwards). Its *anterior boundary* is formed by the *anterior pillars* of the fornix ; the anterior commissure, crossing

Fig. 313.



in front of these and visible in their angle of divergence ; and the lamina cinerea. *Posteriorly* lie the posterior commissure, the pineal gland with its peduncles, and the aqueduct of Sylvius.

The *Anterior commissure* is a round bundle of white fibres which

Fig. 313.—Transverse vertical section of the cerebrum made immediately behind the corpora albicantia (H. E. Clark).

1. Longitudinal fissure.
2. Corpus callosum.
3. Fornix.
4. Island of Reil.
5. Nucleus caudatus.
6. Internal capsule.
7. External capsule.
8. Teniaform nucleus or claustrum.
9. Lenticular nucleus.

5, 6, 7, 8, and 9 together constitute the corpus striatum.

10. Thalamus opticus.
11. Third ventricle.
12. Crus cerebri.
13. Corpora albicantia.
14. Tuber cinereum and commencement of infundibulum.
15. Optic tract.
16. Extremity of middle horn of lateral ventricle.

may be traced on either side into the temporo-sphenoidal lobe, and is joined in front by a commissural band between the two olfactory nerves. The *Posterior commissure*, also white, is a thinner band of fibres running transversely between the two optic thalami beneath the pineal body. Between the anterior and posterior commissures is seen the *middle* or *soft commissure*, a flat grey band joining the two internal nuclei of the optic thalami.

The third ventricle communicates with the two lateral ventricles by the foramina of Munro, and with the fourth ventricle by the *iter a tertio ad quartum ventriculum* or *aqueduct of Sylvius*, a narrow canal about half an inch in length, which passes beneath the posterior commissure, the pineal gland, and the corpora quadrigemina (Fig. 317, 16).

The **Thalamus Opticus** (Fig. 314, 6) is now fully exposed as a large ovoid body, grey within, and covered by a thin layer of white matter (*stratum zonale*) externally. It is placed behind and internal to the corpus striatum, and is continuous externally with the substance of the hemisphere (Fig. 311). It forms part of the floor of the lateral ventricle, the external wall and roof of the middle horn of the same cavity, and the lateral wall of the third ventricle. Its anterior extremity (in the lateral ventricle) presents a slight prominence, the *anterior tubercle;* its posterior extremity, within the lateral curve of the great transverse fissure, has another tubercular prominence, the *pulvinar* or *posterior tubercle;* its under surface partly rests upon the crus cerebri and the grey matter of the floor of the third ventricle, and is partly free, forming the roof of the terminal portion of the middle horn. In the latter situation it has two projections, the *external* and *internal geniculate bodies*, which lie in contact with the upper surface of the uncinate gyrus, and are connected with the quadrigeminal bodies and optic tract. Its relations to the anterior and middle commissures have been mentioned. A white band, the *pineal stria*, continuous with the peduncle of the pineal gland, runs along the junction of its upper and inner surfaces.

By turning the brain on its side the *optic tract* may be readily traced to the under surface of the optic thalamus, and will be found to divide into two parts, which are connected with the external geniculate body and pulvinar, and pass on to the superior quadrigeminal body.

The principal *grey nuclei* of the optic thalamus are: (1) The nucleus of the anterior tubercle; (2) The posterior external nucleus, extending into the posterior tubercle; (3) The posterior internal nucleus; (4) The nucleus of the external geniculate body. Three other layers of grey matter will be found in the subthalamic region, the *stratum dorsale* above, the *zona incerta* in the middle, and the *corpus subthalamicum* beneath.

The **Pineal Body** (Fig. 314, 10) (*conarium*) is a reddish grey flattened conical body, lying between the anterior pair of the corpora quadrigemina (nates), and above the posterior commissure of the third ventricle. Its anterior part or base is connected with the margins of the optic thalami by two slender *anterior peduncles* or *habenulæ*, and with the posterior commissure by two slender *inferior peduncles*. It receives a special investment from the velum inter-

Fig. 314

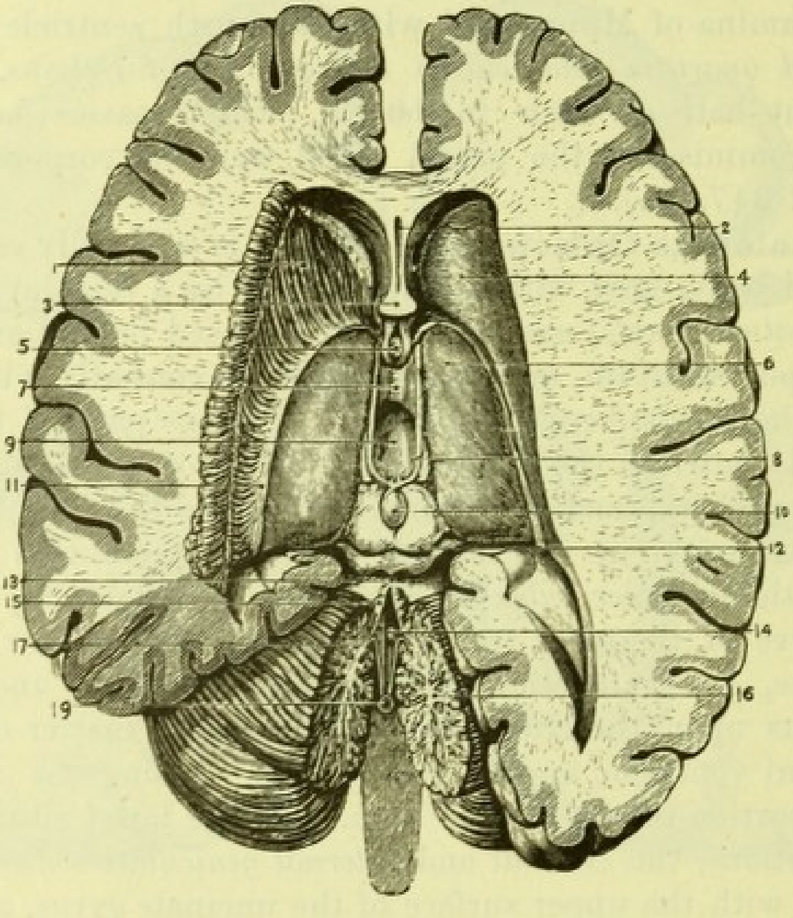


Fig. 314.—Third ventricle of brain (from Hirschfeld and Leveillé).

1. Corpus striatum dissected.
2. Fifth ventricle.
3. Anterior crura of fornix (cut).
4. Corpus striatum.
5. Anterior commissure of third ventricle.
6. Optic thalamus.
7. Middle of soft commissure.
8. Habenæ or peduncles of pineal gland.
9. Third ventricle.
10. Pineal body.
11. Tænia semicircularis.
12. Corpora quadrigemina.
13. Valve of Vieussens.
14. Fourth ventricle.
15. Anterior extremity of superior vermiform process.
16. Arbor vitæ cerebelli.
17. Anterior extremity of inferior vermiform process (nodulus).
19. Communication of 4th ventricle with subarachnoid space.

positum. The triangular depression, between the anterior peduncle and the pulvinar, is called the *trigonum habenulæ*. A grey *nucleus* is found in the floor of this space.

The **Corpora Quadrigemina** or **Optic Lobes** (Fig. 314, 12) are four white prominences containing grey matter, placed immediately behind the third ventricle. They have been named *Nates* and *Testes*, from their fancied resemblance to those parts; the superior being the nates and the inferior the testes. They are connected with the corpora geniculata by white bands or *brachia*, the brachium from the superior quadrigeminal body on each side passing to the external geniculate body and the optic tract, the brachium from the inferior quadrigeminal body to the internal geniculate body. Two broad white bands, the superior peduncles of the cerebellum (*processus a cerebello ad testes*), pass from the cerebellum to the inferior quadrigeminal bodies (Fig. 315, 3), and are connected by a thin layer of white matter, the *Valve of Vieussens* (Fig. 314, 13, Fig. 317, 15), to which may be traced the fourth pair of nerves.

A small band of white matter seen passing transversely inwards to the corpora quadrigemina on each side, beneath the superior peduncle of the cerebellum, is called the *Fillet of Reil* (Fig. 315, 2). It is a portion of a tract of ascending fibres passing from the nuclei of the opposite posterior columns of the medulla, to end in the corpora quadrigemina and base of the cerebrum.

[Opportunity may now be taken to trace out the anterior commissure of the third ventricle and the anterior pillar of the fornix, by carefully scraping away the corpus striatum of one side.]

The *Anterior pillar of the Fornix* has been seen descending in front of the third ventricle, and behind the anterior commissure, to reach the base of the brain, where it is twisted upon itself and forms the superficial white substance of the corpus albicans. At this point it is probably continuous with the *bundle of Vicq d'Azyr*, which ascends to become lost in the grey matter of the optic thalamus.

The Cerebellum.

The **Cerebellum** (Fig. 305, 28), or smaller brain, lies beneath the posterior lobes of the cerebrum, and in the skull is separated from them by the tentorium cerebelli. It is of a darker colour than the cerebrum, and its surface is divided by sulci into laminæ instead of convolutions. It consists of two lateral hemispheres united by a median portion; and a *horizontal fissure*, which passes round the margin, divides the organ into an upper and a lower part.

The **Upper surface** is flat, except in the middle, where there is a slight elevation called the *superior vermiform process.* A deep notch in the middle line in front lodges the corpora quadrigemina, and a deeper notch or furrow behind receives the falx cerebelli.

The surface presents a number of subdivisions. The parts of the superior vermiform process enumerated from before backwards are as follows :—

(1) The *lingula*, three or four cerebellar laminæ prolonged over the valve of Vieussens; (2) the *central lobe*, at the fore part of the superior vermiform process; (3) the *culmen monticuli*; (4) the *clivus monticuli*; and (5) the *folium cacuminis*, a thin lamella bounding the horizontal fissure.

On each side of the superior vermiform process are :—(1) The *ala of the lobus centralis* continued from the central lobe; (2) the *lobus lunatus anterior* continuous with the culmen monticuli; (3) the *lobus lunatus posterior* continuous with the clivus monticuli; (4) the *postero-superior semilunar lobe* continuous with the folium cacuminis. The fissures separating these lobes from before backwards are :—(1) the *precentral*; (2) the *postcentral*; (3) the *preclival*; and (4) the *postclival.*

The cerebellum is connected to the cerebrum and spinal cord by three peduncles or crura :—superior, middle and inferior. The superior can now be seen.

The *Superior Peduncle* (Fig. 315, 3) (*processus a cerebello ad testem*) is a broad flattened white band, which is connected below with the inferior vermiform process, and passes upwards, forwards, and inwards to the corresponding testis (inferior quadrigeminal body). It forms the superior lateral boundary of the fourth ventricle. The two processes are prolonged beneath the corpora quadrigemina to the optic thalami, their fibres decussating in their passage.

The *Valve of Vieussens* (Fig. 314, 13) (*Velum medullare anterius*) is the thin layer of white nervous matter, stretched between the two superior peduncles of the cerebellum, and connected with the lingula of the superior vermiform process. It is narrow in front, but broader behind, and bridges over the upper part of the cavity of the fourth ventricle. The fourth pair of nerves arise from the middle line of the valve close behind the corpora quadrigemina (Fig. 317, 15), and a small mesial ridge, the *frænulum*, extends from its apex to the groove between the inferior quadrigeminal bodies.

[The preparation is to be turned over for the examination of the remaining peduncles and of the under surface of the cerebellum.]

The *Middle Peduncle* (Fig. 315, 4) (*processus a cerebello ad pontem*) has been already seen at the base of the brain. It is the largest of the three, and the fibres pass across from one hemisphere of the cerebellum to the other constituting the transverse fibres of the pons Varolii, which have been already dissected (p. 674).

The *Inferior Peduncle* (Fig. 315, 5) (*processus a cerebello ad medullam*) will be better seen when the fourth ventricle is opened.

The **Inferior Surface** (Fig. 316) of the cerebellum is divided into two hemispheres by a deep fissure, the *vallecula*, at the bottom of which is the *inferior vermiform process*.

Each hemisphere is subdivided into five lobes. Behind is the *Posterior Lobe* (11); next the *Slender Lobe* (10); and in front of that the *Biventral* or *Digastric Lobe* (5); the *Amygdala* or *Tonsil* (Fig. 305, 29) is a prominent lobe close to the vallecula, which it partially conceals; and the *Flocculus* (Fig. 316, 4) is a small lobe immediately in front of the biventral lobe and beneath the crus cerebelli, whence it is sometimes called the subpeduncular lobe. It is closely related to the roots of the seventh, eighth, ninth, tenth, and eleventh nerves.

Fig. 315.

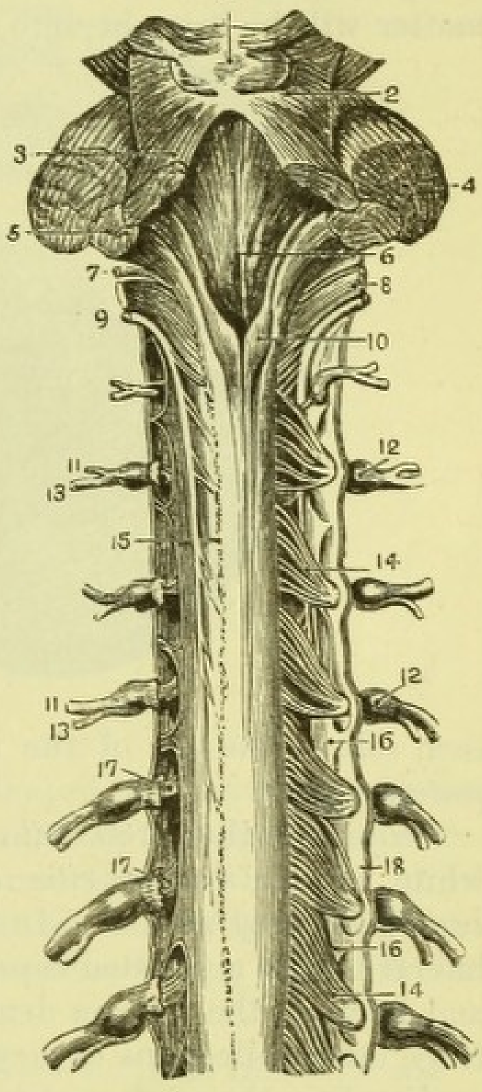


Fig. 315.—Fourth ventricle and upper part of spinal cord and membranes. The posterior roots of the nerves are removed on the left side (from Hirschfeld and Leveillé).

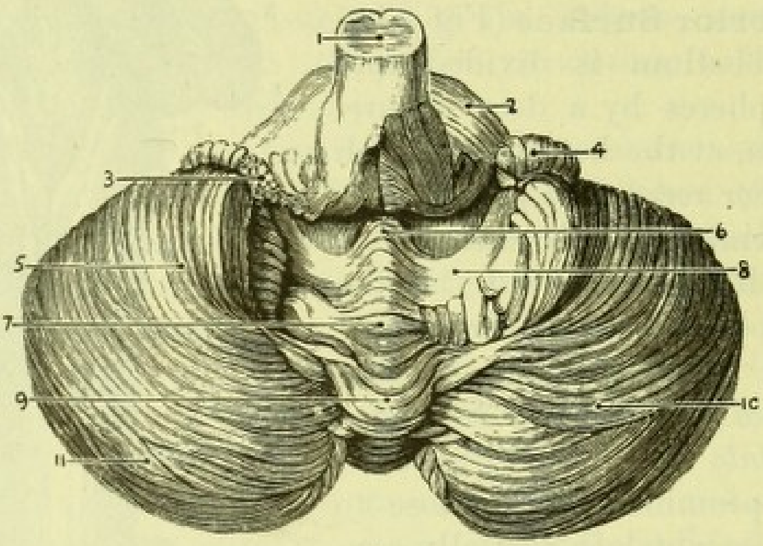
1. Corpora quadrigemina.
2. Fillet of the olivary body.
3. Processus a cerebello ad testem.
4. Processus a cerebello ad pontem.
5. Processus a cerebello ad medullam.
6. Floor of fourth ventricle.
7. Glosso-pharyngeal nerve.
8. Pneumo-gastric nerve.
9. Spinal accessory nerve.
10. Posterior columns of spinal cord.

11, 11. Anterior divisions of spinal nerves.
12, 12. Ganglia of nerves.
13, 13. Posterior divisions of spinal nerves.
14, 14. Posterior roots of spinal nerves.
15. Line of origin of posterior roots of left side.
16, 16. Ligamentum denticulatum.
17, 17. Anterior roots of spinal nerves
18. Dura mater.

The *Inferior Vermiform Process* (Fig. 316) is divided into four portions. Most anteriorly is the *Nodule* (6) which projects into the fourth ventricle; next is a narrow ridge called the *Uvula* (7), so-called from its position between the two tonsils; this is succeeded by the *Pyramid* (9), and most posteriorly are a few transverse laminæ, constituting the *tuber valvulæ.*

By turning aside or cutting away the amygdalæ, a layer of white matter will be brought into view extending from the flocculus on

Fig. 316.



each side to the top of the nodule. This is the *Velum medullare posterius* (8).

On section the cerebellum shows an arborescent arrangement of white matter (*arbor vitæ cerebelli*) capped by the folia of the superficial grey matter. In the centre of the white matter of each lateral lobe is a plicated capsule of grey matter, the *corpus dentatum*, and between the corpora dentata on each side of the middle line are three other collections of grey matter, the *nucleus fastigii*, close to the median line, the *nucleus globosus*, outside this, and the *nucleus emboliformus*, still more externally, close to the corpus dentatum.

[The brain being again placed with the base downward, an incision

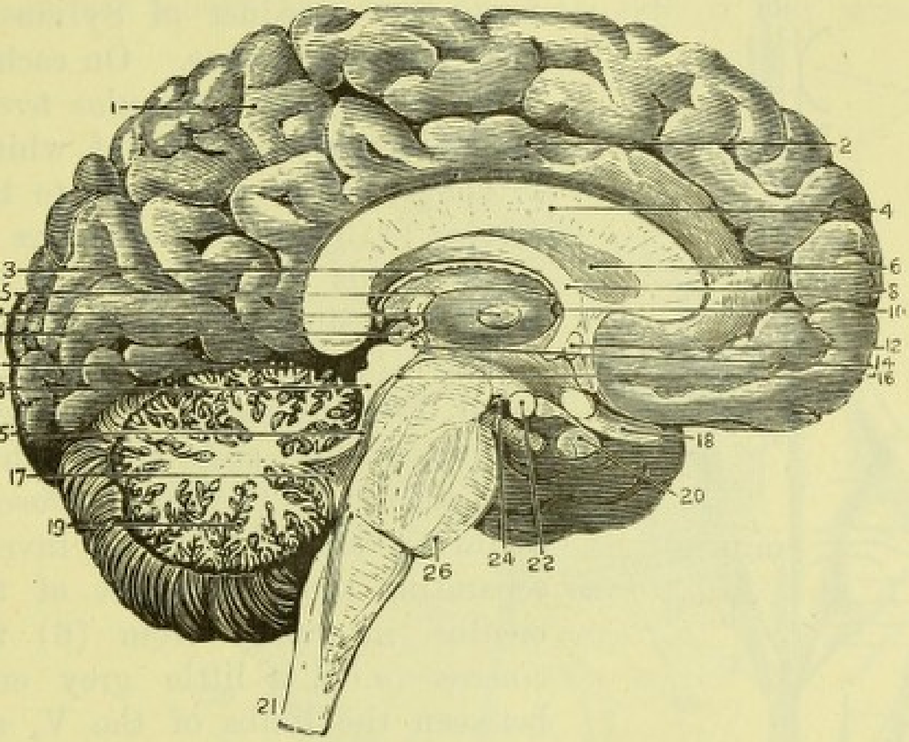
Fig. 316.—Under surface of cerebellum, the amygdalæ having been removed (from Hirschfeld and Leveillé).

1. Medulla oblongata.
2. Pons Varolii.
3. Choroid plexus of the 4th ventricle.
4. Flocculus.
5. Biventral lobe of cerebellum.
6. Nodulus of inferior vermiform process.
7. Uvula.
8. Posterior medullary velum.
9. Pyramid.
10. Slender lobe.
11. Posterior inferior lobe.

is to be made through the valve of Vieussens and the cerebellum, in order to expose fully the cavity of the fourth ventricle.]

The **Fourth Ventricle** (Fig. 315, 6) is a serous cavity situated between the pons Varolii and medulla oblongata in front, and

Fig. 317.



the cerebellum behind. It is lozenge-shaped, and presents anterior and posterior walls, superior and inferior lateral boundaries, superior, inferior, and lateral angles. It communicates with the third ventricle by the aqueduct of Sylvius above, with the central canal of the cord by the *ventricle of Arantius* below, and with the

Fig. 317.—Vertical longitudinal section of the brain (from Hirschfeld and Leveillé).

1. Convolution of longitudinal fissure.
2. Gyrus fornicatus.
3. Velum interpositum.
4. Corpus callosum.
5. Peduncle of Pineal gland on the margin of optic thalamus.
6. Septum lucidum.
7. Middle commissure of third ventricle joining optic thalami.
8. Fornix.
9. Pineal gland.
10. Foramen of Monro.
11. Fissure of Bichât.
12. Anterior commissure.
13. Corpora quadrigemina.
14. Posterior commissure.
15. Valve of Vieussens.
16. Iter a tertio ad quartum ventriculum.
17. Fourth ventricle.
18. Optic nerve.
19. Arbor vitæ cerebelli.
20. Pituitary body and infundibulum.
21. Section of medulla oblongata.
22. Corpus albicans.
24. Locus perforatus posticus.
26. Section of pons Varolii.

subarachnoid space by three apertures in the pia mater of its posterior wall, one in the middle, the *foramen of Magendie*, and one in each lateral recess.

The *anterior wall* or *floor* (Fig. 318) is vertical. It is formed by the posterior surface of the pons Varolii and medulla oblongata, and presents for notice the following parts :—(1) The *median furrow* (*c.sc.*), extending from the aqueduct of Sylvius to the ventricle of Arantius. On each side of this are (2) the *fasciculus teres* (*f.t.*), an eminence consisting of white fibres prolonged from the cord to the crus cerebri ; (3) *Striæ acousticæ* (*a.st.*), white bands of origin of the auditory nerve crossing the fasciculus transversely ; (4) The *superior fovea* (*f.s.*), a small longitudinal furrow external to the fasciculus and above the striæ acousticæ ; (5) The *inferior fovea* (*f.i.*), a furrow shaped like an inverted V, separating the lower part of the fasciculus internally from (6) the *ala cinerea* (*a.c.*), a little grey eminence between the limbs of the V, and (7) the *acoustic tubercle* (*a.t.*), another grey nucleus external to the outer limb. Some grey matter, the *locus cæruleus*, is seen in front of the acoustic striæ, and close to the superior fovea it may be prolonged to the Aqueduct of Sylvius by a thin reddish or purple streak, the *tænia violacea* or *substantia ferruginea.*

Fig. 318.

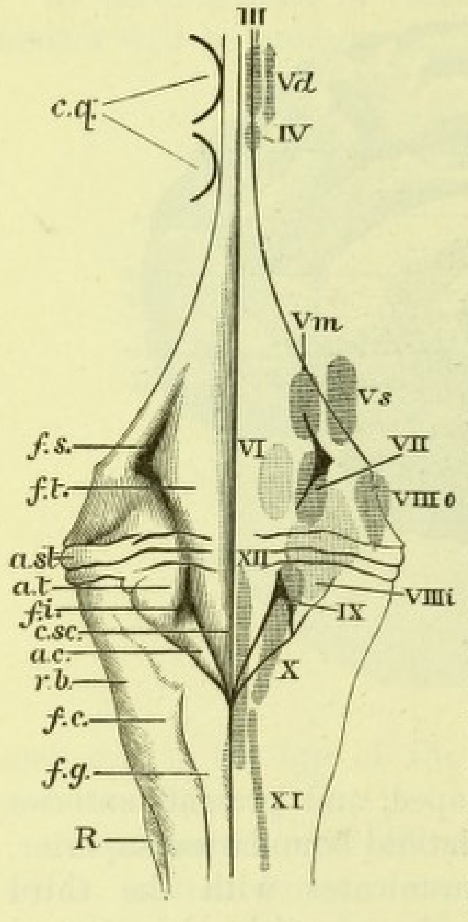


Fig. 318.—Diagram showing the position of the nerve nuclei near the floor of the fourth ventricle (after Thane).

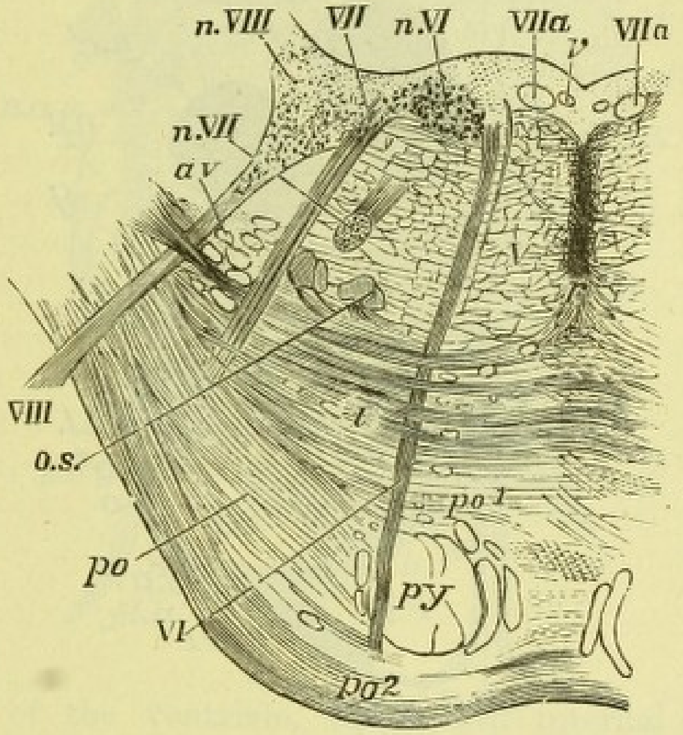
c.q. Position of the corpora quadrigemina.
f.s. Fovea superior.
f.t. Fasciculus teres.
a.st. Auditory striæ.
a.t. Auditory tubercle.
f.i. Fovea inferior.
c.sc. Calamus scriptorius.
a.c. Area cerulea.
r.b. Restiform body.
f.c. Funiculus cuneatus.
f.g. Funiculus gracilis.
R. Tubercle of Rolando.

The Roman numbers indicate the nuclei of the corresponding nerves: V*d*. Nucleus of the descending root of 5th. V*m*. Motor nucleus of 5th. V*s*. Sensory nucleus of 5th. VIII*o*. Outer auditory nucleus. VIII*i*. Inner auditory nucleus.

The *posterior wall* or *roof* is formed by the inferior vermiform process of the cerebellum, the valve of Vieussens (with its lingula), and a layer of pia mater continuous with that of the medulla and cerebellum. This membrane is pierced in the middle by the *foramen of Magendie*, and laterally by two other foramina (*foramina of Key and Retzius*); and its ventricular surface presents the choroid plexus of the fourth ventricle.

The *superior lateral boundary* on each side is the *processus a*

Fig. 319.



cerebello ad testem. The *inferior lateral boundary* is the inferior cerebellar peduncle or restiform body, continuous with the cuneate and Rolandic funiculus of the medulla, and fringed by the *clava* and *funiculus gracilis* of the posterior pyramid. The clava and funiculus show remains of a median union with their fellows of

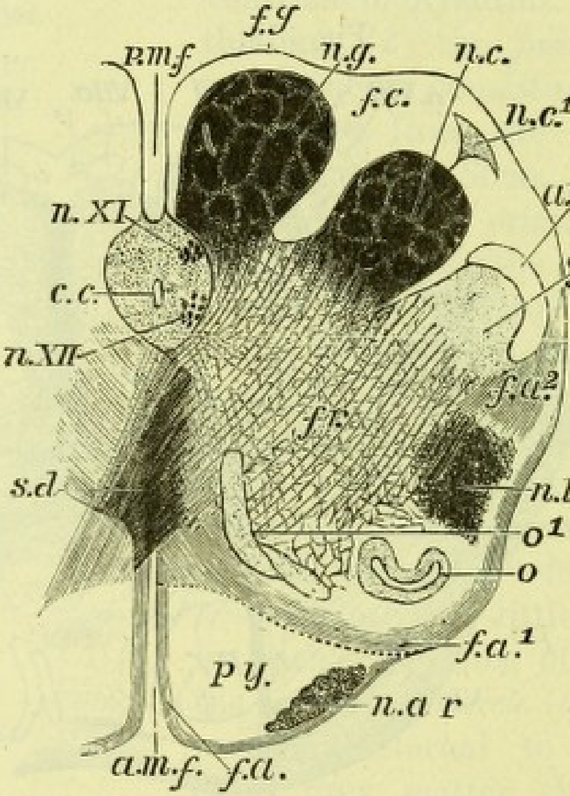
Fig. 319.—Section through Pons Varolii and anterior wall of Fourth Ventricle (Stilling and Schwalbe).

py. Pyramid, continued up from medulla.
po. Transverse fibres passing some behind (po^1) and some in front (po^2) of pyramidal bundles.
t. Deeper fibres constituting trapezium.
r. Raphé.
o.s. Superior olivary nucleus.
a.v. Ascending root of fifth.
VI. Sixth nerve.
*n.*VI. Its nucleus.
VII. The seventh nerve.
VII.*a.* Intermediary nerve of Wrisberg.
*n.*VII. Its nucleus.
VIII. Superior root of auditory nerve.
*n.*VIII. Part of the outer or superior nucleus.
V. Section of a vein.

the opposite side in the form of a little irregular ridge, to which has been given the names of *ligula* above, of *ponticulus* in the middle, and of *obex* below at the clava.

The *deep origins of the cranial nerves*, except the first and second (Fig. 318) are found in or near the anterior wall of the fourth ventricle. The nuclei for the third and fourth nerves lie in the

Fig. 320.



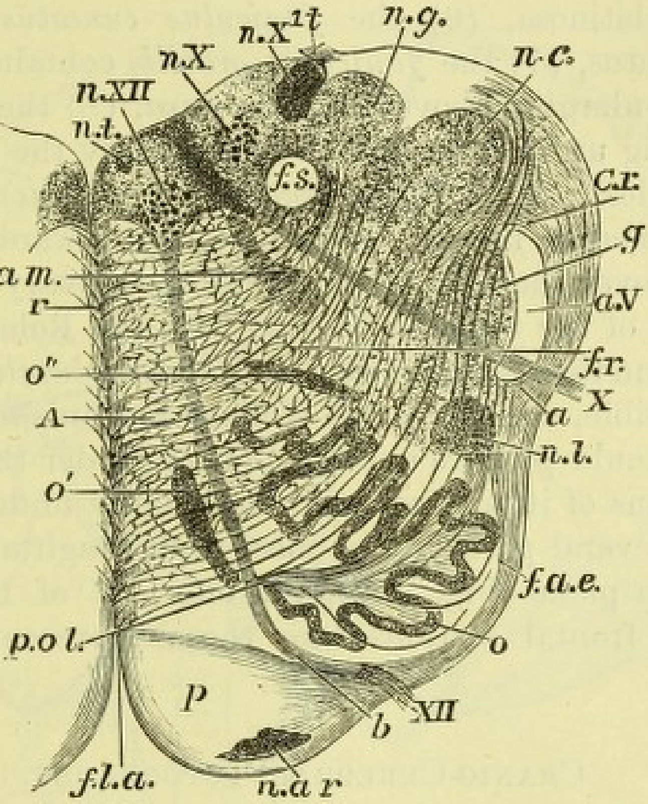
anterior wall of the Aqueduct of Sylvius. The motor and sensory roots of the 5th arise each by two groups of cells, which extend the whole length of the medulla and by the side of the Sylvian

Fig. 320.—Section of the medulla at the level of the decussation of the pyramids (Schwalbe).

a.m.f. Anterior median fissure.
p.m.f. Posterior median fissure.
py. Anterior pyramid.
n.ar. Nucleus of the arciform fibres.
f.a^1. Deep arciform fibres becoming superficial.
o. Lower end of olivary nucleus.
o^1. Accessory olivary nucleus.
n.l. Nucleus lateralis.
f.r. Formatio reticularis.
f.a^2. Arciform fibres coming from formatio reticularis.
g. Substantia gelatinosa of Rolando.
a.v. Ascending root of fifth nerve.
n.c. Nucleus cuneatus.
n.c^1. External cuneate nucleus.
f.c. Funiculus cuneatus.
n.g. Nucleus gracilis.
f.g. Funiculus gracilis.
c.c. Central canal, with grey nuclei for (*n.* XI.) spinal accessory nerve, and (*n.*XII.), hypoglossal nerve.
s.d. Inferior decussation.

aqueduct. The sixth arises from the upper part of the wall close to the middle line, the seventh external and a little inferior to the 6th, the eighth by two nuclei, one beneath the acoustic striæ, the other altogether outside the ventricle. The ninth and tenth near the

Fig. 321.



inferior angle of the ventricle, the twelth internal to these close to the middle line, and the eleventh below the 9th and 10th, and running downwards into the cord as low as the 6th cervical vertebra.

Fig. 321.—Section of medulla about the middle of olivary body (Schwalbe).

f.l.a. Anterior median fissure.
n.ar. Arcuate nucleus.
p. Pyramid.
XII. Surface origin of hypoglossal, which is seen at *b*, passing between the pyramid and olive.
o. Dentate nucleus of olive.
o'. & *o''.* Accessory olivary nuclei.
f.a.e. External arcuate fibres.
n.l. Nucleus lateralis.
a. Arcuate fibres passing towards restiform, partly through substantia gelatinosa, *g*, partly superficial to ascending root of fifth.

X. Surface origin of vagus.
f.r. Formatio reticularis.
c.r. Restiform body.
n.c. Nucleus cuneatus.
n.g. Nucleus gracilis.
t. Attachment of ligula.
f.s. Funiculus solitarius.
*n.*X. & *n.*X¹. Two nuclei of vagus.
*n.*XII. Nucleus of hypoglossal.
n.t. Nucleus of fasciculus teres.
n.am. Nucleus ambiguus.
r. Raphé.
A. Anterior column of cord.
p.ol. Peduncle of olive.

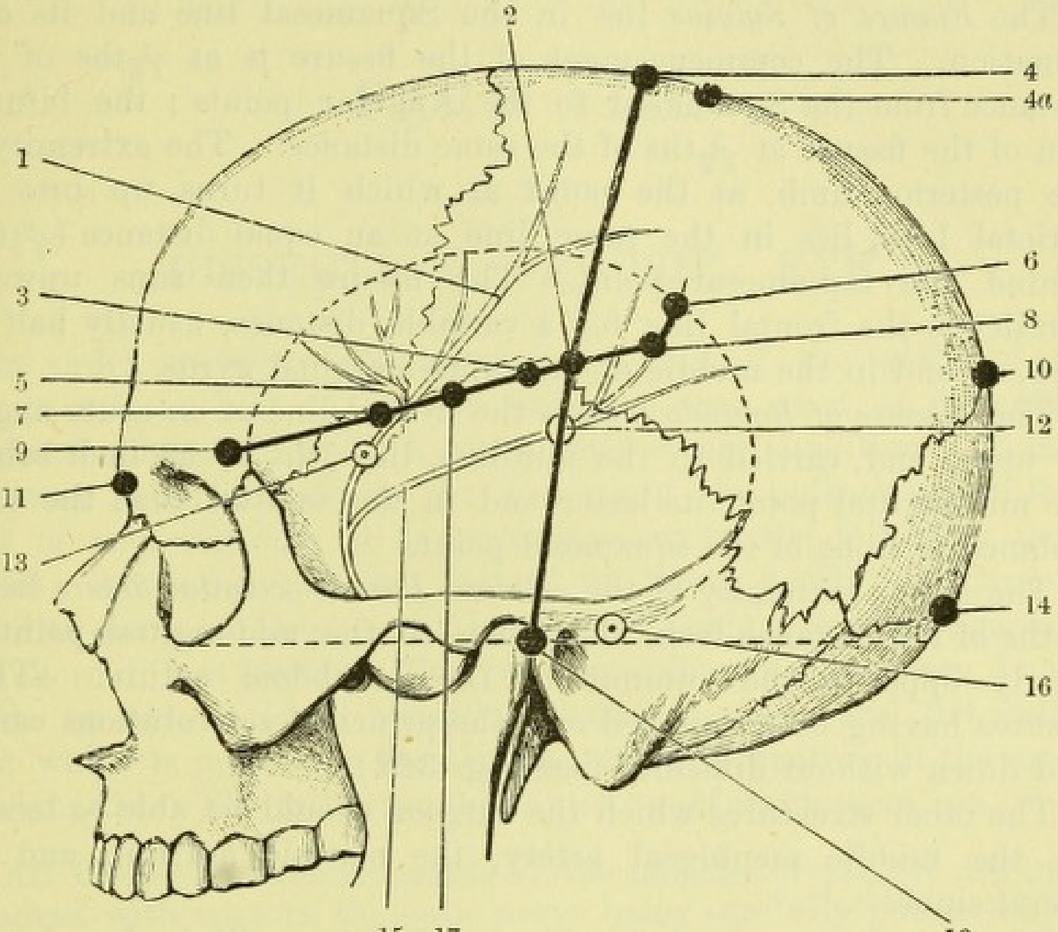
The *Medulla oblongata* may now be seen in its whole extent. Its anterior aspect has been already described (page 675). The parts for notice on each side, enumerated from before backwards from the anterior median fissure, are (1) the anterior pyramid, (2) the hypoglossal furrow with the 12th nerve, (3) the olivary body, (4) the 9th, 10th, and 11th nerves, (5) the *funiculus of Rolando* with the substantia gelatinosa, (6) the *funiculus cuneatus* containing the nucleus cuneatus, (7) the *funiculus gracilis* containing the nucleus gracilis and enlarging above into the *clava*, (8) the *posterior median fissure*, opening up into the fourth ventricle by the separation of the funiculi graciles. Some fibres (*superficial arcuate*), emerging from the anterior median fissure, are seen to run upwards and backwards on each side over the anterior pyramid and olivary body to the posterior surface of the medulla, joining with the Rolandic and cuneate funiculi to form the *restiform* body or *inferior peduncle of the cerebellum.*

When possible, as soon as the student has finished the above dissection, he should procure another brain in order that he may make various sections of it, and so more thoroughly understand the relations of the several parts. The most useful sagittal section is made in the median plane (Fig. 317), and one half of the brain may be reserved for frontal sections like those represented in Figs. 311 and 313.

Cranio-Cerebral Topography.

The relation of the convolutions and fissures of the brain to the surface has been closely studied in the past few years, and many systems have been elaborated for the localisation of any required area upon the shaven scalp. For the details of these the student is referred to the writings of Reid, Hare, Cunningham, Horsley, Poirier, Fraser and other recent investigators, but it is not desirable that more than one method should be given here. It need only be remarked that the desiderata for any scheme of the kind are, firstly, that the cranial landmarks employed shall be distinct, and subject as little as possible to variations in relation to the general proportions of the skull-cap; secondly, that the guiding lines, drawn with the aid of these landmarks, shall adapt themselves to skulls of varying size and conformation; and thirdly, that no special apparatus shall be required for the localisation. The method recommended by Anderson and Makins is the following :—The cranial landmarks (Fig. 322) are (1) The *Glabellar point*, in the mid line of the nasal eminence, on a level with the upper margin of the orbit; (2) The *Inial point*, corresponding to the external occipital protuberance ; (3) The *Mid-sagittal point,* midway between these ; (4) The *Pre-auricular point,* in front of the tragus on a level with the upper border of the external auditory meatus ; (5) The *Angular*

Fig. 322.



point over the external angular process of the frontal bone, on a level with the upper border of the orbit ; (6) The *Squamosal point,* midway between the pre-auricular and mid-sagittal points. By the aid of these points may be drawn upon the shaven scalp three lines, which are definitely related to the principal fissures of the outer

Fig. 322.—Cranial topography (Anderson and Makins).

1. Course of anterior branch of middle meningeal artery.
2. SQUAMOSAL POINT.
3. Rolandic fissure, lower end.
4. Mid-sagittal point.
4a. Rolandic fissure, upper end.
5. Frontal branch of middle meningeal artery.
6. Termination of Sylvian fissure.
7. Sylvian fissure, commencement.
8. Angle of Sylvian fissure.
9. ANGULAR POINT.
10. LAMBDA. External parieto-occipital fissure.
11. GLABELLAR POINT.
12. Posterior meningeal point.
13. Anterior meningeal point.
14. INIAL POINT.
15. Course of posterior branch of middle meningeal artery.
16. Mastoid antral point.
17. Sylvian fissure, bifurcation.
18. PRE-AURICULAR POINT.

surface of the brain; (1) The *Sagittal line* from the Glabellar to the Inial point; (2) The *Frontal line* from the Pre-auricular to the Mid-sagittal point; and (3) the *Squamosal line* from the Angular to the Squamosal point, and about two inches beyond.

The *Longitudinal fissure* coincides with the Sagittal line.

The *Fissure of Sylvius* lies in the Squamosal line and its continuation. The commencement of the fissure is at $\frac{7}{12}$ths of the distance from the Squamosal to the Angular points; the bifurcation of the fissure at $\frac{5}{12}$ths of the same distance. The extremity of the posterior limb, at the point at which it turns up into the parietal lobe, lies in the same line at an equal distance ($\frac{5}{12}$ths) behind the Squamosal point. The fissure then runs upwards parallel to the frontal line for a variable distance, usually half an inch, to end in the middle of the supra-marginal gyrus.

The *Fissure of Rolando* crosses the frontal line at an acute angle; its upper end, carried to the mid-line, lies $\frac{3}{8}$ths of an inch behind the mid-sagittal point, its lesser end in the sagittal line, the same distance in front of the squamosal point.

The upper extremity of the *external Parieto-occipital fissure* lies at $\frac{5}{12}$ths of the distance from the Inion to the mid-sagittal point, or nearly opposite the summit of the Lambdoid suture. These fissures having been mapped out, the principal convolutions can be laid down without difficulty (see Fig. 322).

The other structures which the surgeon should be able to localise are the middle meningeal artery, the mastoid antrum, and the lateral sinus.

The *anterior branch of the Meningeal Artery* will be found on a level with the external angular process, and about an inch and a half behind it. The *posterior branch* of the artery commences about an inch below this level, and runs obliquely backwards and upwards towards the parietal eminence.

The *Mastoid Antrum* may be opened by carefully gouging away thin layers of the bone, about a quarter of an inch behind the upper border of the external auditory meatus.

The *Lateral Sinus* runs about an inch behind the upper border of the external meatus, and curves backwards along the course of the superior curved line to the occipital protuberance.

PART VIII.

DISSECTION OF THE EYE.

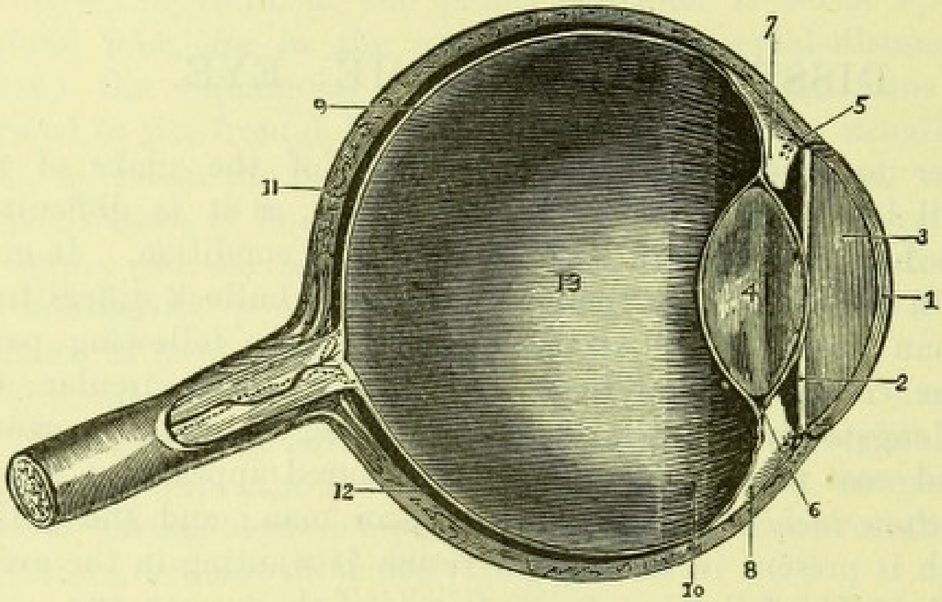
In order to study the general anatomy of the globe of the eye it will be best to procure bullock's eyes, as it is difficult to obtain the human eye in a sufficiently recent condition. It must be borne in mind however that the eye of the bullock differs from that of man not only in its larger size but in the following particulars; the cornea is oval instead of being nearly circular; the pupil is elongated into a slit instead of being a circular aperture; the choroid coat presents the peculiar coloured appearance known as the *tapetum lucidum*, which is absent in man; and the yellow spot which is present in the human retina is wanting in the eye of quadrupeds. The following description is of the human eye.

[All the fat and the remnants of the muscles of the eye are to be removed with scissors, the optic nerve being carefully preserved.]

The **Human Eyeball** (Fig. 323) is nearly globular in shape. The posterior five-sixths (sclerotic segment) consists of the greater part of a sphere with a radius of about half an inch; the anterior sixth (corneal segment) is formed by a portion of a smaller sphere having a radius of a little less than a third of an inch. Hence the antero-posterior diameter is greater than the transverse diameter.

The **Sclerotic** (Fig. 323, 11) or external tunic, constituting the framework of the larger posterior segment, is composed of dense white fibrous tissue, which serves to maintain the shape of the eyeball and to protect the internal parts. It is thicker behind than in front, and is perforated behind by the optic nerve, a little to the inner side of the axis of the globe. The opening for the optic nerve is funnel-shaped, and bridged across by a layer of fibrous tissue, the *lamina cribrosa*, which is pierced by numerous apertures for the fibrils of the nerve, and a central orifice for the *arteria centralis retinæ.* The sclerotic is also penetrated at various points by the ciliary vessels and nerves :—around the optic nerve entrance by the long and short ciliary arteries and nerves ; near the corneal margin by the anterior ciliary arteries ; and near the equator, by the venæ vorticosæ. In front it gives insertion to the recti muscles, from which it receives an expansion, and anteriorly to this point the conjunctiva is reflected upon its surface, but can be readily stripped up as far forwards as the margin of the cornea. The eyeball

Fig. 323.



behind the corneal margin is surrounded by the *Capsule of Tenon* (see p. 431).

The sclerotic overlaps the margin of the cornea, especially above and below. The tissue of the two structures is continuous.

The **Cornea** (Fig. 323, 1) is one of the transparent media of the eye. In man it is perfectly circular when seen from within, but appears wider in the transverse direction if looked at from without, on account of the greater overlapping by the opaque sclerotic above and below.

The curvature of the cornea varies in different individuals, but

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Fig. 323.—Longitudinal section of the eye (drawn by H. Power).

1. Cornea.
2. Iris.
3. Anterior chamber communicating with the posterior chamber through the pupil.
4. Lens enclosed in its capsule.
5. Canal of Schlemm.
6. Canal of Petit.
7. Ciliary body and process.
8. Ciliary muscle.
9. Retina.
10. Ciliary zone.
11. Sclerotic.
12. Choroid.
13. Vitreous humour.

the anterior and posterior surfaces are always parallel. Its structural elements are divisible into five layers : 1, anterior epithelium (conjunctiva corneæ) ; 2, anterior elastic lamina ; 3, cornea proper ; 4, posterior elastic lamina, or membrane of Descemet ; 5, posterior epithelium (of anterior chamber). The cornea in health is a non-vascular structure, and its nourishment is derived from the surrounding vessels ; but it is traversed by a multitude of delicate branches of the ciliary nerves, some of which may be traced into the anterior epithelium.

By squeezing the eyeball between the finger and thumb the cornea will be rendered white and opaque, but resumes its former appearance when the pressure is relaxed.

[Holding the eye lightly with the left hand, the scalpel is to be thrust through the margin of the cornea into the anterior chamber, when the aqueous humour will necessarily escape. With scissors the cornea may then be removed entirely.]

The **Anterior Chamber** (Fig. 323, 3) is the space between the cornea and the iris. It communicates with the posterior chamber through the pupil, and is filled with the aqueous humour.

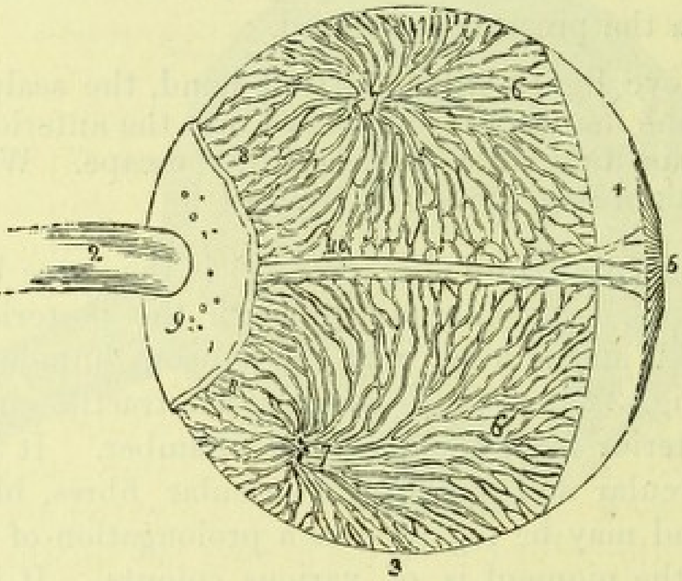
The **Iris** (Fig. 323, 2) is the vascular contractile curtain which separates the anterior from the posterior chamber. It is composed of unstriped circular and radiating muscular fibres, blood-vessels, and pigment, and may be regarded as a prolongation of the choroid coat. In man, the pigment is of various colours. It is contained partly in cells dispersed through the tissue, and partly in a multiple layer of cells called the *Uvea*, which covers the posterior surface of the iris, and is continuous with the pigment of the ciliary processes. The *Pupil* is a circular opening (in man) in the centre of the iris, and varies in size according to the degree of the contraction of the annular muscular fibres under the influence of light or during convergence of the eyes.

The **Posterior Chamber**, lying behind the iris, is little more than a virtual space, since the iris is usually in contact with the front of the lens.

[In order to see the choroid coat entire, a fresh eye should be taken. A puncture having been made through the sclerotic, about its middle, a blowpipe is to be introduced, and air forced between the sclerotic and choroid coats, which will thus be separated from one another. The sclerotic may then be divided around the equator of the globe, and the posterior cup-like portion being left as a support to the eye, the anterior part (with the cornea) is to be carefully detached from the choroid. In order to do this it will be necessary to scrape the interior of the sclerotic with the handle of the scalpel near its junction with the cornea, so as to tear through the ciliary muscle which attaches the choroid and iris to the sclerotic coat.]

The **Choroid Coat** (Fig. 324, 3) is a vascular pigmented membrane, expanded over the whole of the posterior portion of the globe of the eye, and continuous in front with the ciliary processes and iris. It is pierced by the optic nerve, and at this point is closely connected to the sclerotic ; is loosely attached to the inner surface of

Fig. 324.



that coat by a delicate connective tissue, called the *membrana fusca*. Between the choroid and sclerotic may be seen the two *long ciliary arteries*, passing to join the anterior ciliary arteries in forming the great arterial circle of the iris, and the *long* and *short ciliary nerves* running forwards to the ciliary processes and iris. The outer surface of the choroid presents the vasa vorticosa, converging to form trunks which pierce the sclerotic between the recti and a little behind the equator of the globe. Within this venous layer is the

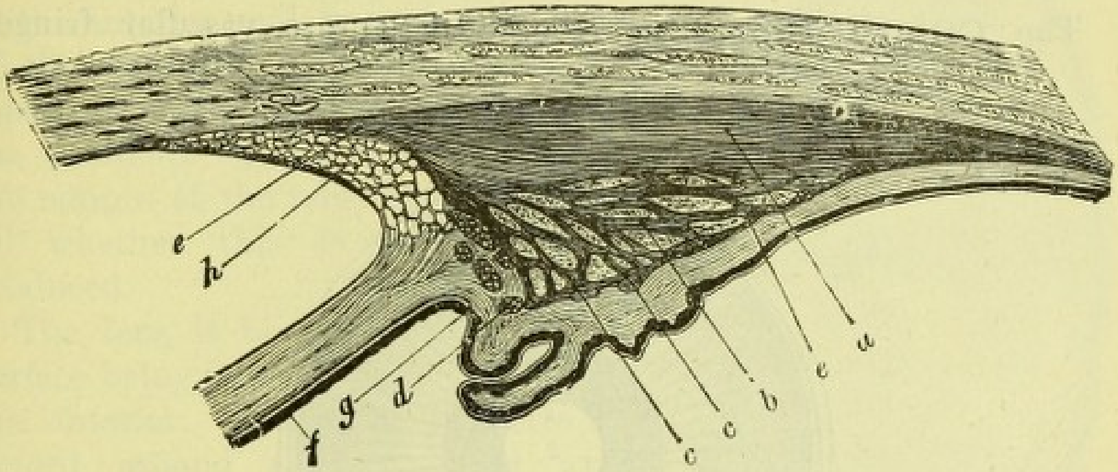
Fig. 324.—The choroid coat and the distribution of the vasa vorticosa (from Wilson, after Arnold).

1. Part of the sclerotic coat.
2. Optic nerve.
3, 3. Choroid coat.
4. Ciliary muscle.
5. Iris.
6, 6. Vasa vorticosa.
7, 7. Trunks of the vasa vorticosa at the point where they have pierced the sclerotica.
8, 8. Posterior ciliary veins which leave the eyeball in company with the posterior ciliary arteries, by piercing the sclerotic at 9.
10. One of the long ciliary nerves, accompanied by a long ciliary artery.

tunica Ruyschiana or *chorio-capillaris*, a plexus of capillaries formed by the breaking up of the short ciliary arteries, which have been seen to pierce the back of the sclerotic near the optic nerve. The dark pigment of the choroid is interspersed among the vessels, and is washed out when the eye is immersed in water.

Surrounding the iris is the annular **Ciliary Muscle** (Fig. 323, 8), composed of unstriped fibre and having a grey appearance. The muscle lies beneath the ciliary processes and is connected anteriorly with the sclerotic coat, close to its junction with the cornea. It

Fig. 325.



consists of both radiating and circular fibres. The *radial fibres* arise from the junction of the cornea and sclerotic, and from the marginal fibres of the membrane of Descemet around an annular sinus called the canal of Schlemm (Fig. 323, 5); and spread out to become attached to the outer surface of the ciliary processes, as far back as the anterior limit of the choroid at the *ora serrata.* The *circular fibres* form a ring around the margin of the lens. It is doubtful whether these are not continuous with the radial fibres (Fig. 325).

The mode of action of the ciliary muscle is still uncertain. There is no doubt that it is the chief or sole agent in effecting the accommodation of the lens to near vision, and it is usually believed that by drawing forward the suspensory ligament, with the posterior part of the ciliary processes, it lessens the tension upon the elastic lens

Fig. 325.—Section of ciliary muscle (after Jevans).

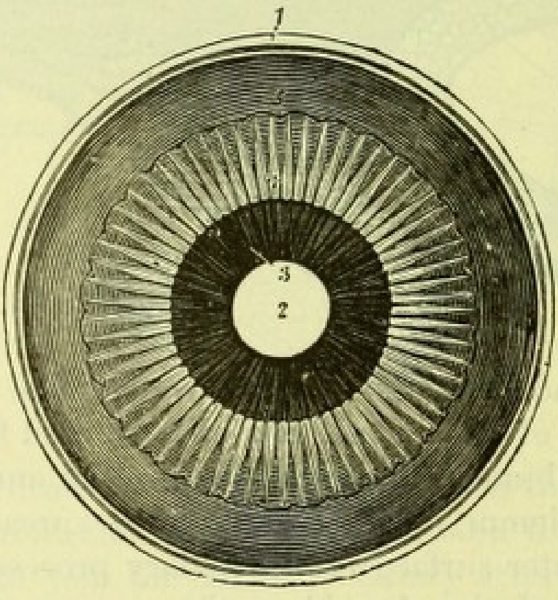
a. Radiating fibres of the ciliary muscle.
b. Circular fibres or muscle of Müller.
c. Circular fibres surrounded by radiating fibres.
d. Circular fibres by themselves.
e. Muscular fibres shown in their connection with the corneo-sclerotic junction.
f. Iris.
g. Uveal tract.
h. Ligamentum pectinatum.

substance, and so allows that body to become more convex. It is however possible that the circular fibres may aid this effect by directly compressing the margin of the lens.

[In order to see the ciliary body and processes, a third eye should be divided circularly through the sclerotic and choroid coats, without damaging the vitreous humour; the vitreous humour and lens are then to be carefully separated from the anterior part of the choroid, the ciliary processes being detached from the hyaloid membrane, upon which they will leave a circle marked with more or less pigment (circle of Zinn). The ciliary processes and iris are now seen from behind.]

The **Ciliary Processes** (Fig. 326, 4) are vascular fringes,

Fig. 326.



which resemble a series of minute convergent conical ridges, forming a ring posterior to the iris and continuous behind with the choroid, the point of junction with the latter being indicated by a festooned line, the *ora serrata*. They are covered with a thick layer of pigment cells (deficient, however, over the most prominent part of the larger cones), continuous with the uvea of the iris in front, and with the pigmental layer of the retina behind. Each cone represents a vascular glomerulus.

Between the anterior margin of the sclerotic and the ciliary body

Fig. 326.—Anterior half of the eye, seen from within (from Wilson).

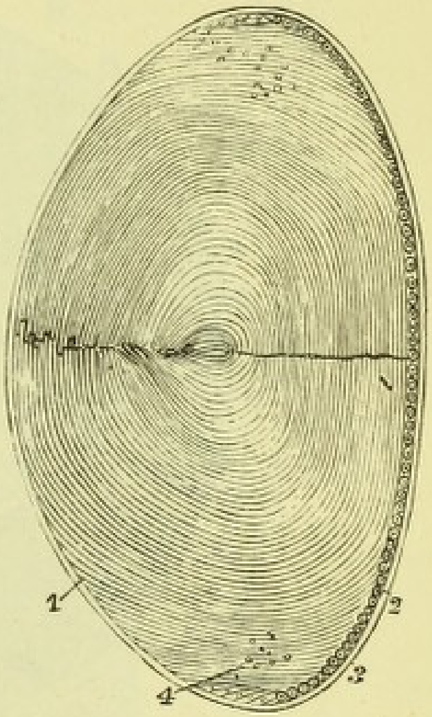
1. Divided edge of the three coats; sclerotic, choroid (the dark layer), and retina.
2. Pupil.
3. Posterior surface of the Iris.
4. Ciliary processes.
5. The anterior border of the retina (ora serrata).

is a venous canal, which runs round the entire circumference of the eye and is called the *Canal of Schlemm* or sinus circulus iridis (Fig. 323, 5).

[The lens will be seen on the posterior half of this section, or may be shown on the first eye by carefully removing the iris.]

The **Lens** (Fig. 323, 4) is situated in front of the vitreous humour, and is kept in its place by the *suspensory ligament*, a transparent structure passing from the hyaloid membrane at the ora serrata to the junction of the anterior and posterior segments of the capsule. A space called the Canal of Petit (6) may be found in the substance of the ligament, around the margin of the lens, but it is doubtful whether this is not artificially produced.

Fig. 327.



The lens is bi-convex, the posterior surface being more strongly curved than the anterior. It consists of fibres arranged around two Y-shaped axes, which may be seen, after a little manipulation, upon the anterior and posterior surfaces of the structure. The central layers are denser than the more circumferential, and form what is called the *nucleus*. Investing the fibrous laminæ is a structureless elastic *capsule*, which receives at its periphery the attachment of the suspensory ligament. The anterior segment of the capsule is separated from the lens substance by a layer of cells (Fig. 327).

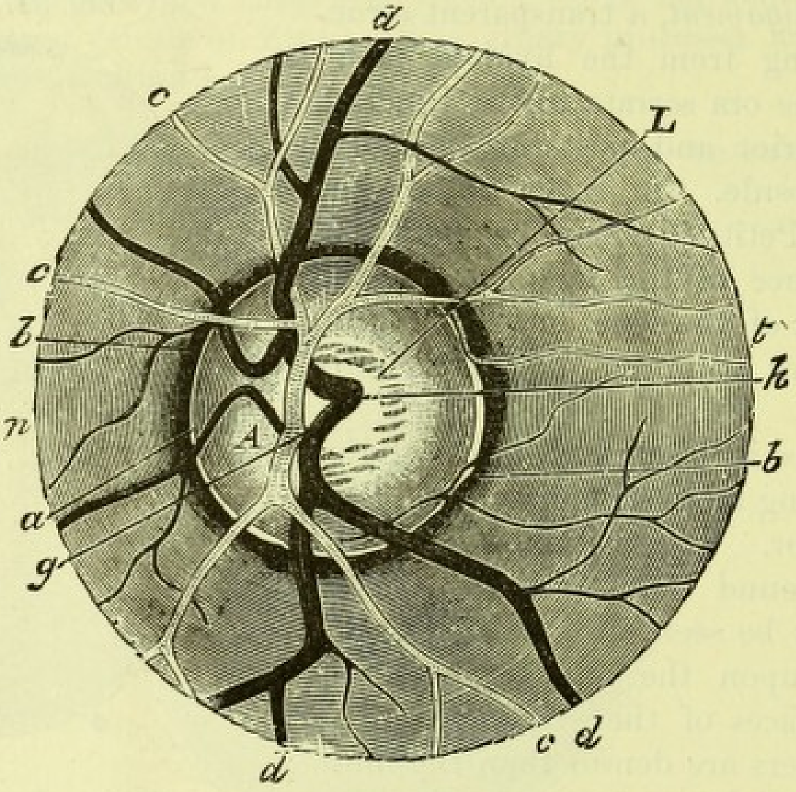
The **Vitreous Body** (Fig. 323, 13) is a transparent structure filling the posterior part of the eyeball. It consists of a gelatinous substance enclosed in a transparent membrane called the *hyaloid membrane*, and is traversed by numerous delicate and perfectly transparent septa, the existence of which may be demonstrated by pressing out the fluid from the body with the fingers. In fœtal life it is pierced axially by a vessel which passes to the lens.

Fig. 327.—The crystalline lens (from Wilson's Anatomy).

1. The laminæ of which the lens is composed.
2. The cells contained between the capsule and front of the lens.
3. Capsule of the lens.
4. Nuclear zone.

In an eye from which the vitreous humour has been removed, the greyish unpigmented strata of the retina will shrink, leaving exposed the retinal pigment adherent to the inner surface of the choroid; and in the bullock's eye will be seen the *tapetum lucidum*, that gives the coloured appearance peculiar to the lower animals. The tapetum consists of a thick layer of wavy fibrous tissue outside the retinal pigment.

Fig. 328.



[The retina is best seen by looking through the vitreous humour of an eye from which the iris and lens have been removed.]

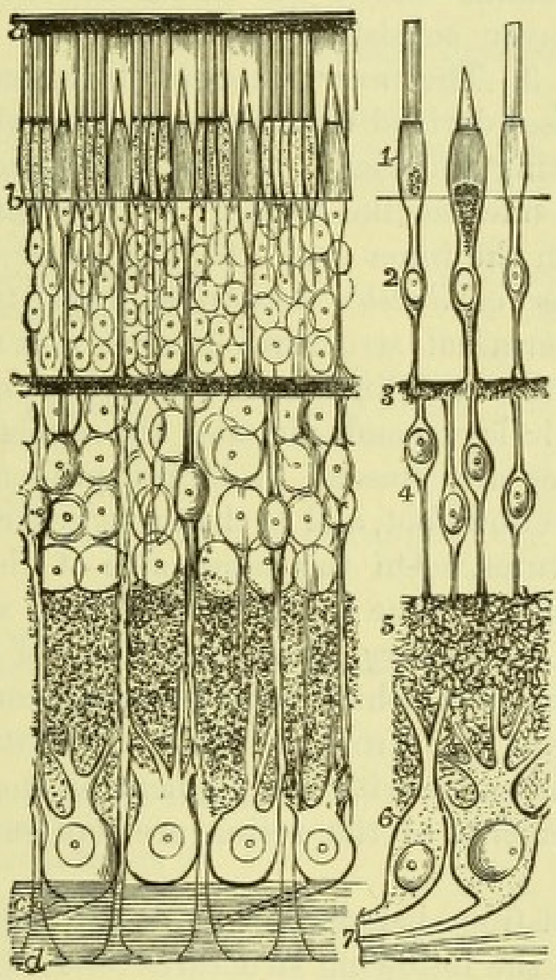
The **Retina** (Fig. 323, 9) lines the choroid coat, and is the nervous membrane of the eye. It is connected posteriorly with the optic nerve, and extends in front as far forward as the finely serrated circle corresponding to the posterior part of the ciliary processes (*ora serrata*), gradually losing in thickness as it leaves the nerve. Beyond this point it is continued over the ciliary processes in a modified form, but without any specific nervous elements.

Fig. 328.—Optic disc (after Jaeger).

A. Optic disc.
b, b. Choroidal ring.
c, c. Retinal arteries.
d, d. Retinal veins.
g. Arteria centralis retinæ dividing
h. Venous radicles uniting to form a trunk.
n. Inner side.
t. Outer side.
L. Physiological cup and lamina cribrosa.

The entrance of the optic nerve (*optic disc*) may be seen as a white circle, the outer side of which lies about one-tenth of an inch to the inner side of the axis of the eye. Radiating from its centre are the branches of the *arteria* and *vena centralis retinæ* (Fig. 328). In the axis of the eyeball in the human eye lies a minute depression, the *fovea centralis* or *yellow spot of Soemmering*, the most sensitive point of the retina.

Fig. 329.



Examined by the naked eye, the retina may be divided into an inner transparent layer in contact with the hyaloid membrane,

Fig. 329.—The Retina (after Schultze).

A. The structures viewed *in situ*.
B. The supposed connection of the several layers.
1. Bacillary layer (rods and cones).
2. Outer nuclear layer.
3. Outer molecular layer.
4. Inner nuclear layer.
5. Inner molecular layer, with a network of branches derived from the ganglion cells.
6. Ganglionic layer.
7. Fibrous layer.
a. Pigmentary layer.
b. External limiting membrane.
c. Rods of Müller.
d. Internal limiting membrane.

colourless during life, but greyish in the dead subject; and an outer pigmentary layer, intimately connected with the choroid coat. Under the microscope the membrane is found to consist of eight layers of nervous structures supported by a delicate connective tissue, and arranged as follows, beginning from the inner surface :— 1. The *fibrous* layer continuous with the optic nerve, composed of radiating nerve fibrillæ which have lost their white substance of Schwann, and are connected with the cells of the ganglionic layer. The connective tissue on the axial side of this layer is condensed into a delicate lamina called the *membrana limitans interna.* 2. The *ganglionic* layer consisting of nerve cells of spheroidal or pyriform shape. 3. The *inner molecular* layer, consisting of a fine network of processes derived from the ganglion cells, imbedded in a molecular supporting material. 4. The *inner nuclear* layer consisting of transparent nucleus-like bodies. 5. The *outer molecular* layer much thinner than the inner one. 6. The outer *nuclear* layer. 7. The *Bacillary layer* or *Jacob's membrane,* consisting of a peculiar arrangement of terminal structures named *rods* and *cones.* These are continuous with some fibres called the *fibres of Müller*, derived from the ganglionic layer and piercing the nuclear and molecular layers. The cones are present in largest proportion in the neighbourhood of the yellow spot, and in the fovea centralis constitute the only retinal structures. On the inner side of the rods and cones the retinal connective tissue is condensed into a *membrana limitans externa.* 8. The *pigmentary* layer, consisting of a single layer of hexagonal pigment cells, which were formerly considered to belong to the choroid coat. In front of the ora serrata the pigmentary layer becomes continuous with the pigment of the ciliary processes, and the other elements of the retina are represented by a layer of columnar cells.

A needle passed from before backwards through the axis of the eye, would pierce the following structures :—1. Cornea. 2. Anterior chamber filled with aqueous humour. 3. Pupil. 4. Posterior chamber. 5. Anterior capsule of lens, with its layer of cells. 6. Lens. 7. Posterior capsule of lens. 8. Vitreous, with hyaloid membrane. 9. Retina (fovea centralis). 10. Choroid. 11. Sclerotic. 12. Capsule of Tenon.

The capsule of Tenon and the vessels and nerves of the eyeball have been described in connexion with the orbit.

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THE END.

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