MANUAL

OF

GENERAL, DESCRIPTIVE, AND PATHOLOGICAL

ANATOMY,

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ANATOMY.

DESCRIPTIVE ANATOMY.

BOOK II.

OF SYNDESMOLOGY.

§ 818. Under the head of *Syndesmology*(1) we shall describe only the modes of union between the bones and the cartilages which cover their extremities. The connections between other organs, as the muscles and the viscera, will be mentioned when speaking of those organs.

The bones are connected by very different substances, and the degree of motion between the bones which are united varies exceedingly. Descriptive syndesmology however treats of the two classes of ligaments, the *synovial* or *capsular* (§ 367), and the *fibrous* or *accessory* (§ 299).

As these organs are intimately connected with the bones, it will be better to describe them in the same order. Hence we shall mention, first, the ligaments of the trunk, then those of the head, and conclude with those of the extremities.

SECTION I.

OF THE LIGAMENTS OF THE TRUNK.

§ 819. The *ligaments of the trunk* are divided into those of the *vertebral column*, of the *ribs*, and of the *sternum*.

(1) The principal books of reference are, J. Weitbrecht, *Syndesmologia, seu Historia ligamentorum corporis humani*, Petersburgh, 1742.—*Desmographie, ou Description des ligamens du corps humain*, Paris, 1752.—M. Alberti, *Nützliche Lehre von der Articulationen des menschlichen Körpers*, Freyberg, 1745.

CHAPTER I.

LIGAMENTS OF THE VERTEBRAL COLUMN.

§ 820. The vertebræ are attached to one another in all parts of their surfaces by fibrous or fibro-cartilaginous ligaments, and in some parts by capsular ligaments also; the former serve to retain these bones in their places and to confine their motions, while the latter facilitate their motions, but are also covered externally by fibrous ligaments.

The principal ligaments of the vertebral column are, 1st, *the intervertebral fibro-cartilages*, which are of all the modes, the strongest bonds of union; 2d, the *synovial capsules*, situated between the articular processes and which facilitate their motions.

These two kinds of ligaments are strengthened, as in all parts, by fibrous fasciculi, placed directly upon them, or which are attached to the other parts of the vertebral column. These fasciculi are the *anterior* and the *posterior vertebral* ligaments, the *accessory fibres of the capsular* ligaments, the *yellow* ligaments, the *interspinal*, and the *intertransverse* ligaments.

We had better consider first the fibrous and fibro-cartilaginous ligaments, and then the synovial capsules.

I. FIBROUS AND FIBRO-CARTILAGINOUS LIGAMENTS.

I. BETWEEN THE BODIES OF THE VERTEBRÆ.

A. ANTERIOR VERTEBRAL LIGAMENT.

§ 821. The *anterior vertebral* ligament (*fascia longitudinalis anterior, ligamentum corporibus vertebrarum commune anterius*) covers the anterior and convex face of the bodies of the vertebræ. It extends from the centre of the anterior part of the large occipital foramen which Weitbrecht has wrongly disputed, to the last bone of the coccyx.

It is composed of longitudinal fibres which do not extend uninterruptedly from one extremity of the column to the other, but cover in fact only a single vertebra, and which unite above and below on the surface of the intervertebral ligaments with those of the adjacent vertebræ.

The fibres are thicker on the vertebra than in any other part; they grow thinner and shorter as they approach the upper and lower faces of the bone. Hence the anterior surface of the vertebral column is more uniformly convex than it would be without this arrangement, since the bodies of the vertebræ are concave from above downward.

Besides the straight fibres, we also find many which are oblique; these cross the former at a very acute angle.

This ligament is thicker, and its fibres are much closer in its centre than on the sides. The fibres separate very much from each other on the two sides of the median line, while on the contrary they unite backward so that they form three bands, the central of which is the strongest while the two lateral bands are weaker.

The ligament covers all the anterior face of the bodies of the vertebræ; it is not confined to the centre and to sending only irregular prolongations to the sides. Its lateral parts are composed of longitudinal fibres as regular as those of the central portion; and they differ so little in their essential characters from the periosteum, that the ligament may be regarded as a periosteum more developed. We cannot at least refuse it this character in most of the vertebral column, especially in the dorsal, the lumbar, the sacral, and the coccygæal regions. In the cervical vertebræ, especially the upper two, the anterior ligament assumes still more the appearance of a very thick, rounded, and very projecting band, which covers only the centre of the anterior face, while the fibres on the lateral parts of the bodies are thin and irregular. This difference doubtless exists because the anterior face of the cervical region is covered with muscles, which are not found in the other regions of the vertebral column. The lateral part of the anterior ligament in these last, appears in the neck as the tendons of the anterior muscles of the neck. So too on the second lumbar vertebra, this ligament becomes the tendons of the diaphragm.

The narrowness of the anterior ligament on the upper cervical vertebræ depends upon the great degree of motion possessed by these bones, and being formed in this manner their motions are not so much obstructed.

This ligament is not equally thick on all the vertebræ. Its thickest parts cover the upper cervical and dorsal vertebræ, the thinnest are found on the superior lumbar vertebræ.

It not only unites the bodies of the vertebræ forward, but also prevents the column from bending too much backward.

B. POSTERIOR VERTEBRAL LIGAMENT.

§ 822. The *posterior vertebral* ligament (*fascia*, s. *ligamentum commune posterius*) extends along the posterior face of the bodies of the vertebræ, within the medullary canal.

It diminishes in breadth from above downward; in the cervical vertebræ it is as broad as the bodies of the vertebræ; it is much thinner on the sides in the dorsal vertebræ, and finally disappears entirely in the lumbar regions, becoming a single waving band situated on the median line, being a little broader on a level with the upper and lower faces of the bodies of the vertebræ.

At the same time, it is attached to the intervertebral substance more firmly than to the posterior face of the bodies of the vertebræ.

Its relations with the vertebræ and with the dura mater are not exactly the same. In most of the vertebral column it is intimately connected with the bodies of the vertebræ, and it is attached to the dura mater only by a loose mucous tissue. But at the third cervical vertebra its relations with these vertebræ change, since the ligaments extending from the head to the cervical vertebræ form, between it and their posterior faces, a peculiar fibrous mass, *the fibrous mass between the head and the cervical vertebræ*, to which that ligament adheres but very slightly as far as the upper extremity of the vertebral column.

In its first portion, it unites as usual to the dura mater; but at the upper extremity of the vertebral column it is so closely connected with this membrane that some skill is required to separate them; hence the separation between the fibrous membrane of the central portions of the nervous system and the largely developed periosteum of the vertebræ begins in this place.

In the same place the posterior vertebral ligament unites intimately with the fibrous mass between the head and the cervical vertebræ.

This ligament limits, to a certain extent, the flexion of the vertebral column forward.

C. INTERVERTEBRAL LIGAMENTS.

§ 823. The *intervertebral* ligaments (*Lig. intervertebralia*) are the principal means of uniting the bodies of the vertebræ, and the vertebræ generally; for the attachments of these bones in other parts, are much looser and much less extensive.

These ligaments completely fill the spaces between the bodies of the vertebræ; they form layers, the upper and lower faces of which are attached to the corresponding faces of two superimposed vertebræ.

They are formed of a considerable number of perpendicular and almost concentric layers, shaped like the circumference of the upper and lower faces of the vertebræ, and they are consequently annular. Their two edges are attached to the two faces of the vertebræ. Their layers are evidently fibrous; in the external layers the fibres are oblique, and almost horizontal in the internal. The oblique fibres of the external layers cross at acute angles. The layers adhere very firmly together by the fibres which extend from one to the other; hence they form only a single dense scaly tissue.

Between the layers we find a softer, yellowish, gelatinous, and shapeless mass.

The nature, the relations, and the proportional quantity of these two substances, differ in all parts of the ligament.

In the circumference, and especially in its anterior portion, the layers much exceed the intermediate substance; they are very compact and are evidently fibrous. Internally, they are much softer; they separate from each other and finally disappear entirely, so that the nucleus, formed by the gelatinous substance, only remains. In whatever direction the vertebral ligaments are cut, this nucleus projects from the incision, being pushed out by the elasticity of the fibrous layers.

These ligaments are thicker in the centre than on the circumference, because the bodies of the vertebræ are concave in this place.

They are very solid, so that the bones of the vertebral column will break before they tear.

From their great elasticity, the height of man varies at all periods of life, and diminishes or increases according as the vertebral ligaments have been for a longer or shorter time pressed down by the weight of the head and that of the vertebræ upon each other; hence man is taller in the morning than at night. This difference is not the same at all ages; it is less evident in old than in young men. In general it amounts to about one inch.(1)

The intervertebral ligaments have not the same thickness in all parts. It diminishes from the cervical vertebræ to the lower extremity of the vertebral column, whence there is a difference in this respect of several lines. Between the lumbar, these ligaments are only three or four lines thick.

§ 824. There are no intervertebral ligaments between the first and second cervical vertebræ, nor between the first and the head, between the sacrum and the coccyx, nor between the bones of the coccyx; these bones are united in a looser manner.

§ 825. The intervertebral ligaments are strengthened directly by anterior and posterior vertebral ligaments (§ 822, 823), which cover most of their circumference, and pass before them in going from one vertebra to another.

II. OF THE FIBROUS AND FIBRO-CARTILAGINOUS LIGAMENTS BETWEEN THE ARCHES AND THE PROCESSES.

A. YELLOW LIGAMENTS.

§ 826. The arches of the vertebræ are united by the *yellow* ligaments (*Lig. crurum vel arcuum subflava*, s. *flava*), as their bodies are connected by the intervertebral ligaments. These two kinds of ligaments may then be compared to each other.

The yellow ligaments are yellowish, lustreless, and smooth; they are formed of several perpendicular and very elastic fibres, of which the external are evidently of a tendinous nature. These external fibres, which have a more oblique direction, fill all the space between the arches of two adjacent vertebræ, from the roots of the transverse processes to the angle of union, which however remains unattached.

Their upper edge is always attached to the internal face, and never to the inferior edge of the arch of the vertebra above. The inferior is attached to the upper edge, and slightly to the external face of the

(1) *Mém. de Paris*, 1725, 1730.

arch of the vertebra below. The vertebræ are rough where these ligaments are inserted.

The thickness, solidity, and elasticity of these ligaments are very considerable.

They fix the extent of flexion forward and backward in the vertebral column.

They are not perfectly similar in all parts of the spinal column. The smallest are in the dorsal region, those in the neck are larger, and the largest in the lumbar region. Those in the lumbar region are the thickest, and the thinnest are those of the cervical region. Their insertions also vary in extent in the different regions; in the neck they are attached by a thin upper edge to a very narrow portion of the internal face of their arches, above their inferior edge. In the back and loins, this portion is a very broad surface, almost as high as the ligaments, and extends from the centre of the arches to their inferior edge.(1) These differences are worthy of remark, first, because anatomists have hitherto neglected the second; secondly, because they serve to increase the power of the lower portions of the vertebral column and the mobility of its upper portions.

The yellow ligaments do not exist between the first and the second cervical vertebræ, nor between the first cervical vertebra and the occipital bone, or at least they are developed very feebly in these two parts.

B. INTERSPINAL MEMBRANES AND SUPRASPINAL LIGAMENTS.

§ 827. Between the spinous processes we find two kinds of fibrous ligaments, the *interspinal membranes* (*membranæ interspinales*), and the *supraspinal* ligaments (*Lig. inter apices processuum spinosorum*).

a. Interspinal membranes.

§ 828. The *interspinal membranes* are thin and broad, and are formed of irregular, and generally of horizontal fibres. They extend from the roots of the spinous processes to near their summits. They limit flexion forward and are destined especially for the insertion of the long muscles of the back.

b. Supraspinal ligaments.

§ 829. The *supraspinal* ligaments are small rounded bundles of longitudinal fibres, which attach the summits of the spinous processes of the vertebræ to each other, so as to form in fact but one ligament. They also serve to limit flexion forward.

(1) Weitbrecht is mistaken in saying of these ligaments (*loc. cit.* page 107), *Margines prædictorum crurum vix sensibiliter superscandunt*, since they are every where attached much higher than the lower edge, and none of their fibres are inserted in the vertebræ of the neck.

C. INTERTRANSVERSE LIGAMENTS.

§ 830. The *intertransverse* ligaments (*Lig. recta processuum transversalium vertebrarum*, s. *intertransversaria*) do not every where exist. They are found only between the transverse processes of the inferior dorsal vertebræ forward. They serve not so much to unite the vertebræ as to multiply the points of attachment for the sacro-lumbalis and the levatores costarum muscles.

II. CAPSULAR LIGAMENTS.

§ 831. We find on each side, between every two vertebræ, a *capsular* ligament, the ligament of the *articular processes* (*Lig. capsulare processum obliquorum*); this arises from the circumference of the articular faces of the adjacent oblique processes by irregular bundles of fibres. In the dorsal and lumbar regions this ligament is strengthened anteriorly by the yellow ligaments.

These ligaments have not the same extent in every part. They are much looser and less tense in the neck than in the other parts of the vertebral column. The broadest, the thinnest, and the loosest, is that between the first and second cervical vertebræ.

CHAPTER II.

OF THE LIGAMENTS OF THE RIBS.

§ 832. The ligaments of the ribs are divided into three classes:

1st. Those situated between the ribs and the vertebræ.

2d. Those situated between the ribs and the sternum.

3d. Those which exist between the ribs.

I. LIGAMENTS BEWEEN THE RIBS AND THE VERTEBRÆ.

§ 833. The ligaments between the ribs and the vertebræ, are some of them synovial capsules, and others supplementary fibres, which unite the posterior parts of the ribs with the bodies and the transverse processes of the vertebræ.

A. LIGAMENTS OF THE HEADS OF THE RIBS.

§ 834. The ligaments of the heads of the ribs (*Lig. capitulorum costarum*) are short capsules, which extend from the lateral articular facets of the dorsal vertebræ to the heads of the ribs. These capsules are strengthened in front by the oblique fibrous ligaments, which have two different directions; the upper go from within outward, and from above downward, and the inferior in the opposite direction.

B. LIGAMENTS OF THE TUBERCLE, AND THE EXTERNAL TRANSVERSE LIGAMENTS OF THE RIBS.

§ 835. Short synovial capsules arise from the anterior face of the summits of the transverse processes of the dorsal vertebræ, and go to the circumference of the articular surface of the tubercles. These capsules are looser in the lower than in the upper ribs.

The *quadrangular ligaments* (*ligamenta transversaria costarum externa*) are situated on them posteriorly, and proceed from the summits of the transverse processes of the vertebræ: they are formed of very strong, more or less transverse fibres. These ligaments are narrower from above downward than from without inward, and are longer in the inferior than in the superior vertebræ. Their fibres descend to the upper and ascend to the lower ribs, from the transverse processes of the vertebræ.

They serve to strengthen the articulations of the ribs with the vertebræ.

C. INTERNAL LIGAMENTS OF THE NECKS OF THE RIBS.

§ 836. The *internal ligaments of the necks of the ribs*, or the *internal transverse ligaments* (*Lig. cervicis costarum interna* s. *transversaria interna*) do not extend, like the former, from the vertebræ to the ribs, which are articulated with them; but from the inferior edge of the transverse process of the vertebra above, to the neck of the rib below. They are formed of fibres, which proceed obliquely from above downward, and from without inward. Their form is rhomboidal, and they are thinner and more feeble than the former.

D. EXTERNAL LIGAMENTS OF THE NECKS OF THE RIBS.

§ 837. The *external ligaments of the necks of the ribs* (*Lig. costarum cervicis externa*) are situated opposite the internal, and are composed of fibres which proceed in an opposite direction, and also extend from the transverse processes of the vertebræ to the necks of the ribs next below. They are scarcely apparent, or in fact do not exist, between the two upper and the two lower ribs.

E. ACCESSORY LIAGMENTS OF THE RIBS.

§ 838. The *accessory ligaments of the ribs* (*Lig. accessoria costarum*) are rounded bands situated beyond the articular heads, which, descend from the transverse processes of the vertebræ to the posterior extremities of the bodies of the ribs.

II. COSTO-STERNAL LIGAMENTS.

§ 839. The ribs unite to the sternum by the costal cartilages, in part directly, in part indirectly.

The cartilage of the first rib is attached to the handle of the sternum, and those of the other six true ribs unite to the articular depressions of this bone by very short capsular ligaments, on which pass strong tendinous fibres united to the periosteum. These ligaments radiate and extend very far, particularly on the anterior face of the body, so that those of one side intercross with those of the side opposite.

III. INTERCOSTAL LIGAMENTS.

§ 840. If we except some tendinous fasciculi of the intercostal muscles which are situated between the bony portions of two adjacent ribs, and which are continuous posteriorly with the intertransverse ligaments of the vertebræ (§ 830), only the costal cartilages are united by particular and constant ligaments. These ligaments are arranged in two different ways.

A. ARTICULAR LIGAMENTS OF THE COSTAL CARTILAGES.

§ 841. The fifth, sixth, seventh, and eighth costal cartilages are united by synovial capsules, on which are strong fibres passing obliquely from above downward, and from without inward. Instead of these capsules, we find between the two following ribs only short tendinous fibres; and between the last ribs only the fibres of the intercostal muscles, and of the obliqui abdominis muscles.

B. FIBROUS LIGAMENTS OF THE COSTAL CARTILAGES.

§ 842. Narrower fibrous ligaments (*Lig. coruscantia*) are situated perpendicularly or obliquely from above downward, and from without inward. They proceed forward, rarely backward, and unite together the costal cartilages, beginning with that of the third rib, except those of the four mentioned in the paragraph above.

CHAPTER III.

OF THE LIGAMENTS OF THE STERNUM.

§ 843. Between the three pieces of the sternum is a fibro-cartilaginous mass formed of horizontal fibres, which go from before backward. This mass seldom disappears entirely, and never except at a very advanced age; but it is effaced between the second and the third pieces more frequently than between the first and second. It may be compared with the intervertebral cartilages (§ 823).

On its surface, and also on the anterior and the posterior face of the sternum, are expanded firm tendinous bands, which unite to form membranous expansions termed the *anterior* and *posterior sternal membranes* (*membrana ossium sterni anterior et posterior*).

The *posterior sternal membrane* is formed almost entirely of perpendicular fibres, which are connected with the fibrous bands coming from the membrane of the costal cartilages, at the place where the latter unite to the sternum.

In the *anterior sternal membrane*, on the contrary, we see only at its inferior portion and on the median line, a narrow band formed of longitudinal fibres which arise from the fibres of the membrane of the cartilages of the inferior true ribs. Most of its fibres are formed of fan-like expansions, the summits of which correspond to the insertions of the costal cartilages in the sternum, and intercross with those of the posterior face of the sternum, partially covering the longitudinal fibres from the same origin, and partly covered by them.

These two sternal membranes evidently correspond to the two ligaments of the vertebral column (§ 821,822). They should then, from analogy, be called the sternal ligaments.

SECTION II.

OF THE LIGAMENTS OF THE HEAD.

§ 844. The *ligaments of the head* are,

1st. The ligaments which unite the head to the vertebral column.

2d. The ligaments of the lower maxillary bone.

CHAPTER I.

OF THE LIGAMENTS BETWEEN THE HEAD AND THE VERTEBRAL COLUMN.(1)

§ 845. The head and particularly the occipital bone considered as a single bone articulated to the vertebral column, unites with the first and second cervical vertebræ, and with each differently. The peculiarities of the articulations between the first and second cervical vertebræ, have determined us to examine them separately and to describe them apart from the general ligaments of the vertebral column.

I. LIGAMENTS BETWEEN THE OCCIPITAL BONE AND THE ATLAS.

§ 846. The connection between the occipital bone and the atlas is less intimate than between the vertebræ. The intervertebral and the yellow ligaments do not exist; they are, like the fibrous ligaments, replaced only by looser fibrous bands, which extend from the anterior and posterior arches to the large occipital foramen, and are called the *occipito-atloidal membranes*.

(1) Mauchart, resp. Rumelin, *Capitis articulatio cum primâ et secundâ colli vertebrâ*, Tubingen, 1747.

I. ANTERIOR OCCIPITO-ATLOIDAL MEMBRANE.

§ 847. The *anterior occipito-atloidal* ligament (*membrana annuli anterioris atlantis*) is, in fact, only the summit of the anterior vertebral ligament, and extends from the anterior arch of the atlas to the anterior edge of the large occipital foramen. It is formed of perpendicular fibres, of which those in the centre are stronger, and form a distinct and projecting fasciculus, which is continuous with the central and prominent portion of the anterior vertebral ligament (§ 821), and is attached to the centre of the basilar process of the occipital bone.

II. POSTERIOR OCCIPITO-ATLOIDAL MEMBRANE.

§ 848. The *posterior occipito-atloidal membrane* (*membrana annuli posterioris atlantis*) is situated between the posterior extremities of the two articular ligaments, and extends from the upper edge of the posterior arch to the posterior part of the circumference of the occipital foramen, and fills the posterior space between the two bones. It is thinner and weaker than the anterior, and does not form a continuous membrane, as that does.

III. ARTICULAR LIGAMENTS.

§ 849. The articular processes of the occipital bone and of the atlas are united, like the articular surfaces of the transverse processes, by a complete capsular ligament (*Lig. articulationum capitis cum atlante, Lig. articulare superius*), which arises from the circumference of their contiguous surfaces. It differs from the others in being broader and looser, so that it allows more extensive motions.

IV. ACCESSORY LIGAMENTS.

§ 850. The *accessory* ligaments (*Lig. accessoria*) are fibrous bands, which proceed obliquely from above downward, and from without inward, from the summit and from the upper edge of the transverse processes of the atlas, and are attached partly to the capsule and partly to the occipito-atloidal membranes, and around the occipital foramen. They strengthen the ligaments already described, and furnish points of attachment to the small deep muscles of the head.

II. LIGAMENTS BETWEEN THE BASILAR BONE AND THE AXIS.

§ 851. The union between the head and the axis by means of the basilar bone is much firmer and stronger than that between the head and the atlas. It is formed by very dense bands of longitudinal fibres, which extend from the edges of the occipital foramen to the centre of the axis. There are no capsular ligaments in this articulation.

I. SUSPENSORY LIGAMENT OF THE SECOND CERVICAL VERTEBRA.

§ 852. The *middle straight* ligament, or the *suspensory ligament* of the second cervical vertebra(1) (*Lig. suspensorium dentis epistrophæi*, s. *rectum medium*), is oblong and composed of straight fibres. It extends from the centre of the anterior edge of the occipital foramen to the summit of the odontoid process, to which it is attached directly above the small anterior articular fossa. It prevents the head from turning too far backward.

II. LATERAL LIGAMENTS OF THE SECOND CERVICAL VERTEBRA.

§ 853. The *lateral* ligaments of the second cervical vertebra (*Lig. epistrophæi lateralia*, s. *alaria Maucharti*) are one on each side, and arise some lines behind the suspensory ligament, from the anterior part of the lateral region of the occipital foramen, and from the rough fossa situated above the internal edge of the condyles of the occipital bone. Their fibres are oblique and are attached to the lateral edges of the odontoid process.

When the head is turned to one side the fibres of the lateral ligament of the opposite side are tense; so that these ligaments limit the lateral motions of the head.

These three ligaments are the most important of those which unite the head with the first cervical vertebra. If one or all three of them be torn, the odontoid process is displaced by the least exertion, slips into the vertebral canal, suddenly compresses the origin of the spinal marrow, and thus occasions death. Hence death from hanging, and hence too, when the head is quickly turned to the side, or when it executes similar motions, the subject sometimes dies.

III. COMMON LIGAMENTS BETWEEN THE BASILAR BONE AND THE CERVICAL VERTEBRÆ.

§ 854. The common ligaments between the basilar bone and the cervical vertebræ are of several kinds, and differ in form, situation, and

(1) Sœmmerring (*Banderlehre*, p. 17) has already remarked that Weitbrecht was wrong in denying the existence of this ligament. In fact, we have always found it perfectly distinct from the crucial ligament; so that we cannot agree with Weitbrecht in thinking that anatomists have been induced by this branch to admit its existence, since we have found both of them constantly, and they were separated by a loose cellular tissue. This remark might seem superfluous, if Bichat had not adopted Weitbrecht's opinion. True, he describes a special ligament between the middle of the odontoid process and the basilar bone, but he is mistaken in stating it to be formed by the upper branch of the crucial ligament and the suspensory ligament; so that he describes the crucial ligament as formed only of a transverse part and of the lower branch, and even mentions a connection between its fibres and those of the posterior ligaments of the vertebræ, although in fact they are separated by the capsule of the crucial ligament (§ 857).

extent. We may divide them into those which are situated *within* and those which are placed on the *outside* of the vertebral column.

I. COMMON INTERNAL LIGAMENTS.

A. CRUCIAL LIGAMENT.

§ 855. Behind the ligament described we find another, which is weaker, called the *crucial* ligament (*Lig. cruciforme*). It is also called the *transverse ligament of the atlas* (*L. atlantis transversale*); this term is however improper, as it points out only one of its parts. It unites the basilar bone with the first two cervical vertebræ.

Its strongest transverse part, called the *transverse ligament of the atlas*, is formed of transverse fibres. It is attached by its two extremities to the rough lateral edge of the medullary foramen of the atlas. It is very tense, and is situated behind the odontoid process: it is much broader in the centre than at its two extremities, and it is cartilaginous forward on the side of the posterior face of the odontoid process. Mauchat has noticed this peculiarity, but he adds, that in this part the ligament does not adhere to the process but is only in contact with it. Bichat only has described the connection of this cartilaginous portion with the process; he states that a synovial capsule exists between them. In fact we have constantly observed this capsule, which we have always found also very broad and very loose.

This transverse ligament forms the two horizontal branches of the cross. The two perpendicular branches of the cross, the upper and the lower, called also the *appendages* (*appendices*), arise from its centre; these are much weaker and are both formed of longitudinal fibres.

The *upper* branch is much longer than the lower, becomes much broader upward, and is not only attached behind the suspensory ligament, from which it is evidently distinct at the centre of the occipital foramen, but also extends some lines on the centre of the upper face of the basilar process of the occipital bone.

The *inferior branch* is much shorter than the other, and it is attached directly below the posterior articular facet of the odontoid process, which is smooth and not cartilaginous, to the upper part of the posterior edge of its base, which is considerably rough.

The use of this ligament is not merely to strengthen the connections between the three bones to which it is attached, but also to allow the atlas to rotate around the odontoid process as around an axis, in which the synovial capsule assists, and at the same time to protect the spinal marrow from the action of this process.

B. LIGAMENTOUS ENVELOP OF THE HEAD AND CERVICAL VERTEBRÆ.

§ 856. Behind the crucial ligament, between it and the posterior ligament of the vertebral column to which it is loosely attached, we find a broad layer of longitudinal fibres, which arises from the upper face of the basilar process of the occipital bone and descends to the third or fourth cervical vertebra. This layer unites above with the dura mater and below with the posterior bridge of the vertebræ. It is called the *ligamentous envelop of the cervical vertebræ* (*apparatus vertebrarum colli ligamentosus*).

II. COMMON EXTERNAL LIGAMENT BETWEEN THE HEAD AND THE CERVICAL VERTEBRÆ.

§ 857. The common external ligament between the head and the cervical vertebræ is the *cervical* ligament (*Lig. nuchæ* s. *cervicis*), which begins at the spinous process of the seventh cervical vertebra, whence it extends to the posterior occipital spine and to its upper curved line. This ligament is thin and perpendicular, and gradually enlarges as it approaches the head. Its upper edge is thicker, it being formed of the united tendons of the muscles of the neck. It is continuous between the cervical vertebræ with the interspinal ligaments, and its posterior edge represents the supraspinal ligaments.

IV. LIGAMENTS BETWEEN THE FIRST AND SECOND CERVICAL VERTEBRÆ.

§ 858. Beside the posterior ligament and the two common capsular ligaments, which are looser here than in the rest of the vertebral column, the anterior face of the odontoid process unites also with the centre of the posterior face of the anterior arch of the atlas by a loose capsular ligament.

CHAPTER II.

OF THE LIGAMENTS OF THE LOWER MAXILLARY BONE.

§ 859. The *ligaments of the lower maxillary bone* are, 1st, those which unite it with the temporal bones; and, 2d, those between it and the hyoid bones.

I. LIGAMENTS OF THE TEMPORO-MAXILLARY ARTICULATION.

§ 860. The temporo-maxillary articulation is formed by an *interarticular cartilage*, two *synovial capsules*, and by accessory *fibrous ligaments*.

I. INTERARTICULAR CARTILAGE AND SYNOVIAL CAPSULES.

A. INTERARTICULAR CARTILAGE.

§ 861. The *interarticular cartilage* (*operculum cartilagineum*) belongs to the class of fibro-cartilages; it is oval, situated horizontally, with concave surfaces, and much thinner in its centre than at the edges. There is often in its centre a cavity filled by synovial membranes, which are then directly united. Its circumference is attached only to these membranes, and its external edge slightly adheres to the fibrous ligaments.

This fibro-cartilage diminishes the friction between the articular surfaces of the two bones.

B. SYNOVIAL CAPSULES.

§ 862. One of the two synovial capsules (*ligamenta cartilaginis intermediæ*) is situated above and the other below the interarticular cartilage.

The *superior synovial capsule* arises from the anterior edge of the transverse articular tubercle and from the posterior edge of the articular cavity of the temporal bone, and is attached to the circumference of the interarticular cartilage. It unites above with the cartilaginous covering of the articular surface of the temporal bone, and below with the upper face of the interarticular cartilage.

The *inferior* arises from the circumference of the maxillary condyle, and is attached to the edge of the interarticular cartilage, and unites partly with this cartilage and partly with the cartilage of the maxillary condyle.

These two capsules are very loose, and permit very extensive motions, especially upward and downward, since they are not confined forward or backward by fibrous ligaments.

II. FIBROUS LIGAMENTS.

§ 863. The firmness of the temporo-maxillary articulation depends on an external and an internal fibrous ligament.

A. EXTERNAL FIBROUS LIGAMENT.

§ 864. The *external fibrous* ligament (*membrana maxillæ inferioris*) consists of very firm longitudinal fibres, which arise from the posterior extremity of the zygomatic process of the temporal bone, descend to the neck of the lower maxillary bone, and are attached to the outside and partly to the posterior part of the circumference of the synovial capsule. It is very tense when the jaw is moved forcibly forward or backward, so that it limits these two motions.

B. INTERNAL LATERAL LIGAMENT.

§ 865. The *internal lateral* ligament (*Lig. maxillæ laterale*) should not be considered, properly speaking, as belonging to the temporo-maxillary articulation; for it is situated at some distance from it and adds nothing to its firmness.

It is a thin, oblong, tendinous layer, arises from the spine of the sphenoid bone, and descends obliquely from above downward, from behind forward, and from within outward, to the lower maxillary bone, where it is attached below the internal orifice of the dental canal.

The vessels and the nerves of the lower maxillary bone pass between this ligament and its neck. Its principal use is, to enlarge those surfaces to which the two pterygoid muscles are attached, the outer part of which arises from them, and it is situated between their outer extremities.

II. LIGAMENTS BETWEEN THE SKULL, THE LOWER MAXILLARY BONE, AND THE HYOID BONE.

§ 866. In nearly the same direction as the ligament already described, but more deeply situated, we find a membrane which is thinner, slightly tense, and formed by condensed cellular tissue: this is strengthened only by some fibrous bands, which extend from the lower extremity of the styloid process of the temporal bone to the posterior edge of the angle of the jaw, and send a cylindrical slip to the small horn of the hyoid bone. This is the *stylo-mylo-hyoid* ligament (*Lig. stylo-mylo hyoideum*): it serves partly to unite the temporal, the inferior maxillary and the hyoid bones, and partly to enlarge the surface to which the pterygoideus internus muscle is attached.

CHAPTER III.

OF THE LIGAMENTS OF THE HYOID BONES.

§ 867. The body or the central portion of the hyoid bone articulates with the large and small horns by two synovial capsules; one of them is narrow and tight, and the second is broad and loose. Both, but the first particularly, are strengthened by tendinous fibres.

The posterior extremity of the large horn is attached to the superior horn of the thyroid cartilage by a round perpendicular ligament, in the centre of which we often find a round cartilage or bone.

SECTION III.

OF THE LIGAMENTS OF THE EXTREMITIES.

CHAPTER I.

OF THE LIGAMENTS OF THE UPPER EXTREMITIES.

§ 868. The ligaments of the upper extremities are,
1st. Those between the trunk and the upper extremities.
2d. Those of the scapula.
3d. Those of the elbow-joint.
4th. Those of the fore-arm.
5th. Those of the wrist-joint.
6th. Those of the fingers.

ARTICLE FIRST.

LIGAMENTS BETWEEN THE TRUNK AND THE UPPER EXTREMITIES.

§ 869. The upper extremities are attached to the anterior and superior part of the trunk by the clavicles, to which they are united by synovial and fibrous ligaments. The scapula, trunk, and head, are united only by muscles.

The clavicle is articulated, by its anterior extremity, with the clavicle of the opposite side, and also with the first piece of the sternum and the first rib.

I. INTERCLAVICULAR LIGAMENT.

§ 870. The *interclavicular* ligament (*Lig. interclaviculare, transversum*) is thin and formed of transverse fibres. Its upper edge is loose and concave; the inferior is straight or slightly convex, and is mostly attached to the upper part of the handle of the sternum. It extends from the upper extremity of the articular surface of the internal edge of one clavicle to the corresponding part of the opposite clavicle; so that it unites these bones with each other and with the sternum, and prevents them from moving too far backward.

II. STERNO-CLAVICULAR ARTICULATION.

§ 871. The clavicle and sternum are connected by an *interarticular cartilage*, *two synovial capsules*, and a *fibrous ligament*.

A. INTERARTICULAR CARTILAGE.

§ 872. The *interarticular cartilage* is generally very soft, almost membranous, extremely thin in its centre, and, on the contrary, very thick in its circumference, so that its two faces are concave. It is attached downward, backward, and inward, by a thick and firm fibro-cartilaginous tissue to the facet where the clavicle unites with the sternum ; downward and forward to the clavicle, and to the inner part of the cartilage of the first rib ; upward, forward, and outward, to the margin of the articular facet of the clavicle. It unites intimately forward and backward, with the fibrous ligaments of the sterno-clavicular articulation. It is firmly attached, and admits of but little motion on account of the thickness and breadth of that part of the cartilage which is external to the synovial capsules.

B. SYNOVIAL CAPSULES.

§ 873. The synovial capsules are two, an *upper* and *external*, and a *lower* and *internal*.

The *upper* arises from the margin of the anterior part of the anterior articular facet of the clavicle, which is smooth and covered with cartilage, and is attached around the upper face of the thin and internal part of the interarticular cartilage.

The *lower* arises from the upper part of the lower face of this cartilage, and is attached to the anterior, inferior, and external portion of the articular facet of the handle of the sternum.

Both are small and narrow.

C. FIBROUS LIGAMENTS.

§ 874. The synovial capsules are strengthened by fibrous ligaments which are attached principally to the anterior and posterior parts of their circumference, but never form a dense layer.

The *anterior fibrous* ligament is the stronger, and is formed by perpendicular descending fibres. The *posterior* is formed of radiated fibres, which are attached partly to the posterior face of the upper part of the handle of the sternum and partly to the cartilage of the first rib, and are united with the anterior and the posterior periosteum of the sternum.

III. OF THE COSTO-CLAVICULAR LIGAMENT, OR THE RHOMBOID LIGAMENT.

§ 875. The space between the sternal extremity of the clavicle, the anterior extremity of the rib and most of its cartilage, is filled by a ligament formed of oblique intercrossing fibres : this arises from the posterior edge of the clavicle, goes obliquely from above downward, and from behind forward, and is inserted in the upper and posterior edge of the rib and of its cartilage. A band of transverse fibres is often detached from its inner and inferior extremity, which goes to the lower external extremity of the articular facet of the handle to which the clavicle is attached. It is called the *rhomboid* ligament (*Lig. rhomboideum*), from its form. It unites the bones to which it is attached, retains the clavicle and the first rib in their places, and increases the number of points of attachment of the subclavian muscle.

ARTICLE SECOND.

OF THE LIGAMENTS OF THE SCAPULA.

§ 876. Some of the ligaments of the scapula unite this bone with the clavicle, and others directly or indirectly with the humerus.

I. OF THE LIGAMENTS BETWEEN THE SCAPULA AND THE CLAVICLE.

§ 877. The clavicle and scapula are united by a capsular ligament and by several fibrous ligaments.

A. ACROMIO-CLAVICULAR LIGAMENT.

§ 878. A *capsular* ligament (*connexio claviculæ cum acromio*) unites the acromion process of the scapula with the humeral edge of the clavicle. We may then term it the *acromio-clavicular* ligament (*Lig. acromio-claviculare*). It is short, very tense, and sometimes double, when an inter-articular cartilage exists between these two bones: this articular cartilage, however, is *not* constant, and often fuses with them completely.

Very solid and transverse fibres go upward and downward, but especially upward, over this ligament, which are attached also to the circumference of the interarticular cartilage.

B. CORACO-CLAVICULAR LIGAMENT.

§ 879. The fibrous ligaments are generally two, which are also known as the common ligaments of the scapula, and both unite the clavicle with the coracoid process of the scapula. We cannot however deny but that it would be more convenient to consider them simply as two bands of the same ligament, the fibres of which have not the same direction; one of them is external, the other internal, and they are uninterruptedly continuous with each other. This ligament is called the *coraco-clavicular* ligament (*Lig. coraco-claviculare*), to distinguish it from the preceding, and is formed by strong thick fibres.

It arises from the outer half of the upper face of the coracoid process, and is composed of ascending fibres. It is attached by its upper extremity to the inferior face, and to the posterior edge of the scapular extremity of the clavicle, but it does not extend to the outer end of this bone.

The internal and posterior fibres are shorter and more perpendicular: the anterior and external are longer and more oblique.

The two bands which form this ligament are commonly described, the inner as the *common conoid* ligament, and the external as the *common trapezoid* ligament of the scapula (*Lig. scapulæ communia conoides et trapezoides*).

The *conoid* ligament arises from the root of the coracoid process, proceeds more from before backward, and is attached to the posterior edge of the clavicle: its blunt summit corresponds to the coracoid process, and its broader base to the clavicle. Its anterior fibres are shorter and more perpendicular than the posterior.

The *trapezoid* ligament arises from about the centre of the upper part of the coracoid process; its direction is more transverse, and it is attached more externally than the preceding, to the inferior face of the scapular extremity of the clavicle. The anterior are longer than the posterior fibres.

II. OF THE LIGAMENTS BETWEEN DIFFERENT PARTS OF THE SCAPULA, OR OF ITS PROPER LIGAMENTS.

§ 880. The proper ligaments of the scapula are simply fibrous, and extend, like a bridge, between the two eminences of this bone.

A. ACROMIO-CORACOID LIGAMENT.

§ 881. The *acromio-coracoid* ligament (*Lig. coraco-acromiale, s. anterius, majus, triquetrum*) is a thin band formed of horizontal fibres, which converge from before backward. It sometimes arises by two separate bundles from the whole posterior edge of the coracoid process, and is attached to the anterior extremity of the acromion process. It gradually contracts from before backward, and from within outward, and terminates in a very acute summit. The inner and outer edges (the former of which is the longer) are loose. The whole ligament is covered by the scapular extremity of the clavicle, and by the deltoid muscle, rests on the anterior part of the supraspinatus muscle which keeps it in place, and terminates by a thick layer placed under the deltoid muscle; it projects over the scapulo-humeral articulation, and thus prevents the displacement of the humerus upward.

B. COSTO-CORACOID LIGAMENT.

§ 882. The *costo-coracoid* ligament (*Lig. coraco-costoideum*), calle also the *coracoid* (*Lig. coracoideum*) or the *proper small* ligament of

(1) Sœmmering, *loc. cit.*, p. 42.—Bichat, *An. descr.*, vol. i. p. 273.

the scapula (*Lig. scapulæ proprium, posterius, minus, obliquum*), is much smaller than the preceding; it has the form of a thin square band, and it extends from the root of the coracoid process to the inner end of the upper edge of the scapula or of the rib above the scapular fissure, which it changes into a canal through which the nerves and vessels of the shoulder pass. It often ossifies.

III. HUMERO-SCAPULAR ARTICULATION.

§ 884. The *humero-scapular articulation* is formed by a synovial capsule and a fibrous capsule, which covers the former. These two capulses are called the *large capsular* ligament of the humerus (*Lig. capsulare ossis humeri magnum*).

A. SYNOVIAL CAPSULES.

§ 884. The *synovial capsule* covers the articular surface of the scapula above, and the head of the humerus below. After leaving these two surfaces, it reflects on itself to form a large and loose sac.

This sac, like all the synovial capsules, is entirely closed; but it covers also the bicipital groove, and even the upper part of the tendon of the long portion of the biceps muscle, for it is reflected from the groove over the tendon, although no opening exists on this part.

B. FIBROUS CAPSULE.

§ 885. All the surface of this synovial capsule is covered by a complete fibrous capsule, which forms a broad and loose sac, open on the two sides. It is attached above to the circumference of the glenoid cavity of the scapula, and below to the neck of the humerus: in both points it is continuous with the periosteum.

Its upper edge is continuous with a fibro-cartilaginous ring, which surrounds the glenoid cavity, and slightly projects above its surface. It is called the *glenoid* ligament (*Lig. glenoideum*). It is formed of closely interlaced fibres, and is thicker at its upper portion than in its other parts, since it is there strengthened by a fibrous band coming from the coracoid process. Its internal face is thinner, and even there we occasionally see spaces filled by the tendon of the subscapularis muscle.

It is strengthened above by the tendon of the supra-spinatus muscle, backward by that of the infra-spinatus muscle and of the teres minor muscle.

Below and forward its internal edge presents a slight opening, through which the long tendon of the biceps flexor muscle passes.

The looseness of this ligament allows great freedom of motion in the upper extremities.

ARTICLE THIRD.

OF THE LIGAMENTS OF THE ELBOW-JOINT.

§ 886. We find at the articulation of the elbow a *synovial capsule* and several *fibrous ligaments*.

I. SYNOVIAL CAPSULE.

§ 887. The *synovial capsule* (*membrana cubiti capsularis*) unites the lower extremity of the humerus and the upper extremities of the ulna and radius.

Above, after covering the cartilaginous articular surface of the lower extremity of the humerus with which it is blended, it detaches itself forward from the upper part of the two anterior articular cavities; on the sides from the base of the two condyles along the posterior cartilaginous edges of the pulley and of the lower head; backward from the upper part of the posterior articular cavity. From these different points it goes toward the radius and ulna, to which its inferior edge is attached. It is much looser and more extensive than on the sides.

The portion attached to the radius descends deeply below the head of this bone to the commencement of its neck; so that the head, enveloped by the reflected portion of the synovial capsule, is loose and inclosed in its cavity.

From the inferior part of the neck of the radius it goes on the anterior side of the upper extremity of the ulna; there it lines the lateral sigmoid cavities, and the upper edge of the condyle and the coronoid process of the ulna.

We find considerable masses of articular fat in many places, but principally in the anterior and posterior articular cavities, especially above the pulley, between the heads of the radius and ulna, and within the large upper sigmoid cavity; consequently, in all those parts most exposed to compression and friction.

From this description it follows that this synovial capsule, between the anterior part of the articular face of the humerus and that of the radius, is much looser than between the posterior and that of the ulna, which is owing to the greater extent of motion of the radius; for the radius rotates on its axis, while the ulna has only the motions of flexion and extension.

II. FIBROUS LIGAMENTS.

§ 888. The synovial capsule of the elbow-joint is strengthened, on its anterior and posterior faces and on the sides, by fibrous bands, which may be considered so many distinct ligaments, the *lateral*, the *anterior*, and the *posterior*.

The two lateral ligaments are oblong and formed of longitudinal fibres.

I. INTERNAL LATERAL LIGAMENT.

§ 889. The *internal lateral* ligament (*Lig. cubiti laterale internium*) arises from the inner part of the anterior face of the internal condyle of the humerus, covers the internal part of the synovial capsule, and is attached below to the internal edge of the coronoid process of the ulna.

II. EXTERNAL LATERAL LIGAMENT.

§ 890. The *external lateral* ligament (*Lig. cubiti laterale externum*) extends from the anterior face of the external condyle to the inner portion of the circumference of the head of the radius.

III. ANTERIOR AND POSTERIOR LIGAMENTS.

§ 891. The *anterior and posterior fibrous* ligaments (*Lig. cubiti anterius et posterius*) are formed of less regular fibres, and they are broader but weaker than the lateral ligaments.

The *anterior* is strongest in its centre. It is formed of longitudinal fibres, which are loose at its upper part, oblique in the centre, and more transverse in the lower part.

The *posterior* is not well marked, except on the sides, where it is strongest and composed of bands which converge downward; in other parts it is hardly seen.

ARTICLE FOURTH.

OF THE LIGAMENTS OF THE BONES OF THE FORE-ARM.

§ 892. The bones of the fore-arm are united in most of their length, but not in the same manner, nor do the agents of union form a continuous whole. We find at the upper part two fibrous ligaments, in the centre a fibrous ligament, and below a synovial capsule.

I. SUPERIOR REGION.

I. ANNULAR LIGAMENT.

§ 893. The *annular* ligament of the radius (*Lig. radii annulare*) is very strong, and arises from the anterior and posterior extremities of the lateral sigmoid articular cavity of the ulna. It is formed of horizontal and circular fibres, and loosely surrounds the neck of the radius. Behind the sigmoid cavity it forms a circle, lined by the synovial membrane of the elbow-joint, in which the head and the neck of the radius move. Its fibres interlace above with those of the anterior, posterior, and external lateral ligaments; but it terminates downward in a loose edge.

This ligament strengthens the synovial capsule; it confines the motions of the upper part of the radius and keeps it in place.

II. ROUND LIGAMENT.

§ 894. The *round* or *oblique* ligament, called also, but very improperly, the *transverse* ligament (*Lig. antibrachii*, s. *cubiti teres*, s. *membrana obliqua*, s. *transversa*), is a thin but strong band, broadest at its upper part, situated on the anterior face of the bones of the fore-arm: it descends obliquely from the tubercle of the ulna to the internal face of the radius, and is attached below its tubercle.

Its uses are to limit the motion of supination in the radius.

II. MIDDLE REGION.

INTEROSSEOUS LIGAMENT.

§ 895. The *interosseous* ligament (*Lig.*, s. *membrana antibrachii interossea*) unites the two bones of the fore-arm in most of their length. It occupies the deepest region of the fore-arm, being situated between the extensor and the flexor muscles. Its upper part commences below the tubercle of the radius. It is attached in its whole extent to the external edge of the ulna, and to the internal edge of the radius, and extends almost to the lower extremity of the bones of the fore-arm; so that its lower part is much broader than its upper.

It is formed of parallel fibres; these descend from the radius to the ulna, and are much stronger at its upper than at its lower part. In several places, particularly above and below, we observe foramina for the passage of the interosseous vessels.

III. INFERIOR REGION.

SYNOVIAL CAPSULE.

§ 896. The inferior extremities of the bones of the fore-arm are united by a very loose and very broad *synovial capsule* (*membrana capsularis sacciformis extremitatum inferiorum cubiti*), which is strengthened only by some straight and isolated fibres. This capsule arises on the ulna from the semilunar cavity and on the radius from the corresponding eminence.

ARTICLE FIFTH.

OF THE LIGAMENTS BETWEEN THE FORE-ARM AND THE WRIST.

§ 897. The articulation of the bones of the fore-arm with those of the wrist(1) presents a thin and loose synovial capsule and some very strong fibrous bands, which cover its external surface.

I. SYNOVIAL CAPSULE.

§ 898. The synovial capsule arises above from the edge of the triangular and cartilaginous articular surface at the lower extremity of the radius, and from a fibro-cartilage which terminates this articular surface forward; below, from the cartilaginous circumference of the superior or antibrachial articular facet of the scaphoid, the semilunar, and the pyramidal bones, consequently from the bones of the upper range of the carpus, except the pisiform bone, and also fills the spaces between these bones. Prolongations, called *mucous* ligaments (*ligamenta mucosa*), go from several of its parts, among which we distinguish that which proceeds from the union of the first two bones of the carpus to the projection which arises between the two portions of the articular surface of the radius. These prolongations increase the extent of the surface which secretes synovia.

II. INTERARTICULAR CARTILAGE.

§ 899. The *interarticular cartilage* (*cartilago triangularis intermedia extremitatum ossium antibrachii*) (§ 898) is a small triangular fibro-cartilage; its base looks inward, and its summit outward; it is loose at its external edge, and its internal edge is attached to the anterior edge of the lower articular surface of the radius; and it is situated between the lower edge of the ulna and the semilunar bone. Its upper face is covered by the synovial capsule, and the inferior by the synovial membrane of the articulation of the fore-arm with the carpus, so that it belongs to neither; but as it evidently concurs to form the articular surfaces of the bones of the fore-arm, which correspond to the carpus, we must study it here, instead of describing it when treating of the articulation of the bones of the fore-arm, as is generally done.

(1) The carpal ligaments in the back and the palm of the hand, and also the proper carpal ligament in the palm of the hand, are not mentioned here, as they serve not to unite the bones, but only to retain the tendons in their places. They will be described in myology.

III. FIBROUS LIGAMENTS.

§ 900. We may describe, as is most usual, four principal fibrous ligaments, which strengthen the synovial capsule of this joint; the *palmar*, the *dorsal*, the *radial*, and the *ulnar*. The first two are larger and particularly broader than the others.

I. FIBROUS PALMAR LIGAMENT.

§ 901. The *fibrous palmar* or the *anterior* ligament (*Lig. accessorium articuli cubito-carpalis*, s. *lacerti adscititii palmaris*, with the *Lig. accessorium obliquum et rectum*) is composed of mostly horizontal bands, which leave the lower extremity of the palmar face of the radius and the styloid process of the ulna, go a little outward, meet, and unite, being attached to the palmar face of the pyramidal and the semilunar bones. These bands form particularly the *oblique accessory* ligament (*Lig. accessorium obliquum*, Weitbrecht.)

Besides, from the posterior part of the palmar face of the inferior edge of the radius arise strong perpendicular fibres, which are attached above the preceding to the upper edge of the palmar face of the pyramidal and semilunar bones, thus forming the *straight accessory* ligament (*Lig. accessorium rectum*).

These fibres are generally interrupted in parts.

II. FIBROUS DORSAL LIGAMENT.

§ 902. The *fibrous dorsal* ligament (*Lig. fibrosum dorsale articuli cubito-palmaris*), or the *rhomboid* ligament (*Lig. rhomboideum*), is formed of several very strong bands which are also interrupted from place to place; these arise from the external edge of the articular face of the radius, go obliquely from before backward, and are attached to the dorsal face of the pyramidal bone. Their posterior part is the thickest, and there the fibres are most compactly arranged.

III. FIBROUS ANTERIOR OR RADIAL LIGAMENT.

§ 903. The *fibrous anterior* or *radial* ligament (*Lig. radiale articuli cubito-carpalis*) arises from the summit of the styloid process of the radius, unites at its upper part with the anterior bands of the dorsal ligament, and terminating rather pointedly, is attached to the anterior asperity of the radial face of the scaphoid bone.

IV. FIBROUS POSTERIOR OR ULNAR LIGAMENT.

§ 904. The *fibrous posterior* or *ulnar* ligament (*Lig. cubitale articuli cubito-carpalis*) is longer and stronger than the preceding, and arises from the summit of the styloid process of the ulna, and, united with the posterior part of the dorsal ligament, is attached to the dorsal face and to the ulnar side of the pyramidal bone.

ARTICLE SIXTH.

OF THE LIGAMENTS OF THE CARPAL BONES.

§ 905. The ligaments of the carpal bones comprise those which unite the two ranges and those which unite the separate bones of the same.

I. OF THE LIGAMENTS BETWEEN THE TWO RANGES.

§ 906. The two ranges of carpal bones are connected together by a synovial capsule and by fibrous ligaments.

I. SYNOVIAL CAPSULE.

§ 907. The short and close *synovial capsule* extends from the first three bones of the upper range to the four bones of the lower, unites with their cartilaginous faces and also sends small culs-de-sac between the adjacent bones, which are covered by the fibrous ligaments, by which the surfaces are kept in continual contact.

II. FIBROUS LIGAMENTS.

§ 908. The *fibrous* ligaments which exist only externally are very similar to those of the radio-carpal articulation, as respects situation, number, and proportional size.

The *palmar* ligament is short, but broad and triangular. Its central fibres are transverse, its anterior and posterior fibres are oblique; all converge towards the base. They arise from the pyramidal and scaphoid bones, and are attached below to the trapezoides and the os magnum.

The *dorsal* ligament is weaker than the preceding. It is formed of transverse fibres, and partly of those which are a little oblique. It is attached above to the dorsal face of the three anterior bones of the upper range, and below, to the upper region of the dorsal face of the four bones of the lower range.

The *anterior lateral* ligament is formed of perpendicular fibres which extend from the radial side of the scaphoid bone to the os trapezium.

The *posterior lateral* ligament is situated between the base of the unciform process of the unciform bone and the outer edge of the pyramidal bone.

III. LIGAMENTS BETWEEN THE PISIFORM BONE AND THE ANTERIOR RANGE.

§ 909. Besides these ligaments we find two others which are oblique; the upper is smaller, the lower is stronger; these go from the anterior extremity of the pisiform bone to the unciform bone: the second is attached to the inferior face of the body of this last bone, and the other to the summit of its unciform process.

II. OF THE ARTICULATION OF THE DIFFERENT CARPAL BONES.

I. SUPERIOR OR ANTIBRACHIAL RANGE.

A. ARTICULATION OF THE CORRESPONDING FACES.

§ 910. The four bones of the upper range of the carpus are articulated with each other differently, and do not possess the same degree of motion.

The corresponding faces of the three anterior bones are united superiorly by short, firm, and solid fibres, which cover the culs-de-sac of the synovial membrane (§ 907); these are called ***transverse*** or ***interosseous*** ligaments (*Lig. transversa*, s. *interossea*). The fourth on the contrary is attached to the pyramidal bone by a very loose capsule, the dorsal face of which is covered by transverse fibres.

B. ACCESSORY LIGAMENTS.

§ 911. Beside the interosseous ligament (§ 910) we also see, in several parts of the corresponding faces of the carpal bones, fibres, which go from one of these bones to another; these are called the *dorsal* and the *palmar* ligaments of this range. These ligaments are formed of transverse fibres. They unite with each other and also with the supplementary fibres of the synovial capsule, and are stronger in the palm of the hand than on the back.

II. INFERIOR OR METACARPAL RANGE.

§ 912. The corresponding faces of the os magnum and of the unciform bone, of the os magnum and of the trapezoides, are united by transverse and very tense interosseous ligaments, which are seen at their anterior portion. The strongest are situated between the first two bones.

We also observe in this range transverse *dorsal* and *palmar* ligaments, which are formed for the most part of several distinct bands; these extend from the different small bones of the anterior range to the bones adjacent, and usually to those of the succeding range: we generally number three on each side; they are continuous with the fibrous ligaments of the articulation between the two ranges.

ARTICLE SEVENTH.

OF THE LIGAMENTS OF THE CARPO-METACARPAL ARTICULATION.

§ 913. The five metacarpal bones are united by synovial membranes and external fibrous ligaments with the bones of the anterior or inferior carpal range, and also by bands of fibres with the pisiform bone.

I. SYNOVIAL CAPSULE.

§ 914. The *synovial capsule* of the first metacarpal bone is loose and broad; it arises from the edge of the articular surface of the trapezium. The others are for the most part only prolongations of the common synovial capsule (§ 907).

II. FIBROUS LIGAMENTS.

§ 915. The synovial capsule of the first metacarpal bone is strengthened on the radial side by the tendons of the abductor muscles, and also on its edge by longitudinal fibres, which extend from the os trapezium to the first metacarpal bone. These fibres it is true do not exist every where, but they are strongest on the dorsal face; and as they are almost entirely deficient in some places, we usually number four ligaments in this articulation, the *dorsal*, the *palmar*, and two *lateral* ligaments, the *external*, and the *internal*.

§ 916. The fibrous ligaments of the four other metacarpal bones are divided into *dorsal* and *palmar*.

The *dorsal* ligaments are composed of oblique and perpendicular thin fibres, which are generally united in bands; these go from the dorsal faces of the anterior range of the carpal bones to the upper extremity of the dorsal faces of the metacarpal bones.

The *palmar* ligaments on the contrary are composed of more horizontal, and in part of more oblique fibres, which are mostly interlaced with the inferior palmar ligaments of the metacarpal bones. They extend from the palmar face of the anterior carpal range to the palmar face of the posterior extremity of the metacarpal bones.

The strongest of all these ligaments goes from the anterior extremity of the posterior face of the trapezium to the base of the third metacarpal bone, and is attached to its anterior edge.

We find also some superficial bands which extend from the summit of the unciform process of the unciform bone, from within outward, to the base of the fifth metacarpal bone.

§ 917. A very strong round ligament arises from the inferior extremity of the pisiform bone, and goes directly to the base of the fifth metacarpal bone, and which, passing under the band extended from the unciform bone to the fifth metacarpal bone, goes obliquely to the base of the third and the fourth, where it unites with the large ligament described above (§ 909).

ARTICLE EIGHTH.

OF THE ARTICULATION OF THE METACAPAL BONES WITH EACH OTHER.

I. SYNOVIAL CAPSULE.

§ 918. The metacarpal bones of the second, third, fourth, and fifth fingers touch each other at their posterior extremities by smooth and cartilaginous surfaces, over which passes a synovial membrane, which is sometimes only a simple prolongation of the synovial capsule, situated between the posterior and the anterior ranges of the carpal bones (§ 910), but which sometimes also forms several distinct sacs.

The metacarpal bone of the thumb is entirely insulated from the others.

II. FIBROUS LIGAMENTS.

§ 919. The *fibrous* ligaments are situated between the posterior and the anterior extremities of the metacarpal bones. The posterior are of three kinds, the *dorsal*, the *palmar*, and the *lateral*; the anterior are single.

I. POSTERIOR FIBROUS LIGAMENTS.

§ 920. The *dorsal* ligaments are four; one between every two metacarpal bones.(1) All are composed of transverse fibres. They increase very much in breadth and power from the thumb to the fifth finger; the first is however larger than the second. Sometimes they are divided into two bands, an anterior and a posterior; the latter is broader.

The *lateral* ligaments are the narrowest of all. They are usually formed of several distinct bands, and descend below the former from the upper edge of the ulnar side of the metacarpal bone, to the lower edge of the radial side of the next bone; at the same time they turn a little forward.

The *inferior* or *palmar* ligaments are the strongest. They are formed of transverse fibres and extend in this direction between the inferior faces of the bases of the adjacent metacarpal bones.

The lateral and palmar ligaments are sometimes deficient between the first and second metacarpal bones.

(1) Generally, only three are admitted, the ligament between the thumb and finger being considered deficient; but nice dissections convince us that this opinion is erroneous.

II. ANTERIOR FIBROUS LIGAMENTS.

§ 921. There are three *anterior fibrous* ligaments formed of transverse fibres; they are very tense, and extend between the inferior faces of the heads of the second, third, fourth, and fifth metacarpal bones, where they are continuous with the tendinous fibres. They are much larger and more movable than the preceding.

ARTICLE NINTH.

OF THE METACARPO-PHALANGEAN AND PHALANGEAN LIGAMENTS.

§ 922. The anterior extremities of the metacarpal bones, and the posterior extremities of the bones in the first phalanx, and also the three phalanges, are united exactly in the same manner by synovial capsules and accessory ligaments.

I. SYNOVIAL CAPSULES.

§ 923. The *synovial capsules* are loose and broad, especially on the dorsal face of their circumference. At their upper portion, that which looks towards the fore-arm, they extend much farther on the inferior extremity of the upper of the two bones, between which they are found, so that beside the cartilaginous portion they embrace a considerable part which presents no cartilage.

The synovial capsule of the metacarpo-phalangean articulation is much looser and broader than are those of the phalangean articulations.

II. FIBROUS LIGAMENTS.

§ 924. Each of these articulations is confined by three strong ligaments, two *lateral* and an *inferior* ligament.

I. LATERAL LIGAMENTS.

§ 925. The two *lateral* ligaments, the *external*, and the *internal*, are rhomboidal, and formed of oblique fibres. They extend from the two rough depressions, at the two extremities of the head of the upper bone to the same depression in the base of the lower. Being attached directly to the lateral faces of the synovial capsule, they prevent it from separating on the sides.

II. INFERIOR LIGAMENT.

§ 926. The *inferior*, *internal*, or *anterior* ligament is situated on the palmar face of the synovial capsule, and is intimately connected with it. It is composed of transverse fibres. Its tissue is fibro-cartilaginous. It forms a very thick square layer, which is more broad than long, and bi-concave, the upper face of which looks towards the articulation, and the lower to the flexor tendon.

The upper part of the synovial capsule has no special fibrous ligament, but it is strengthened by the tendon of the extensor muscle of the fingers.

III. UNGUAL LIGAMENTS.

§ 927. The *ungual* ligaments (*Lig. unguium*, s. *lateralia subtensa*) are fibrous oblong and rounded bands, situated on both sides of the bones in the third phalanx, and extend from the lateral tubercles of the base to those of the summit. These ligaments are united to the lateral edges of the roots of the nails, and serve to render them firm, and to enlarge the surface on which the nervous tissue of the fingers is expanded.

CHAPTER II.

OF THE LIGAMENTS OF THE INFERIOR EXTREMITIES.

§ 928. The ligaments of the lower extremities are,

1st. Those of the pelvis, and those which unite either the lower extremities to the trunk, or the upper parts of the lower extremities with each other.

2d. The ligaments of the ilio-femoral joint.

3d. The ligaments of the knee-joint.

4th. The ligaments of the leg.

5th. The ligaments of the tibio-tarsal joint.

6th. The ligaments of the tarsus.

7th. The ligaments of the tarso-metatarsal joint.

8th. The ligaments of the metatarso-phalangean and phalangean joints.

ARTICLE FIRST.

OF THE LIGAMENTS OF THE PELVIS.

§ 929. The bones of the pelvis are connected by fibro-cartilages and by fibrous ligaments; but there are no apparent synovial capsules. The fibro-cartilages are the principal and most extensive modes of union. The fibrous ligaments only strengthen the joint formed by the fibro-cartilages; some pass upon these articulations, others go to other parts, so that they assist to form the walls of the pelvis, to increase the surfaces for the insertion of the muscles, and to protect the vessels and nerves.

I. FIBRO-CARTILAGINOUS LIGAMENTS.

§ 930. The articulations of the first kind are the *sacro-iliac symphyses*, and the *symphysis pubis*.

I. SACRO-ILIAC SYMPHYSIS.

§ 931. The *sacro-iliac symphysis* (*symphysis sacro-iliaca*) unites the sacrum with the iliac bones.

The mode of articulation is not the same in all parts.

The smaller anterior and ear-shaped part of each of these two bones is covered with a smooth cartilage. These two cartilages touch; but they are rarely united, at least completely. They are very distinct from each other and smooth in youth; but as age advances they become rougher. We even find between them a fluid, which is thicker and less liquid than synovia.

The two bones are very differently articulated at their larger posterior part. The bones there have no cartilage, are very rough, and separated very far from each other, especially upward and backward, and are united by a very dense, strong, felt-like, fibro-cartilaginous, irregular mass, formed particularly of transverse fibres; this mass is never torn, even when the bones are forcibly separated in this point, but detaches itself from one bone and remains fixed to the other.

We may consider this posterior part of the sacro-iliac symphysis as a particular ligament. This has been done by Bichat, who terms it the *sacro-iliac* ligament (*Lig. sacro-iliacum*).(1)

II. SYMPHYSIS PUBIS.

§ 932. The symphysis pubis is situated between the upper parts of the descending branches of the pubes.

The upper convex portion of the descending branch of the pubis is covered by a thin cartilage, which diminishes from above downward. This cartilage is entirely covered upward, downward, forward, and backward by a very thick layer of ligament, formed of transverse fibres, which are strongly developed at the lower part of the symphysis, and which are continuous with the periosteum and with the tendons of the adjacent muscles. This mass is generally thin on its internal face, but often also projects longitudinally, a difference not dependent on the sex, although sex has no influence upon it.

(1) W. Hunter, *Remarks on the symphysis of the ossa pubis;* in the *London Med. Obs. and Enq.*, vol. ii. p. 321–339.—Tenon, *Mémoire sur les os du bassin de la femme*, in the *Mém. de l'Institut*, vol. vi. Paris, 1806, p. 149–201. This memoir points out very clearly the varieties in the arrangement of the symphysis.

This fibrous layer always renders the articulation much firmer, and is even the principal agent of it. Its firmness however is less than that of the fibro-cartilaginous layer in the sacro-iliac symphyses, since it is generally ruptured when the bones of the pubis are forcibly separated.

The internal arrangement of the joint is not every where the same. Many anatomists admit that the two articular cartilages of the pubis are always united, others assert that they are always separated; some think, that in the first case, they form a single cartilage. We have reason to think however that the last arrangement never exists, and that when a single cartilage only appears, there are, in fact, two, separated by a layer of fibro-cartilage, which intimately unites with them in their whole length, and is connected forward and backward with the fibrous layer already described; at least we have never found a single cartilage, and this arrangement is always seen when the cartilages are united. The mass of fibro-cartilage is inversely as that of cartilage.

The arrangement we have described is not general. At all periods of life, without distinction of age, sex, or any other circumstance, we find the two articular cartilages perfectly separated from each other by a greater or less space, and to a greater or less extent of their height, and united only at their lower extremity by a cartilage, or more properly by a fibro-cartilage, which may be removed without any suspicion of violence. If, sometimes, they are completely united, they are also often entirely separated at their posterior part. The first mode of articulation is most common in the male, and the second in the female; hence the sexes differ, if not constantly, at least primitively and really; for it is not the consequence of pregnancy and parturition, since it is found also in females before they have attained the age of puberty.

II. FIBROUS LIGAMENTS.

§ 933. Some of the *fibrous ligaments of the pelvis* are extended over the fibro-cartilages already described, and others attach the bones of the pelvis to its different parts. The former are *supplementary*, the latter *proper* ligaments.

I. SUPPLEMENTARY FIBROUS LIGAMENTS.

§ 934. The supplementary fibrous ligaments of the sacro-iliac symphysis are two, a *posterior* and an *anterior*.

A. LONG POSTERIOR LIGAMENT OF THE PELVIS.

935. The *long posterior* ligament of the pelvis (*Lig. pelvis posticum, s. ossis ilei longum, s. superficialis*) extends almost perpendicularly, although a little from without inward, from the posterior extremity of

the iliac crest to the summit of the transverse process of the fourth false sacral vertebra. It is very strong, and its form is oblong.

B. SHORT POSTERIOR LIGAMENT OF THE PELVIS.

§ 936. The *short posterior* ligament of the pelvis (*Lig. pelvis*, s. *ilei posticum breve*, s. *profundum*) arises directly below the preceding; it follows the same direction with it, but is shorter and narrower. It is attached to the summit of the transverse process of the third false sacral vertebra.

§ 937. Besides these two ligaments, we also see arise from the posterior part of the internal face of the iliac crest some irregular fibres, which are for the most part oblique and flat, which intercross and proceed from below upward, from without inward, and from behind forward. They unite in several bands, placed one after another from above downward, on the posterior face of the lateral parts of the upper false vertebræ of the sacrum. They concur with the preceding ligaments to strengthen the sacro-iliac symphyses posteriorly.(1)

The latter fibres lead to the anterior pelvic ligaments, which strengthen the sacro-iliac symphysis anteriorly.

C. UPPER ANTERIOR PELVIC LIGAMENT.

§ 938. The *upper anterior pelvic* ligament (*Lig. pelvis anticum superius*) is composed of oblique fibres, which ascend from the commencement of the posterior third of the iliac crest to the transverse processes of the last two lumbar vertebræ. Its form is triangular; it is very thin, and usually perforated for the passage of vessels and nerves, especially when it ascends to the transverse process of the fourth lumbar vertebra.

D. LOWER ANTERIOR PELVIC LIGAMENT.

§ 939. The *lower anterior pelvic* ligament (*Lig. pelvis anticum inferius*) arises from the same point as the preceding, but a little lower and a little farther back. It ascends obliquely from before backward, and is inserted in the transverse process of the fifth lumbar vertebra. It sends fibres downward and forward, which are inserted in the cartilage between the last lumbar and the first sacral vertebra.

II. PROPER FIBROUS LIGAMENTS.

§ 940. The *proper fibrous* ligaments are three on each side, and serve less to keep the bones in their position than to complete the parietes of the pelvis, by a substance which is solid, but is yielding to a certain extent. Two of them are situated behind, one on each side of the

(1) The *lateral posterior* ligament of the pelvis (*Lig. laterale posticum ossis ilei*) will not be described in this place, but in myology.

pelvis; the third is found forward. The posterior two unite two bones, which are separated in the normal state; the anterior is extended between the different parts of one and the same bone.

A. SACRO-SCIATIC LIGAMENT.

§ 941. The *sacro-sciatic* ligament, the *large posterior pelvic* ligament, or the *external posterior pelvic* ligament (*Lig. pelvis posticum magnum*, s. *tuberoso-sacrum*) arises from the posterior and inferior iliac spine, from the posterior part of the external face of the inferior portion of the iliac bones, from the lateral edges, and from the outer part of the posterior face of the inferior portions of the sacrum and coccyx, goes obliquely forward, downward, and outward, contracts and thickens, and is attached to the internal edge of the inferior face of the sciatic tuberosity, where it again enlarges, and gives off a loose, falciform, and thin slip, which goes from the internal face of the ascending branch of the ischium to the descending branch of the same bone.

Beside (§ 940) the uses pointed out, it enlarges the surfaces of attachment of the glutæus maximus muscle and closes the ischiatic notch, which changes into an oval foramen.

B. SMALL SACRO-SCIATIC LIGAMENT.

§ 942. The *small sacro-sciatic*, or the *sacro-spinal* ligament (*Lig. pelvis posticum parvum*, s. *spinoso-sacrum*) arises before the preceding, from the outer edge of the inferior portion of the sacrum and of the pieces of the coccyx. Its fibres go forward, outward, and upward; the upper fibres descend, the central are straight, and the inferior ascend. It crosses the preceding, and is attached to the sciatic spine. Its form is an equilateral triangle, and its internal face is usually muscular.

This ligament divides the great fissure or the sciatic foramen into two parts, an upper and a lower; the first is much larger, and is separated from the other by the parts which pass through it.

C. OBTURATOR MEMBRANE.

§ 943. The *obturator membrane* (*Lig.* s. *membrana obturatoria*, s. *foraminis thyroidei ossium pubis*) is thin, and formed of irregular fibres, which are mostly transverse and a little oblique, and which intercross variously. It arises from the sharp edges of the obturator foramen, further forward at its upper than at its lower portion, and it closes this opening almost entirely. We see at its upper and external part only a constant rounded and oblong hollow, through which the obturator vessels and nerves pass out from the cavity of the pelvis. But this hollow is partly though imperfectly filled, for one or more bands of very strong transverse fibres go from the anterior edge of the ascending branch of the ischium to the beginning of the external edge of the descending branch of the pubis, several lines behind the membrane; so that it would seem as if the upper fibres had been separated from each other in this place by the vessels and nerves which pass out from the pelvis.

This space deserves notice ; since in thyroidal hernia, which is very rare, the abdominal viscera protrude from it and follow the course of the vessels.

We also find other openings in the obturator membrane, particularly at its lower part ; but these are less constant.

III. CHANGES OF THE PELVIC LIGAMENTS DURING PREGNANCY.(1)

§ 944. Most usually, the bones of the pelvis have but a slight degree of motion on each other. Hence arises a question, whether this mobility is not increased under certain circumstances, and particularly if this change does not supervene during pregnancy.

Opinions differ in this respect. Some admit that the change occurs normally in every state of pregnancy. Others think it supervenes only under certain circumstances, as when the bones are diseased, or after very difficult labors ; and others, that it never takes place.

The first of these opinions, already advanced by Pineau, is undoubtedly the most correct ; since, according to the testimony of the best observers as Sandifort and Hunter, about the period of parturition, the symphyses, especially that of the pubis, always become looser, broader, and yield more easily. Beside, the latter symphysis is always broader in those females who are mothers of several children, than in virgins. This phenomenon deserves to be pointed out, as it demonstrates that all the parts interested in the act of parturition are analogously changed and become looser and more spungy.

Finally, this change does not necessarily imply a real separation of the pubic cartilages, but only the softening of the fibro-cartilage,—a state in which the articular cartilages do not seem to participate. Tenon has maintained the contrary, but he is wrong: if the cartilages have sometimes been found really separated, this state must be considered as congenital or morbid ; since this arrangement has been observed even in very young girls, or the loose surfaces of the cartilages were likewise rough, or pus has been found in the cavity.(2)

This softening begins to take place in the eighth month of pregnancy, that is to say, precisely at that time when the lower region of the genital organs begins to enlarge and to secrete a great quantity of mucus.

(1) S. Pineau, *De distractione ossium pubis in partu naturali, deque rationibus quibus ea probatur ; in libris de virginitatis notis, graviditate et partu*, book ii.—Sandifort, *De pelvi ejusque in partu dilatatione*, Leyden, 1763.—Hunter, *loc. cit.*—Louis, *Sur l'écartement des os du bassin*, in the *Mém de l'ac. de chir.*, vol. iv. Paris, 1769. Hist. p. 63-102.—Tenon, *loc. cit.*

(2) A singular case of the separation of the ossa pubis, in the *Med. obs. and inq.*, vol. ii. no. 28.

This phenomenon is important, as by it the pelvis is enlarged and the act of parturition is facilitated. We must not confound it with the separation and the rupture of the cartilages, which may result from disease, either by destroying the fibro-cartilage between the two cartilages or by detaching the latter from the surfaces of bone, where the fibro-cartilage separates from the two lateral cartilages; so that then three cartilages are formed, two of which adhere, while the central one is loose.(1)

ARTICLE SECOND.

OF THE ILIO-FEMORAL ARTICULATION.

§ 945. The ilio-femoral joint is formed by the fibro-cartilaginous prolongation of the cotyloid cavity, a synovial capsule, a fibrous capsule, and an internal fibrous ligament.

I. FIBRO-CARTILAGINOUS LIGAMENT.

§ 946. The *fibro-cartilaginous* ligament of the cotyloid cavity, or the *cartilaginous lip* (*Lig. cotyloideum fibro-cartilagineum, acetabuli labrum cartilagineum*), is a complete triangular ring, formed of fibro-cartilage, which is several lines high and thick. It is thickest above and outward, and passes above the cotyloid fissure, so as to complete the edge of this cavity. Its loose edge is sharp and looks a little inward; hence this ligament serves also to enlarge the cotyloid cavity, but contracts its circumference, although but slightly.

This ligament is formed entirely of cartilaginous substance only where it passes over the cotyloid fissure.

The space below is filled by some bands, situated, one within, the other without,—the *external* and *internal ligaments of the cartilaginous lip* (*Lig. labri cartilaginei externum et internum*), which are continuous, the first with the obturator membrane and both with the fibro-cartilage.

II. SYNOVIAL CAPSULE.

§ 947. The *synovial capsule* (*capsularis synovialis membrana*) passes from the bottom of the cotyloid cavity on the cartilaginous lip (§ 945). It is intimately connected with both, completely covers the external face of the lip, then is reflected on itself at an acute angle, and finally descends loosely to go to the femur. There it is attached to the lower extremity of the neck, goes to the anterior oblique line, descending lower forward than backward, reflects at an acute angle from below upward, and blends with the cartilage which covers the head.

(1) Tenon, *loc. cit., Onsieme obs.*, p. 174.

The posterior, superior, inferior, and external parts of the cotyloid cavity are covered by a semicircular cartilage, which extends, on all sides except the cotyloid notch, even to the loose edge of the cavity and to the cartilaginous lip, from which it is evidently separated. This cartilage is intimately connected with the synovial capsule.

The anterior and middle part of the cotyloid cavity is the deepest, and has an irregular quadrilateral form: it is rough, but is not covered with cartilage. It contains much articular fat. The synovial capsule adheres but slightly in this place, and is separated from the bone by layers of fat.

III. ROUND LIGAMENT.

§ 948. Directly before the portion of the synovial membrane which passes on the space below the bridge formed by the cartilaginous lip, arises a quadrangular ligament about an inch long, called the *round ligament of the femur* (*Lig. ossis femoris teres* s. *rotundum*). The extremities of this ligament enlarge a little, and its outer end is attached to the bottom of the cavity in the head of the femur. It retains this bone more firmly in its situation.

It is formed of longitudinal fibres, which are attached to the upper and lower horns of the cotyloid fissure and unite with the ligaments of the cartilaginous lip and also with the lip itself; but they are covered in all their circumference by a sheath of synovial membrane, which is reflected on itself.

This ligament prevents the luxation of the femur upward, outward, and downward, as it prevents the femur from escaping in that direction: it is at least necessarily broken when this dislocation takes place, although the femur can quit the cotyloid cavity forward without its being ruptured.

§ 949. The round ligament is sometimes deficient, either primitively or from a violent and often repeated compression of the ilio-femoral joint.

IV. FIBROUS CAPSULE.

§ 950. The *fibrous capsule* (*capsula fibrosa ossis femoris*) is the strongest and most perfect of all in the body. It arises above from the circumference of the inferior edge of the outer face of the cartilaginous lip, unites very narrowly in its whole extent with the external face of the synovial capsule, and is attached to the lower extremity of the head of the femur exactly in that part where the outer part of the capsule is reflected to cover the neck of the bone. It is very strong at its upper external and anterior portion, is two or three lines thick, and is formed of several superimposed layers of longitudinal fibres.

This capsule is protected by the adjacent muscles of the thigh; although the tendons of the muscles are not connected with it.

From its upper, anterior and internal part arise several bands, which ascend obliquely toward the internal part of the anterior face of the horizontal branch of the pubis and the anterior face of the obturator membrane, with the fibres of which they are blended.

ARTICLE THIRD.

OF THE ARTICULATION OF THE KNEE.

§ 951. The knee-joint is the most complex articulation in the body; for the synovial capsule is not only strengthened externally by three fibrous ligaments, but the corresponding surfaces of the femur and tibia are attached within this capsule by strong fibrous ligaments, which are even their principal mode of union. From this arrangement, the knee-joint is also the strongest of all. What renders the joint more complex is, that the two bones are separated from each other by an interarticular cartilage.

I. SYNOVIAL MEMBRANE.

§ 952. The *synovial membrane* (*membrana synovialis articuli genu*) arises some lines before the cartilage of the articular surface of the femur, and backward from directly above this same cartilage. It is attached below to all the circumference of the rough edge of the upper articular cartilaginous surface of the tibia.

Its upper and lower faces unite with the cartilages which cover the articular surfaces of the two bones. A part of its anterior face covers also the posterior face and the lateral edges of the patella; so that the patella slightly projects within the cavity.

Beside, its upper and anterior portion covers rather closely the lower part of the extensor muscle of the leg, from which however it may be separated more easily than from the bone. The rest is united to the adjacent parts only by a very loose mucous tissue.

The lower part of the cavity which it thus forms is divided into a right and a left portion; because a perpendicular fold is formed, which is loose upward and extends from the posterior intercondyloid fossa of the femur to the anterior part of its circumference behind the ligament of the patella, and which is attached in this place below the patella itself.

We find considerable accumulations of articular fat in many parts, especially on the anterior wall, around the patella, in the fold we have mentioned, and behind the condyles of the femur.

The whole capsule is very broad and loose, especially at its anterior part; less so however on the sides, which must be ascribed to the nature of the motions of the leg, which are only flexion and extension.

The outer face of the synovial membrane is strengthened behind by oblique fibres, which descend from the external condyle of the femur to the internal condyle of the tibia.

II. EXTERNAL FIBROUS LIGAMENTS.

§ 953. On the circumference of the synovial membrane we find an internal and two external lateral fibrous ligaments.

I. INTERNAL LATERAL LIGAMENT.

§ 954. The *internal lateral* ligament (*Lig. laterale internum*) is the strongest, and is formed of perpendicular fibres. It descends from the anterior part of the internal face of the inner condyle to the upper part of the internal face of the tibia, where it is attached. It is broader above than below and is triangular, the base of the triangle being turned forward. It prevents the articular surfaces from being dislocated inward.

II. LONG EXTERNAL LATERAL LIGAMENT.

§ 955. The *long*, *anterior*, *or external lateral* ligament (*Lig. genu laterale externum*, s. *longum*, s. *anterius*) forms an oblong, rounded, firm band. It is situated before the short ligament, between the lower extremity of the external condyle, from the external face of which it arises below, and the anterior part of the external face of the head of the fibula, to which it is attached.

III. SHORT EXTERNAL LATERAL LIGAMENT.

§ 956. The *short external* or *posterior lateral* ligament (*Lig. genu laterale externum breve* s. *posterius*) is still feebler than the preceding. It arises a little above, and half an inch behind it, from the inferior part of the posterior face of the external condyle of the femur, goes a little obliquely from above downward and from within outward, and is attached to the summit of the head of the tibia, higher than the preceding.

The two external lateral ligaments prevent the luxation of the knee-joint outward. The terms *anterior* and *posterior* are more convenient than those generally used, as the length of both is the same or nearly the same.

III. INTERNAL FIBROUS OR CRUCIAL LIGAMENTS.

§ 957. The *crucial* ligaments (*Lig. cruciata genu*) are the strongest of all the connections between the femur and the tibia. We find two, an *anterior* and a *posterior*.

The *posterior* is longer, broader, and stronger than the other, and its lower part is thicker but narrower than the upper part. It extends from the posterior extremity of the depression between the two condyles of the tibia, toward the anterior extremity of the posterior intercondyloid fossa, at the internal face of the external condyle of the femur, where it is attached by a semicircular edge. Its direction is from below upward, from behind forward, and from within outward.

The *anterior* arises from the anterior extremity of the internal point on the upper articular face of the tibia, goes outward, upward, and backward, crosses the preceding but does not touch it, and is attached a little behind it to the internal face of the outer condyle of the femur.

These ligaments unite the tibia to the femur firmly, and also limit the turning of these bones on their axes. The posterior opposes the rotation of the thigh outward and that of the leg inward, while the anterior prevents the rotation of the thigh inward and that of the leg outward.

IV. SEMILUNAR CARTILAGES.

§ 958. The *semilunar* or *falciform* cartilages (*cartilagines interarticulares genu semilunares*, s. *falcatæ*) derive their name from their form. Both are broader behind than before: the external edge which is convex, is much thicker than the internal which is concave and terminates obliquely in a point. The first adheres intimately to the synovial capsule, while the second is entirely loose; but their two extremities are attached by a strong fibrous ligament to the posterior part of the intercondyloid fossa of the tibia. Another strong transverse ligament unites them at their anterior extremities. Their inferior faces are plain, but their superior are concave to a greater or less extent, and pointed near the two extremities. Each rests on one of the portions of the cartilaginous face of the tibia, and corresponds to one of the condyles of the femur. They are separated by the eminence on the upper articular face of the tibia, and their concave edges are turned toward each other.

The *external falciform* cartilage is uniformly broader than the internal in its whole extent, and also a little larger; hence it covers more of the upper face of the external condyle of the tibia. Its posterior extremity is very firmly attached to the fossa placed behind the spine of the tibia. It is also attached to the femur by a very strong ligament, which arises more posteriorly, ascends obliquely from without inward between the two crucial ligaments, and is inserted directly behind the posterior, on the internal face of the internal condyle of the femur. Its anterior extremity, which is reflected from before backward behind the anterior articular ligament of the two cartilages, is attached to the anterior part of the depression before the spine of the tibia, directly behind the lower extremity of the anterior crucial ligament.

The *internal falciform* cartilage is attached by its posterior extremity farther inward and backward than the external, directly before the posterior crucial ligament, at the posterior extremity of the depression placed behind the spine of the tibia, much farther forward and outward than the external.

These two cartilages elevate the edge of the upper articular surface of the tibia, and thus impede the gliding of the condyles of the femur; but they prevent particularly the compression of the femur and the tibia in the motions of the leg.

§ 959. Of all the joints, the articulation of the knee is the most subject to morbid alterations of texture, although it is not often dislocated, since the arrangement and firmness of its fibrous ligaments admit of but slight motions.

In this particularly, above all other articulations, abnormal bones and cartilages are developed, which are at first attached to the synovial membrane by thin peduncles, but which in time are detached and isolated.

This articulation is also almost the only one exposed to *fungus of the joints* (*fungus articulorum*).

These conditions depend, partly on its great size, or partly on its position, as it is exposed to mechanical injury and compression more than any other joint.

ARTICLE FOURTH.

OF THE ARTICULATIONS OF THE BONES OF THE LEG.

§ 960. The bones of the leg are attached to each other at their upper, middle, and lower portions.

I. UPPER ARTICULATION.

§ 961. The upper articulation of the two bones of the leg is formed by a short synovial membrane, the capsule of the head of the fibula (*Lig. capituli fibulæ*), which arises some lines above the head of the cartilaginous lateral articular facet of the tibia, and below the upper articular facet of the fibula, and the anterior face of which especially is strengthened by very strong transverse fibres, which extend from the internal edge of the head of the fibula to the external face of the upper extremity of the tibia.

II. MIDDLE ARTICULATION.

§ 962. The middle articulation is formed by the *interosseous* ligament (*Lig. interosseum*, s. *membrana interossea*). This ligament is thin and smooth; it gradually contracts from above downward, and is formed of oblique fibres, which descend from the external edge of the tibia to the crest of the fibula.

At its upper part we see a foramen, through which the anterior tibial vessels and nerves pass, and another below for the peroneal artery. We also occasionally see in all its extent similar but smaller openings.

It is situated between the flexor and the extensor muscles of the leg; the fibres of which arise in part from its two faces.

III. INFERIOR ARTICULATION.

§ 963. Between the inferior extremities of the tibia and fibula a very narrow slip of the synovial membrane of the articulation of the foot extends in the form of a cul-de-sac, but there is no special articular capsule. This slip is attached by three broad fibrous bands.

I. ANTERIOR TIBIO-PERONEAL LIGAMENT.

§ 964. The *anterior tibio-peroneal* ligament (*Lig. tibio-fibulare anterius*) arises from the external part of the anterior face of the lower extremity of the tibia, and is attached to the inner part of the anterior face of the external malleolus. It is formed of fibres which descend obliquely from within outward.

II. POSTERIOR TIBIO-PERONEAL LIGAMENT.

§ 965. The *posterior tibio-peroneal* ligament (*Lig. tibio-fibulare posterius*) is formed of fibres which follow the same direction as those of the preceding; they extend from the external part of the posterior face of the inferior extremity of the tibia to the internal part of the posterior face of the external malleolus.

III. SUPERIOR TIBIO-PERONEAL LIGAMENT.

§ 966. The *superior tibio-peroneal* ligament (*Lig. tibio-fibulare superius*) is formed of fibres similar to, but much shorter than the two preceding, and extends from the external face of the tibia to the internal face of the fibula, directly above the inferior processes of these two bones.

§ 967. A division of the anterior (§ 963) and of the posterior (§ 664) ligament into two portions, an upper and a lower, is useless, and does not naturally exist.

ARTICLE FIFTH.

OF THE ARTICULATION OF THE FOOT.

I. SYNOVIAL CAPSULE.

§ 968. The *synovial capsule* of the joint of the foot (*membrana articuli pedis synovialis*) arises from the edge of the articular and cartilaginous face of the articulation of the tibia and fibula, and from the corresponding face of the astragalus. It blends with all these surfaces, and sends a slip between the tibia and the fibula (§ 963). It is every where very loose, but loosest at its external part.

II. FIBROUS LIGAMENTS.

§ 969. The synovial capsule is covered forward, backward, and on the sides, by several bands, which do not unite in a fibrous capsule, and which extend from the tibia and fibula to the astragalus and calcaneum.

I. ANTERIOR LIGAMENTS.

§ 970. We may admit two anterior ligaments, an *internal* and an *external*. The central part of the anterior wall of the synovial capsule being loose, its two ligaments are much thinner than the others.

The *internal anterior* ligament (*Lig. anterius internum*) is composed of perpendicular fibres, some of which ascend a little obliquely outward. It is larger than the external, and goes from one part of the anterior edge of the lower articular face of the tibia to the back of the scaphoid bone.

The *external anterior* ligament (*Lig. anterius externum*) arises from the anterior part of the outer face of the external malleolus, and being formed of oblique fibres, proceeds from without inward and from behind forward, and is attached to the outer part of the anterior face of the body of the astragalus. It is usually formed of two bands, situated one at the side of the other, and separated by an interval. The upper band is much larger than the lower. The whole ligament has an irregular quadrilateral form.

II. POSTERIOR LIGAMENTS.

§ 971. Usually there are two posterior ligaments, one superficial and the other deep. The *superficial posterior* ligament (*Lig. posterius superficiale*) has an elongated cylindrical form, and extends from the internal edge of the external malleolus, below the insertion of the posterior tibio-peroneal ligament, to the centre of the posterior edge of the body of the astragalus, where it is attached to an eminence of this bone. Usually, a special and smaller band is detached from this point, which unites to the preceding, but goes in a contrary direction downward and outward, to be inserted in the upper part of the internal face of the tuberosity of the calcaneum.

The *deep posterior* ligament (*Lig. posterius profundum*) is much stronger than the preceding, and is separated from it by fat and cellular tissue. It rests directly on the posterior wall of the synovial capsule, and is formed of longitudinal and oblique fibres, which arise from the posterior edge of the lower articular face of the tibia, and from the under part of the inner face of the external malleolus. These fibres converge and go downward, and are inserted above the preceding ligament in the posterior face of the body of the astragalus.

Sometimes the two ligaments are blended together.

The fibres which come from the fibula are always the strongest.

III. LATERAL LIGAMENTS.

§ 972. The *lateral ligaments* are much stronger than all the other fibrous ligaments.

A. EXTERNAL LATERAL LIGAMENT.

§ 973. The *external lateral* ligament (*Lig. laterale externum fibulæ rectum, s. perpendiculare, s. medium, s. triquetrum*) is much longer from above downward than from before backward, and gradually enlarges in the first direction. It extends from the summit of the internal malleolus to the external face of the calcaneum, to which it is attached, after dividing into an anterior and a posterior fasciculus.

B. INTERNAL LATERAL LIGAMENT.

§ 974. The *internal lateral* ligament, called generally the *triangular* ligament, and which might be called the *trapezoid* (*Lig. laterale internum deltoides, trapezium*), goes from the inferior edge of the internal malleolus to the internal faces of the astragalus and calcaneum. It is more broad than high, is lower than the external, but is broader and as strong. It blends with the inner anterior ligament forward, and with the internal portion of the deep posterior ligament backward.

ARTICLE SIXTH.

OF THE LIGAMENTS OF THE TARSUS.

§ 975. All the bones of the tarsus are confined by short and thick synovial capsules, over which in many parts fibrous ligaments are extended. The latter are divided into those of the back, of the sole, of the tibial and fibular edges of the foot.

I. LIGAMENTS OF THE POSTERIOR RANGE.

I. SYNOVIAL CAPSULE.

§ 976. The two bones of the posterior range are united by two synovial membranes, a *proper* and a *common*.

The *proper synovial capsule* (*capsula propria astragalo-calcanea*) arises below from the edges of the upper and cartilaginous face of the body of the calcaneum, extends a little backward, over the portion of this same face, which is not cartilaginous, and is attached above to the corresponding circumference of the cartilage on the cartilaginous inferior face of the body of the astragalus.

The *common synovial capsule* (*capsula communis*, s. *astragalo-calcaneo-scaphoidea*) will be described hereafter. It is situated between the upper cartilaginous face of the anterior process of the calcaneum and the lower face of the head of the astragalus.

II. FIBROUS LIGAMENTS.

§ 977. The two synovial capsules are strengthened in several parts by fibrous ligaments, and the proper capsules particularly by the lateral and the posterior ligaments of the articulation of the foot (§ 971).

Besides, a broad internal ligament extends from the internal part of the posterior face of the body of the astragalus, to the posterior part of the internal face of the calcaneum, and is called the *internal* and *posterior astragalo-calcanean* ligament (*Lig. astragalo-calcaneum internum*, s. *posterius*.

The anterior face is confined by an internal and an external ligament.

The *internal anterior astragalo-calcanean* ligament (*Lig. astragalo-calcaneum internum anterius*) extends from the internal extremity of the cartilaginous surface of the anterior process of the calcaneum to the internal face of the astragalus.

The *external astragalo-calcanean*, or *interosseous* ligament (*Lig. astragalo-calcaneum externum*, s. *interosseum*) is composed of five or six very strong fasciculi, which are situated behind one another, and which diminish in length very much from behind forward and also from without inward. These fasciculi go from the external rough part of the upper face of the anterior process of the calcaneum to the external face of the neck and head of the astragalus, and to the channeled and acartilaginous part of the inferior face which separates the upper faces of the body and the anterior process. They fill the large space between these two bones.

II. OF THE LIGAMENTS BETWEEN THE ANTERIOR AND THE POSTERIOR RANGE.

I. SYNOVIAL CAPSULES.

§ 978. There are two synovial capsules, one for the astragalus, the calcaneum, and the scaphoid bone; the other for the calcaneum and the cuboid bone.

The first, or the *astragalo-calcaneo-scaphoid* capsule, has already been mentioned (§ 976). It arises from the margin of the anterior articular face of the astragalus, forms a cul-de-sac backward, which is reflected on the upper articular face of the anterior process of the calcaneum, and goes to the circumference of the posterior articular face of the scaphoid bone, and is blended with its posterior cartilaginous face.

The proper, or the *calcaneo-cuboid* capsule (*capsula synovialis calcaneo-cuboidea*), extends between the corresponding articular faces of these two bones.

II. FIBROUS LIGAMENTS.

§ 979. The astragalus and the calcaneum are united to the scaphoid bone, and this latter to the cuboid bone by external fibrous ligaments.

A. CALCANEO-SCAPHOID LIGAMENTS.

§ 980. There are two *calcaneo-scaphoid* ligaments (*Lig. calcaneo-scaphoidea*), a *superior* and an *inferior*.

The *superior* is much weaker than the other, and arises from the anterior edge of the rough portion of the tuberosity of the calcaneum, and ascends obliquely from behind forward, and from without inward, where it is attached to the external extremity of the back of the scaphoid bone.

The *inferior*, much stronger than the superior, being formed of several distinct bands, is more broad than long. It extends from the anterior edge of the tuberosity of the calcaneum to the external part of the inferior face of the scaphoid bone. It forms, conjointly with the calcaneum and scaphoid bones, a cavity for the head of the astragalus.

B. ASTRAGALO-SCAPHOID LIGAMENT.

§ 981. The *astragalo-scaphoid* ligament (*Lig. astragalo-scaphoideum*) covers all the upper surface of the synovial capsule of the two bones. It is formed of thin fibres, the direction of which is from before backward. Some of these fibres proceed even to the cuneiform bones.

C. CALCANEO-CUBOID LIGAMENTS.

§ 982. The calcaneum is united to the cuboid bone by superior, external, and inferior ligaments.

The *superior* ligaments (*Lig. calcaneo-cuboidea superiora* s. *dorsalia*) are usually three in number, placed successively from without inward. They form thin and flat bands, which increase progressively in length, from within outward, and are situated between the upper edge of the articular face of the calcaneum and the same edge of the corresponding face of the cuboid bone.

The *external* ligament (*Lig. calcaneo-cuboideum externum* s. *fibulare*) extends as high as the cartilaginous faces of the two bones, on the outsides of which they are attached. It is also thin, but stronger than the superior.

The *inferior* ligament (*Lig. calcaneo-cuboideum inferius* s. *plantare*) may be considered as formed by three superimposed layers, each of which is stronger than the other ligaments of these bones, and which unite to form one of the strongest fibrous ligaments of the tarsus, perhaps the strongest even in the whole body.

The *superficial* layer, the longest and strongest, arises directly from the lower face of the tuberosity of the calcaneum, and is attached to all the tuberosity of the cuboid bone.

The *central* layer is much shorter and narrower, and is not entirely covered on the inside by the preceding. We ought, properly speaking, to consider it as a continuation of the inferior calcaneo-scaphoid ligament (§ 980). It arises from the inner part of the anterior edge of the articular face of the calcaneum, and is attached behind to the internal part of the rough inferior face of the cuboid bone.

The deep layer is entirely covered by the superficial; but by the central layer, only at its internal part. It is formed of fibres which go more obliquely from without inward and forward. It arises from the same parts of the two bones, but a little more externally.

III. LIGAMENTS BETWEEN THE BONES OF THE ANTERIOR RANGE.

I. SCAPHOIDO-CUBOID LIGAMENTS.

§ 983. The scaphoid and cuboid bones are united, especially posteriorly, in their whole extent by the *interosseous* ligament (*Lig. interosseum scaphoido-cuboideum*), the fibres of which are oblique, short, and very compact. We usually find a synovial capsule before this ligament.

§ 984. The external fibrous ligaments are two:

1st. The *dorsal scaphoido-cuboid* ligament (*Lig. scaphoideo-cuboideum dorsale*) which is square, and arises from fibres which extend obliquely from behind forward, and from within outward. It goes from the external edge of the scaphoid to the centre of the upper face of the cuboid bone.

2. The *plantar*, *Lig. scaphoideo-cuboideum plantare*) has the same form and direction as the preceding, but is composed of fibres which are more detached from each other: it extends from the centre of the inferior face of the scaphoid bone to the centre of the internal edge of the cuboid bone.

II. LIGAMENTS BETWEEN THE SCAPHOID AND CUNEIFORM BONES.

§ 985. The ligaments which unite the scaphoid to the three cuneiform bones, are a synovial capsule and fibrous ligaments.

A. SYNOVIAL CAPSULE.

§ 986. The *synovial capsule* is situated between the commencement of the anterior face of the scaphoid bone, and the posterior face of the three cuneiform bones. It also penetrates between the latter.

B. FIBROUS LIGAMENTS.

§ 987. *a.* The *fibrous* ligaments are, the *dorsal*, the *internal*, and the *plantar*.

We may admit two dorsal ligaments (*Lig. scaphoideo-cuboidea dorsalia*), an internal and an external.

The *internal* is triangular, and extends from the anterior and external part of the upper face of the scaphoid bone to the upper face of the second cuneiform bone. Its fibres go forward and outward.

The *external* is smaller than the other, from which it is entirely separated, is square, and formed of fibres which proceed in the same direction. It arises more externally, immediately at the side of the preceding, and is attached to the upper face of the third cuneiform bone. It is blended with the dorsal scaphoido-cuboid ligament (§ 984).

b. A strong *internal* ligament, (*Lig. scaphoideo-cuboideum internum*), the fibres of which are straight and almost horizontal, extends from the anterior edge of the internal face of the scaphoid bone to the posterior part of the inner face of the first cuneiform bone, and unites these two bones in their whole extent.

c. We may admit three *plantar* ligaments. The *internal*, the strongest is the continuation of the preceding, but is thicker than it. It is square, and its fibres which are straight, extend from the tuberosity of the scaphoid bone to that on the inferior face and the posterior edge of the first cuneiform bone.

The *central* is feebler, but longer, and arises at the side of the preceding a little more externally. It goes obliquely from before backward, and from without inward, to the posterior part of the inferior edge of the second cuneiform bone.

The *external*, which is feebler and situated more deeply, is composed of detached, oblique, and transverse fasciculi. It extends from the external and anterior part of the inferior face of the scaphoid bone, to the posterior extremity of the inferior edge of the second and third cuneiform bones.

III. LIGAMENTS BETWEEN THE CUBOID AND CUNEIFORM BONES.

§ 988. These ligaments are, a *synovial capsule* and *two fibrous ligaments*.

The *synovial capsule* is situated between the cartilaginous points of the cuboid and of the third cuneiform bones.

There are two fibrous ligaments, a dorsal and a plantar.

a. The *dorsal* ligament, which is not constant, being often entirely replaced by the dorsal scaphoido-cuboid ligament (§ 984), when it exists, is very feeble, and is situated at the external edge of this last: it is formed of longitudinal fibres, which extend from the back of the cuboid bone to the posterior extremity of the back of the third cuneiform bone.

b. The *plantar* ligament is much stronger, and is formed of several distinct fasciculi, the anterior of which is the largest, and which all extend transversely from the internal edge of the plantar face, and from the lower part of the inner face of the cuboid bone to the inferior face and to the inferior part of the internal face of the third cuneiform bone.

IV. LIGAMENTS OF THE CUNEIFORM BONES.

§ 989. 1st. The synovial capsules between the three cuneiform bones, arise from the common capsule between the scaphoid and the cuneiform bones (§ 986).

2d. The fibrous ligaments are,

a. The *dorsal* ligaments which form several feeble layers of oblique and transverse fibres, which extend from the first to the second, and from this to the third cuneiform bone.

b. The *interosseous* ligaments, which are very firm transverse fibres, extend between the internal faces of the first and second, and of the second and third cuneiform bones, where there is no slip from the synovial capsule.

c. The *plantar* ligaments are firm but isolated and usually oblique bands, which go from the posterior part of the internal face of the first cuneiform bone to the posterior extremity of the inferior edge of the second, and from this to the posterior extremity of the inferior edge of the third. They unite with the interosseous and plantar scaphoido-cuboid ligament.

ARTICLE SEVENTH.

OF THE LIGAMENTS BETWEEN THE TARSUS AND METATARSUS.

I. SYNOVIAL CAPSULE.

§ 990. The synovial membrane between the bones of the metatarsus on one side, the three cuneiform and the cuboid bones on the other, are not arranged in the same manner in all parts nor in all subjects.

We however find a special synovial membrane between the anterior extremity of the first cuneiform bone and the posterior extremity of the first metatarsal bone.

Usually, the second metatarsal bone is united to the three cuneiform bones by a common synovial capsule.

We find a third synovial membrane between the third metatarsal and the third cuneiform bones.

Finally, the fourth and fifth metatarsal bones are united to the cuboid bone by a common capsule.

II. FIBROUS LIGAMENTS.

§ 991. The *fibrous* ligaments which strengthen these synovial membranes are divided into *dorsal* and *plantar*.

a. The *dorsal* form several square and thin bands, which go from the upper face of the bones of the metatarsus corresponding to the tarsal bones, to the posterior extremity of the latter. The fibres of the external are a little oblique from within outward and from behind forward; those of the internal go directly from before backward.

b. The *plantar* correspond to the dorsal: they are however, except the first, a little weaker. They are strengthened by the tendons of the tibialis anticus and posticus muscles.

We see also strong fibrous bands, which go from some of the metatarsal to the tarsal bones which do not articulate with them; for instance, from the base of the second and fourth metatarsal bones to the anterior extremity of the third cuneiform bone going directly from before backward, and from the plantar face of the posterior extremity of the fifth metatarsal bone, transversely, to the extremity of the third cuneiform bone.

The posterior part of the circumference of the articulation of the first cuneiform bone with the metatarsal bone of the first toe is also furnished with strong ligamentous fibres, which go directly from before backward.

ARTICLE EIGHTH.

OF THE LIGAMENTS OF THE METATARSAL BONES AND PHALANGES.

I. METATARSAL LIGAMENTS.

I. POSTERIOR LIGAMENTS.

§ 992. The metatarsal bones, except the first, have the corresponding faces of their posterior extremities covered by slips of the synovial membranes extended between them and the bones of the anterior range of the tarsus (§ 990).

The *fibrous* ligaments resemble those of the metacarpus (§ 919–921). They are divided into *dorsal*, *middle*, and *plantar*.

The *upper* or *dorsal* (*Lig. ossium metacarpi dorsalia*) are formed of transverse fibres, which arise from the dorsal side of the corresponding faces of the posterior extremity of the adjacent bones. We find only three of them, because the metatarsal bone of the first toe does not articulate in this manner with the second. The upper ligament is however here replaced by an analogous ligament, which extends from the first cuneiform bone to the base of the second metatarsal bone.

The *middle* or *interosseous* ligaments (*Lig. ossium metatarsi media* s. *interossea*) are sometimes only three in number, and proceed obliquely from above and inward to go to the next metatarsal bone: more frequently however there are four. Similar fibres exist also between the first and second metatarsal bones.

The *inferior* or *plantar* ligaments (*Lig. ossium metatarsi inferiora* s. *plantaria*) are like the dorsal, only three in number, and are the strongest. The ligament between the first and second metatarsal bone becomes a very strong fibrous layer, which extends from the first cuneiform bone to the second and third metatarsal bones.

The fibres of this very long ligament proceed in a direction opposite to that of those between the fourth and fifth metatarsal bones; that is, the former go from behind forward and from within outward, the latter from without inward and from behind forward, so that they converge anteriorly.

II. ANTERIOR LIGAMENTS.

§ **993.** On the plantar face between the anterior extremities of all the metatarsal bones, are very strong square ligaments, formed of longitudinal fibres, which are attached to the synovial capsules rather than to the bones. These are called the *anterior metatarsal* ligaments (*Lig. metatarsi anteriora plantaria*).

II. LIGAMENTS OF THE TOES.

§ 994. Synovial capsules, with lateral and inferior fibrous ligaments, exist between the posterior phalanx of each toe and the corresponding metatarsal bone, and also between the different phalanges. The final phalanges also have ungual ligaments. These parts being similar to those of the hand (§ 922–927), it is unnecessary to describe them.

BOOK III.

OF MYOLOGY.

§ 995. The general characters of the muscles(1) have been mentioned in the first volume. We shall here describe only the voluntary muscles, and not all even of these; but shall confine ourselves to those which move the bones; the history of all the others being placed more conveniently after the description of the parts which they move, with which we must first be acquainted if we wish to have an exact idea of the attachments of the muscles and of their modes of action. The system of the involuntary muscles is distributed in the vascular system and the viscera, in describing which also they will be examined.

§ 996. We consider as single muscles all those parts of the muscular system which can be separated from each other without dividing the fibres. In this manner we count in the normal state two hundred and thirty-eight different muscles, six of which are unmated and composed of two parts which unite on the median line, and two hundred and thirty-two are in pairs; so that the whole number of the muscles is four hundred and seventy.

The nomenclature of these muscles is not uniform: for a long time the inconvenient method of numbering them was used. It is, however equally inconvenient to establish a uniform principle of nomenclature in myology, by changing the names of the muscles into descriptions of their situations and attachments, as Dumas and Chaussier have done; for then the extremely long and very complex names resemble each other too much.

The muscles derive their names principally from their modes of action, their attachments, their form, and their volume.

(1) Among the descriptions we shall mention: Stenon, *Elementorum myologiæ specimen*, Amsterdam, 1669.—Douglas, *Myographiæ comparatæ specimen*, Leyden, 1729.—Garengeot, *Myologie humaine et canine*, Paris, 1728.—Albinus, *Historia musculorum hominis*, Leyden, 1734.—Duverney, *l'Art de disséquer méthodiquement les muscles du corps humain*, Paris, 1749.—G. F. Petersen, *Gründliche Anwiesung zu der Zergliederung der Muskeln des menschlichen Kôrpers*, Hamburg, 1763.—J. Innes, *A short account of the human muscles*, Edinburgh, 1788.—J. G. Walter, *Myologisches Handbuch*, Berlin, 1777.—Sandifort, *Descriptio musculorum hominis*, Leyden, 1781.—Gavard, *Traité de myologie suivant la méthode de Desault*, Paris, an vii.—Fleischmann, *Anleitung zur Kenntniss der Muskeln des menschlichen Körpers*, Erlangen, 1811.—The principal plates are: G. Cowper, *Myotomia reformata*, London, 1724.—*Myologie complète en couleur et de grandeur naturelle*, Paris, 1746.—Albinus, *Tabulæ sceleti et musculorum corporis humani*, Leyden, 1747.—Duverney, *Tabulæ anatomicæ*, 1748.—G. G. Muller, *XII. Kupfertafeln welche die meisten kleinen und zarten Muskeln des menschlichen Kôrpers vorstellen*, Erfort, 1755.—J. Innes, *Eight anatomical tables of the human body, containiug the principal parts of the skeleton, muscles, etc.*, Edinburgh, 1776.—J. Bell, *Engravings explaining the anatomy of the bones, muscles, and joints*, London, 1808.—Lewis, *Views of the muscles of the human body*, London, 1820.

For the same reason that we commenced in osteology by describing the vertebral column, we shall mention first the muscles of the trunk, then those of the head, and lastly those of the extremities.

These three large divisions of the body, from the great number of their muscles and the different layers that they form, are usually subdivided into a greater or less number of *regions* (*regiones*), which modern writers have too extensively multiplied, by insulating the descriptions of the different muscles and by disregarding undoubted analogies.

When about to describe the muscles, a great difficulty presents itself relative to the order which we should adopt. Must we follow the *anatomical* order, which regards only the situation and the manner in which the different layers succeed each other? or the *physiological* order, which is founded on their action, so that those muscles which should be considered together or immediately after each other, according to the first method, are separated from each other and allied on the contrary to others, which the anatomical order would separate from them? Thus, for instance, many of the muscles which move the upper extremities are muscles of the back if we consider their situation; so that they are generally referred to this region. The custom of considering the muscles according to their situation and the order in which they succeed each other is also proper; since it presents all their relations more exactly and allows us to demonstrate the different layers in the presence of the pupil. This then is the order which we shall adopt, always however with the proviso mentioned above (§ 995).

SECTION I.

OF THE MUSCLES OF THE TRUNK.

§ 997. The muscles of the trunk are divided into those which move the different bones of the trunk and head, and into those which go from the trunk to the first two divisions of the upper limbs: the latter, although they do not act on the bones of the trunk, deserve to be considered in this place, because many of them form the external layers of the muscles situated on the trunk and cover the others. The best method of classing them is to make two series:

1. The *posterior muscles of the trunk*, or the muscles of the back and the posterior muscles of the neck.

2. The *anterior muscles of the trunk*, or the muscles of the abdomen, of the thorax, and of the anterior part of the neck.

CHAPTER I.

MUSCLES OF THE BACK.

§ 998. The muscles situated on the posterior part of the trunk, or on its dorsal side (*musculi dorsales*), form several superimposed layers, which are four in number and which differ in their attachments and also in their modes of action. The external muscles are for the most part larger, but they are fewer. They cover the other muscles of the back and belong to the class of the *broad* muscles. Those below them are more oblong; most of them are *short*, especially those situated most deeply. Some are composed of several short separate bellies.

In regard to the functions and attachments of these muscles, we may say, that most of them belong to the vertebræ, the head, and the ribs; for but few are attached to the bones of the upper extremities.

The superficial belong to the second section and the deep-seated to the first.

The direction of the fibres is not the same in all. In some for instance, as the trapezius and the latissimus dorsi, it varies in the different regions. But in most of the others it is the same every where. We may remark generally, that no muscle of the back is composed entirely of longitudinal fibres, which are found only in the centre of the trapezius and in the upper part of the latissimus dorsi. The fibres of all the others are more or less longitudinal. The latter may be referred to three classes.

First, those which ascend in a straight line and which move the parts in that direction. These are the sacro-lumbalis and longissimus dorsi muscles, the cervicalis decendens, the interspinales and their corresponding muscles, the rectus capitis posticus major and minor, the intertransversarii, and the lateral muscles of the head, which correspond to them; these may be called the straight muscles of the back (*M. dorsales recti*).

Second, those which descend obliquely outward; some arise from the spinous processes, and are attached to the transverse processes of the lower vertebræ, to the ribs, or to the scapula; others proceed from the transverse processes and go to the scapula or to the ribs; finally, some proceed from one rib to the following. We may call them the descending oblique muscles (*M. dorsales obliqui descendentes*) from their analogy to abdominal muscles; these are, considering them from without inward, the levator scapulæ, the rhomboidei, the serratus anticus and posticus, the complexus, the digastricus, the spinales colli, the semispinales dorsi, the multifidus spinæ, the obliquus capitis superior, the supracostales, the scaleni, and the intercostales externi.

Third, those which descend obliquely outward, or the ascending oblique muscles (*M. obliqui dorsales ascendentes*). They extend either from the transverse to the spinous processes, or from the internal part of these latter to the bones situated more externally. They are, considering them from the surface internally, the splenii, the serratus posticus inferior, the transversalis, the complexus colli, and the obliquus capitis inferior muscles.

ARTICLE FIRST.

MUSCLES OF THE FIRST, SUPERFICIAL, OR EXTERNAL LAYER.

§ 999. The external layer is composed of two muscles, the trapezius and the latissimus dorsi, which are attached not only to the bones of the trunk and which serve principally to move the upper extremities.

I. TRAPEZIUS.

§ 1000. The trapezius muscle, *Dorso-sus-acromien*, Ch. (*M. cucullaris*, s. *trapezius*) is so called from its position and its figure when united to that of the opposite side. In fact each of these muscles has an inequilateral triangular form, the base of which looks inward. They unite on the median line, from the centre of the squamous portion of the occipital bone to the last dorsal vertebra, so that they cover the region of the neck, the back, and the shoulder. This muscle at its lower part is still more superficial than the latissimus dorsi, the upper and inner part of which it covers.

This broad, flat, and thin muscle arises, first, from the external occipital protuberance, and from a greater or less portion of the upper curved line of the occipital bone, and rarely also from the mastoid process of the temporal bone; second, from the cervical ligament, where it blends with that of the opposite side; third, from the spinous processes of the last cervical, and of the eighth, ninth, tenth, eleventh, and twelfth dorsal vertebræ, also from the interspinal ligaments, where the muscles of the two sides meet. The fibres which come from this last point have in general a very short tendon, except at the centre and at the inferior extremity.

The muscle is attached to the posterior edge, and to the upper face of the external or posterior part of the clavicle, to the acromion process, and to almost all the loose edge of the spine of the scapula.

The upper fibres descend obliquely from behind forward and from within outward, the centre are longitudinal, and the inferior ascend from within outward; it is much thicker at its upper than at its lower part, and is broadest in the centre. Its fixed point is the vertebral column, so that it acts principally on the scapula and clavicle, which it draws upward by its upper part; inward, backward, and from the side of the opposite shoulder, by its central part; below and inward by the lower portion. When all its parts contract simultaneously, it draws these bones, and with them the whole upper extremity, backward. Its upper portion also draws the head backward and bends the neck.

II. LATISSIMUS DORSI.

§ 1001. The *latissimus dorsi* muscle, *Lombo-humeral*, Ch. occupies the lower part of the back and the whole lumbar region. Its form is triangular, and it arises from the summit of the spinous processes of from four to eight of the lower dorsal, of all the lumbar and of the sacral vertebræ, from the transverse processes of the sacrum, where it is continuous with the glutæus maximus muscle, and from the outer lip of the central portion of the crest of the ilium, by a tendon which gradually enlarges from below upward, and finally becomes very large; and lastly, from the external face of the four lower ribs, near their anterior extremity, by four fleshy digitations, between which the lower digitations of the obliquus abdominis externus muscle are situated. It is attached by a strong tendon to the posterior lip of the bicipital groove of the humerus, directly behind its small tubercle, so that it forms the external wall of the hollow of the axilla. The centre of its upper edge covers the inferior part of the scapula, and it is usually strengthened in this place by a strong fasciculus, which arises from the inferior angle.

The tendon of the latissimus dorsi turns from below upward and from behind forward on the inferior edge of the teres major muscle, with which it is for the most part united. But towards its extremity they most generally separate, and a large bursa mucosa exists between them. At its point of insertion it unites slightly with the tendon of the pectoralis major muscle. Toward its internal extremity, the inferior edge of its tendon sends a tendinous band to the brachial aponeurosis. A second is detached from its posterior face and goes to the small tubercle of the humerus.

The latissimus dorsi is very thin in its inner part, especially at its upper portion, but gradually increases in thickness from within outward and is finally considerably thick. Its upper fibres are longitudinal and the lower ones are oblique; the latter become straighter as they arise more externally, and are finally almost perpendicular. This muscle acts principally on the upper extremities which it draws downward and backward; hence the obscene but very significant term *anitersor* or *aniscalptor*. When however the upper extremity is fixed, it will draw the ribs to which it is attached upward and outward, so that it acts whenever respiration is very much impeded. Farther, it will under the same circumstances move the trunk upon the upper extremity, and raise or bend it.

§ 1002. A fleshy or tendinous band not unfrequently (about once in thirty times) detaches itself from the upper part of the latissimus dorsi, before the coraco-brachialis muscle, and goes to the posterior face of the tendon of the pectoralis major muscle, to which it is attached. This peculiar arrangement, which is found in the normal state in the mole and in birds, renders the brachial vessels and nerves very liable to compression.(1) Sometimes also, but more rarely, a similar band goes to the coracoid process of the scapula, where it unites with the upper extremity of the coraco-brachialis muscle.(2)

ARTICLE SECOND.

MUSCLES OF THE SECOND LAYER.

§ 1003. The second layer is formed by the rhomboidei, the levator anguli scapulæ, the splenii, and the serrati muscles, which partially or wholly cover each other. All are thin and vary in length and breadth.

RHOMBOIDEI MUSCLES.

§ 1004. The *rhomboidei muscles*, *Dorso-scapulaire*, Ch. are the most superficial; they occupy most of the space between the vertebral column and the scapula.

A. RHOMBOIDEUS MAJOR.

§ 1005. The *rhomboideus major* or the inferior rhomboid muscle arises by short tendons from the lateral part of the summits of the spinous processes of the four, and sometimes of the five, upper dorsal vertebræ, sometimes even of the last cervical vertebra, and is attached to most of the external lip of the base of the scapula, from its triangular surface to near its inferior angle. Its fibres are parallel, and go obliquely outward and downward.

B. RHOMBOIDEUS MINOR.

§ 1006. The *rhomboideus minor* or *superior rhomboid* muscle is situated directly above the preceding, and is sometimes blended with it. It is about one fourth the size of it. It arises from the first dorsal, and from the seventh and sometimes the sixth and fifth cervical vertebræ, and is attached, its fibres having the same direction, to that part of the base of the scapula which the preceding does not occupy. At its origin, it is at first blended with the serratus magnus muscle which passes over it.

The uses of these muscles are nearly the same; they draw the scapula upward and backward, and consequently act in shrugging the shoulders.

(1) Wardrop, in the *Edin. Med. Journ.* vol. viii. p. 282.—Kelch, *Beyträge zur pathologischen Anatomie*, 1813, p. 34, Berlin.—We have also seen this anomaly.

(2) Rosenmüller, *var. musc.* p. 5.—Kelch, *loc. cit.* p. 35. We have seen this variety also.

II. LEVATOR ANGULI SCAPULÆ.

§ 1007. The *levator anguli scapulæ* muscle, *Trachelo-scapulaire* Ch. (*M. levator scapulæ*, s. *anguli scapulæ*, *M. patientiæ*) is situated behind and on the side of the neck, over the rhomboidei muscles. It is longer, but thicker and more rounded than these muscles. It arises from the posterior tubercle of four, and more rarely of three or five, of the upper cervical vertebræ, by as many digitations, which are at first tendinous, generally very long, and which, especially the first, remain distinct through the whole length of the muscle. These digitations, the first of which is much the strongest, unite in a common belly, which descends obliquely backward and outward, and is attached by short tendinous fibres to the upper angle of the scapula. It is rare to find only two digitations which are attached to the first two vertebræ; however we have once observed this arrangement which was perfectly symmetrical on both sides; at the same time, the levator scapulæ was completely divided into two muscles, an internal above, an external below; the latter was inserted in the commencement of the spine.

This formation is similar in more than one respect to what is seen in animals: in fact, in most mammalia, the levator anguli scapulæ muscle has but two or three digitations, which are always attached to the upper cervical vertebra, seldom to the occipital bone. On the other hand, in apes this muscle is inserted into the spine of the scapula, and in the dolphin covers the surface of this bone.

Its upper tendons are blended with those of the splenius colli and of the cervicalis descendens. In its course it lies above the splenius muscle and is covered below by the trapezius.

This muscle corresponds in its situation and its action to the rhomboidei muscles, of which we recognize that it is only a repetition when we find it divided into several bellies, each of which is attached to but one vertebra.

It draws the upper angle of the scapula upward, but at the same time turns it round its axis, and depresses the region of the shoulder when it acts alone; so that it is the antagonist of the trapezius and serratus magnus muscles. When it contracts at the same time with the rhomboidei and trapezius, the shoulder is directly elevated. When the upper extremities are fixed, it draws the neck to its side, if only one muscle acts; but if both contract, the neck is fixed and kept straight.

§ 1008. Sometimes a long slip is detached from this muscle, which goes between the scapulæ and the vertebral column, an arrangement similar to what is seen in the dolphin.

III. SERRATI MUSCLES.

§ 1009. The *posterior serrati* muscles (*M. serrati*, s. *dentati postici superior et inferior*) form in fact but a single muscle, since they are united by an aponeurotic expansion. Both arise from the spinous processes of the vertebræ, and are attached to the ribs. The inferior is covered by the latissimus dorsi, the upper by the trapezius and the rhomboidei muscles; both are broad and thin. They are both square, and are attached by several digitations to the ribs.

A. SERRATUS POSTICUS SUPERIOR.

§ 1010. The *serratus posticus superior* muscle, *Dorso-costal*, Ch., usually arises by a broad tendon from the spinous processes of the last cervical and of the first and second dorsal, rarely also from the sixth cervical and from the third dorsal vertebræ. Its fibres are directed obliquely downward, and divide most frequently into four and more rarely into three digitations, which are attached to the upper edge and to the external face of the second, third, fourth, and fifth ribs, a little beyond their angle.

§ 1011. Sometimes a single head leaves the upper part of this muscle, ascends along the levator anguli scapulæ muscle, and goes to the transverse process of the first cervical vertebra.(1)

B. SERRATUS POSTICUS INFERIOR.

§ 1012. The *serratus posticus inferior* muscle, *Lombo-costal*, Ch., is broader but thinner than the superior. It arises by a very broad but thin tendinous expansion from the spinous processes of the last two dorsal and the first three lumbar vertebræ, and adheres to the posterior tendon of the latissimus dorsi muscle so intimately that it may be said in fact to come from it. Its fibres have the same direction as that of the tendon, that is, they descend obliquely from behind and downward, and are attached, usually by four digitations, to the inferior edge of the last four ribs before their angle, from which they separate still more as they are lower, so that the upper in some measure cover the lower.

Between these two muscles is an elongated, very thin, aponeurotic expansion (§ 1009), in the tissue of which we evidently perceive transverse fibres in one part and another, but especially at its upper and lower parts: this expansion arises from the spinous processes of the dorsal vertebræ situated between the two muscles, and is attached to the angle of the ribs.

§ 1013. The two muscles form, with the aponeurosis which unites them and the bones placed before them, a kind of canal, in which are situated the subjacent dorsal muscles, which are compressed and kept in place by their simultaneous action. The upper raises the ribs to which it is attached. The lower acts with more power, because the ribs in which it is inserted are less firmly fixed, and it draws them downward and outward. These two muscles assist in inspiration, and are not antagonists.

(1) Rosenmüller, *loc. cit.*, p. 5.

IV. SPLENII MUSCLES.

§ 1014. The *splenii* muscles (*M. splenii*) are considered by many anatomists as forming only one muscle, because their two lower extremities are so intimately connected. But the proportionally small extent of their union makes it more convenient to regard them as two separate muscles, one of which however is a repetition of the other: the lower is the *splenius colli*, the upper the *splenius capitis.* Both are situated directly under the trapezius, and go, from below and inward, upward, forward, and outward. They are elongated, flat, and thin. They occupy the space between the spinous processes of the lower and the transverse processes of the upper vertebræ or of the corresponding bones.

A. SPLENIUS COLLI.

§ 1015. The *splenius colli* muscle, *Dorso-trachelien*, Ch., arises, by short and tendinous fasciculi which are not very deeply separated, from the spinous processes of the third, fourth, and fifth dorsal vertebræ. It is attached by two, rarely by three, other longer digitations to the extremities of the transverse processes of the two, rarely of the three, upper cervical vertebræ.

B. SPLENIUS CAPITIS.

§ 1016. The *splenius capitis* muscle, *Cervico-mastoidien*, Ch., is broader and stronger than the preceding, and is situated immediately above it; hence its lower edge is attached to the upper edge of the other. It arises, by short tendons, from the cervical ligament at the side of the spinous processes of the third, fourth, fifth, and sixth cervical vertebræ, rarely also of the second, from the spinous process of the last cervical vertebra, and more rarely from those of the upper two dorsal vertebræ, and is attached to the posterior part of the mastoid process in its whole extent, where it covers the sterno-cleido-mastoideus muscle, and to the external part of the asperity situated below the upper curved line of the occipital bone, and consequently to a part of the bones of the skull which corresponds to the transverse processes of the vertebræ.

§ 1017. The splenius colli muscle turns the neck, and the splenius capitis turns the head, so as to carry the face to the opposite side. At the same time they incline these parts a little backward; and when they have been turned from the opposite side, they render them straight.

ARTICLE THIRD.

MUSCLES OF THE THIRD LAYER.

§ 1018. The third layer comprises the sacro-spinalis, the cervicalis descendens, the biventer cervicis, the complexus, the trachelo-mastoideus, and the transversalis colli muscles which are attached to the ribs and head, and have all an oblong form.

I. SACRO-SPINALIS.

§ 1019. The *sacro-spinalis* muscle, the largest of all these muscles, extends almost the whole length of the vertebral column. It fills most of the channel between the spinous processes and the transverse processes of the vertebræ and the ribs, and divides into two bellies, which are united below to a considerable extent. The external belly is called the *sacro-lumbalis* muscle, and the internal the *longissimus dorsi* muscle.

The common belly, which is considerably thick, arises from the upper, inner, and posterior part of the crest of the ilium, from the upper oblique and spinous processes of the sacrum, from the posterior sacro-iliac ligament, where it unites with the glutæus maximus muscle, from the spinous processes of all, or only from the lower four of the lumbar vertebræ, and besides from each lumbar vertebra by short digitations, the external of which is attached to almost all the transverse process, and the internal to the *accessory process* (*processus accessorius*) of the latter. Its external part is fleshy. The internal is entirely tendinous at its lower part, but only on the surface at its upper. The tendon is very strong and dense, especially where it comes from the spinous processes of the lumbar vertebræ.

This common belly extends to the twelfth rib, where it divides to form the two muscles above mentioned. These gradually become thinner as they ascend, and divide into a great many slips.

The *longissimus dorsi* muscle is attached, 1st, by twelve bands, which grow shorter as they ascend, to the extremities of the transverse processes of the dorsal vertebræ; 2d, farther outward, by seven or eight shorter, weaker, closer, broad slips, to the posterior and smooth face of the necks of the corresponding lower ribs.

The *sacro-lumbalis* muscle, the outer belly of the sacro-spinalis muscle, receives in its course several accessory fasciculi which may be considered so many origins. These fasciculi arise by tendinous fibres from the angles of the twelve ribs. Their form is oblong, and they become longer and thinner the higher they are; they go a little upward and outward. Arising from all these points, the muscle is attached by thirteen slips, which gradually diminish in length from above downward, 1st, to the inferior edges of the angles of the ten or eleven lower ribs, and to the upper edge of the angle of the first or of the two upper ribs, near their tubercles; 2d, by the thirteenth slip, which is the uppermost, to the transverse process of the last cervical vertebra.

The two bellies extend the trunk, prevent it from bending forward, incline it backward and a little to the side, and draw the ribs downward.

II. CERVICALIS DESCENDENS.

§ 1020. The *cervicalis descendens*, more properly *ascendens* muscle, is only, strictly speaking, the upper part of the sacro-lumbalis muscle. It arises from the angle of the third, fourth, fifth, and sixth ribs, by three or four longitudinal slips which correspond to the accessory fasciculi of the sacro-lumbalis muscle, and unite in a short, thin belly. This usually divides into four, sometimes only three or even two digitations, which gradually increase in volume from below upward.

These digitations are attached to the posterior roots of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ.

It draws the neck backward, and inclines it a little to the side. When the neck is fixed, it slightly raises the ribs.

III. BIVENTER CERVICIS.

§ 1021. The *biventer cervicis* muscle* is situated very near the median line, and is mostly covered by the splenii muscles, which entirely conceal it, except at its upper and lower extremities. It extends from the centre of the pectoral portion of the vertebral column to the occipital bone. It is an elongated and thin muscle composed of two rounded bellies, and of a central tendon nearly as long as the two bellies. The upper part of its external edge blends intimately, especially by the tendon of the upper belly, with the complexus muscle situated at its side.

The lower belly arises by from two to five fasciculi, the inferior of which are the longest and thinnest, from the posterior face of the transverse processes of the second, third, fourth, fifth, sixth, seventh, and eighth dorsal vertebræ.

It usually blends with the longissimus dorsi muscle by one of the inferior fasciculi, or by a distinct muscular band. Its lower extremity is constantly united with the heads of the transversalis colli muscle, and most generally with the lower extremity of the trachelo-mastoideus muscle.

These fasciculi, situated one above another, so that the posterior cover the anterior, unite to the inferior belly, which terminates imperceptibly in a point at its summit, and which almost always sends along the inferior face of the central tendon, a thin muscular slip which extends to the upper belly.

This central tendon, which, from its situation, is much longer, and more apparent on the posterior face of the muscle, the only place,

* The long portion of the complexus muscle of most anatomists.

properly speaking, where it is entirely loose; commences nearly opposite the third dorsal, and extends as high as the fifth cervical vertebra.

The upper rounder belly is stronger and longer than the lower, and enlarges at its upper extremity, and is thinner in this part than the rest. It becomes a short tendon upward, by which it is attached to the inner part of the upper curved line of the occipital bone.

Sometimes, and even usually, this muscle has three bellies, because the upper belly at the point of union with the tendon of the complexus muscle, is divided into two portions, an upper larger, a lower smaller, by a tendon which is often an inch long, and which is likewise seen on its posterior face.

Usually also we see one of the three fasciculi coming from the spinous process of the last cervical, or of the first dorsal vertebra, sometimes also from the fifth and the sixth cervical vertebræ, to go to the internal edge of the upper belly, a little above its lower extremity.

This muscle extends the neck, keeps it straight, and brings it backward. When it acts with its fellow, it extends it backward.

V. COMPLEXUS.

§ 1022. The *complexus* muscle is situated at the side of the preceding, and should be regarded as its external portion.(1) It is broader and stronger, but shorter than it, and generally extends only from the third cervical vertebra to the occipital bone. Its form is an oblong and irregular quadrilateral.

It arises by from six to nine fleshy heads, which are very tendinous at their lower part, of which an inferior is deficient more frequently than a superior; these arise from between the third cervical and the fifth dorsal vertebræ. The three or four lower heads arise from the upper and external parts of the transverse processes; the others more internally, from the articular processes; so that each of the latter arises from two successive vertebræ. All ascend obliquely, the inferior straighter than the others towards the spinous processes and the biventer cervicis muscle, and unite in a large fleshy belly, in which we can always trace the fasciculi of the heads which form it.

We perceive a little above the centre of this belly an intermediate tendon, more or less perfect, and usually stronger at its internal part; which unites by this part with the second intermediate tendon of the biventer cervicis muscle, and which is also more apparent on its external than on its internal face.

The complexus muscle is attached by very short tendinous fibres which form a broad, single, rounded, and convex edge, to the external part of the upper curved line of the occipital bone.

(1) This muscle and the preceding, are described by Chaussier as the *trachelo-occipital*. F. T.

Its uses are the same as those of the preceding muscle, but it draws the head more obliquely to its side when it acts alone.

§ 1023. A thin accessory muscle sometimes arises from the transverse process of the second dorsal vertebra, ascends toward the head, and is attached to the occipital bone between the complexus and the rectus posticus muscles. This formation is remarkable as being analogous with the formation of birds.

V. TRACHELO-MASTOIDEUS.

§ 1024. The *trachelo-mastoideus* muscle, *Trachelo-mastoidien*, Ch. (*M. trachelo-mastoideus*, s. *mastoideus lateralis*, s. *complexus parvus*), is next on the outside of the complexus muscle, is by no means as powerful, and strictly speaking should not be separated from the transversalis colli muscle, being in fact its internal and upper part.

It arises by from one to seven heads, of which a superior is deficient more frequently than an inferior. It extends from the third cervical to the sixth dorsal vertebra, arising by its lower heads from the upper part of the outer extremities of the transverse processes and from the oblique processes by its upper heads, and is here intimately united with the origin of the biventer cervicis, the complexus and the transversalis colli, and most generally at its lower part with the longissimus dorsi muscle. These heads unite in a thin muscle, which ascends along the anterior edge of the complexus muscle, and its upper extremity is attached to the posterior edge and to the lower extremity of the mastoid process of the temporal bone.

This is the usual arrangement: but sometimes this muscle is divided into two bellies by a long intermediate tendon. Sometimes its upper part is separated into two and even three slips, the lower of which are attached to the transverse processes of the first and even of the second cervical vertebra.

It flexes the neck, which it inclines obliquely to its side, making the head lean a little in the same direction.

VI. TRANSVERSALIS COLLI.

§ 1025. The *transversalis colli* muscle is situated on the outside of the preceding, and is sometimes closely united with it and sometimes separated from it in a very inconstant manner. It extends between the first cervical and the middle and even the inferior dorsal vertebræ.

It arises by five, six, or seven heads from the transverse processes of the upper eight dorsal and the lower three cervical vertebræ; so that the upper heads are deficient more frequently than the lower.

Usually it is not situated so high, does not arise so low, and is attached by four or five upper heads to the extremities of the posterior roots of the transverse processes of the first six cervical vertebræ, although generally it does not extend to the first.

Its size, the number of slips of its origin and insertion, are opposite to those of the trachelo-mastoideus muscle in all these respects, if we would consider it a muscle distinct from the last.

It extends the neck and inclines it a little backward.

ARTICLE FOURTH.

FOURTH LAYER OF MUSCLES.

§ 1026. The fourth layer comprises numerous muscles, all of which are situated between the vertebræ or between these bones and the head. Those between the different vertebræ are the semispinalis cervicis, the semispinalis dorsi, the spinalis dorsi, the multifidus spinæ, the interspinales, the supraspinales, and the intertransversarii; those situated between the upper vertebræ and the head are the recti muscles, the obliqui muscles, and the rectus capitus lateralis muscle.

I. DORSAL MUSCLES OF THE FOURTH LAYER.

A. SEMISPINALIS COLLI.

§ 1027. The *semispinalis colli* muscle(1) arises by five or six heads, the inferior of which are the longest, feeblest, and straightest, from the posterior face of the extremities of the transverse processes of the five or six upper dorsal vertebræ. It extends obliquely upward and inward and is attached by four separate heads to the lower edge of the tubercles of the spinous processes of the second, third, fourth, and fifth cervical vertebræ.

It extends the neck, and inclines it a little obliquely backward.

B. SEMISPINALIS DORSI.

§ 1028. The *semispinalis dorsi* muscle resembles the preceding in form and situation. It arises by six or seven inferior heads from the posterior faces of the transverse processes of the fifth, sixth, seventh, eighth, ninth, tenth, and eleventh dorsal vertebræ, goes obliquely upward and inward, and is attached by five or six separate slips to the lower edge of the summit of the spinous processes of the lower two cervical and the three or four superior dorsal vertebræ.

These two muscles should be considered as one, and their separation is purely artificial.(2) When united, they correspond to the complexus and to the biventer cervicis muscle.

(1) This muscle is generally termed the *spinalis colli* muscle; but this term should be rejected, because then its analogy with the following muscle, of which it is the continuation, is neglected. Albinus noticed this fact. (*Hist. musc.* p. 381.)

(2) Albinus' remark upon these muscles is generally correct: "With which (the spinalis) it is sometimes so blended, that it is doubtful to which the proximate heads and extremities belong." (*Hist. musc.* p. 382.)

The semispinalis dorsi resembles the preceding in its action on the back and lower part of the neck.

C. SPINALIS DORSI.

§ 1029. The *spinalis* muscle, usually called the *spinalis dorsi* muscle, can never be presented as a distinct muscle, being always blended with the longissimus dorsi, the multifidus spinæ situated below, and the semispinalis dorsi muscles. It rests directly on the upper and posterior parts of the arches of the vertebræ, and arises by four or five separate heads from the lateral faces of the spinous processes of the upper two lumbar and lower two or three dorsal vertebræ. These heads remain for a long time tendinous. The middle belly soon divides into from four to eight upper heads, which are attached to the lateral faces of the spinous processes of the upper dorsal vertebræ.

This muscle represents particularly the digitations of the biventer cervicis muscles, which are usually attached to one or some of the spinous processes of the lower cervical vertebræ.

It extends the vertebral column and inclines it to its side.

D. MULTIFIDUS SPINÆ.

§ 1030. The *multifidus spinæ* muscle is formed by a great many fleshy bands, which extend obliquely downward from the transverse processes to the spinous processes of the vertebræ above, and which interlace so differently that they thus give rise to a muscle. This muscle forms the last layer of the muscles of the back and neck, and fills the inner and deepest part of the hollow between the transverse and spinous processes.

The highest slip is attached by its upper extremity to the spinous process of the second cervical vertebra, and the lowest slip is inserted in the transverse processes of the fourth and fifth vertebræ of the sacrum.

The muscle becomes considerably thinner as it ascends, and in the same proportion less fleshy but more tendinous. The lower its fibres the more perpendicular its direction.

It is united more or less intimately with the spinalis and the semispinalis dorsi and colli muscles. Taken as a whole with these three muscles, it represents for the rest of the vertebral column and for the vertebræ the biventer cervicis and the complexus.

It extends the vertebral column and moves it to one side.

E. INTERSPINALES.

§ 1031. The *interspinales* muscles are short muscles formed of longitudinal fibres, which are situated between the summits of the spinous processes of two adjacent vertebræ.

The most apparent are those of the cervical vertebræ. Those of the lumbar vertebræ are the most feeble. Those of the dorsal vertebræ are the least distinct and often partially deficient. The cervical, as their spinous processes enlarge, become doubled more frequently than in the other regions, and thus divide into two separate muscles, a right and a left.

§ 1032. We sometimes find in the neck *supraspinales* muscles (*M. interspinales supernumerarii*, s. *supraspinales*), which are more superficial than the preceding and which sometimes pass over several vertebræ. Thus we sometimes find in the same subject thin and small muscles, which pass from the summits of the transverse processes of the sixth or seventh to the corresponding parts of the second cervical vertebra, and below them other feebler muscles, which go from the seventh to the third cervical vertebra: both exist either on one or on both sides. These supraspinales muscles are sometimes shorter.

According to our dissections, the supraspinales muscles exist more frequently than they are absent. They evidently correspond to the spinalis dorsi muscle (§ 1029); so that they would be more properly termed the *spinales cervicis* muscles. They are generally situated on the summits of the spinous processes and not on their sides. Their presence in the neck is remarkable as an analogy with the rectus capitis posticus major muscle, which normally passes over the first cervical vertebra.

They are always looser and more detached than the fleshy slips which compose the spinalis colli muscle, in which they resemble the type of the other muscles of the neck and of the cervical vertebræ.

They extend the vertebral column.

F. INTERTRANSVERSARII.

§ 1033. The *intertransversarii* muscles are formed of longitudinal fibres and are situated between the transverse processes of two vertebræ. In the cervical region they are double, like the interspinales muscles, and are called the *anterior* and *posterior*: the former extend between the anterior roots and the latter between the posterior roots of two transverse processes.

They incline the vertebral column to the side.

II. MUSCLES OF THE FOURTH LAYER BELONGING TO THE HEAD.

§ 1034. The muscles of the fourth layer belonging to the head perfectly resemble in their essential characters those muscles of the same layer which belong to the back or those of the layers over them, and are more largely developed only from the weight which they are obliged to move. They are imbedded in loose cellular tissue, which separates them from each other and from the muscles below.

They are the two straight, two oblique, and one lateral muscle.

A. POSTERIOR RECTI MUSCLES OF THE HEAD.

§ 1035. The two recti muscles of the head (*M. capitis recti*) correspond to the interspinales muscles, and are in fact the two superior. The transition from them to the latter is marked by the interspinales colli muscles, which are strongest and in pairs, and also by the supraspinales muscles, (§ 1032), which are often seen.

a. Rectus capitis posticus major.

§ 1036. The *rectus capitis posticus major* muscle, *Axoido-occipital*, Ch., (*M. capitis posterior rectus major*, s. *superficialis*, s. *epistrophico-occipitalis*), is triangular and arises from the upper face of the spinous process of the second cervical vertebra. It begins below in a point, enlarges very much at its upper part, passes above the arch of the atlas and over the rectus capitis posticus minor muscle, and is attached by a thin and rounded edge to the lower curved line of the occipital bone.

§ 1037. This muscle not unfrequently occurs double, and this excess is analogous to the normal formation in the ruminating animals and in birds.

It extends the head directly backward.

b. Rectus capitis posticus minor.

§ 1038. The *rectus capitis posticus minor* muscle, *Atloido-occipital*, Ch., (*M. posticus capitis minor*, s. *profundus*, s. *atlanto-occipitalis*), arises from the spinous process of the first cervical vertebra and is attached to the internal part of the lower curved line and also to the rough surface below, between it and the posterior edge of the large occipital foramen. It is triangular like the former, but much broader in proportion to its length. Its summit is likewise turned downward.

This muscle acts like the preceding, but is less powerful, from its smallness and its unfavorable insertion.

These two muscles represent the upper two spinales colli muscles. The rectus major muscle corresponds to the second, which from the great weight it moves passes by the first vertebra and is attached to the corresponding part of the occipital bone. The rectus minor corresponds to the first; it is not an exception to the rule.

B. OBLIQUE MUSCLES OF THE HEAD.

a. Obliquus capitis inferior.

§ 1039. The *obliquus capitis inferior* muscle, *Axoido-atloidien*, Ch., is the strongest of the small muscles of the head and has an oblong quadrilateral form. It arises below and on the outside of the rectus capitis major muscle (§ 1035), from the lateral face of the spinous process of the second cervical vertebra, goes obliquely upward, outward, and forward, and is attached to the posterior face of the extremity of the transverse process of the first cervical vertebra.

It moves the neck and at the same time the head, which it rotates on their axes; so that the face is turned toward the side of the muscle which contracts.

This muscle seems to be the external part of the second spinalis colli muscle largely developed, the upper extremity of which would proceed to the next vertebra, as do all the other spinales muscles, but it goes more externally on account of the turning of the head. Farther, we may compare it to the splenii muscles of the preceding layer, for it resembles them perfectly in its insertions, direction, and uses.

b. Obliquus capitis superior.

§ 1040. The *obliquus capitis superior* muscle, *Atloido-sous-mastoidien*, Ch., is triangular. It arises above the preceding, from the upper face of the summit of the transverse process of the first cervical vertebra. It goes obliquely upward and inward, enlarges, and is attached to the occipital bone on the external part of the rough surface in the space between the two ridges.

It draws the head backward and a little to the side, so as to bring it near the occiput and turn the face from the opposite side; hence it is the antagonist of the preceding muscle.

We may consider it as a part of the upper intertransversarius cervicis muscle or as the upper and posterior part of the second interspinalis muscle, and consequently as the upper part of the preceding. This similarity however is still greater if we compare it to the upper slip of the multifidus spinæ muscle, the deficiency of which as stated by most anatomists will be compensated for in this manner.

C. RECTUS CAPITIS LATERALIS.

§ 1041. The *rectus capitis lateralis* muscle, *Atloido-sous-occipital*, Ch., is the smallest in this region, and arises from the upper part of the transverse process of the first cervical vertebra, goes forward and outward, and is atttached to an impression in the occipital bone behind the posterior edge of the foramen lacerum.

It draws the head to the side and a little forward.

It evidently wholly or partially represents the posterior intertransversarius cervicis muscle, which is here larger and goes a little farther forward.

This muscle is sometimes double, an arrangement normally seen in birds.

ARTICLE FIFTH.

ACCESSORY MUSCLES OF THE FOURTH LAYER.

§ 1042. We may also for the convenience of study refer to this fourth layer of the dorsal muscles the levatores costarum, the scaleni, the quadratus lumborum, and the intercostales muscles, and oppose them to the preceding as being accessory muscles, from the analogy of the bones of the trunk.

I. LEVATORES COSTARUM.(1)

A. LEVATORES COSTARUM BREVES.

§ 1643. Each rib has a short levator muscle. These muscles (*levatores costarum breves*) are triangular: they arise from the inferior edge of the summit of the transverse process of the next superior dorsal vertebra, go obliquely downward and outward, gradually enlarge in their course, and are attached to the posterior and superior edge of the portion of the ribs comprised between the tubercle and the angle, but they do not extend to the latter.

They are mostly tendinous on their posterior face.

B. LEVATORES COSTARUM LONGI.

§ 1044. Besides, the three to five inferior ribs have long levators (*levatores costarum longi*), which are also triangular, but broader, situated more externally, and more superficially than the short. They arise near the summit of the transverse processes of the inferior dorsal vertebræ and pass over one rib to be attached to the following.

The long and short levators of the ribs are uninterruptedly continuous with the external intercostal muscles.

The action of these muscles is indicated by their name.

II. SCALENI.

§ 1045. The *scaleni* should be called the long levators of the upper ribs, for they resemble the preceding in situation and form, although they act less on the ribs than upon the cervical vertebræ.

Their general characters are: 1st, they are oblong, triangular, and pointed at their two extremities; 2d, they arise from the upper edge and from the external face of one or both of the two upper sides by a single

(1) The levatores breves and longi are sometimes termed collectively the supracostales muscles.

broad tendon ; 3d, they are attached to the transverse processes of several cervical vertebræ by different tendinous bands; 4th, they flex the neck to the side and raise the ribs. Their number is not always the same, and varies from three to six. The most constant and the largest are three in number ; the *anterior*, the *lateral* or *middle*, and the *posterior*.

A. SCALENUS ANTICUS.

§ 1046. The *scalenus anticus* muscle, *Costo-trachelien*, Ch., is situated behind and below the sterno-cleido-mastoideus muscle. It arises from the upper face of the first rib, some distance behind its anterior extremity, goes upward and backward, and terminates in two, three, or four bellies, which are usually separated only at their upper part, and are attached to the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ.

B. SCALENUS MEDIUS.

§ 1047. The *scalenus medius* muscle, the longest of all, arises from the first and second ribs, about an inch farther backward and outward than the preceding, goes directly from below upward, and is attached most generally by seven slips to the posterior tubercles of the transverse processes of the seven cervical vertebræ.

C. SCALENUS POSTICUS.

§ 1048. The *scalenus posticus* muscle, the shortest of all, arises much farther back than the others, from the posterior part of the external face of the second rib, goes obliquely upward and forward, and is attached, behind the two preceding by two and rarely by three long and tendinous slips, to the posterior extremities of the transverse processes of the fourth, fifth, and sixth cervical vertebræ. It is sometimes deficient.

D. SUPERNUMERARY SCALENI MUSCLES.

§ 1049. The *unusual* or *supernumerary scaleni* muscles are usually developed between those already described and are smaller than them. An *anterior*, which is situated between the scalenus anticus and medius, and is sometimes called the *Scalenus minimus*, Albinus, is sometimes formed by the division of the anticus, since it is situated directly behind it and comes from the first rib. It is attached by one, two, or three heads to the anterior extremity of the transverse processes of the fifth, sixth, and seventh cervical vertebræ. Usually, the inferior nerves of the brachial plexus and the axillary vessels pass along its posterior face, between it and the scalenus medius, and the upper nerves along its anterior face, between it and the scalenus anticus muscle, although when this muscle is deficient they all pass between the scalenus anticus and medius.

This supernumerary scalenus anticus muscle often forms a more distinct muscle, being still more remote from the anticus and arising farther behind the upper face of the first rib. It is then always shorter, and is attached only to the summit of the transverse process of the sixth cervical vertebra, or of this and the fifth.

We have sometimes found it double. In this case there is an *external* and an *internal*, the former situated behind and the second before the last two nerves of the brachial plexus. The external or posterior is attached by a double upper slip to the anterior and posterior tubercle of the transverse process of the sixth cervical vertebra; and the internal or anterior is inserted by four slips placed above each other only in the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ.

The supernumerary scalenus lateralis or posticus muscle is situated between the scalenus medius and the scalenus posticus. It arises from the posterior part of the first rib and is attached between the slips of these muscles to the summits of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

We have sometimes found these three supernumerary scaleni at once in the same subject.

§ 1050. It is more unusual to find an analogous muscle coming from the transverse process of the sixth cervical vertebra and inserting itself into the inferior face of the humeral extremity of the clavicle.(1)

III. QUADRATUS LUMBORUM.

§ 1051. The *quadratus lumborum* muscle, *Ilio-costal*, Ch., is an oblong and rounded muscle, situated at the side of the lumbar vertebræ, between the posterior portion of the crest of the ilium and the twelfth rib, so that it forms in part the posterior wall of the abdomen.

It is composed of two more or less evident layers, an *anterior* and a *posterior*. The *posterior* layer is the most extensive. It arises from the inner lip of the iliac crest, a little behind its centre, and from the ilio-lumbar ligament by a broad tendon; becomes larger after arising, inclines inward toward the vertebral column, divides into five or six heads which are attached to the inferior portion of the extremities of the transverse processes of the three or four upper lumbar vertebræ and to the lateral portion of the bodies of the two inferior dorsal vertebræ, and is finally inserted by a broad slip in the inner part of the inferior edge of the twelfth rib.

The *anterior* layer is thinner, and arises by some tendinous slips from the upper part of the extremities of the transverse processes of the three or four inferior lumbar vertebræ,, and blends with the preceding.

(1) Kelch, *Beytræge zur pathologischen anatomie*, p. 32, No. xxxiv.

The quadratus lumborum muscle evidently represents the levatores costarum, the scaleni, the levator anguli scapulæ, and the rhomboidei muscles; and anteriorly, the pyramidal muscles. We must not compare this muscle, but the two obliqui abdominis muscles, to the intercostales muscles. The two layers of which it is composed, fully justify the parallel drawn between it and the preceding muscles.

It flexes the lumbar vertebræ to its side, and depresses the lower ribs.

IV. INTERCOSTALES.

§ 1052. The *intercostales* muscles are divided into the proper intercostales, and the subclavius muscles.

I. PROPER INTERCOSTALES.

§ 1053. Each intercostal space is filled on each side by two thin muscular layers formed of oblique fibres, which are called the *intercostales* muscles. The whole number of these muscles is consequently forty-four, of which eleven on each side are external, and eleven internal.

a. Intercostales Externi.

§ 1054. The *intercostales externi* muscles, go from the lower part of the external face of the ribs, obliquely from behind forward, to the upper part of the outer face of the next rib below, so that their posterior fibres are more oblique than their anterior. They commence near the tubercle of the ribs, and extend to the costal cartilages. At their termination, they are replaced by an aponeurosis formed of fibres which have the same direction. Many tendinous fibres leave their upper and lower edges, and are expanded on their external face, which extend almost to the opposite edge.

b. Intercostales Interni.

§ 1055. The *intercostales interni* muscles occupy all the space between the costal cartilages and the bony parts of the ribs to their angle. Their fibres are oblique from within outward, and from before backward, and extend from the internal margin of the inferior edge of each rib to the internal lip of the upper edge of the rib directly below.

The inferior, at their posterior part, occasionally give off slips which pass to the next rib, and even to the one below.

The central are divided by slips, situated between each pair of costal cartilages, into two portions; an *anterior*, which is smaller, and a *posterior*, which is larger.

They differ from the intercostales externi muscles because they extend farther forward, and not so far backward; because they are not so broad, and because their fibres, which follow a contrary direction, are straighter.

The two layers of intercostal muscles approximate the ribs to each other, and usually raise the lower ribs which are more movable, to the superior, which are less so.

§ 1056. We also remark on the internal face of the cavity of the thorax, muscular fasciculi, which are not constant, have no fixed place, vary much in size, sometimes lean to one side, and may be called the *infracostales* muscles. Kelch has described them as the internal serrati muscles.(1)

II. SUBCLAVIUS.

§ 1057. The *subclavius* muscle, *Costo-claviculaire*, Ch., resembles the intercostales, especially the externi, in situation and uses.

It arises by fleshy fibres, which descend obliquely downward and outward from the greater external part of the inferior face of the clavicle, and from the outer part of the anterior face of the rhomboid ligament; and it is attached by a strong tendon, which extends along its inferior edge to the anterior face of the cartilage of the first rib, not far from its anterior extremity.

It brings the clavicle towards the first rib, which it most generally draws downward; but it can also act in an opposite direction, and approximate the rib to the clavicle.

§ 1058. The analogy between the subclavius and the intercostales muscles, is sometimes rendered more evident by the presence of a second subclavius muscle, which arises from the coracoid or the acromion process, and is attached to the first rib.(2) This anomaly indicates the relation between the subclavius and the pectoralis minor muscles, and connects the normal state with that in which we find a third accessory muscle.

CHAPTER II.

ANTERIOR MUSCLES OF THE TRUNK.

§ 1059. The anterior muscles of the trunk comprise the muscles of the abdomen and chest, the anterior muscles of the neck, and the muscles of the sacrum and coccyx, when they exist.

(1) *Beitr. zur Path. Anat.*, p. 41, No. 32.
(2) Rohmer, *Obs. Anat.* part 1. p. 4.—Rosenmüller, in Isenflamm and Rosenmüller, *Beit.*. vol. i., p. 375, and *De nonnullis musc. corp. humani varietatibus*, p. 6.

ARTICLE FIRST.

OF THE ABDOMINAL MUSCLES.

§ 1060. We find in the abdominal region seven pairs of muscles which form its parietes; four are broad, two are long, and one is short.

§ 1061. The four broad muscles are the obliquus externus, the obliquus internus, the transversalis, and the diaphragm. The two long muscles are the rectus abdominis and the pyramidalis. The short muscle is the quadratus lumborum (§ 1051). This latter has already been described.

Among the broad muscles, the first three are situated before and on the sides of the abdominal cavity, while the diaphragm occupies the upper and posterior part: the two long muscles belong to the anterior wall, and are situated on the median line.

I. OBLIQUUS EXTERNUS ABDOMINIS.

§ 1062. The *obliquus abdominis externus* or *descendens* muscle, *Costo-abdominal*, Ch., is situated directly under the skin. It covers not only the other two broad abdominal muscles, but also the anterior part of the inferior intercostales and the last eight ribs, on the anterior face of which it is placed.

Its posterior part is fleshy, and its fibres go obliquely downward, inward, and forward. It arises from the last eight ribs by eight slips, the extremities of which are tendinous, and which are blended with the pectoralis major, the serratus major, and the latissimns dorsi muscles.

Of the eight slips which form the external edge of this muscle the upper is the thinnest, but the longest. It is united by the lower part of its anterior edge with the inferior part of the pectoralis major muscle, while the upper part of this same edge proceeds directly at the side of the lower part of the posterior edge of this muscle, and is attached to the external face of the fifth rib, about two inches behind its anterior extremity.

The second and third slips are the broadest. The fourth, fifth, and sixth gradually become narrower; the seventh and eighth are much narrower than the others, with the exception of the first.

The eighth is attached not only to the cartilage of the last false rib, but also, by its lower part, to the common tendon of the two succeeding abdominal muscles. The whole posterior edge is oblique downward and backward, from the first slip to the last; in the rest of its extent, which is less, it follows an inverse direction, and goes obliquely downward and forward.

The four upper slips are so blended with the four lower slips of the serratus magnus muscle, and the four lower with those of the latissimus dorsi muscle, that all these slips intercross with each other by tendinous edges, directed obliquely upward and inward.

The substance of the muscle becomes much thicker from above downward.

The inferior edge of the fleshy portion is attached by short tendinous fibres to the anterior half of the internal lip of the iliac crest. It terminates at the anterior and superior iliac spine. The anterior edge describes, inward and forward, two convexities, a superior which is shorter, and a posterior which is much larger, which are separated by an intermediate depression. It is continuous with the broad anterior tendon.

The fleshy part of the obliquus externus abdominis muscle represents an oblong rhomboid, the centre of which is the broadest portion and the upper part the narrowest.

The tendon of this muscle is as broad, but much higher than its fleshy portion, since it extends from the inferior edge of the pectoralis major muscle and the cartilage of the sixth rib to the symphysis pubis.

Its upper part is the weakest and thinnest, and it terminates upward in a straight edge, which corresponds to the median line; backward by another edge which is channeled in two places, a superior and an inferior. The anterior edge of its fleshy portion is attached to the latter. Its inferior edge is oblique from above downward. The superior is much shorter than the others and is attached to the anterior face of the cartilage of the sixth rib, and blends with the tendinous fibres of the pectoralis major muscle.

The internal is so intimately united with the same muscle of the other side that the fibres of both muscles extend in their whole extent a little beyond the median line.

The inferior is loose, and extends from the upper and anterior spine of the ilium to the symphysis pubis; its direction is consequently oblique from above downward and forward. It forms a kind of bridge, which is extended over the space which exists in this place between the crest of the ilium and the horizontal portion of the pubis. This inferior edge is very improperly called the *ligament of Fallopius* (*Lig. Fallopii*, s. *Pouparti*); it is more properly termed the *crural arch* (*arcus cruralis*).

Although the lower edge of the tendon of the obliquus externus abdominis muscle leaves the bones when it reaches the anterior and superior spine of the ilium, still it unites intimately an inch and a half farther, below and inward, with the outer part of the anterior face of the crural aponeurosis, and of the tendon of the fascia-lata muscle, which fixes it so firmly that the origin of the crural aponeurosis cannot be displaced except at the place where this union ceases. From its point of union with the aponeurosis of the thigh, fibres ascend, of which the internal particularly are very strong, and go to the anterior face of the tendon.

The *crural arch* is the thickest and strongest part of the tendon of the obliquus externus muscle. In its course, it turns slightly upward and inward, thus forming a channel or semicanal, in the anterior part of which the spermatic cord descends.

This semi-canal commences about an inch on the outside of the external angle of the inguinal ring which we are about to describe. It is changed on the inside by the lower part of the obliquus internus and transversalis muscles into a canal, which descends obliquely, and may be called the *inguinal canal* (*canalis inguinalis*). This canal commences at the place where the spermatic cord in the male, and the round ligament of the uterus in the female, leave the abdominal cavity through the *superior*, *posterior*, or *abdominal* opening (*apertura canalis inguinalis superior*, *posterior*, s. *abdominalis*), and terminates by another *inferior*, *anterior*, or *external* opening (*apertura canalis inguinalis inferior*, *anterior*, *externa*), called also the *inguinal* or *abdominal ring* (*annulus abdominalis*).

From the posterior wall of the crural arch a thin layer arises, which is often formed by tendinous fibres, and is frequently simply cellular, called the *transverse band* (*fascia transversalis*).(1) This band extends between the external face of the transversalis muscle and the external face of the peritoneum. It strengthens, sustains, and limits the upper opening of the inguinal canal.

The connection between the aponeurosis of the thigh and the crural arch can be observed in no other place except the point above mentioned, and we may always demonstrate the loose and smooth edge which terminates it. Still a tendinous band, some lines broad, not unfrequently separates from the inferior edge of the tendon, being attached to it only by a condensed cellular tissue, and proceeds below and a little behind it, but in a parallel direction, and extends from the internal part of the upper extremity of the tendon of the tensor fasciæ-latæ muscle to the pubis, where it is attached to the internal part of the posterior face of its horizontal branch.

This band causes, to a certain extent, the crural arch to appear double, or it may be regarded as a special ligament which contracts the opening over it.

Below the crural arch the crural nerves and vessels pass out of the cavity of the abdomen to go upon the thigh, and are attached to it only by a very loose cellular tissue. The abdominal viscera follow the same route in *crural hernia*.

The tendon of the obliquus abdominis externus muscle is formed principally of fibres which descend obliquely inward. We however see on the whole of its anterior face other more feeble and less adherent fibres, which go in a contrary direction upward and inward, cross the preceding, and serve to increase the solidity of the tendon.

(1) Cooper in Munro, *Morbid Anatomy of the human gullet*, &c., p. 422.—See also J. Cloquet, *Recherches Anatomiques sur les hernies de l'abdomen*, Paris, 1817-1819.

This tendon presents at its internal part a dozen rounded foramina, situated one above another, and forming two series which are not arranged in pairs, but on the contrary alternate regularly. These openings are for the passage of the cutaneous vessels and nerves.

The lower part of this tendon presents a broader and more important foramen. This foramen is called the *inguinal* or *abdominal ring* (*annulus abdominalis*). It is an oblong and rounded opening, about an inch and a half long and an inch broad, the direction of which is oblique downward and inward, which is formed by the separation of the fibres of the tendon.

The opening in this place is only a greater development of the peculiar arrangement of the tendon of the obliquus externus muscle. In fact, when we examine this last attentively, we perceive that from the external and concave edge of the inguinal ring to the posterior edge of the tendon, and in a direction corresponding to that of the ring, thin fibres unite in fasciculi separated from each other, so that here and there the tendon is formed of weak external fibres, through which the color of the subjacent muscles may be seen. The two fibrous fasciculi are called pillars; they immediately surround the inguinal ring, and the upper is generally in part separated from the rest of the tendon by two very considerable foramina, through which nerves and vessels pass. They are distinguished into the *upper* or *internal* and the *lower* or *external pillar* (*crura annuli abdominalis superius*, s. *internum*, *et inferius*, s. *externum*). These are the thickest and strongest parts of the tendon. The lower pillar is stronger than the upper.

The upper pillar is broader and flatter than the lower and intercrosses with that of the opposite side, so that, the left usually covering most of the right, each is attached to the spine of the pubis of the opposite side, and is blended more or less intimately in this place with the fibres of the lower pillar of the other side.

The lower pillar is shorter and more rounded than the upper, and forms the true termination of the lower edge of the fallopian tendon or ligament. It is slightly concave at its upper part, and forms a semicanal, which receives the lower part of the spermatic cord. It is attached for nine or ten lines by an edge, which is oblique from without inward and from behind forward, to the inner part of the horizontal branch of the pubis, as faras its spine.

The spermatic cord passes through the inguinal ring, following the direction of the greatest diameter of this foramen, and fills its lower portion. Many ascending fibres of the external layer, which are weaker and adhere less firmly to each other, go upon its anterior part.

The external portion of the tendon of the obliquus externus muscle is loose and united with that of the obliquus internus muscle, which lies below it, only by a looser mucous tissue. The outer half of this part corresponds to the anterior region of the fleshy portion, and the inner part to the posterior edge of the tendinous portion of the obliquus internus muscle.

The smaller internal portion of the tendon unites very firmly with the tendon of the obliquus internus muscle, and forms with it the anterior layer of the sheath of the rectus abdominis muscle. This muscle is the most superficial and the largest of all the abdominal muscles which it covers almost entirely, except a small posterior and inferior part of the obliquus internus and transversalis muscles. It corresponds so much to the intercostales externi muscles in its position, in the direction of its fibres, and the slight distance to which its fleshy portion extends forward, that we are authorized to say that it represents them in the abdomen.

It draws the ribs downward, contracts the abdominal cavity in every direction, and in this manner it assists the other muscles in expelling the foreign bodies contained in it. At the same time, as the abdominal viscera acted upon by it tend to escape in every direction, it contributes immediately to compress the chest from below upward, and hence is a muscle of expiration. It assists a little to flex the vertebral column forward.

§ 1062. This muscle presents sexual differences in the form of the inguinal ring. In fact, in the male, where the large spermatic cord passes through it, the ring is broader and rounder than in the female, where it gives passage only to the thin round ligament of the uterus.

§ 1063. Besides the absence of a greater or less portion of its middle and anterior part, a defect of formation which is common to it with the other muscles of the abdomen in the fissure of the abdomen, the obliquus externus muscle is subject also to another anomaly, viz. the lower part of its anterior tendon is very imperfectly developed, is feeble, and presents numerous foramina. This anomaly depends on the absence of the external fibres which tie down and retain those of the deep layer. It results in a variety of external inguinal hernia, which resembles crural hernia because the viscera do not escape through the ring, but much more outward.(1)

II. OBLIQUUS INTERNUS ABDOMINIS.

§ 1064. The *obliquus internus abdominis* muscle, *Ilio-abdominal*, Ch. (*M. abdominis obliquus internus*, s. *obliquus ascendens*), is situated directly under the preceding, and forms the middle of the three broad muscles of the abdomen. It is much smaller than the obliquus externus muscle, and occupies the space between the lower edges of the cartilages of the last five ribs, the crest of the ilium, the pubis, and the median line.

The direction of its fibres is directly opposite to that of the fibres of the obliquus externus muscle, for they proceed inward, forward, and upward. The posterior however are straight, the central very oblique, the internal, anterior, and inferior longitudinal, and the lowest of all

(1) Burns, in Monro, *Morbid anatomy of the human gullet*, &c., Edinburgh, 1811, p. 467.

oblique and descending downward and inward. Considered as a whole, it is then formed of fibres which are separated from each other like a fan.

The fleshy part of this muscle arises, by its upper edge, by short tendinous fibres from the whole inferior edge of the cartilage of the tenth and from the anterior part of those of the eleventh and twelfth ribs.

Its posterior edge unites with the posterior aponeurosis of the transversalis abdominis muscle, and with the common aponeurosis of the latissimus dorsi and of the serratus inferior posticus muscles, which aponeurosis arises from the spinous processes of the lumbar and sacral vertebræ.

It extends forward and downward much farther than the fleshy part of the obliquus externus muscle, and passes as far below it as the latter rises above it.

Its anterior edge is convex above, concave below ; it extends from the summit of the cartilage of the tenth rib to near the symphysis pubis, terminates about half an inch above this articulation, and its direction is generally oblique downward and inward.

The inferior edge arises from the central face of the larger anterior part of the crest of the ilium, and below its anterior and superior spine, from the larger external part of the internal face of the crural arch. Its inferior fasciculi go very obliquely downward, pass out through the inguinal ring with the spermatic cord, which they surround externally, and descend with it into the scrotum: they form the *cremaster* muscle.

The tendon of the obliquus internus muscle is less extensive than that of the obliquus externus muscle; but from its origin it divides in the centre into two layers, an anterior and external, and a posterior and internal. The anterior layer is intimately blended with the tendon of the obliquus externus muscle (§ 1061), and forms the anterior wall of the sheath of the rectus abdominis muscle. The posterior layer unites in the same manner with the tendon of the transversalis muscle, and forms the posterior wall of the same sheath.

At its two extremities, on the contrary, the tendon is single, and formed only by the anterior layer which passes before the rectus muscle, and unites less intimately with the tendon of the obliquus externus muscle, especially below.

The upper edge of the tendon begins at the cartilage of the ninth rib ; but the posterior layer disappears in the space between the seventh and eighth ribs. After leaving this point, the rectus muscle is situated directly on the tendon of the transversalis muscle, and higher on the costal cartilages.

The posterior layer of this tendon terminates downward, in the centre of the space between the umbilicus and symphysis pubis, by a semicircular edge, concave below, where its fibres separate a little from each other, and finally disappear.

The obliquus internus muscle corresponds to the intercostales interni muscles (§ 1045), 1st, by the direction of its fibres; 2d, by its situation below the obliquus abdominis externus muscle; and 3d, because its fleshy fibres extend farther forward than those of the latter.

Like the preceding, it contracts the abdominal cavity in every direction, so that its effects are the same.

III. TRANSVERSALIS.

§ 1065. The *transversalis* muscle, *Lombo-abdominal*, Ch., (*M. abdominis transversus* s. *internus*) much resembles the obliquus internus muscle in its extent and direction. Its fleshy part is however longer and narrower. The fibres which form it have a transverse direction; the direction of the lower fibres however is a little oblique from above downward and from behind forward.

The external edge is convex outward, and is oblique from above downward and from within outward. Most of it arises, by seven broad fasciculi which generally are not very distinct, from the internal face of the cartilages of the seven lower ribs, and is here blended with the anterior edge of the costal portion of the diaphragm.

The smaller and the inferior part of the posterior edge goes directly downward, and is attached to the anterior edge of the posterior tendon to be described directly, which comes from the lumbar vertebræ.

The inferior edge is attached to the internal lip of the large anterior part of the crest of the ilium, and gradually unites, from the anterior and upper spine of the iliac bone to near the inguinal ring, with the inferior edge of the obliquus internus muscle; so that it also gives fibres to the cremaster muscle.

The anterior edge is very concave, especially directly below its centre. Its upper part is attached by short fibres to the lateral edge of the xiphoid cartilage, but in almost all its length it is attached to the anterior tendon. This latter is a little broader at its centre than that of the obliquus internus muscle; but it is much narrower above, because of the greater breadth of its fleshy portion.

It is composed almost wholly of transverse fibres, and forms the posterior layer of the sheath of the rectus muscle. This sheath does not extend the whole length of the muscle: it does not ascend to the same height, and is deficient on the costal cartilages which the recti muscles cover; it frequently terminates also downward, a little above the centre of the space between the umbilicus and the pubis; but we generally find in this place a very thin tendinous expansion, to which the lower part of the anterior edge of the transversalis abdominis muscle is attached, and which sometimes passes behind the rectus muscle, to unite beyond its internal edge to the anterior layer of the sheath, and sometimes, especially at its inferior part, unites at its external edge principally with that of its lower tendon.

Besides this anterior tendon, the transversalis muscle has a posterior. This is attached by a straight edge to the posterior edge of the fleshy portion of the muscle, and divides into two layers, an *anterior* and a *posterior*.

The posterior layer is stronger; it is composed of transverse fibres, and is attached by separate slips to the summits of the transverse processes of the upper four lumbar vertebræ and to the lower edge of the twelfth rib. Near its insertion, the fibres converge from above and below, and unite in a point. This layer is situated between the common belly of the longissimus dorsi and quadratus lumborum muscles.

The anterior layer is much thinner, passes before the quadratus lumborum muscle, and is attached by its posterior edge to the roots of the transverse processes of the lumbar vertebræ.

The transversalis abdominis muscle corresponds to the triangularis sterni muscle in the direction of its fibres, in its situation, in the attachments of its external edge to the inner faces of the ribs, and by the insertion of its inner edge in the sternum and linea alba.

It acts like the preceding, but serves especially to contract the cavity of the abdomen in a transverse direction.

IV. LINEA ALBA.

§ 1066. The *linea alba* is a very firm tendinous band, which extends along the median line of the anterior wall of the abdomen. It is formed, by the union and crossing of the anterior tendons of the three broad abdominal muscles, within the sheath of the rectus abdominis muscle. Its greatest breadth, which is nearly half an inch, corresponds to the region of the umbilicus. From the umbilicus to the pubis, it narrows very rapidly; but it is there much thicker than at its upper part, where it is, on the contrary, much broader. Above, for nearly two thirds of the space between the umbilicus and xyphoid cartilage, it is from two to four lines broad; but below the umbilicus it is a line or two less.

In place of the umbilicus, in the early periods of life, we find an opening, called the *umbilical ring* (*annulus umbilicalis*), through which the umbilical vessels and cord pass; but shortly after birth the opening closely unites with the remains of these same, so that here the linea alba has the most firmness.

The tendinous part of the anterior wall of the abdomen is here the firmest and strongest.

The linea alba is to the abdomen what the sternum is to the chest, except that it is not formed of bones. The anterior tendons of the broad muscles are attached to it, as the cartilages of the ribs articulate with the sternum; and the difference of tissue between it and the sternum depends on the general difference of structure between the thoracic and abdominal cavities, the former being almost wholly formed of bones, while the parietes of the latter are fleshy and tendinous.

Finally, we find in the crocodile a real abdominal sternum and abdominal ribs, a more perfect development of what is only indicated in man and most other animals.

§ 1067. The linea alba is sometimes deficient in a greater or less portion of its extent, from a primitive deformity, or at least from an imperfect development. It often happens that it is torn or accidentally distended.

These original deformities and these consecutive alterations occasion an abnormal prolapsus of the abdominal viscera, which is called *umbilical hernia* (*hernia umbilicalis*) when it takes place through or near the umbilicus, and is most frequently the cause of *ventral hernia* (*hernia ventralis*) when it exists in any other place.

V. RECTUS ABDOMINIS.

§ 1068. The *rectus abdominis* muscle, *Sterno-pubien*, Ch., is situated on the inner part of the anterior face of the abdomen. It is very long, and narrow in proportion to its length, but still more thin than narrow. Its thickness gradually diminishes from below upward, while its breadth in this direction increases.

It is attached to the anterior edge and to the lower part of the anterior face of the cartilages of the fifth, sixth, and seventh ribs by three broad slips, of which the internal is the deepest and the external the highest. The two internal are the broadest and are generally equal in breadth. The external is sometimes much thinner, simply tendinous, and adheres to the first slip of the obliquus externus abdominis muscle, or is replaced by it entirely; so that the rectus abdominis muscle extends before it to the sixth rib.

The internal slip is attached also to the anterior face of the xyphoid cartilage and its ligaments.

Below, the rectus muscle terminates by a broad and short tendon, which is attached behind the pyramidalis muscle to the upper face of the horizontal branch of the pubis. Sometimes this tendon divides into two pillars, an external and an internal, the latter of which is broader; although this division is not generally very perceptible.

The tendons of the two recti muscles are blended with each other at their lower part, even partly intercross, and descend from the symphysis pubis to the suspensory ligament of the penis.

The rectus abdominis muscle belongs to the class of poly-gastric muscles, and exhibits this arrangement more evidently than any other muscle. In fact it is always divided into several bellies by undulating tendinous intersections, formed of longitudinal fibres. Usually there are three of these intersections and hence there are four bellies.

All these intersections have not exactly the same type. Their general characters are:

1st. They adhere intimately to the anterior layer of the sheath of this muscle. Generally speaking, they are more apparent forward than backward, where they are sometimes invisible; sometimes they are seen in one part only. They adhere slightly and usually not at all to the posterior layer of the sheath.

2d. They are not generally found except above the umbilicus. The first is situated about as high as this region, the upper an inch below the upper extremity of the muscle, and the central about the centre of the space between the other two, although usually a little nearer the upper than the lower end.

Generally the lower two extend completely across the muscle, while the upper exists only in its inner part.

Sometimes however we find a fourth which is imperfect, below the umbilicus. Sometimes also one of the superior is deficient or is at least imperfect, as is always the case with the third.

These tendinous intersections are doubtless imperfect representations of the ribs in the parietes of the abdomen.

The rectus muscle is enclosed in a sheath formed by the three broad abdominal muscles, with which it is united by mucous tissue. Its fleshy portion is but feebly attached to it, but the tendinous intersections are very firm.

The posterior layer of this sheath is deficient at the upper part of this muscle, that which covers the costal cartilages to which it is attached, and at its lower part, from about the centre of the space between the umbilicus and the symphysis pubis. In these two parts the muscle rests directly on the anterior face of the costal cartilages above, and below on the anterior wall of the peritonæum, to which it unites by very loose cellular tissue.

The rectus abdominis muscle contracts the abdominal cavity in the direction of length and assists to flex the vertebral column.

As it unites by its tendinous intersections with the external and internal oblique muscles, the effects of its contractions extend to these muscles, which in their turn affect the recti muscles. Consequently all these muscles act in concert.(1)

§ 1069. The rectus muscle sometimes presents a fourth slip, which arises from the external or internal part of its upper edge, more usually from the internal, and goes to the fourth rib. This formation resembles that of most mammalia, where it usually reaches to the second rib. It leads also by an insensible gradation to the formation of a special external abnormal sternal muscle.

This muscle divides in the direction of breadth more rarely than in that of length. We have however found on each side external to the proper rectus abdominis muscle, between the two obliqui muscles, a muscle which extended from the lower edge of the tenth rib to the centre of the external edge of the crest of the ilium.(2) This formation

(1) Bertin, *Mémoire sur l'usage des énervations des muscles droits du bas-ventre*, in the *Mém. de l'acad. de Paris*, 1746, p. 585.

(2) Kelch. *loc. cit.* p. 42.

resembles that of birds, in which the rectus abdominis muscle is very broad.

The increase in number of the tendinous intersections of this muscle, and especially their existence below the umbilicus, are two circumstances important as being analogous with the formation of the ape.(1)

VI. PYRAMIDALIS.

§ 1070. The *pyramidalis* muscle, *Pubio-sous-umbilical*, Ch., is situated at the lower part of the sheath formed by the tendons of the three broad abdominal muscles, and is covered forward by the anterior layer of this sheath and backward by the lower part of the rectus muscle. It is triangular and oblong; its base is turned downward and its summit upward. It goes obliquely upward and inward and arises from the internal portion of the horizontal branch of the pubis, between the insertion of the external pillar of the descending oblique muscle and the symphysis pubis, and its summit is attached to the lower part of the linea alba.

It strengthens the linea alba, and contracts the abdominal cavity from above downward.

§ 1071. The pyramidalis muscle is rarely abnormal. It is most usually deficient on one or both sides, and then the lower part of the rectus muscle is thicker and broader.(2) The absence of this muscle is a remarkable analogy with the formation of most animals.

More rarely it is multiplied on one(3) or on both sides,(4) thus presenting three or four muscles.

VII. DIAPHRAGM.

§ 1072. The *diaphragm* (*septum transversum*, *diaphragma*(,(5) a thin and broad muscle, is situated between the pectoral and abdominal cavities. It adheres by its upper face to the pleura and pericardium, and by its inferior face to the peritoneum. Its form resembles an inverted figure ∞, for it is broader from one side to the other than from before backward, contracts in the centre, and is circumscribed by rounded and convex edges. It arises from the upper lumbar vertebræ and is attached to the lower six ribs, and generally also to the unciform cartilage.

We may distinguish in it an *inferior* or *lumbar* portion (*pars lumbaris*), a *superior* or *costal* portion (*pars costalis*), and a *median tendon* (*tendo intermedius.*)

(1) Drelincourt in Blasius, *Anat. animal.*, p. 110.—Vicq. d'Azyr, *Encyc. méth.*, *Syst. anat. quadrup.*, vol. ii. p. 22.
(2) Santorini, *Obs. anat.* ch. ix. p. 160.
(3) Winslow, *Exp. anat.* p. 36.
(4) Sabatier, *Tr. complet d'anat.*, vol. i. p. 263.
(5) Haller, *Nova icon. septi transversi*, Gottingen, 1741.—Santorini, *Tabulæ anat.* xvii. Parma, 1775, tab. x. fig.—Tissot, *Des fonctions du diaphragme*, Montpellier, 1823.

The lumbar part is much thicker and smaller than the other, and arises on each side by four heads from the upper three lumbar vertebræ, and terminates in the posterior edge of the central tendon. The two halves of this portion represent an X; in fact they unite in their centre and again separate from each other above.

The four *heads* (*crura*), by which each portion of the lumbar part arises, follow from within outward and from below upward, so that they gradually shorten and go still farther outward and backward. Besides, the heads of the two sides are not perfectly similar; those of the left are generally smaller than those of the right.

The first, the *internal* or most *inferior* right head is stronger than the left, and arises below it, by a broad tendon, from its half of the anterior face of the third lumbar vertebra, sometimes also from the intervertebral ligament situated between the third and fourth. It is the largest of all.

The second strait head is situated behind the first, arises usually by a single tendon, sometimes by two, from the anterior face of the body of the second lumbar vertebra. Its muscular fibres are attached behind those of the first.

The third, which is sometimes larger and broader than the preceding, comes from the anterior face of the intervertebral ligament of the first and second lumbar vertebræ, and from the lateral part of the body of the first. It goes upward and outward.

The fourth arises from the transverse process of the second or first lumbar, or even of the last dorsal, vertebræ.

The heads of the left side generally arise half or even a whole vertebra higher than those of the right side.

Between the internal heads we find an oblong rounded transverse opening, tendinous at its lower part, which is the most extensive, and called the *hiatus aorticus*, through which the aorta descends, from the cavity of the thorax to that of the abdomen.

When the fleshy fasciculi of the several heads of the same side are united(1) those of the right and left side are blended, and partly cross, before the upper extremity of the first lumbar vertebra.

A small part of the internal fasciculus of the left side usually passes before the right; but a much larger portion of the right passes to the left, beneath this fasciculus, and forms the most internal portion of the left half of the lumbar part of the diaphragm.

This union is about an inch long. Above its upper extremity the lumbar portions of the muscle again separate, and form a longitudinal, rounded, and very oblong fissure, called the *hiatus* or *foramen* of the *esophagus*. This opening is from an inch and a half to two inches long, and is a little on the left of the median line, and gives passage to the esophagus. This opening is formed upward and inward by some thin fasciculi of the lumbar portions of the two sides, which incline towards each other and are blended together.

(1) The four heads on each side unite to form the *pillars* of the diaphragm.

The upper anterior edge of the two lumbar portions which proceeds on each side obliquely downward, outward, and backward, is attached to the posterior edge of the median tendon. The external is uninterruptedly continuous with the costal portion of the muscle.

The fibres of this part go from below upward. They separate like the sticks of a fan. The median tendon is triangular. Its form is similar to that of a trefoil leaf, and is broadest in the centre; its anterior edge is convex, and the posterior is concave. It extends from within outward, and from before backward, and its anterior and median portion is nearer the anterior edge of the muscle than the lateral parts are.

It is formed of tendinous fibres which extend in different directions. The strongest and most numerous follow the direction of the fleshy fibres, that is, the internal and anterior go forward, those next more obliquely outward, the posterior backward, outward, and downward. But on the lower face of the tendon we also see others which cross them, and are very apparent on the sides, especially toward their posterior edge. The latter tend very much to strengthen the tendon.

We rarely find on a part of the inferior face of this tendon muscular fibres separate from the others.(1)

The right lateral portion of this tendon is perforated at its origin, near its central part, towards its posterior edge, and directly before the insertion of the lumbar portion; this opening is of an oblong square form, and is called the *foramen quadratum*, or the foramen of the *vena cava*, and the vena cava inferior passes through it. This foramen forms a short canal rather than a simple hole, for its lower edge is situated deeper than the upper. The posterior wall of this canal is considerably higher than the anterior, and is formed by the upper part of the right lumbar portion, which is covered with tendinous fibres. Around these edges considerable fibrous fasciculi are reflected, the anterior and posterior of which go obliquely inward, forward, and upward, while the internal and external go downward.

From the anterior edge, and the external part of the posterior edge of this median tendon, the costal portion of the diaphragm arises by a very concave edge, and goes outward and backward, where it terminates by a convex edge.

The two halves of this portion are blended with each other forward and on the median line, but they are separated backward by the lumbar portion.

The anterior fibres are the shortest and the central fibres the longest. The anterior go directly forward; the next in succession became more oblique, and finally go transversely outward; the posterior go from before backward, and from within outward.

The external edge of this part is always attached by rounded slips, which are separated more or less distinctly and are sometimes cleft, to the internal face of the cartilages of the seventh, eighth, ninth, tenth,

(1) Huber, in *Sœmmerring*, *Muskellehre*, p. 162.

and eleventh ribs, and also to the inner face of all the twelfth, and usually blends with the posterior edge of the transversalis abdominis muscle, which goes forward to meet it.

The central part of the anterior edge is also most generally fixed to the posterior face, and to the lower extremity of the xiphoid cartilage, by two thin slips, which go downward and outward.

Sometimes however these slips do not exist. Their absence must be considered as a slight indication of the imperfect union of the right and left halves of the body.

When the diaphragm contracts it acts on the thoracic and abdominal cavities; but its action on them is opposite. In contracting, it rises and falls; its fleshy portion, which is attached backward to the lumbar vertebræ, and forward to the ribs, draws the central tendon downward. Hence the pectoral cavity is considerably enlarged from above downward, while the abdominal cavity is proportionally diminished in the same direction. The former places the diaphragm among the agents of inspiration; in fact, when the respiration is calm and tranquil, its contraction and relaxation produce the alternate motions of inspiration and expiration. Again, it constantly contributes, by the changes it causes in the cavity of the abdomen, to the progress and in general the motion of the substances in the alimentary canal, and consequently it assists directly in digestion. In this last relation it is an auxiliary to the other broad and straight muscles of the abdomen, while it is an antagonist to them in relation to the cavity of the thorax. Simultaneous and powerful contractions of the diaphragm and of the other abdominal muscles, produce *efforts* (*nixus*)(1) which contract the abdominal cavity as much as possible, in order to expel the foreign matters actually within or which we believe to be within it, and the expulsion of which is unusually difficult. This combined action consequently takes place in all cases where fœcal matter or urine is retained from any cause whatever, as dysentery, inflammation of the neck of the bladder, parturition, &c.

§ 1073. The diaphragm is sometimes wholly or partially deficient from a primitive deviation of formation, or it may be torn by some mechanical cause acting with violence on it. In both cases, as also when the muscle is ruptured, a part of the viscera usually passes into the chest through the abdominal opening; hence results a *diaphragmatic hernia* (*hernia diaphraghmatica*) which generally has no herniary sac.

(1) Bourdon (*Recherches sur le mécanisme de la respiration et sur la circulation du sang*, Paris 1820) has determined by some interesting inquiries that the functions of the diaphragm are confined to inspiration and analogous acts, and that it thus affects digestion and the abdominal secretions; but that in respect to these efforts, it only prepares for them by filling the lungs with air, and that it does not take an active part in this phenomenon, since the suspension of respiration, which is the principal source of them, and which depends upon the closing of the glottis, occurs, not during respiration, but during the tendency to expiration, which is caused solely by the contraction of the abdominal muscles. F. T.

ARTICLE SECOND.

OF THE MUSCLES OF THE CHEST.

§ 1074. In the pectoral region of the anterior and lateral faces of the body we count three superficial muscles, which go from the first two sections of the upper extremities to the accessory bones of the trunk, and are usually attached to the latter. These muscles are the pectoralis major, the pectoralis minor, and the serratus major anticus muscles.

I. PECTORALIS MAJOR.

§ 1075. The *pectoralis major* muscle, *Sterno-humeral*, Ch., an extensive muscle, the largest and most superficial of those found on the anterior part of the chest, is triangular, or, to speak more precisely, is irregularly quadrilateral, and is much thicker but much narrower at its outer than its inner part. Its smaller upper edge arises by short tendinous fibres from the greater inner half of the anterior edge of the clavicle. The inner edge, which is larger and concave, also arises by very short tendinous fibres, from the anterior face of the handle of the sternum, from that of almost all the upper part of the body of this bone, and also from the upper edge of the anterior face of the cartilage of the fifth rib. A smaller slip is also detached from the rest of the muscle in all its extent, which sometimes descends very low, and unites to the second slip of the obliquus externus abdominis muscle, as the lower outer part of this edge blends with the upper edge of the tendon of this muscle and of its upper slip.

The upper part of the pectoralis major muscle is called the *clavicular* portion (*pars clavicularis*), the central part the *sternal* portion (*pars sternalis*), and the lower the *costal* portion (*pars costalis*). The last however is not separated from the others as the first is.

The upper fibres of this muscle descend obliquely outward, the central are transverse, and the lower go more and more obliquely upward. They all converge towards a very strong tendon, composed of transverse fibres, which, passing above that of the long head of the biceps flexor muscle, goes to attach itself to the lower part of the outer rough line of the humerus, and blends in the bicipital groove with the tendon of the latissimus dorsi and teres major muscles, unites in this place with the lower part of the deltoid muscle, and becomes an aponeurosis, which envelops the muscles of the shoulder.

This muscle draws the arm, and also all the upper extremity, inward and forward, which at the same time is turned on its axis inward and depressed if it be raised. Its central and transverse portion goes directly inward and forward; the upper portion raises the arm, the lower depresses it.

§ 1076. The clavicular portion of this muscle is very often entirely separated from the sternal portion, so that a considerable space exists between them, and on the anterior edge of the latter we see several fissures of different depths. This formation is very analogous with that of the mammalia, in most of which the pectoralis major muscle is divided into several distinct muscles.

A considerable muscular band is sometimes detached from the pectoralis major muscle, which goes to the arm, where it is attached either to the aponeurosis, or to the short head of the biceps flexor, or finally to the latissimus dorsi muscle, which arrangement resembles the common muscle of the arm, shoulder, and head, found in animals destitute of a clavicle.

§ 1077. On the anterior face of the pectoralis major muscle, more or less distant from its inner edge, directly between it and the cellular coat, we often find a supernumerary muscle, called from its situation the *thoracic*, the *straight sternal* or the *sternal* muscle of animals (*M. thoracicus, rectus sternalis, sternalis brutorum*).

This muscle is a more or less perfect repetition of the rectus abdominis and of the sterno-cleido-mastoideus. It often unites these two muscles, or at least extends from one to the other; sometimes also it is unconnected with either, and is attached by its upper extremity to the handle of the sternum and by the lower to the costal cartilage or to the lower part of the sternum: its two extremities are often blended with the pectoralis major muscle. In certain cases it is indicated only by a tendon, which extends from the sterno-cleido-mastoideus to the rectus abdominis muscle, or by an unusually long slip of the latter.

The accessory muscle varies in thickness, breadth, and even in number, no less than in its length. In fact its thickness is sometimes only a few lines and is sometimes several inches; sometimes it exists only on one side, sometimes also it is double either on one or on both sides; sometimes we number four of these muscles.

In certain subjects there are transverse tendinous intersections, which render it still more analogous to the rectus muscle: these intersections are not common.

The side of the body and the sex of the individual seem not to influence the existence of this muscle.(1)

It is curious inasmuch as it establishes a relation between man and animals, renders the analogy between the anterior and posterior halves of the body more sensible than it is generally, and particularly renders the whole anterior face more uniform.

It is not peculiar in blacks.

(1) For farther details on this interesting muscle, see Sandifort, *De musc. nonnullis qui rarius occurrunt*, in the *Exerc. acad.* Book i. ch. vi. p. 82-88.—Meckel, *De monstr. duplicitate*, Halle, 1815, p. 35-40.—Kelch., *Beytræge*, p. 33, No. 25.

II. PECTORALIS MINOR.

§ 1078. Directly below the pectoralis major we find the *pectoralis minor* muscle, *Costo-coracoidien*, Ch., (*M. pectoralis minor*, s. *serratus anticus minor*), which is much smaller. The form of this muscle is an elongated triangle, the base of which looks downward and forward, and the summit is turned upward and backward.

Its anterior edge is generally attached by three, more rarely by two or four slips, all of which proceed equally far forward but at unequal distances from each other, to the anterior face and upper edge of the third, fourth, and fifth, rarely also the sixth rib.

A fourth slip is sometimes found behind the second, and more or less covered by it and also by the third, which is inserted in the outer face of the fourth rib.

The upper and the posterior or lower edge, which are much longer than the anterior and which are nearly equal in length, are loose and unite above in a tendon, which is attached to the anterior edge of the summit of the coracoid process of the scapula.

The pectoralis minor muscle is much narrower but also much thicker at its upper than at its lower part.

It draws the coracoid process and consequently the scapula forward, downward, and inward. When the scapula is fixed, this muscle raises the ribs to which it is attached.

§ 1079. Sometimes we find a curious analogy with the formation of birds in the existence of a third pectoral muscle below these: this arises from the first and second ribs by separate digitations, and is attached to the coracoid process of the scapula.(1) A similar anomaly consists in a band, which sometimes comes from the upper rib, and which, covered by the pectoralis minor muscle, ascends to the capsular ligament of the scapulo-humeral articulation.(2)

III. SERRATUS MAJOR ANTICUS.

§ 1080. The *serratus major anticus* muscle, *Costo-scapulaire*, Ch., is a broad, thin, and triangular muscle, the base of which is downward and the summit upward. It covers in great part the lateral region of the upper eight ribs.

Its anterior concave edge arises by nine triangular slips, of which the lower four are situated farther forward than the others, from the bony parts of the first eight ribs, nearer their anterior than their posterior extremity.

The number of slips then exceeds that of the ribs, because the second and third, one of which is often deficient, are attached together to the second rib. The four lower slips intercross with the upper four of the

(1) Rosenmüller, p. 6. (2) Gantzer, p. 11.

obliquus externus abdominis muscle. The lower edge is loose. The posterior is attached to all the internal lip of the inner edge of the scapula.

The upper fibres descend obliquely forward and inward: the central are transverse; the lower fibres have the same direction as the upper, but are less perpendicular than they.

This muscle generally draws the scapula and with it all the upper extremity forward and inward. When this bone is fixed it carries the ribs to which it is attached outward and backward.

§ 1081. Sometimes but very rarely the central portion of the serratus major muscle is deficient, so that it is completely divided into two unconnected parts.

IV. TRIANGULARIS STERNI.

§ 1082. The *triangularis sterni* muscle, *Sterno-costal*, Ch., is thin; it is situated upon the inner face of the sternum and costal cartilages, and is formed of several successive slips placed over each other. It arises by a thin and broad tendon from the edge of the under part of the body of the sternum, from the ensiform cartilage, and from the inner face of the costal cartilages from the third to the sixth or seventh. Its fibres are oblique and go to the cartilages of the second, third, fourth, and fifth ribs, to which they are attached by long digitations.

Of all the muscles this is one of the most variable. Sometimes one or more slips are deficient, and the internal edge is not attached to the costal cartilages but only to the inner face of the sternum; and again several slips are formed which are entirely isolated, or at least some of them are not connected with the others.

It is always continuous at its lower extremity by tendinous fibres and often by its fleshy portion with the upper end of the transversalis abdominis muscle; so that in many cases, but not however in all, we may consider it as forming but one with it and call it the *sterno-abdominal* muscle (*M. sterno-abdominalis*).(1)

It at least always represents in the thorax the transversalis abdominis muscle. This comparison terminates the analogy betwen the muscles of the abdominal and thoracic parietes.

ARTICLE THIRD.

OF THE ANTERIOR MUSCLES OF THE NECK.

§ 1083. The anterior muscles of the neck form a superficial and a deep layer.

(1) Rosenmüller, *De nonnullis musculorum corp. hum. varietatibus*, Leipsic, 1814.

I. SUPERFICIAL LAYER.

§ 1084. The superficial layer of the anterior muscles of the neck is situated in front and on the sides of the larynx, the trachea, the pharynx, and the hyoid bones. It comprises the platysma myoides, the sterno-cleido-mastoideus, the sterno-hyoideus, the omo-hyoideus, the sterno-thyroideus, and the muscles which extend from the larynx to the hyoid bones, from the thyroid to the cricoid cartilages, and from the skull to the hyoid bones and to the pharynx. We shall mention in this place only the first two. The others will be described with the organs of digestion and of voice,—1st, because their points of attachment have not yet been described; 2d, because it is more convenient to refer the history of those which are inserted in parts already described, as for instance the muscles of the hyoid bones, to that of the muscles near them, which are intimately connected and always act with them.

I. PLATYSMA MYOIDES.

§ 1085. The *platysma myoides* muscle, *Thoraco-facial*, Ch., (*M. latissimus colli*, s. *platysma myoides*, s. *quadratus*, s. *tetragonus genæ*), has an oblong square form. It is very thin and composed of muscular bands, which are generally very loosely united and often have considerable spaces between them. It is situated directly below the cellular tissue, to which it adheres, and arises in the thoracic and scapular region by separate bands, which extend a little below the clavicle, so that it covers part of the upper edge of the deltoides and pectoralis major muscles. It gradually contracts, becomes thicker, and going obliquely upward, inward, and forward, on the side of the neck, attains the lower part of the face, where it is attached partly to the under edge of the lower maxillary bone, and partly blends with the levator anguli oris muscle and ascends to the corner of the mouth, and partly loses itself below the adipose covering of the face.

It wrinkles the skin which covers it and draws the mouth downward and outward. The latter motion is executed particularly by the last fasciculus, hence called the *risorius Santorini* muscle.

This muscle is evidently only a rudiment of the intercostales and of the broad abdominal muscles in the neck, as is proved by its situation, its relations with the other muscles and the common integuments, and by the direction of its fibres. The looseness of its lower edge, which is wholly unattached, corresponds very well with the arrangement of the anterior part of the lower edge of the broad abdominal muscles, as likewise its insertion in the lower maxillary bone resembles that of the upper edge of these muscles in the ribs, to which the lower maxillary bone is analogous.

Its less degree of development depends partly on the smallness of the region in which it is found and partly also because there is no special cavity in it.

§ 1086. A special fasciculus frequently but not always arises from its upper part and goes toward the face. This fasciculus is sometimes loose under the cellular tunic and sometimes arises from the tendon of the masseter muscle. It goes from behind forward and is attached with the platysma to the angle of the lip; it is sometimes replaced by the upper part of the latter which is broader.

It is more rare to find an inferior slip arising from the clavicle, which extends under the skin to near the deltoid muscle, where it disappears in the cellular tissue ; it resembles the fleshy coat of animals.(1)

We also rarely find a small transverse muscular slip between the platysma and the skin, below the chin.(2).

We more rarely see the platysma not thin and superficial as usual but rounded and thick, not proceeding forward but going backward and attached to the occipital bone.(3)

II. STERNO-CLEIDO-MASTOIDEUS.

§ 1087. The *sterno-cleido-mastoideus* muscle, *Sterno-mastoidien*, Ch., must be regarded not as a single muscle but as the union of two muscles, since its two bellies are more distinct from each other than some other muscles, especially those of the dorsal region, which are considered as separate.

The anterior belly, the *sterno-mastoideus* muscle (*M. sterno-mastoideus*, s. *nutator capitis anterior*), arises by a short but strong tendon from the most upper and outer part of the anterior face of the handle of the sternum. It is elongated and rounded and becomes insensibly broader and thinner at its summit, goes obliquely upward and backward, and is attached to the outer face of the mastoid process of the temporal bone and to a small part of the outer face of the upper curved line of the occipital bone.

The posterior belly, the *cleido-mastoideus* muscle (*M. cleido mastoideus*, s. *nutator capitis posterior*), is shorter and weaker than the preceding. It arises an inch more outwardly, from the upper edge and the upper part of the anterior face of the sternal part of the clavicle (but it does not come from its inner edge) by a thin and broad tendon ; it descends obliquely but straighter than the preceding, gradually becomes round, and terminates in a point, where it is attached below the preceding, to the lower part of the outer face of the mastoid portion of the temporal bone by a rounded tendon, which covers its upper portion and with which it is united by some separate fibres.

(1) Gantzer, *loc. cit.*, p. 111.
(2) Fleischmann, in *Erlanger Abhandl.*, vol. i. p. 28.—Gantzer, *loc. cit.*, p. 6.
(3) Zagorsky, *Mém. de l'acad. de Petersburgh*, vol. i. p. 357.

These two muscles correspond from above downward, the first to the rectus abdominis and the second to the pyramidalis muscle, in this respect, that they are more similar than the latter in regard to size. They represent also from before backward the splenii muscles, to which they are antagonists.

The sterno-cleido-mastoideus muscle inclines the head obliquely forward, so as to bring the face from the opposite side. When the two act in concert the head is flexed. The external belly draws it more directly forward and downward, and the inner belly more obliquely from the opposite side.

§ 1088. The greatest anomaly of this muscle is an increase in number, arising from the detachment of some fasciculi from the rest of the mass.(1)

Thus for instance we not unfrequently find between the two bellies a special and smaller fasciculus, which sometimes continues separated as far as its upper extremity, or which before arriving there blends with one of the other two; this generally arises directly at the side of the anterior belly, either on the outside of it from the sternum or from the most internal part of the sternal end of the clavicle.

We less frequently find a thinner and usually very broad accessory muscle, which arises from the clavicle behind the second belly, ascends behind it from before backward, and attaches itself on the outer side of it to the occipital bone.

The numerous divisions and multiplications of this muscle remind us of the analogy between it and the rectus abdominis and pyramidalis muscles.

Nor is it rare to see a fleshy or tendinous slip which extends from the lower edge of the sterno-mastoid portion to the angle of the lower maxillary bone.(2)

All these varieties form so many analogies with animals; for in most mammalia the sterno-mastoid and cleido-mastoid portions are almost entirely separated from each other, and the latter is most frequently doubled. Besides, this always increases in volume and number outwardly; this circumstance establishes a manifest relation with the formation in most mammalia, in which the cleido-mastoideus muscle is generally blended with the clavicular portion of the deltoides muscle; even in the solipedes, the sternal portion extends only to the lower maxillary bone.

II. DEEP LAYER.

§ 1089. The deep layer of the anterior muscles of the neck is situated directly on the anterior face of the upper part of the vertebral column. It comprises the *rectus capitis anticus major*, the *rectus capi-*

(1) G. Meckel, *De duplicitate monstrosâ*, p. 40, 41.—Kelch, *Beytræge zur path. anat.*, p. 31.

(2) Brugnone, p. 160.

tis minor, and the *longus colli* muscles, all of which serve to bend the head and neck.

I. RECTUS CAPITIS ANTICUS MAJOR.

§ 1090. The *rectus capitis anticus major* muscle, *Grand trachelo-sous-occipital*, Ch. (*M. rectus capitis anterior*, s. *internus*, s. *major*), is oblong and thicker at its upper than at its lower part. It generally arises by five thin and tendinous slips, which increase in size from below upward, from the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and from one slip of the longus colli muscle, which is attached to the sixth cervical vertebra. It goes from below upward and from without inward, gradually approaching its congenital. It is mostly strongly tendinous. Its upper edge is attached directly before the large occipital foramen to the basilar process of the occipital bone.

It bends the head directly forward.

§ 1091. We sometimes find two additional upper tendinous slips which come from the first and second cervical vertebræ, an arrangement resembling the formation of the carnivorous animals.

II. RECTUS CAPITIS ANTICUS MINOR.

§ 1092. The *rectus capitis anticus minor* muscle, *Petit trachelo-sous occipital*, Ch. (*M. rectus capitis anterior*, s. *internus*, s. *minor*), is a smaller, thinner, and triangular muscle, which gradually enlarges from below upward. It arises above and forward from the anterior arch and from the root of the transverse process of the first cervical vertebra, ascends, covered by the preceding, before the articular ligament between the occipital bone and the first cervical vertebra, goes obliquely inward, and is attached before the occipital foramen to the basilar process, and more outwardly to the fibro-cartilaginous mass which fills the space between the body of the occipital bone and the petrous portion of the temporal bone.

It bends the head forward and a little to the side.

III. LONGUS COLLI.

§ 1093. The *Longus colli* muscle, *Predorso-atloidien*, Ch., descends from the first cervical to the third or fourth dorsal vertebra. Its structure is very complicated, and we may consider it to a certain extent as formed of two muscles, an upper and lower, which are united.

The internal is smaller, and goes directly downward and a little outward. It arises by separate tendinous slips from the side of the body, and the intervertebral cartilages of the upper three dorsal vertebræ, and also from the body and the anterior roots of the transverse processes of the lower four cervical vertebræ, ascends in a straight line, and is attached externally, by two or three short tendons, to the anterior tubercle of the transverse processes of the fourth and fifth cervical vertebræ; and inward, by a strong tendon, to the anterior face of the bodies of the second and third cervical vertebræ.

The upper muscle is stronger than the preceding, and is directly continuous with it; it arises by small tendinous slips from the anterior roots of the transverse processes of the third, fourth, and fifth cervical vertebræ. It ascends obliquely inward, gradually becomes straighter, and is attached to the anterior tubercle of the first cervical vertebra, seldom to the basilar portion of the occipital bone.

The longus colli muscle bends the neck forward, and a little to the side.

ARTICLE FOURTH.

OF THE SACRO-COCCYGŒAL MUSCLES.

§ 1094. The *sacro-coccygœal* muscles (*M. sacro-coccygœi, s. curvatores coccygis*) are not constant. When they exist they appear as small, elongated, thin, and mostly tendinous fasciculi, situated on the two sides, which arise from the anterior face of the last sacral and first coccygœal vertebra, and are attached by several slips to the anterior face of the lower pieces of the coccyx, where that of the right and left are usually blended.

They draw the lower pieces of the coccyx forward and upward, so as to curve the whole range of these bones.

These muscles are the rudiments of the caudal flexors in animals. They evidently correspond to the three muscles of the upper half of the body, which we have just described.

SECTION II.

OF THE MUSCLES OF THE HEAD.

§ 1095. The muscles of the head comprise those of the skull and those of the face.

The muscles of the skull are the occipito-frontalis, the auricular muscles, and one muscle of the lower jaw.

The muscles of the face are those of the eyes, the nose, the lips, the other muscles of the lower jaw, and the hyoid muscles.

Of these muscles we shall here examine only the occipito-frontalis, and those of the lower jaw, both because the parts which must necessarily be known to understand the descriptions of the others are not yet mentioned, and also because it is more convenient to examine them in connection with the other constituent parts of the organs which they assist to form.

I. OCCIPITO-FRONTALIS.

§ 1096. The *occipito-frontalis* or *epicranial* muscle (*M. epicranius*, s. *cranii cutaneus*, s. *occipito-frontalis*) is a flat, digastric muscle, situated directly under the skin, to which it is intimately attached, and covers the anterior, upper, and posterior parts of the skull, and also the central and upper part of the face.

Its posterior belly, which is also described as a separate muscle, termed the *occipitalis*, has an oblong square, or triangular form. It arises by tendinous fibres from the root of the mastoid process, and from the upper occipital ridge of the basilar bone, where it unites with the sterno-cleido-mastoideus and trapezius muscles, soon becomes fleshy, ascends on the squamous portion of the occipital bone, and terminates by a concave edge which unites with the median tendon.

This tendon is called the *skull-cap* (*galea capitis*), and is formed of very distinct longitudinal fibres. It extends all along the skull to the frontal bone, where it is attached to the anterior belly or the frontalis muscle.

The anterior belly or the *frontalis* muscle is much more extensive than the posterior. It begins by an upper convex edge, then descends along the squamous portion of the temporal bone, goes straight to its inner part, which is the thickest, and obliquely forward to the outer, which is thinner, and terminates as follows: at its inner part, it is continuous by several slightly tendinous slips with the pyramidalis nasi and the levator labii superioris alœque nasi muscles; in the region of the inner angle of the eye, it is attached to the nasal process of the upper maxillary bone and to the lower portion of the frontal bone; finally, at its outer part, it blends with the corrugator supercilii and the orbicularis palpebrarum muscles.

The occipito-frontalis muscle corresponds in situation and attachment to the interspinales muscles of the vertebræ. It resembles one of these muscles which is enlarged, rounded, and divided in its centre, from before backward, into two parts, united by an intermediate tendon.

Considered as a whole, this muscle moves the skin of the top of the head. Its two bellies wrinkle in a transverse direction the skin above them, and extends that near them when they contract from the side of their tendon. Thus the frontal muscle raises that of the upper part of the neck.

II. MUSCLES OF THE LOWER MAXILLARY BONE.

§ 1097. The muscles of the lower maxillary bone comprise those which raise it, those which move it to the side, and those which depress it.

I. LEVATORS OF THE LOWER JAW.

§ 1098. The lower jaw is moved by three levators, the action of which is to bring it towards the upper jaw, which is fixed. These are the temporalis, the masseter, and the pterygoideus internus muscles.

A. TEMPORALIS.

§ 1099. The *temporalis* muscle, *Temporo-maxillaire*, Ch., the largest and strongest of all the muscles of the lower jaw, is broad and triangular. It occupies all the lower region of the central part of the lateral face of the skull, for it fills the temporal fossa, and covers the plain semicircular surface.

It arises by very short tendinous fibres and by a convex edge from the semicircular line which bounds the lower part of the outer face of the frontal bone, from the large wing of the sphenoid bone, from the parietal bone, and the squamous portion of the temporal bone, and by fleshy fibres from the parts of these same bones situated below this line. Its posterior fibres go from above downward and from behind forward, the central are almost perpendicular, the upper go from above downward and from before backward; all converge to unite in the temporal fossa.

As they leave the circumference the muscle becomes narrower and thicker, and terminates in a short but very strong tendon, which is attached to the coronoid process of the lower maxillary bone.

The entire muscle is covered externally by a tendinous expansion, formed of descending fibres which arise immediately over it, serves for the attachment of its fibres above, is separated below, on its outer face, by a greater or less quantity of fat, and is very loosely united to it in this place by cellular tissue and vessels, and is attached to the posterior edge of the malar bone and also to the upper edge of the zygomatic arch.

This muscle draws the lower jaw forward and upward.

B. MASSETER.

§ 1100. The *masseter* muscle, *Zygomato-maxillaire*, Ch. (*M. masseter*, s. *mandibularis externus*), has an oblong square form. Its length exceeds its breadth, and it is formed of fibres which go upward. It covers the outer face of the ascending branch of the lower maxillary bone, and fills the space between the posterior part of the lower edge of this bone and the zygomatic arch.

It is very evidently formed of two layers entirely separate from each other, which differ also in the direction of their fibres, and which may be regarded as two distinct muscles.

The anterior external layer is the longest and strongest, and covers most of the lower. It is formed of fibres which are oblique from above downward and from before backward, and become a little narrower from below upward. It arises by short tendinous fibres from the lower edge of the malar bone, and is attached to the lower half of the ascending branch of the lower maxillary bone, as far as its inferior edge and its angle.

The inferior or posterior layer is much smaller and feebler than the preceding; its form is also square, and it is composed of fibres which go backward. It becomes thicker from below upward, is loose posteriorly, and is covered anteriorly by the preceding layer. It arises by fleshy fibres from the lower edge of the posterior part of the zygomatic arch, and is attached by short tendinous fibres above the upper end of the insertion of the external layer in the centre of the outer face of the ascending branch of the lower maxillary bone.

The two layers unite and draw the lower jaw upward, the external brings it forward, and the internal backward.

C. PTERYGOIDEUS INTERNUS.

§ 1101. The *pterygoideus internus* muscle, *Grand ptereygo-maxillaire*, Ch., an oblong quadrangular muscle, arises by its upper thick edge from all the pterygoid fossa of the pterygoid process of the sphenoid bone, goes obliquely downward and outward and is attached, opposite the preceding, but to a much less extent than it, to the lower part of the inner face of the ascending branch of the lower maxillary bone, as far as the angle.

It draws the jaw upward and inward; but if the muscles of both sides act, the jaw is moved directly upward.

II. PTERYGOIDEUS EXTERNUS.

§ 1102. The lower jaw is moved laterally by a single muscle, the *pterygoideus externus* muscle, *Petit pterygo-maxillaire*, Ch., situated between the lower maxillary bone and the pterygoid process. This is the smallest muscle of the lower jaw, and differs from the others in the transverse direction of its fibres. It arises by short tendinous fibres from all the outer face of the outer layer of the middle sphenoid or pterygoid process, then goes directly backward and outward, and is inserted by short tendinous fibres in the inner face of the neck, and of the condyle of the lower maxillary bone.

It draws the lower jaw from the opposite side, that is inward and forward, when it acts alone; but forward only when it contracts with its synonymous muscle of the other side.

III. DIGASTRICUS.

§ 1103. Although several muscles contribute more or less directly to depress the lower jaw,(1) there is however but one appropriated specially to this function; this is the *digastricus* muscle, *Mastoido-genien*, Ch., (*M. biventer maxillæ inferioris*), so named because formed of two oblong bellies united by a central tendon.

The posterior longer and stronger belly is more rounded than the other and arises from the mastoid fissure of the temporal bone, and is covered in this part by the upper end of the sterno-cleido-mastoideus muscle. Leaving this point, it goes downward, forward, and inward, and gradually becomes a thinner oblong median tendon, which is attached by a small tendinous expansion on its anterior extremity to the lateral end of the central piece of the hyoid bone; so that it is situated between the temporal and hyoid bones.

The anterior belly is shorter and flatter than the posterior, and arises behind the median tendon; goes forward and inward, and is attached directly at the side of the synonymous belly of the opposite side to the centre of the inner lip of the lower edge of the jaw.

This muscle draws the lower jaw downward and backward. If the posterior acts alone, it raises the hyoid bone and draws it backward. If the anterior acts singly, this bone is also raised but carried forward. When the posterior belly contracts behind and the anterior before, it draws the skull and the face, except the lower jaw, backward, and thus by its action on the skull raises the upper jaw, separates it from the lower, and opens the mouth.

§ 1104. A very common anomaly of this muscle consists in the union of the anterior bellies of the two sides with each other and with the pterygoideus externus muscle, by the formation of a larger or smaller fleshy portion.(2) Sometimes too we find between it and the skin a special transverse fasciculus, which is extended between the branches of the lower maxillary bone.(3)

These anomalies are evidently imitations of what is seen in several mammalia, where the anterior bellies even blend with each other.

More rarely the anterior belly does not extend to the chin, but is attached to the centre of the horizontal branch of the lower maxillary bone, as is also the case in many mammalia, where the single muscle. with which it is provided is also inserted more posteriorly than in man

(1) A Monro, *Remarks on the articulation, muscles, and luxation of the lower jaw*, in the *Edinburgh medical Essays*, vol. i. p. 103–129.—J. C. Platner, *De musculo digastrico maxillæ inferioris*, Leipsic, 1737.—Winslow, *Observ. par l'anatomie comparée sur l'usage des muscles digastriques de la machoire inférieure dans l'homme*, in the *Mém. de Paris*, anno 1742, p. 236.

(2) G. Meckel, *De duplic. monstr.*, p. 42.

(3) Fleischmann, in the *Erlanger Abhandl.*, vol. i.

SECTION II.

OF THE MUSCLES OF THE EXTREMITIES.

§ 1105. The muscles of the extremities form the greater part of these sections of the body. Most of them have a more or less elongated form and assume a longitudinal direction, although this is not the direction of their fibres, which go obliquely from one or more edges to the tendons. Very few of them have a transverse direction or one intermediate between it and the preceding: the latter are shorter.

The muscles which follow the longitudinal direction flex and extend the different parts of the limbs; the transverse and the oblique separate them from each other or turn them on their axes.

The muscles of both extremities are surrounded with general *tendinous sheaths* (*fasciæ aponeuroticæ*) and the tendons of the inferior, which are the longest in proportion, and are firmly attached in several places by strong fibrous ligaments to the bones over which they pass.

In regard to situation, arrangement, and number, they correspond perfectly in their essential particulars, and differ only in modifications dependent on the different functions of the two limbs.

CHAPTER I.

MUSCLES OF THE UPPER EXTREMITIES.

§ 1106. The muscles which move the first section of the bones of the upper extremity, or the bones of the shoulder, all come from the bones of the trunk, from which arise also some of those which move the bone of the second section—the humerus. The former are the trapezius, the rhomboidei, and the levator anguli scapulæ; the others the pectoralis major and the latissimus dorsi muscles, which have already been described (§ 1001).

It is convenient to commence the description of these muscles by that of their common aponeurotic sheath.

ARTICLE FIRST.

OF THE APONEUROTIC SHEATH OF THE UPPER LIMBS.

§ 1107. The muscles of the upper extremities are surrounded by a tendinous envelop called the *brachial aponeurosis* (*fascia brachialis*).

This arises in very muscular subjects from the deltoid muscle, but sometimes we do not see it except below this muscle. It is always stronger on the fore-arm than on the arm. However, at the posterior part of the anterior and posterior faces it is always much thicker than on the other faces and strengthened by transverse and oblique fibres, which cover the longitudinal fibres externally.

In most of its extent it envelopes the muscles externally only. However, at the lower end of the arm, in the inner angle, there is a triangular slip, the *internal* and *external intermuscular* ligament (*L. intermusculare internum et externum*), which leaves the aponeurosis and goes forward. The external extends from the outer condyle to the upper extremity of the projecting part of the anterior angle; the internal from the inner condyle to the corresponding point of the inner angle. They extend between the extensors and flexors of the fore-arm and increase their surfaces of attachment.

Two similar but much weaker ligaments are also found in the fore-arm in a similar situation. They separate the flexors and the extensors, both on the ulnar and radial side; because they proceed from the inner face of the aponeurosis to the posterior edge of the ulna and of the radius to which they are attached.

Near the lower end of the fore-arm, the transverse fibres disappear, or at least become evidently thinner; but they again accumulate on the end of its posterior face and on the back of the thumb, become much more thick than high, and give rise in this place to the *dorsal ligament of the carpus* (*Lig. carpi dorsale*, s. *armillare*).

This ligament extends from the transverse process of the radius to the small head of the ulna, the pisiform, and the tuberosity of the fifth metacarpal bones. It is formed at its upper part, which is the weakest, of transverse fibres, which descend from the ulna to the radius, and at the lower part of fibres, which go backward and downward from the radius, and consequently partially cross the preceding.

Under it pass the tendons of the abductor magnus and extensor pollicis, the radiales externi, the extensor digitorum communis, the extensor indicis proprius, the extensor minimi digiti proprius, and the ulnaris externus muscles. Their passage is facilitated by the partitions which descend from the inner face of the ligament to the asperities on the ends of the bones of the fore-arm and divide it into six parts.

The first, the anterior, extends from the anterior edge of the lower end of the radius to the first asperity on the back of this bone, and contains the tendons of the abductor pollicis longus and of the extensor pollicis brevis muscles.

Through the second, which is larger and which extends from the first dorsal asperity to the second, pass the tendons of the two radiales externi muscles.

The third, a little oblique forward and downward, extends from the second to the third dorsal asperity of the radius, to the posterior edge of its lower extremity, and lodges the tendon of the extensor pollicis longus muscle.

The fourth, the largest, extends from the third dorsal eminence to the posterior edge of the radius, and receives the tendons of the extensor digitorum communis and extensor proprius indicis muscles.

The fifth, the smallest, is comprised between the radius and the anterior edge of the small head of the ulna; it receives the tendon of the extensor minimi digiti proprius muscle.

Finally, the sixth, which extends from the posterior edge of the small head of the ulna to its styloid process, embraces the tendon of the ulnaris externus muscle.

The lower edge of this ligament, which should be regarded not as a separate ligament but only as the development of the brachial aponeurosis, is uninterruptedly continuous with the aponeurosis of the back of the hand, which gives a loose common envelop to the tendons of the extensor muscles, blends with the oblique tendinous fibres by which the tendons of the extensors of the fingers are retained in place, and concurs to form them.

The brachial fascia is also strengthened at the lower part of the anterior face of the fore-arm and on the palmar side of the carpus.

The upper part of this portion, which is the feeblest and which extends from the anterior edge of the radius to the pisiform bone, forms the *common palmar ligament of the carpus* (*Lig. carpi volare commune*). It unites at its ends with the dorsal ligament. Under it pass the tendons of the flexors of the fingers, and in a special sheath that of the radialis internus.

The lower part, which is much stronger, forms the *proper palmar ligament of the carpus* (*Lig. carpi volare proprium*). This ligament is formed by transverse and oblique fibres. Above, it blends in great part with the preceding. Below, it strengthens the palmar aponeurosis. Its two edges arise from the palmar eminences of the carpus, which are formed on the radial side by the trapezium and the pyramidal bones and on the ulnar side by the pisiform and unciform bones.

ARTICLE SECOND.

MUSCLES OF THE SHOULDER.

§ 1108. The muscles of the shoulder, which surround the scapula and which extend from this bone and also from the clavicle to the humerus, are the deltoides, the supraspinatus, the infraspinatus, the teres major, the subscapularis, the teres minor, and the coraco-brachialis muscles.

I. DELTOIDES, OR THE EXTENSOR OF THE ARM.

§ 1109. The deltoides muscle, *Sus-acromio-humeral*, Ch. (*M. deltoides, levator, attollens humeri*), is a very strong muscle, which occupies the upper and anterior part of the region of the shoulder. It arises by its upper longest and concave edge from the anterior edge of the scapular end of the clavicle, from the anterior edge of the acromion process, and from the lower edge of all the spine of the scapula at its anterior part, by fibres almost entirely fleshy or which at least have very short tendons, and by very long tendinous fibres at its posterior.

After leaving this point, the muscle gradually becomes thicker, goes downward, and terminates by a fleshy summit externally, but possessing within a very long tendon, which is attached directly below the tendon of the pectoralis major muscle, at the posterior end of the external linea aspera, which arises from the outer tubercle of the humerus and at the central part of the outer face of this bone, which presents in this place a triangular impression.

These fibres converge from above downward; so that the central are straight, the anterior oblique from before backward, and the posterior from behind forward.

In examining this muscle more attentively, we recognize that it is composed of two orders of triangular fasciculi. The first order contains four fasciculi, which are larger than the others and the bases of which are turned upward and their summits downward. Between are the three smaller fasciculi of the second order, which are broader below than above but the two ends of which are a little narrower than the central part.

Below the upper edge of this muscle, between it and the capsular ligament, we find a considerable mucous bursa, which corresponds usually to the acromion, extends between this last process and the proper anterior ligament of the shoulder, and sometimes divides into two bursæ, one of which is situated near the coracoid process.

The deltoid muscle raises the arm and separates it from the side of the body.

§ 1110. A remarkable analogy with the structure of the mammalia is the existence of a posterior slip, entirely distinct from the rest of the muscle, which we have found several times. This slip arises from the tendinous expansion of the infraspinatus muscle (§ 1112), and from the centre of the inner edge of the scapula, by a broad and thin tendon, and is attached to the tendon of the deltoides. In most mammalia, in fact, the deltoides divides into a clavicular and a scapular portion and the latter is subdivided into an acromial and a spinous portion.

We more frequently find the posterior part of the muscle simply separated from the anterior. We ought also to place among these anomalies the existence of a head, which goes from the anterior edge of the scapula to the deltoides,(1) and which is still more analogous with a part of the deltoides in birds.

(1) Albinus, p. 422.

II. ROTATORS OUTWARDLY.

I. SUPRASPINATUS.

§ 1111. The *supraspinatus* muscle, *Petit sus-scapulo-trochiterien*, Ch., is a triangular muscle which fills the supraspinal fossa, and is formed of fibres which converge from behind forward, from below upward, and from within outward. At first it is rather thick, but gradually becomes thinner. It arises from all the supraspinal fossa, from that part of the posterior edge of the scapula situated above the spine, and from the posterior part of the upper edge and also from the upper face of this spine. It changes under the acromion process, directly below the large proper ligaments of the scapula, into a short and strong tendon, which, passing below the capsular ligament of the scapulo-humeral articulation, which it contributes to strengthen, goes to attach itself to the upper and inner part of the outer tubercle of the humerus.

This muscle turns the arm outward and raises it.

II. INFRASPINATUS.

§ 1112. The *infraspinatus* muscle, *Grand sus-scapulo-trochiterien*, Ch., arises from all the infraspinal fossa of the scapula, except its lower part. It goes outward and forward, so that its upper fibres are transverse, and the lower become more oblique forward and upward the lower they are. Its thickness gradually increases as it proceeds outwardly and it terminates in a strong tendon, which extends farther on the posterior than on the anterior face. This tendon adheres to the capsular ligament of the shoulder which it strengthens, blends above with that of the preceding muscle, and is attached to the central part of the outer tubercle of the humerus.

We find a large mucous bursa between the scapula and this tendon.

This muscle draws the humerus backward and downward, and rotates it from within outward.

III. TERES MINOR.

§ 1113. The *teres minor* muscle, *Plus petit sus-scapulo-trochiterien*, Ch. is quadrangular, and is scarcely distinguished from the preceding. It arises from the central part of the posterior lip of the anterior edge of the scapula, and goes directly before the lower and anterior edge of the infraspinatus muscle forward, outward, and downward, where, gradually becoming narrower but thicker, it terminates by a short and strong tendon at the lower part of the outer tubercle of the humerus, and at the outer ridge of the humerus which descends from this tubercle.

It acts like the preceding, but it draws the humerus more outward·

III. ROTATORS INWARD.

SUB-SCAPULARIS.

§ 1114. The *subscapularis* muscle, *sous-scapulo-trochinien*, Ch., the strongest of the two muscles which turns the humerus on its axis inward, occupies all the lower face of the scapula. Its upper fibres descend obliquely outward and forward, the central are transverse, and the inferior are very oblique from behind forward and from within outward. It gradually contracts to a considerable degree, passes behind the upper end of the coraco-brachialis, and the short head of the biceps muscle, and terminates in a short, flat, and thick tendon, which is attached to all the circumference of the inner tubercle of the humerus.

Its structure is very complex, and we may reduce it to two orders of fasciculi which are more or less evidently distinct. The first, commonly five in number, arise by a tendinous summit along the inner lip of the posterior edge, and the asperities which are found on the anterior face of the scapula. The lower, which is also the strongest, forms the lower and outer part of the muscle. All progressively enlarge, and are attached to the upper tendon.

We find the second layer between them; this also is formed of five fasciculi, of which the upper likewise forms the upper part of the muscle. These fasciculi are generally stronger and broader externally, and pointed inwardly. They come from the spaces between the eminences, whence the former arise.

These two layers however interlace more than once, and we cannot insulate them without cutting their fibres. The third layer, which is described in most works on anatomy, does not in fact exist.

This muscle has two mucous bursæ. The larger is sometimes united with the capsular ligament of the scapulo-humeral articulation, and is situated on the neck, and at the base of the coracoid process of the scapula. The smaller, which does not always exist, is situated much lower and further forward, between the capsular ligament and the tendon of the muscle.

The subscapularis muscle draws the arm towards the trunk, turns it on its axis from without inward, and depresses it when it is raised. If the arm is fixed it can carry the scapula outward.

II. TERES MAJOR.

§ 1115. The *teres major* muscle, *Scapulo-humeral*, Ch. (*M. teres*, s. *rotundus major*, s. *deprimens humerum rotundus*) arises from the lower and triangular part of the outer face of the scapula, and from the posterior lip of the anterior edge, where it usually adheres to the subscapularis and teres minor muscles; but it soon leaves these two muscles and ascends, always much less obliquely than the teres minor, from which it is separated by the long portion of the biceps, between the latter and the coraco-brachialis, approximates the humerus, and is attached by rather a short, broad, but thin tendon, to the inner rough line, directly behind and a little below the latissimus dorsi.

Its form is the same as that of the teres minor, but it is at least twice as large as that muscle.

We find below and forward, between its tendon, the latissimus dorsi muscle, and the humerus, a small mucous bursa, and beside these, we also find one or more in its anterior tendon where it divides.

This muscle draws the humerus backward, downward, and inward; when the arm is turned outward, it brings it a little inward.

§ 1116. It is often united with the posterior part of the latissimus dorsi muscle by a large fasciculus which leaves its posterior extremity.

IV. CORACO BRACHIALIS.

§ 1117. The *coraco-brachialis* muscle, *Coraco-humeral*, Ch. (*M. coraco-brachialis*, s. *coracoideus*, s. *perforatus Casserii*) is formed like an oblong triangle. United above, rather intimately, and to some extent, to the origin of the short portion of the biceps flexor muscle (§ 1120), it arises from the coracoid process farther forward than the latter. It is tendinous before, in most of its length, and fleshy behind. In quitting the short portion of the biceps muscle it goes inward, becomes thicker at its central part, but contracts much at its lower end, and is attached, partly fleshy, partly tendinous, to the middle region of the inner face of the humerus.

The musculo-cutaneous nerve generally perforates it in its centre. Its lower part often blends with the upper end of the brachialis internus muscle, a curious fact, as it adds a new feature to the analogy between the flexors of the fore-arm and those of the leg. We find one imperfect bursa, and sometimes two, between its upper tendon, that of the short portion of the biceps muscle, and the capsular ligament of the scapulo-humeral articulation.

This muscle approximates the humerus and the scapula to each other, carries the arm to the side of the body, and rolls it a little outward, when it is turned inward.

Sometimes, instead of a simple perforation, it presents a real fissure, which is often confined to its lower part, and sometimes exists its whole length, so that the tendons are separated although the musculo-cutaneous nerve passes constantly between the two portions. This arrangement establishes a striking similarity with the structure of the apes.

ARTICLE THIRD.

MUSCLES OF THE ARM.

§ 1118. The muscles found on the humerus arise partly from this bone, others from the scapula, and are attached to the bones of the fore-arm. They are the triceps extensor, the biceps flexor, and the brachialis internus; the first is situated at the posterior and outer part of the arm; the other two are placed on its anterior and inner face.

I. TRICEPS EXTENSOR.

§ 1119. The *triceps extensor* muscle, *Scapulo-olecranien*, Ch. (*M. triceps brachii*, *cubiti*, s. *brachieus externus*, s. *posterior*) occupies most of the posterior face of the humerus, and extends from the scapula to the olecranon process.

The long or the posterior head (*caput longum*, *anconœus longus*) arises by a short, flat, and thick tendon, directly before the anterior insertion of the teres minor muscle, from the upper end of the anterior edge of the scapula, and goes from above downward, gradually increasing in thickness. The tendon descends very low on its inner face. Its lower tendon extends in all its lower half along the inner part of its inner face, and the fleshy fibres are inserted in it obliquely. Its form is elongated.

The large head, or the outer head, (*caput externum*, s. *magnum*, *anconœus magnus*, s. *externus*) arises above by a thin extremity which terminates by a convex edge, and presents very short tendinous fibres. This end is attached, directly below the insertion of the teres minor muscle, at the upper part of the posterior face of the humerus. The fleshy fibres come also from all the anterior edge of the bone. This head descends as far as the outer condyle, by a short tendon, which is oblique from above downward, from before backward, and from without inward, unites backward and inward to the lower tendon of the long head. In all its lower portion its inner and posterior part is covered by the common lower tendon of the brachialis internus muscle. Its form is that of an elongated rhomboid, its breadth exceeds its thickness.

The short or internal head arises, directly below the upper extremity of the preceding, from most of the posterior face of the humerus, and descends along the inner edge of the bone to near the inner condyle, rests, by its posterior and inner edge, upon the tendons of the teres major and coraco-brachialis muscles, and also the inner edge of the brachialis internus. Its fibres go obliquely downward and outward; they are attached to the lower tendon of the long head in all the lower part of the short head.

The common lower tendon of these three heads, which covers them outwardly at their lower part, is not destitute of fleshy fibres except in a very small portion of its extent below, and is inserted in the upper broad edge of the posterior face of the olecranon process of the ulna.

We find a considerable mucous bursa between this tendon and the olecranon process, besides which we sometimes find two smaller ones on each side. We less commonly see another, also smaller, above.

This muscle extends the articulation of the elbow and usually moves the fore-arm; but it can also move the arm when the fore-arm is fixed. The long head brings the scapula towards the humerus, and draws the latter inward and backward.

II. BICEPS FLEXOR.

§ 1120. The *biceps flexor* muscle, *Scapulo-radial*, Ch. (*flexor antibrachii biceps*, s. *radialis*, s. *biceps internus*), is a very long muscle, situated on the anterior and the outside of the arm, and extends its whole length. Its two heads are separated above in almost all the muscle, and extend from the scapula, whence they arise, to the upper extremity of the radius.

The internal, posterior, or short head (*caput breve*), called also the *coraco-brachialis* muscle, from one of its attachments, is not only shorter but also thinner than the long head. It arises from the coracoid process by a short, flat, and narrow tendon, which it has in common with the coraco-brachialis muscle, more forward and outward than the latter, proceeds on its outside a little obliquely from within outward, covers below the inner and upper part of the brachialis internus muscle, and lower down becomes a tendon, which is first seen on its external face, on the side corresponding to the long head. This tendon, which unites to that of the last, is attached to the tuberosity of the radius.

The *long head* (*caput longum*, s. *M. gleno-radialis*) arises by a long, thin, and flat tendon from the centre of the upper part of the edge of the glenoid cavity of the scapula. This tendon is inclosed in a special fold of the capsule of the scapulo-humeral articulation, which answers as a mucous sheath, passes upon the head of the humerus, and is situated in the groove between the two tuberosities of this bone, where it is retained by the fibres of the fibrous ligament of the shoulder-joint, and on the anterior extremity of which the mucous sheath ceases. It thus comes to the anterior and outer side of the arm, where it soon continues with its fleshy belly but deeper than the tendon of the short head. This latter descends above, along the anterior and external edge of the triceps extensor muscle; below, before the central part of the brachialis internus muscle: at its lower extremity it is attached on one side, that is by its internal face, to the tendon of the short head; on the other to a peculiar tendon contained within it, and which when entirely destitute of fleshy fibres is united with that of the first head, being inserted at the same place with it.

We find a large mucous bursa between the lower tendon, that of the supinator brevis and the tuberosity of the radius, to which sometimes a smaller is added, situated on the outer face of the tendon.

The principal use of this muscle is to flex the articulation of the elbow. It also turns the fore-arm backward, contributes to draw it inward when it is extended, and depresses the scapula toward the humerus.

§ 1121. The biceps flexor muscle is one of those muscles most subject to variation, and presents the most singular anomalies.

The least considerable anomaly is where the two heads arise much lower than usual, so that they are only united by the inferior tendon.(1)

A greater anomaly, which is not rare, is when a third head exists, which is usually smaller than the other two and which arises near the centre of the internal face of the humerus,(2) more rarely from only the brachialis internus muscle,(3) although it is often blended with it. Sometimes also it is united with the coraco-brachialis muscle. This anomaly is very remarkable, as it is a repetition of the small head, which properly belongs to the biceps femoris muscle, and because its union with the coraco-brachialis muscle makes the number of the long flexors of the fore-arm equal to those of the long flexors of the leg. At the same time it approximates man to animals; since in birds the long flexor of the fore-arm presents a second smaller head, which arises from the lower tuberosity of the humerus; while in apes the brachialis internus muscle extends much higher.

The number of heads of this muscle sometimes increases still more, so that we number five; but these are not inserted in one common inferior tendon.(4) At the side of the third which is most usually met with we sometimes find a fourth, and along the tendon of the short head a fifth, which unite and are attached to the radius below the usual tendon; in this case, consequently, there were in fact three flexors, as is always found in birds.

III. BRACHIALIS INTERNUS.

§ 1122. The *brachialis internus* muscle, *Humero-cubital*, Ch. (*M. flexor cubitalis ulnaris*, s. *brachieus internus*), a broader and thicker muscle, especially at its posterior part, which entirely covers the inferior portion of the internal and anterior faces of the humerus, arises by an external and an internal slip, the former being higher, from the external and internal faces of the humerus above its centre. These two slips surround the lower extremity of the deltoides muscle; the internal extends to the coraco-brachialis and the external to the upper

(1) Weitbrecht, *Comment. Petrop.*, 1731.—Albinus, *loc. cit.*—Rudolphi, in *Gantzer*, 6.—We have seen it several times but always on one side.
(2) Albinus, *loc. cit.*, p. 438, 439.—Mayer, *loc. cit.*
(3) Kelch, *loc. cit.*, p. 35.
(4) Pietsch, in *Roux Journal de Med.*, vol. xxxi. p. 245.

extremity of the large head of the triceps extensor muscle. Its anterior edge descends along the external edge of the humerus, and the posterior along the internal edge of this bone to the part where it suddenly enlarges.

Its fibres are attached to a strong rounded inferior tendon, which reascends on the anterior face of the muscle almost to its centre. This tendon is inserted in the tuberosity of the ulna.

Between the tendon of the brachialis internus, that of the biceps flexor cubiti, the supinator brevis muscle, and the capsular ligament, we find a mucous bursa, which is not however constant.

This muscle flexes the articulation of the elbow.

§ 1123. We sometimes find at the side of it, but more forward and outward, a second brachialis internus muscle, which is smaller and which is an exact repetition of it as respects its attachments, the inferior tendon of which is inserted deeper than that of the other, and which even presents a rudiment of the preceding muscle, which we said belonged to birds. The first degree of this anomaly is the separation of the posterior from the anterior part of the muscle, which not unfrequently occurs. This division of the brachialis internus muscle into two parts is also worthy of remark, as it assimilates this muscle to the flexors of the leg. Its abnormal union with the biceps flexor by a muscular slip (§ 1121) is on the contrary the first index of the formation of a third head to the latter (§ 1121).

The anomalies of the brachialis internus, the biceps flexor, and the coraco-brachialis muscles (§ 1116), considered collectively, seem to be so many efforts by which nature endeavors to establish a perfect resemblance between the upper and lower extremities. They are generally found singly; but if we suppose them united, we have an arrangement perfectly similar to that of the lower extremities.

The coraco-brachialis and brachialis internus muscles, divided into two portions and often united with each other, evidently represent the semimembranosus and the semitendinosus muscles. The muscular band which goes from the brachialis internus to the lower part of the biceps flexor muscle, united with the unusually deep division of the latter, may be considered as tending to insulate the two heads and to form a second flexor of the ulna, even as the tibia is flexed by two distinct muscles.

ARTICLE FOURTH.

MUSCLES OF THE FORE-ARM.

§ 1124. The muscular mass of the fore-arm is formed of those muscles which move the bones upon each other or on the humerus, by the muscles which act on the carpus, and by the long muscles of the fingers.

The motions of the bones of the fore-arm on each other, or pronation and supination, are performed by four muscles, the supinator longus and the supinator brevis, the pronator teres and the pronator quadratus, all of which except the first are situated deeper than the other muscles of the fore-arm.

The two bones of the fore-arm are moved on the humerus by one muscle, the anconeus.

Five muscles move the carpus; the extensor carpi radialis longus and the extensor carpi radialis brevis extend it; it is flexed by the flexor carpi ulnaris and the flexor carpi radialis muscles; the extensor carpi ulnaris draws it backward.

The fingers are extended by the extensor digitorum communis, the extensor pollicis longus and brevis, the extensor indicis proprius, and the extensor minimi digiti proprius; they are flexed by the flexor sublimis, the flexor profundus, and the flexor pollicis longus.

These different muscles succeed each other in the following order, when we commence their description at the radial edge and follow the external face of the fore-arm to the ulnar edge and return from this to the radial edge along the internal face of the arm.

I. MUSCLES OF THE INTERNAL FACE OF THE FORE-ARM.

I. SUPINATOR LONGUS.

§ 1125. The *supinator longus* muscle, *Humero-sus-radial*, Ch., is a long muscle, which arises by short tendinous fibres from the inferior part of the anterior edge of the humerus, where it unites with the large head of the triceps extensor muscle. It goes downward and passes on the inferior and external part of the brachialis internus, which it covers, and reaches the fore-arm along and before the inferior extremity of this muscle; it goes on the radial edge of the fore-arm and is changed high up into a long and thin tendon, which covers above only the internal face, and is finally attached to the anterior face of the internal edge of the radius, a short distance above its inferior face. It turns the radius backward and inward, consequently carries the hand to the state of supination, and flexes the fore-arm.

II. EXTENSOR CARPI RADIALIS LONGUS.

§ 1126. The *extensor carpi radialis longus* muscle, *Humero-sus-metacarpien*, Ch., resembles the preceding and appears at first view to be a part of it. It arises from the lowest part of the outer edge of the humerus, descends to the outer condyle, passes on the outer part of the articular edge of the humerus, and on the head of the radius; in its course it becomes first thicker, afterward narrower, and terminates at the same place as the preceding in a tendon, at first rather broad, flattened, and loose to a much greater distance, which descends in the same direction along the radius and enters below into the anterior groove of the outer face of the lower extremity of the radius under the posterior ligament of the carpus, thus arrives at the carpus and is attached to the anterior part of the posterior face of the base of the second metacarpal bone.

The lower tendon is surrounded with a mucous sheath where it passes over the lower extremity of the radius. We also find a small bursa at its insertion in the root of the second metacarpal bone.

This muscle extends the hand and draws it a little toward the radial side of the fore-arm; it also serves to execute the motion of pronation to a certain extent and flexes the articulation of the elbow.

§ 1127. Sometimes a smaller and feebler muscle is detached from its lower edge, which succeeds the extensor carpi radialis brevis muscle and is attached a little above it to the root of the third metacarpal bone.(1)

III. EXTENSOR CARPI RADIALIS BREVIS.

§ 1128. The *extensor carpi radialis brevis* muscle, *Epicondylo-sus-metacarpien*, Ch., is very similar to the preceding, but is smaller. Its upper tendon, which is very strong, exists nearly the whole length of its posterior face. It arises from the anterior face of the outer condyle of the humerus, and is attached, below the middle of the fore-arm, by an elongated, flat, but narrow tendon, the upper part of which covers the lower part of the outside of the muscle. This tendon is inserted in the outer face of the base of the third metacarpal bone, and slightly also in that of the second. There is a small bursa between it and the third metacarpal bone.

This muscle acts in the same manner as the preceding.

§ 1129. It is sometimes entirely deficient,(2) as in several mammalia, where we never find but one extensor radialis muscle: the first degree of this formation is the complete union of the second radialis muscle, of which several instances are known. Sometimes its tendon divides into two slips, which are attached to the third metacarpal bone only, or one is inserted into this bone, and the other into the next; even as in the mammalia, which have only one radialis muscle, the tendon divides into two slips.

Besides the bursæ already mentioned, the tendons of the two muscles are surrounded by two common sheaths, the upper of which is situated above the lower end of the radius, while the lower is placed at a short distance from it on this extremity, and on the upper range of the carpal bones.

IV. EXTENSOR DIGITORUM COMMUNIS.

§ 1130. The *extensor digitorum communis* muscle, *Epicondylo-sus-phalangettien commun*, Ch., commences by a strong tendon, which

(1) Albinus, *loc. cit.*, p. 448.

(2) J. G. Salzmann, *Diss. sist. plurium pedis musculorum defectum*, Strasburg, 1734, p. 11.

extends on the upper part of the external face of its belly. It arises from the lower and back part of the outer condyle of the humerus, directly under and behind the radialis externus brevis muscle, with which it is intimately connected for several inches. Near the centre of the fore-arm it separates into three bellies, the posterior of which also divides a little farther in two others, so that the whole number of these bellies is four; these are inserted into as many elongated and flat tendons, of which the second is usually the strongest, the third smaller than the first, and the fourth is the weakest.

All these tendons pass under the posterior ligament of the carpus, between it and the outer face of the lower end of the radius. They become broader and thinner on the back of the hand, partially separate, especially near the anterior end of the metacarpus, and are again united by strong oblique intermediate tendons of various breadths. They go to the second, third, fourth and fifth fingers, and contract on the articulation of the metacarpus with the phalanges; but in this place they give off on each side fibres, which go downward; farther on they again enlarge, and are blended on each side with the tendons of the interosseous muscles. On the first joint of the phalanges they divide into a central and two lateral portions, which are much longer; the central tendon, having strengthened the dorsal face of the capsular ligament, is attached to the upper edge of the base of the second phalanx; the other two are united forward, and are inserted in the upper part of the back of the third phalanx.

At the lower end of the fore-arm, of the carpus and metacarpus, the tendons of this muscle have a mucous sheath, which is single above, but divides on the carpus into three branches, each of which goes with its tendon to the base of the first phalanx.

This muscle extends the second, third, fourth, and usually the fifth finger also.

§ 1131. Sometimes its three bellies are separated high up, and even at their origin.(1) Sometimes it divides into four tendons; the fourth goes to the little finger, and unites to its proper extensor. This fourth tendon sometimes divides on the back of the hand into two parts; the outer joins the tendon of the extensor minimi digiti proprius muscle, and the inner again divides into two portions, one of which unites to the tendon of the fourth finger, and the other to that of the fifth.(2) In some subjects the third and fourth tendons go to the third finger. In this case the muscle itself often divides into two bellies, each of which has two tendons.(3)

These divisions of the fleshy part of the muscle are curious, being similar in one respect to the extensors of the toes and also to the flexors of the fingers, which are both double.

(1) Albinus, *loc. cit.*, p. 452.—Brugnone, *loc. cit.*, p. 167.
(2) Albinus, *loc. cit.*
(3) Brugnone, *loc. cit.*

V. EXTENSOR MINIMI DIGITI PROPRIUS.

§ 1132. The *extensor minimi digiti proprius* muscle, *Epicondylo-sus-phalangettien du petit doigt*, Ch., is slender, elongated, and thin. It arises by two tendinous heads from the outer part of the head of the radius, from the part of the capsular ligament surrounding this head, and from the upper end of the anterior edge of the ulna. It descends behind the preceding, with which it is closely united for some distance, and near the lower end of the fore-arm becomes a thin tendon, which passes below the posterior ligament of the carpus in a special groove, enlarges along the metacarpal bone of the fifth finger, unites inward with the fourth tendon of the preceding muscle, and is attached to the upper face of the head of the third phalanx of the little finger.

Its tendon is surrounded from the lower part of the fore-arm to the centre of the fifth metacarpal bone by a sheath, which is single above, but below divides like the tendon into two parts.

This muscle extends the little finger.

§ 1133. It is sometimes deficient,(1) and then it is generally replaced by a tendon of the extensor digitorum communis muscle. In other cases, on the contrary, its tendon divides into two slips, one of which goes to the fourth finger, an arrangement worthy of remark because of its analogy with several mammalia.

VI. EXTENSOR CARPI ULNARIS.

§ 1134. The *extensor carpi ulnaris* muscle, *Cubito-sus-metacarpien*, Ch. (*M. ulnaris externus*, s. *extensor manus ulnaris*), arises by two tendinous slips, of which the smaller and shorter is situated at the side of the extensor digitorum communis, and comes from the posterior and lower part of the external condyle of the humerus, and the longer arises from the upper part of the anterior face of the tubercle of the ulna. These two slips soon unite in a considerable belly. The latter is tendinous at its inner and outer faces, and adheres in a considerable extent to the extensor proprius minimi digiti muscle, descends along the outer face of the ulna, from which it receives some fibres, and becomes, near the lower third of the fore-arm, a strong tendon, which, passing across a particular portion of the dorsal ligament of the carpus, comes on the back of the hand, where it is attached to the tubercle of the metacarpal bone of the fifth finger. There is but one mucous bursa between its upper extremity and the head of the radius.

This muscle extends the hand and draws it backward toward the posterior edge of the fore-arm.

§ 1135. A tendon of greater or less extent is often detached to go to the fifth finger, and at the base of the first phalanx unites with that of its proper extensor.

(1) Brugnone, p. 167.—We have known two instances where it was deficient.

VII. ANCONŒUS.

§ 1136. The *anconæus* muscle, *Epicondylo-cubital*, Ch. (*M. anconæus*, s. *anconæus quartus*), is a triangular muscle and mostly covered by the upper extremity of the preceding; it arises by a short and strong tendon from the inner part of the outer condyle of the humerus, descends toward the ulna, and is attached by a broad fleshy surface to the upper part of the anterior face of this bone. Its upper straight edge usually blends with the outer belly of the triceps extensor muscle.

This muscle extends the fore-arm, also turns the radius backward, so that it assists in supination.

VIII. SUPINATOR BREVIS.

§ 1137. The *supinator brevis* muscle, *Epicondylo-radial*, Ch., is triangular; its base looks upward, and its apex downward. It arises from the upper part of the anterior face of the ulna, and is tendinous outwardly and fleshy inwardly. Its upper fibres are transverse and the lower oblique. It goes downward and forward, turns on the upper part of the radius, and is attached by a broad fleshy edge to the anterior part of the capsule of the ulna, and also to the upper part of the anterior and inner faces of the radius as far as its posterior edge. It turns the hand and the radius on their axes backward and outward.

§ 1138. The upper part of this muscle often separates from the lower sooner than usual, and differs from it in the direction of its fibres, is separated from it by the radial nerve, and is attached to the radius without being connected with it. This anomaly leads to that in which two small supinator muscles exist; the upper extending from the outer condyle of the humerus to the anterior edge of the upper end of the radius, while the internal goes from the head of the radius to its centre.(1) Probably the second variety may be considered as an index of the formation peculiar to apes, in which three supinators exist.(2)

IX. ABDUCTOR POLLICIS LONGUS.

§ 1139. The *abductor pollicis longus* muscle, *Cubito-sus-métacarpien du pouce*, Ch., is a considerable muscle inserted, by very short tendinous fibres, directly below the anconeus and the supinator brevis, to the second fifth of the anterior edge of the ulna, to the outer face of the interosseous ligament, and to the central part of the outer face of the radius. It descends along the last, passes below on the anterior face of the radius, and there becomes a strong tendon, which passes through a particular division of the dorsal ligament of the carpus. This tendon

(1) Sandifort, *Hist. musc.* p. 93.—Brugnone, *loc. cit.* p. 163.

(2) We have found at least in the *Simia apella* two long supinators, situated at the side of each other.

generally divides into two or three slips: the strongest, which is also the most anterior, is attached to the radial edge of the base of the first metacarpal bone; the other two blend with the posterior extremity of the antagonist muscle of the thumb.

The tendon near its upper extremity is surrounded by a large, oblong, and rounded mucous sheath.

This muscle separates the thumb from the fingers, and moves it toward the radius.

§ 1140. It is often more or less divided into two bellies, each of which terminates by a tendon, and the lower is usually larger than the upper. The tendons of these two bellies are often divided, and sometimes unite; sometimes they are attached to the first bone of the metacarpus and to the trapezium.(1)

We more rarely find a digastric abductor of the thumb, which arises from the outer condyle of the humerus, and is inserted into the base of the first phalanx of the thumb.

X. EXTENSOR POLLICIS BREVIS.

§ 1141. The *extensor pollicis brevis* muscle, *Cubito-sus-phalangien du pouce*, Ch., is a very small muscle, situated below the preceding, and adheres intimately to its inferior edge. It arises from the outer face of the interosseous ligament and from the radius, and becomes a very thin tendon, which passes through the dorsal ligament of the carpus in the same groove with the abductor pollicis longus, then goes on the back of its metacarpal bone, becomes broader, and is attached to the centre of the upper edge of the base of its first phalanx.

This muscle extends the thumb, and at the same time removes it from the other fingers.

§ 1142. A small tendon sometimes arises from the anterior extremity of its tendon, which blends with that of the next muscle.

Sometimes this muscle does not exist as a distinct muscle, and forms only the lower part of the abductor pollicis longus muscle.

XI. EXTENSOR POLLICIS LONGUS.

§ 1143. The *extensor pollicis longus* muscle, *Cubito-sus-phalangettien du pouce*, Ch. (*M. extensor pollicis major* s. *longus*), is much stronger than the preceding, and covers its upper part; it arises, a little below the abductor magnus, and directly below its upper extremity, above from the outer face and below from the anterior edge of the ulna, and from the adjacent part of the external face of the interosseous ligament. It soon becomes a long tendon, which passes through the second groove of the dorsal ligament of the carpus, goes forward at the side of the preceding, but much more inwardly, partially covers it, and

(1) Fleischmann, in the *Erlanger Abhand.*, vol. i. p. 28.

is attached to the base of the second phalanx of the thumb, in the same manner as the tendon of the extensor digitorum communis is; but it does not divide.

Its tendon has two mucous sheaths: the upper and larger is situated at the lower part of the fore-arm, and extends to the carpus; the inferior is smaller, and is placed on the carpus and on the base of the first metacarpal bone.

It extends the thumb, and brings it a little towards the other fingers.

§ 1144. Sometimes it is completely double.

XII. EXTENSOR INDICIS PROPRIUS.

§ 1145. The *extensor proprius indicis* muscle, *Cubito-sus-phalangettien de l'index*, Ch. (*M. indicator*, s. *indicatorius*, s. *indicis extensor*, s. *abductor*), is nearly as large as the preceding. It arises directly below it by two slips from the third quarter of the anterior face of the ulna, and near the lower part of the fore-arm becomes a strong tendon, which, covered by that of the extensor digitorum communis, passes with it through the third division of the dorsal ligament of the carpus, below the tendinous band which goes from the latter muscle to the indicator finger; it proceeds more inwardly than this band, and is attached to the base of the first phalanx of the finger, blending with it.

It extends the indicator finger, and approximates it a little towards the third.

§ 1146. Sometimes it is digastric, and interrupted in its course by a long tendon.(1)

This muscle presents several anomalies which are exceedingly interesting: they consist in its more or less perfect multiplication and in the formation of the extensor pollicis tertii proprius.

The lowest degree of this anomaly is the division of its portion into two slips both of which go to the second finger,(2) or the division of its belly into two parts, the tendons of which unite before arriving at this finger,(3) or finally the existence of two bellies of the usual size, which are entirely distinct, and of which one arises from the radius.(4)

The most complete anomaly is when one of the slips of the tendon does not go to the indicator, but to the middle finger.(5)

Sometimes a small and perfectly distinct muscle arises from the lower part of the outer face of the radius and from the dorsal ligament of the carpus, and is attached to the first phalanx of the indicator.(6) This variety is only a more perfect development of the case in which the muscle arises by two heads.

Next comes the anomaly where we find a proper extensor of the middle finger; this muscle is always smaller than the extensor indicis

(1) Rosenmüller, *loc. cit.*, p. 6.
(2) We have seen it several times.
(3) Albinus, p. 458.—Heymann, p. 13.
(4) Gantzer, p. 14.
(5) Albinus, p. 468.—Peitsch, *Sylloge obs. anat.*
(6) Albinus, *Ann. acad.*, vol. iv. ch. vi.—Heymann, p. 12.

proprius, and arises more or less below and under it. This formation varies the least possible from the normal state when the new muscle comes from the ulna;(1) but sometimes it arises from the radius(2) or from the dorsal ligament of the carpus.(3)

The greatest anomaly is where we find, beside the extensor indicis proprius, an extensor for the middle finger, which divides into two tendons, one of which is attached to the metacarpal bone of the index finger, and the other to that of the middle finger.

Finally, we have seen in one case a small tendon, which extended from this proper extensor of the middle finger to the base of the first phalanx of the index finger.

All these anomalies are curious in two respects: 1st, as a repetition of the normal formation of the lower extremities, since they represent the extensor communis digitorum brevis, and that more perfectly as the supernumerary muscles arise lower; 2d, as analogous with animals; for in many apes the tendon of the extensor indicis proprius furnishes a slip to the middle finger, and in others, for instance in the simia apella, we find a proper extensor of the index finger.(4)

II. MUSCLES OF THE INTERNAL FACE OF THE FORE-ARM.

I. PALMARIS LONGUS AND BREVIS AND THE PALMAR APONEUROSIS.

§ 1147. The *palmaris longus* muscle, *Epitrochlo-palmaire*, Ch., is a thin oblong muscle, which arises, directly below the preceding and farther back than it, from the upper part of the anterior face of the inner condyle of the humerus. It goes directly forward and downward, and becomes in the middle of the fore-arm a broad and thin tendon, which is very near the skin. This tendon however is covered by the anti-brachial aponeurosis in most of its length, and passes over this aponeurosis only at its lower part. At its lower end, it divides into two fasciculi: the anterior, which is shorter, and which is attached to the posterior end of the abductor pollicis; and the posterior, which is much larger, and is called the *palmar aponeurosis* (*aponeurosis palmaris*). This aponeurosis is thinner than the tendon, but much broader and triangular. It gradually enlarges from behind forward, so that it corresponds by its anterior edge to the four fingers. It however becomes thin, and its fibres occasionally have intervals between them.

It is composed essentially of longitudinal fibres, like the tendon of which it is the expansion. Its anterior edge is however formed of transverse fibres, which are arranged over the preceding.

It covers most of the muscles of the palm of the hand, except those of the thumb and the little finger.

(1) We have seen it several times.
(2) We have seen it once.
(3) Brugnone, *loc. cit.*, p. 168.
(4) Meckel, *Beytrage zur vergleichenden anatomie*, vol. ii. p. 11.

The *palmaris brevis* muscle, which is composed of transverse fibres, is attached to its internal edge at its upper part. This muscle, the internal edge of which comes from the skin, serves to tense the aponeurosis outwardly.

§ 1148. The palmaris longus muscle is often deficient; sometimes it is replaced by a tendon of the flexor digitorum sublimis.(1) In other cases, on the contrary, it is unusually developed in fact thinner, but very broad, and descends almost into the palm of the hand.(2) This rudiment of a peculiar muscle, which sometimes extends from the coronoid process of the ulna to the palmar ligament of the carpus, is worthy of remark, especially as it forms an analogy with apes.(3)

II. RADIALIS INTERNUS.

§ 1149. The *radialis internus* muscle, *Epitrochlo-metacarpien*, Ch. (*M. radialis internus*, s. *flexor manus radialis*), is much larger than the preceding, and is blended above with it, and on both sides with the pronator-teres and the flexor communis digitorum sublimis; it comes from the anterior face of the inner condyle of the humerus, and sometimes also by a small head from the radius. It is partly covered by the preceding and goes downward and a little forward, and near the middle of the fore-arm becomes a broad tendon. This tendon passes under the palmar ligament of the carpus in a special canal, formed by the palmar ligament, and by the os trapezium; it is harder and thicker in this place than in other parts. After leaving this canal it becomes thinner but broader, and is attached partly to the os trapezium, but more particularly to the inner face of the second metacarpal bone.

We find a mucous bursa between the lower end of the tendon, the os trapezium, and the proper palmar ligament.

This muscle flexes the hand and carries it a little forward.

III. PRONATOR TERES.

§ 1150. The *pronator teres* muscle, *Epitrochlo-radial*, Ch., a shorter but stronger muscle, arises by very short tendinous fibres from the upper edge and the upper part of the anterior face of the inner condyle of the humerus. It swells a little below its origin, goes obliquely downward and forward, and is covered at its lower part and at its upper edge by a strong tendinous expansion, and is attached by means of this, below the supinator brevis, and before the abductor pollicis longus, to the anterior face and outer edge of the radius, a little above its centre.

It turns the radius and also the hand inward, forward, and downward.

(1) Rosenmüller p. 6.
(2) Albinus, p. 474.
(3) Perrault, *Mem. in Valentini Theatr. zool.* p. 151.—Vicq. d'Azyr., *Encycl. meth.*, *sect.anat.*, vol. ii. p. 25, 257.

§ 1151. It is sometimes double. In this case the supernumerary muscle extends from the posterior edge of the ulna to the posterior edge of the normal muscle, which is an analogy with apes.

IV. FLEXOR ULNARIS.

§ 1152. The *flexor ulnaris* muscle, *Cubito-carpien*, Ch. (*M. ulnaris internus*, s. *flexor ulnaris*), arises by two rather short heads, of which the upper comes from the lower part of the inner face of the inner condyle of the humerus, and the posterior or the inferior from the inner face of the olecranon process of the ulna. It descends along the ulna, from which it is always separated by the flexor digitorum communis, and becomes a strong tendon at the lower end of the fore-arm which is attached to the pisiform bone; we find a very loose mucous bursa between it and this bone.

It flexes the hand and inclines it toward the ulna.

V. FLEXOR DIGITORUM COMMUNIS SUBLIMIS.

§ 1153. The *flexor digitorum communis sublimis* muscle, *Epitrochlo-phalanginien commun*, Ch. (*M. flexor digitorum communis sublimis*, s. *perforatus*), arises below the four preceding, by a much larger head, from the lower part of the anterior face of the inner condyle of the humerus, from the inner part of the capsular ligament of the elbow joint, and from the inner face of the coronoid process of the ulna; it also arises by a small slip from the inner face of the radius at the lower end of the supinator brevis muscle. Long before this slip has joined the upper head, it divides into three bellies, of which the internal and posterior divide still lower into two others. Each of these bellies becomes a tendon, which all pass under the special palmar ligament of the carpus to arrive at the palm of the hand.

Nearly opposite the centre of the first phalanx each tendon divides into two slips which unite farther on the second phalanx, so that their inner fibres interlace and again separate below this point to attach themselves behind the middle of the second phalanx to its radial and ulnar edges.

These tendons are surrounded by a common sheath, near the lower extremity of the fore-arm, which, when arrived at the carpus, divides into several sacs, each of which goes with one of them to the base of the first phalanx. This muscle flexes the second phalanx of the fingers.

§ 1154. One of the tendons, particularly that of the little finger, is sometimes deficient; it is then replaced by one of the tendons of the flexor profundus muscle; sometimes a belly of this muscle, especially that which belongs to the index finger, is entirely separated from the others, and divided besides into two fleshy portions by a long central tendon. As the anomaly is seen more commonly in the belly of the indicator finger, it is worthy of remark, from its analogy with the outer face of the fore-arm, since it represents the proper extensor of the index finger, and more, as the latter is also digastric in some subjects.

VI. FLEXOR DIGITORUM PROFUNDUS.

§ 1155. The *flexor digitorum profundus* muscle, *Cubito-phalangettien commun*, Ch. (*M. flexor digitorum communis profundus*, s. *suadus perforans*), is stronger than the preceding, which covers it anteriorly, and arises from the upper two-thirds of the inner and posterior faces of the ulna, so as to envelop this bone almost entirely, and divides, but much deeper than the flexor sublimis, into four bellies, which become as many tendons. These tendons are retained together by numerous intermediate filaments and by folds of the mucous sheaths, and pass under the palmar ligament of the carpus, with those of the preceding, and go to the same fingers. In this place we see a fissure along the upper and lower faces. They pass through the sheath of the flexor sublimis, afterwards become broader and thinner, and are attached to the base of the third phalanx.

This muscle flexes the third phalanx of the fingers.

§ 1156. Sometimes a muscle proceeds between the flexor sublimis and the flexor profundus, and extends from the inner condyle of the humerus to the latter ;(1) and again, a muscular fasciculus arises from the flexor pollicis longus as high as the wrist, which is attached by a tendinous expansion to that tendon of the flexor profundus which goes to the index finger.(2)

VII. LIGAMENTS OF THE FLEXORS OF THE FINGERS.

§ 1157. The tendons of the flexor profundus and sublimis are surrounded in two places by fibrous ligaments and mucous sheaths.

§ 1158. The upper fibrous ligaments are the common palmar ligament and proper palmar ligament of the carpus.

Below them we find the upper mucous sheath, an elongated sac, which surrounds all the tendons of the two flexors, commences about an inch and a half above the radio-carpal articulation, and extends to the centre of the carpus. Its outer layer is attached to the palmar ligaments of the bones of the carpus, and to the interossei muscles. Numerous folds arise from all the internal face of this outer layer which go inward, surround the tendons of the two flexors, and unite them but very loosely.

§ 1159. The second place, where the common flexors are surrounded with similar ligaments, is that portion which corresponds to the lower face of the fingers.

§ 1160. The lower fibrous ligaments are situated outwardly, and form for the mucous sheath an envelop, which is divided on account of the motion of the fingers.

(1) Gantzer, p. 13.
(2) Gantzer, *ibid.*

The strongest portion is termed the *ligamentous sheaths* (*Lig. vaginalia*). These sheaths are formed almost entirely of transverse fibres; in part, however, especially on the surface, of oblique fibres which cross the preceding. They are strongly extended, like a bridge, from the radial to the ulnar edge of the first and second phalanges. That of the indicator finger is much stronger than the others in every respect.

The feeblest which stand more distinct, extend in the same manner over the metacarpo-phalangœan and the second phalangœan articulations. Their size diminishes much from the first to the third articulation. They are called the *ligamentous rings of the articulations* (*annuli juncturarum ligamentosi*).

Analogous fasciculi are found between the preceding and the ligamentous sheaths; these are the *oblique* or *crucial rings of the first and second phalanges* (*annuli obliqui*, s. *cruciati phalangis primæ et secundæ*).

§ 1161. The inner faces of these fibrous ligaments are covered with elongated mucous sheaths, which begin some lines behind the metacarpo-phalangœan articulation, are attached in this place to the flexor sublimis and profundus of each finger, and extend to the centre of the terminating phalanx. Their upper part is inserted in the upper part of the palmar face of the phalanges. The tendons of the two flexors are mostly loose in these mucous sheaths, of which each finger possesses a separate one; however, from the dorsal face of the sheaths, that which covers the palmar face of the fingers, arise several broader and narrower irregular folds, the largest of which contains more or less fat; these proceed from before backward, are very thin from one side to the other, and are attached to the tendons of the flexor sublimis and profundus. The upper are usually very thin and rounded, and are attached to the radial slip of the flexor sublimis. They are generally deficient in one or several fingers.

The succeeding which are larger are also more constant; they arise near the second phalangœan articulation, and are usually attached to the tendon of the flexor sublimis, where its two slips unite. Usually we find also within or on their sides other prolongations, which go to the tendons of the flexor profundus.

A third prolongation generally arises from the base of the third phalanx which is attached directly to the two anterior slips of the flexor sublimis, unites them, goes from this point to the anterior extremity of the flexor profundus which covers the third articulation, and is there attached in all its extent.

Other single or divided prolongations extend also in many parts between the tendons of the two flexors in their course along the fingers.

These are the *short* and *long accessory* or *vascular ligaments of the flexors* (*vincula tendinum sublimis et profundi accessoria*, s. *vasculosa brevia et longa*).

VIII. FLEXOR POLLICIS LONGUS.

§ 1162. The *flexor proprius pollicis longus* muscle, ***Radio-phalangettien du pouce***, Ch., is much feebler and shorter than the preceding, with the second belly of which its central part usually adheres more or less intimately. It arises by a small distinct slip from the tubercle of the ulna, but in most of its length it arises by fleshy fibres from the lower two-thirds of the inner face, and the anterior edge of the radius. The strong tendon which terminates it passes under the palmar ligament with those of the two preceding muscles, and goes between the abductor and flexor pollicis brevis on the internal face of this finger, and is attached not far from its inferior edge to the second phalanx. This tendon is surrounded by a special mucous sheath from the lower extremity of the fore-arm to the centre of the first phalanx.

It flexes the second phalanx of the thumb.

We sometimes find a second head which comes from the inner condyle of the humerus, and which is only a greater development of its upper slip.

IX. PRONATOR QUADRATUS.

§ 1163. The *pronator quadratus* muscle, ***Cubito-radial***, Ch. (***M. pronator quadratus***, s. *inferior*), is an almost equilateral quadrilateral muscle, being rather more long than broad, which occupies the lowest part of the inner face of the fore-arm, where it is covered by the tendons of all the long muscles. Its fibres are oblique and extend from the posterior edge and from the inner face of the ulna to the inner face and anterior edge of the radius.

This muscle rotates the radius, and the hand with it, on its axis from behind forward and from without inward.

§ 1164. It is sometimes deficient,(1) as in several mammalia.

Again, it is sometimes divided into two bellies which are entirely separated, the fibres of which proceed in opposite directions and cross.(2)

ARTICLE FIFTH.

MUSCLES OF THE HAND.

§ 1165. The muscles of the hand(3) arise from the tendons of the flexor profundus, from the carpus, and from the metacarpus, and are attached to the metacarpal bones and also to the phalanges. They are principally designed to approximate and separate the fingers and serve less

(1) We know of one instance.
(2) We have once seen this.
(3) Albinus, *Icones musculorum manus* iv., *ad calcem hist. muscul.*, Leyden, 1734.

to flex them. Hence they are divided into abductors, adductors, and flexors. The adductors and abductors which are attached to the two external fingers, the thumb, and the little finger, fulfill only the one or the other of these two functions, while those which move the other three fingers are both adductors and abductors; because, in approxiting a finger toward that on one side, they necessarily separate it from that of the other side.

The abductor and adductor muscles of the fingers, except the thumb, are] called the *interossei* muscles, from their situation; the flexors of the second and third and also one of the little finger are called the *lumbricales*, from their form.

I. LUMBRICALES.

§ 1166. The four *lumbricales* muscles, *Palmi-phalangien*, Ch., are long, rounded muscles, which arise fleshy from the lower face and the radial edge of the tendons of the flexor digitorum profundus toward the upper end of the metacarpus. They proceed at the side above and below these tendons and arrive at the fingers, where they become thin tendons, which are reflected on the radial face of the first phalanx, enlarge, and blend with the anterior edge of the tendon of the extensor muscle.

They flex the first phalanx.

§ 1167. We often find one or more of these muscles more or less completely double, and then the supernumerary head or the whole muscle is inserted in the ulnar side of the adjacent finger.

II. INTEROSSEI.

§ 1168. The *interossei* muscles, *Metacarpo-phalangiens lateraux sus-palmaire* and the *metacarpo-phalangiens lateraux*, Ch., are situated between the metacarpal bones. Their anterior tendons are attached partly to the lateral faces of the posterior heads of the first phalanges, partly also to the extensors of the fingers. They are divided into two classes, the *external* (*M. interossei externi*, s. *bicipites*), and the *internal* (*M. interossei interni*, s. *simplices*.)

I. INTEROSSEI EXTERNI.

§ 1169. The common characters of the external interossei muscles are: 1st. They appear on the dorsal and palmar faces of the hand. 2d. They arise from the corresponding faces of two metacarpal bones by two heads, which is inserted in a common tendon.

We number four, which are attached to the index, middle, and little fingers.

The first, which is the strongest, is situated between the thumb and the index finger. It differs from the others, not only in volume but also in the complete separation of its two heads.

The anterior and stronger head arises from the upper larger part of the ulnar face of the metacarpal bone of the thumb. The posterior, which is smaller, arises from almost all the radial face of the second metacarpal bone. These two heads unite below in a common tendon, which is attached partly to the radial face of the base of the first phalanx of the index finger, and partly blends with the tendon sent by the common extensor of the same finger.

The great distance between the two heads has led some anatomists to consider them as two distinct muscles: they have termed the anterior head the *adductor indicis* and the posterior the first internal interosseous muscle.

It draws the second finger toward the thumb.

The other external interosseous muscles are much smaller; their heads unite much higher even in the centre of their course.

The second arises by a smaller anterior and deeper head from the ulnar side of the second, and by a larger posterior looser head from the radial side of the third metacarpal bone. It is also attached to the radial side of the middle finger.

This muscle brings the middle finger toward the index finger.

The third, situated in the space between the third and fourth metacarpal bones, is inserted in the ulnar side of the middle finger.

It brings the middle finger toward the fourth.

The fourth is placed between the fourth and fifth metacarpal bones, and is inserted in the ulnar side of the fourth finger.

It brings the ring finger to the fifth.

II. INTEROSSEI INTERNI.

§ 1170. The *interossei interni* muscles are three in number, when we do not consider the posterior head of the first external interosseous muscle as the first internal interosseous muscle. They are attached to the second, fourth, and fifth fingers. They arise by a single head from the lateral face of the metacarpal bone of the finger to which they are attached, and are very distinct in the palm of the hand.

The first arises from the ulnar face of the second metacarpal bone, is inserted in the ulnar side of the base of the first phalanx of the indicator finger, and blends in the same place with the tendon sent by the common extensor to this finger. It separates the index finger from the thumb and draws it toward the middle finger.

The second comes from the radial side of the fourth metacarpal bone.

The third arises from the radial side of the fifth metacarpal bone.

The second is attached to the first phalanx of the fourth finger, and the third to the first phalanx of the fifth finger.

Both draw the fingers to which they are attached from the side of the thumb or from the radial edge of the hand, and consequently inward.

The index finger has then an external and an internal interosseous muscle; the middle finger has two external interosseous muscles; the fourth finger an external and an internal, and finally the fifth finger an internal interosseous muscle.

§ 1171. The interosseous muscles rarely present anomalies. We have however found the second external interosseous muscle attached to the ulnar side of the index finger, and the first internal interosseous muscle attached not to this finger but to the radial side of the third—a variety the more interesting in the history of the inversion of the organs because it presents an exact repetition of the normal formation of the foot, and because the hand in which we found it presented also an adductor of the thumb, formed likewise in the same manner as that of the great toe.

III. MUSCLES OF THE THUMB.

§ 1172. The metacarpal bone of the thumb is surrounded by a considerable muscular mass, called the ball of the thumb (*thenar*), formed of four muscles, the abductor pollicis brevis, the opponens pollicis, the flexor pollicis brevis, and the adductor pollicis.

I. ABDUCTOR POLLICIS BREVIS.

§ 1173. The *abductor pollicis brevis* muscle, *Carpo-sus-phalangien du pouce*, Ch., the most superficial of the four muscles, arises from the anterior part of the inner face of the ligament of the carpus and of the os trapezium. It is generally blended by a short intermediate tendon with the tendon of the abductor longus (§1139), and extending forward along the radial edge of the metacarpal bone of the thumb, it is attached by a short tendon to the outer face of the posterior head of its first phalanx. It also usually blends more anteriorly with the tendon of the flexor pollicis brevis muscle.

It separates the thumb from the index finger and extends it a little.

II. OPPONENS POLLICIS.

§ 1174. The *opponens pollicis* muscle, *Carpo-metacarpien du pouce*, Ch., is smaller than the preceding, which it partly covers, and its form is rhomboidal. It arises below it by a broad edge and by very broad tendinous fibres from the anterior part of the inner face of the palmar ligament and from the os trapezium, then descends to the metacarpal bone of the thumb, and is attached by a short tendon to all the anterior part of its radial edge.

It draws the thumb inward and turns it on its axis; so that it opposes its palmar face to that of the other fingers.

III. FLEXOR POLLICIS BREVIS.

§ 1175. The *flexor pollicis brevis* muscle, *Carpo-phalangien du pouce*, Ch. (*M. flexor pollicis brevis*, s. *mesothenar*, s. *antithenar*), is stronger than the two preceding. Its upper extremity, which is very much divided, arises first below and inward from the palmar ligament and the os trapezium, on the other side from the palmar face of the os trapezoides, from the os magnum, and the os pyramidale. It partly covers the preceding and is attached to the outer sesamoid bone of the thumb.

It flexes the first phalanx of the thumb.

§ 1176. The largest head, which comes from the palmar ligament, is sometimes entirely separated from the other, which is smaller and situated lower; so that this muscle is in fact double. On the other hand, it often happens that the small head is entirely blended with the adductor pollicis muscle.

IV. ADDUCTOR POLLICIS.

§ 1177. The *adductor pollicis* muscle, *Metacarpo-phalangien du pouce*, Ch. (*M. mesothenar*, s. *hypothenar*), is the strongest and the deepest of the four muscles of this finger. Its form is triangular, the base looking toward the ulnar edge and the summit toward the radial edge. It arises by fleshy and tendinous fibres from the palmar face of the os magnum, and in a greater or less extent from the palmar edge of the third metacarpal bone, goes forward and outward, and is attached by a short tendon to the inner sesamoid bone.

This muscle draws the thumb toward the index finger and slightly rotates it on its axis, so that it turns its palmar face toward that of the other fingers.

§ 1178. Sometimes it divides into a posterior and an anterior belly, which are completely distinct, the posterior being the larger. In this case the first arises only from the os magnum or at the same time from this bone and a small upper portion of the third metacarpal bone: as to the second, it comes from the lower part of the anterior head of the third and fourth metacarpal bones; sometimes also from the fifth as well as from the capsular ligament of the first phalangean articulation, and goes across or a little obliquely from before backward, to the first phalanx of the thumb, where it unites with the posterior head.

This anomaly is worthy of remark, as it coincides perfectly with the normal arrangement of the adductor of the large toe.

IV. MUSCLES OF THE LITTLE FINGER.

§ 1179. The little finger is moved by three muscles, an abductor, a flexor, and an adductor.

I. ABDUCTOR MINIMI DIGITI.

§ 1180. The *abductor minimi digiti* muscle, *Carpo-phalangien du petit doigt*, Ch., the shortest of these three muscles, extends along the ulnar edge of the metacarpus. It arises by short tendinous fibres from the pisiform bone, and near the first phalanx of the finger becomes a small flat tendon, which blends with the ulnar edge of the tendon of its extensor.

It separates the little finger from the others.

II. FLEXOR MINIMI DIGITI.

§ 1181. The *flexor minimi digiti* muscle (*M. flexor proprius digiti quinti*) is covered by the preceding. It arises below and before it from the pisiform bone and from the unciform process of the unciform bone: it forms a short tendon forward, which is attached to the radial side of the first phalanx of the little finger.

It flexes the little finger and separates it from the others.

It is often deficient and then the preceding is more developed.

III. ADDUCTOR MINIMI DIGITI QUINTI.

§ 1182. The *adductor minimi digiti* muscle, *Carpo-metacarpien du petit doigt*, Ch. (*M. adductor digiti quinti*), is thickest and shortest, and arises from the lower anterior edge and the outer face of the unciform process of the unciform bone, goes upward, and is attached to all the ulnar face of the metacarpal bone of the fifth finger.

It carries the little finger forward and draws it toward the others, causing it to rotate around its axis on the metacarpal bone. When it acts in concert with the opponens pollicis muscle, which very much resembles it, the cavity of the palm of the hand enlarges.

§ 1183. The proper muscles of the thumb and little finger are only the lumbricales or interossei muscles largely developed and divided into several fasciculi. We must consider the flexor pollicis brevis muscle as the first lumbricalis. The abductor pollicis brevis and the opponens pollicis correspond to an external; the adductor represents an internal interosseous muscle.

The abductor and the flexor minimi digiti muscles form only one muscle, which represents the last external interosseous muscle.

The adductor minimi digiti muscle is only an enlarged internal interosseous muscle.

CHAPTER II.

MUSCLES OF THE LOWER EXTREMITIES.

§ 1184. The muscles which have with the upper section of the abdominal members relations similar to those which exist between the superficial muscles of the back and of the region of the shoulder, or the broad muscles of the abdomen, have already been examined. We may then pass immediately to those which go from the first section of the bones of the lower extremities to the femur; but we must here also commence by describing the general aponeurotic envelop.

ARTICLE FIRST.

APONEUROTIC SHEATH OF THE LOWER EXTREMITIES.

§ 1185. Most of the muscles of the lower extremities, especially those of the thigh, leg, and sole of the foot, are enveloped by an aponeurotic expansion, which is not arranged every where in the same manner.

This expansion is called on the thigh the *fascia lata*, on the leg the *crural aponeurosis*, in the sole of the foot the *plantar aponeurosis.*

The first two form a whole more continuous with each other than with the plantar aponeurosis, and are also still more similar in their form, as they surround the thigh and the leg.

The *fascia lata* commences behind on the gluteæus maximus muscle, where it is very thin, and gradually loses itself at its upper portion. It arises forward from the iliac crest and from the Fallopian ligament. It extends as far as the knee. It adheres very intimately by the upper and external part of its anterior edge to the lower edge of the tendon of the obliquus externus abdominis muscle, to which it is much more loosely attached on its inner side.

It is thickest at the outer part and thinnest at the inner part of the thigh. It is half a line thick in every part and above even a line in the first region, while it hardly equals the twelfth of a line in the second. In general it is evidently formed of two layers of fibres: the internal is stronger and its fibres are longitudinal; the external is weaker and its fibres are oblique downward, inward, and backward, and are more insulated, and gradually approach each other from below upward.

From the inner face of this aponeurosis arise septa which extend between most of the muscles of the thigh which they separate from each other; we readily distinguish in most of these septa transverse and oblique fibres.

The fascia lata presents oblique fibres in every part. In many places, especially at the inner portion of its circumference, these fibres are extended over a layer which is not evidently fibrous, especially forward, but at the outer part this layer is manifestly formed of longitudinal fibres, and at the same time its inner face presents in different parts more insulated oblique fibres, so that here the aponeurosis evidently consists of three layers.

The outer part of the *crural aponeurosis* is also much thicker, and formed in this part of two layers; the fibres of the internal are longitudinal, those of the external, which is weaker, are oblique.

At the upper part of the aponeurosis the direction of the oblique fibres is inversely that of the oblique fibres of the fascia lata, that is, they proceed forward, downward, and inward.

At the lower part of the crural aponeurosis they have an opposite direction, and at the same time other fibres are developed on the inner side of the aponeurosis, which are oblique from behind forward and from above downward.

These outer and inner fibres cross on the anterior face of the articulation of the foot, and as they increase in strength in this part they there form the *crucial ligament* (*Lig. cruciatum*), composed of two fasciculi, which cross each other in the centre. One of these fasciculi descends from the outer malleolus, goes downward and inward, and is attached to the tibial side of the first metatarsal bone. The second arises from the internal malleolus, and goes to the tuberosity of the fifth metatarsal bone.

Below, they are both continuous with the thin aponeurosis of the back of the foot, which covers the tendon of the extensor digitorum longus and the belly of the extensor communis digitorum pedis, and is lost near the anterior extremity of the metatarsus.

This aponeurosis at the back of the foot is often much stronger toward the posterior end of the first metatarsal bone in this place, where it passes over the tendon of the extensor proprius pollicis pedis, than in the rest of its extent, and it is formed of very evident transverse fibres, which are attached internally to the inner side of the metatarsus, and outside to a special fasciculus of the extensor brevis digitorum pedis. In this case, this portion of the aponeurosis of the foot is provided with a proper tensor muscle.

II. TENSOR VAGINÆ FEMORIS.

§ 1186. The aponeurosis of the fascia lata, like most of the aponeurotic expansions which surround the muscles, has a proper muscle called the *tensor vaginæ femoris* muscle, *Ilio-aponeurosi-femoral*, Ch. (*M. tensor fasciæ latæ*).

This muscle is situated at the anterior edge of the upper part of the lateral face of the thigh. It arises by a short but very strong tendon from the outer face of the anterior and superior spine of the ilium.

Thence it goes downward and outward, gradually enlarges, and is continuous by very short tendinous fibres, towards the summit of the middle third of the thigh, with the fascia lata, which is united with its outer face more firmly than with any other muscle.

ARTICLE SECOND.

MUSCLES OF THE PELVIS.

§ 1187. The muscles of the pelvis arise partly from its outer face, partly from its inner face, and partly from the lumbar portion of the vertebral column; they are attached to the upper part of the femur which they extend, flex, and turn around its axis.

I. EXTENSORS OF THE THIGH.

§ 1188. The thigh is extended by three muscles called the *glutæi*, situated over each other; and they cover the outer face of the iliac bones, and descend outward, downward, and forward toward the femur.

I. GLUTÆUS MAXIMUS.

§ 1189. The *glutæus maximus* muscle, *Sacro-femoral*, Ch., is the largest of all the muscles of the body, and is nearly a regular rhomboid. It arises by its posterior and inner edge from the posterior part of the outer lip of the crest of the ilium, from the lower part of the posterior face of the sacrum, from the sacro-sciatic ligament, and from the sciatic tuberosity. It arises by these different points by short tendinous fibres, goes from within outward and from above downward, forming a very strong and thick muscle, composed of distinct and large fasciculi which are loosely connected with each other. It is attached by a broad and very strong tendon which is continuous below with the lateral part of the fascia lata to the lower part of the large trochanter, and to the linea aspera which descend from this tubercle.

Several mucous bursæ are found on the inner face of the lower tendon of this muscle. The largest and at the same time the uppermost is situated between it and the outer face of the large trochanter. Farther backward and downward we find another which is also large but a little smaller, between it the upper extremity of the vastus externus muscle and the lower end of the tensor vaginæ femoris muscle. Finally, between this muscle and the femur, farther backward and downward, are two which are smaller.

The glutæus maximus extends the thigh, brings it toward the vertebral column, rotates it a little outward, and approximates it to that of the side opposite. When it acts from below upward it draws the iliac bones downward, inward, and forward.

II. GLUTÆUS MEDIUS.

§ 1190. The *glutæus medius* muscle, *Grand ilio-trochanterien*, Ch., is a large muscle, but smaller and closer than the preceding, and has a triangular form. It is covered at its posterior and lower part by the glutæus maximus, and forward by the fascia lata only, with which it is intimately connected. It arises from the outer lip of the crest of the ilium, and from the upper and anterior part of the outer face of the iliac bones which is situated between the iliac crest and the curved line. Its posterior fibres are oblique from behind forward and from without inward; the anterior go from above downward. It proceeds towards the large trochanter, and is attached to its outer face by a broad, short, and very strong tendon, which blends with that of the glutæus maximus muscle.

A small mucous bursa exists between the upper face of this muscle, the pyrifarmis, the gemellus superior, and the inner face of the large trochanter.

The glutæus medius muscle raises the femur, separates it from that of the opposite side, and inclines the pelvis as much as possible towards its side.

Its posterior part turns the thigh outward, and its anterior turns it inward.

III. GLUTÆUS MINIMUS.

§ 1191. The *glutæus minimus* muscle, *Petit ilio-trochanterien*, Ch., has the same form as the preceding, while it is much smaller and is entirely covered by it. It arises directly below it by its upper face and anterior edge from the curved line, and from the anterior and lower part of the outer face of the iliac bones. It is attached by a short and strong tendon to the upper edge of the upper part of the inner face of the large trochanter.

A small synovial capsule exists forward between it and the large trochanter.

Its action is the same as that of the preceding.

II. MUSCLES WHICH ROTATE THE THIGH OUTWARDLY.

§ 1192. The thigh is turned outward by six muscles, the pyriformis, the obturator internus, the obturator externus, the two gemelli, and the quadratus femoris.

I. PYRIFORMIS.

§ 1193. The *pyriformis* muscle, *Sacro-trochanterien*, Ch. (*M. pyriformis*, *pyrimidalis*, *iliacus externus*), is a small muscle of an oblong triangular form coming from the cavity of the abdomen, where it arises by three or four digitations from the sacrum. It arises from the anterior face of this bone, between the third and fourth, the second and third, and the first and second pairs of the anterior foramina of the sacrum, and from the inner face of the posterior and lower spine of the ilium, and from the upper part of the posterior edge of the iliac fossa. It descends through this last behind the upper part of the descending branch of the ischium, goes outward and forward, and is attached by a rounded, strong, and proportionally broad tendon to the summit and upper part of the inner face of the large trochanter.

There is a small mucous bursa between its tendon and the gemellus superior muscle.

It rotates the thigh outward, separates it from that of the side opposite, and raises it a little.

§ 1194. It sometimes divides into an upper and a lower portion, between which the glutæal nerve passes.(1)

II. OBTURATOR INTERNUS.

§ 1195. The *obturator internus* muscle, *Sous-pubio-trochanterien interne*, Ch. (*M. obturator internus*, s. *marsupialis*, *marsupialis internus*), arises from the inner face of the obturator foramen by radiating fibres, which suddenly change their direction on leaving the pelvis and turn at a right angle on the posterior face of the descending branch of the ischium, covered before by this part of the bone, and behind by the sacro-sciatic ligament. It then proceeds outward and forward; and is attached by a strong tendon to the central part of the inner face of the great trochanter, far below the tendon of the pyriformis muscle.

The arrangement of this tendon is then very peculiar. It begins within the pelvis, a short distance from the descending branch of the ischium, but extends to about the centre of the space between the ischium and the trochanter. It does not appear except on the anterior and inner face of the muscle, where it consists of five very regular and very distinct fasciculi, two of which form the upper and lower edge of the muscle. The outer extremity of the middle belly extends between them by four triangular fasciculi, and then immediately unite in a strong tendon near the centre of the space between the ischium and the great trochanter.

We find an oblong synovial capsule backward and outward between the tendon of this muscle, the gemelli, and the great trochanter. A second, external and rounded, situated between the ischiatic spine and the great trochanter, surrounds the inner part of the tendon.

The obturator internus muscle turns the thigh directly outward and draws it from that of the opposite side.

(1) Winslow, *Expos. anat.*, vol. ii. p. 125.

III. GEMELLI.

§ 1196. The *gemelli* muscles, *Ischio-trochanterien*, Ch. (*M. gemini femoris, marsupiales externi, marsupium*), are two small oblong muscles, which are very similar and placed one over the other: they are separated backward and outward by the tendon of the obturator internus muscle, also by that portion of this muscle which is situated out of the pelvis. Their thin edges touch forward.

The *upper* arises by a pointed extremity from the lower part of the posterior face of the ischiatic spine.

The *lower* arises by a broad and semilunar edge from the upper face of the sciatic tuberosity and from the outer face of the descending branch of the ischium. It gradually becomes thicker from within outward.

These two muscles are intimately connected with the obturator internus, especially in their outer portions, entirely cover it, and are attached with it to the inner face of the great trochanter.

They act in the same manner as the preceding.

§ 1197. The upper gemellus is frequently deficient(1)—a remarkable analogy with what is seen in the ape.(2)

We know of one case where both these muscles were deficient, as in bats.

IV. QUADRATUS FEMORIS.

§ 1198. The *quadratus femoris* muscle, *Ischio-sous-trochanterien*, Ch., is oblong and composed of transverse fibres. It is broader from without inward than in any other direction, and its height much exceeds its thickness. It arises from the anterior edge of the sciatic tuberosity and from a small part of the ascending branch of the ischium, passes directly below the gemellus inferior to the posterior face of the femur, where it is attached to a square impression situated between the roots of the large and small trochanters above the posterior intertrochanterian line.

We find a synovial capsule between it and the small trochanter.

It acts like the preceding.

§ 1199. Sometimes it does not exist.(3) More rarely it is divided into several fasciculi, three of which have been known to exist.(4)

V. OBTURATOR EXTERNUS.

§ 1200. The *obturator externus* muscle, *Sous-pubio-trochanterien externe*, Ch., is a rounded and triangular muscle, at first thin, but after-

(1) Gantzer, p. 4.
(2) Vicq. d'Azyr, *Enc. méth. syst. anat. des quadrup.*, p. 29.
(3) Albinus, *loc. cit.*, p. 530.—We know of one case where the gemelli were very large.
(4) Jancke, *De caps. tend. articul.*, Leipsic, 1753.

wards it becomes thicker and again grows thinner. It arises by a rounded edge from the outer face of the ascending branch of the ischium and by short tendinous fibres from the two branches of the pubis and from the anterior face of the obturator membrane.

After contracting considerably in its outer portion and being covered by a broad tendon on its anterior and posterior faces, it is reflected from the anterior to the posterior face of the body, goes obliquely upward and outward directly behind the neck of the femur, and is attached by a short but very strong tendon to the fossa and to the inner face of the great trochanter, a little distance below the tendons of the obturator internus and the gemelli muscles.

It turns the thigh outward, draws it backward toward that of the opposite side, and brings the anterior face of the pelvis to its side.

III. FLEXORS OF THE THIGH.

§ 1201. There are two flexors of the thigh, the psoas magnus and the iliacus internus muscles: to these a third is usually attached, the psoas parvus muscle; but this does not always descend to the thigh.

I. PSOAS MAGNUS.

§ 1202. The *psoas magnus* muscle, *Prelombo-trochanterien*, Ch. (*M. psoas magnus*, s. *lumbaris*, s. *lumbaris internus*), is a considerable elongated and rounded muscle, occupying the inner and anterior part of the lumbar region directly on the side of the bodies of the lumbar vertebræ. It extends from the upper extremity of this region downward and outward to the inner face of the femur.

It arises by an external and posterior and an internal and anterior range of short, flat, and triangular slips from the five lumbar vertebræ and the last dorsal.

The anterior slips come from the lateral faces of the short ligaments and the intervertebral ligaments; the posterior arise from the lower and anterior parts of the transverse processes of the lumbar vertebræ.

The belly of this muscle descends outward, covers the inner part of the iliacus internus, becomes rounded as it descends, and forms before the sacro-iliac articulation, rather outward than inward, a strong tendon which emerges from the abdomen below the crural arch behind the femoral vessels, and is attached to the anterior face of the small trochanter.

The psoas magnus muscle bends the thigh and turns it a little inward, bends the trunk and turns it a little toward its side.

§ 1203. Between this muscle and the iliacus internus we sometimes find another smaller, which arises from one or more transverse processes of the upper lumbar vertebræ, proceeds on the outside of the psoas magnus muscle, and is attached to the small trochanter and sometimes to the tendon of the last. The crural nerve usually passes between it and the psoas magnus muscle.(1) This anomaly reminds us of the multiplication of the psoas magnus muscle in several apes.(2)

This and not the next muscle, as some anatomists assert, is the muscle which sometimes exists abnormally.(3)

II. PSOAS PARVUS.

§ 1204. The *psoas parvus* muscle, *Prelombo-pubien*, Ch., has an oblong square form, and arises from the lateral face of the first lumbar vertebra, and from the intervertebral ligament between it and the last dorsal vertebra, and sometimes from the twelfth dorsal vertebra. It arises generally by one but sometimes by two slips, which come either from the two vertebræ or only from the first lumbar.

It soon after becomes a flat and very long tendon, situated on the outside of the psoas magnus muscle, crosses it to go inward, and is attached in that part where the body of the pubis and ilium unite.

Below, the tendon becomes an aponeurosis, which covers the lower part of the psoas magnus and of the iliacus, is attached to the crural arch, and blends with the fascia lata.

This muscle bends the vertebral column forward and increases the force of the two muscles situated above it, furnishing them with a point of support.

§ 1205. It is sometimes deficient, but this is rare.

III. ILIACUS INTERNUS.

§ 1206. The *iliacus internus* muscle, *Iliaco-trochanterien*, Ch. (*M. iliacus*, s. *iliacus internus*), is a broad and considerable muscle, which fills all the upper part of the inner face of the iliac bones, whence it descends to the inner part of the thigh. It arises by a semicircular and convex edge and by short tendinous fibres from the inner lip of the iliac bone, and also by fleshy fibres from the inner face of this bone to near the anterior and inferior iliac spine, goes inward and forward, becomes in its course considerably narrower and thicker, and is attached a little above the crural arch to the outside of the tendon of the psoas magnus muscle, by which it is fixed to the anterior face of the small trochanter.

We find a considerable mucous bursa between the common tendon of the psoas magnus and the iliacus internus muscle and the capsular ligament of the coxo-femoral articulation. There is another, which is smaller, between it and the small trochanter.

This muscle bends the thigh and carries it inward. It draws the pelvis and with it the trunk downward and forward.

(1) We have seen it several times.—Albinus, p. 315.
(2) Valentine, *Amph. zoot.*, p. 151.
(3) Kelch, *Beytræge zur path. anat.*, p. 22.

ARTICLE THIRD.

MUSCLES OF THE THIGH.

§ 1207. Among the muscles which form the mass of the thigh some serve to move it and others act on the leg. Not only the first but also some of the second arise from the bones of the pelvis.

The muscles of the first class are the adductors of the thigh; those of the second are the adductors, the flexors, and the extensors of the leg.

I. ADDUCTORS OF THE THIGH.

§ 1208. The two lower limbs are drawn toward each other by the *adductors* (*adductores*), which form almost all the internal and posterior part of the muscular mass of the thigh. Three of these muscles in particular have been termed the adductors. They have been considered as forming only a single muscle, called the *triceps* muscle (*M. femoris triceps*), but wrongly, as they are not united by a common tendon. The fourth has been described as a separate muscle, called the *pectinæus*, although it might be considered as a fourth head of the common adductor, as well as the other three.

I. PECTINÆUS.

§ 1209. The *pectinæus* muscle, *Sous-pubio-femoral*, Ch. (*M. pectinæus*, s. *pectinalis*), a flat, long, quadrangular muscle, arises by its upper thin and horizontal edge from the crest of the horizontal branch of the pubis, on which its upper and anterior face passes. It goes from above downward, from within outward, and is attached by a perpendicular edge to the upper end of the inner lip of the rough line of the femur.

We find a small synovial capsule below the small trochanter, between this muscle and the femur.

It draws the thigh toward that of the opposite side, raises it and carries it forward, turns it a little inward, and slightly inclines the pelvis outward and downward.

§ 1210. We sometimes find a second pectinæus, which is smaller, which blends below with the tendon of the other, and is attached above to the inner part of the upper edge of the obturator foramen.(1)

§ 1211. The three adductors, properly so called, are distinguished into the long, the short, and the great adductor.

II. ADDUCTOR LONGUS.

§ 1212. The *adductor longus* muscle, *Pubio-femoral*, Ch. (*M. adductor femoris longus*, *caput primum tricipitis*), has the form of an ob-

(1) Winslow, *Expos. anat.*, vol. i. p. 117.

long triangle. It is the second of the three adductors in size and the longest of all. It arises by a short, narrow, but very strong tendon from the inner part of the anterior face of the horizontal branch of the pubis, from the spine of the pubis, and from the anterior part of the symphysis pubis. Thence it goes outward and downward, in a direction more oblique than the preceding, becomes broader and at the same time thinner, and is attached by a tendinous and interrupted edge to the third quarter of the posterior lip of the rough line of the femur. Its lower end usually unites to the vastus internus muscle.

Its action is nearly the same as that of the pectinæus.

§ 1213. It is sometimes divided into two. And again, it descends much lower, by a thin tendon united to that of the adductor magnus: so too in some mammalia and in birds the pectinæus or the other portions of the adductor muscle descend very low.

III. ADDUCTOR BREVIS.

§ 1214. The *adductor brevis* muscle, *Sous-pubio-femoral*, Ch., (*M. adductor femoris brevis*, s. *adductor secundus*, s. *caput alterum tricipitis*), is rather a broad triangular muscle. It arises at the side of the tendon of the gracilis muscle, but much higher and more externally than it, and is closely united with its upper extremity. Its upper end, situated directly below the adductor longus and formed of very short tendinous fibres, arises from the inner part of the outer face of the horizontal branch of the pubis. It is much broader and much shorter than the preceding, goes less obliquely outward than it, and is attached to the posterior face of the small trochanter and also to the upper third of the inner lip of the rough line of the femur, by several strong tendinous slips, which succeed each other from above downward.

At its lower extremity it is connected more or less intimately with the pectinæus and the adductor magnus muscles.

It acts like the preceding.

§ 1215. It is often partially or wholly divided into two slips, which forms a remarkable analogy between man and the ape.

IV. ADDUCTOR MAGNUS.

§ 1216. The *adductor magnus* muscle, *Ischio-femoral*, Ch. (*M. adductor femoris magnus*, s. *caput tricipitis tertium*), is the largest of the three proper adductor muscles; it also has a triangular form, the base of which rests in the thigh, and the apex looks toward the pelvis. It arises from the anterior face of the descending branch of the pubis, and is intimately connected in this part with the outer face of the lower part of the tendon of the gracilis muscle. It arises also from the ascending branch of the ischium and from the lower edge of the sciatic tuberosity.

Its upper and anterior fasciculi go directly downward and outward. The posterior and inferior on the contrary, which are attached to the sciatic tuberosity, go from below upward, around and behind the latter, so that the muscle seems at its upper part to have been twisted on itself, and is much thicker there than in the rest of its course.

Before the extremity of the portion inserted in the sciatic tuberosity, the upper edge, which is loose and fissured in a semilunar form, goes toward the femur, where it is attached to the posterior lip of the linea aspera, behind the pectinæus and the other two adductors, always descending deeper than they. The lower tendon is very strong, particularly at its lower part, and extends to the posterior face of the inner condyle of the femur.

About the latter fourth of the thigh this tendon is perforated by the superficial vessels of the leg, which pass from its anterior to its posterior face. It unites below to the vastus internus muscle.

This muscle draws the thigh inward, carries it forward, turns its anterior face a little outward, flexes the pelvis forward, and directs its anterior face to the side.

§ 1217. We sometimes find it divided into two portions, as in apes.

II. MUSCLES OF THE THIGH WHICH MOVE THE LEG.

§ 1218. The muscles situated on the thigh forming its mass, and which move the leg, are distinguished into adductors, extensors, and flexors.

I. ADDUCTORS OF THE LEG.

§ 1219. Those nearest the surface are the adductors, of these there are two, the sartorius and the gracilis.

A. SARTORIUS.

§ 1220. The *sartorius* muscle, *Ilio-pretibial*, Ch., the longest of all the muscles of the body, is very thin, and has an elongated square form. The short tendon by which it arises descends lower on its external than on its internal edge. It is inserted directly at the side of the tensor vaginæ femoris muscle, more inward and forward, on the anterior and upper spine of the iliac bone. Thence it passes onward and inward, above the lower part of the adductor longus and adductor magnus muscles. In this manner it attains the anterior face of the thigh, where its lower portion goes to the inner face of the same part. Thence it proceeds directly forward and at the side of the gracilis, and soon becomes rounder and narrower, and forms a short rounded tendon which, passing behind and below the inner condyle of the femur, comes to the inner face of the leg. In this place it rests directly on the upper part of the inner face of the tibia, it becomes broader, and is attached by its anterior edge to the inner face of this bone, near its spine, and is contiguous below with the aponeurotic expansion of the leg.

This muscle flexes the knee, and when this articulation is bent it turns the tibia inward, so that the end of the foot approaches the other. When it acts in an opposite direction it draws the haunch a little forward and turns it inward.

§ 1221. We have met with one subject in which the sartorius muscle did not exist.

Sometimes, on the contrary, there are two which may happen in several different ways.(1) The normal muscle usually appears curved inward, and the additional muscle terminates sooner below, where it is attached either to the tendon of the first or to the femur.

Sometimes the fibres of the sartorius muscle are interrupted by a considerable intermediate tendon which is firmly united to the fascia lata.(2)

B. GRACILIS.

§ 1222. The *gracilis* muscle, *Sous-pubio-pretibial*, Ch. (*M. gracilis*, s. *rectus internus*), is a thin muscle of an oblong triangular form which arises by a broad base which forms its upper edge, from the anterior face of the lower portion of the descending branch of the pubis, and from the upper part of the ascending branch of the ischium. Thence one of its edges turns forward and the other backward, one of its faces outward and the other inward; it goes to the inside of the thigh, and above its latter sixth, becomes a thin and rounded tendon, which proceeds directly behind the lower part and the tendon of the sartorius, and turns with it on the inner condyle of the femur. It is at first covered by it, and is then situated below it, and blended with it in its anterior and inferior part, and is finally inserted a little lower down, in the upper part of the inner face of the tibia.

It bends the knee, turns the leg inward, and draws the anterior face of the iliac bones from the side to which it is attached.

II. EXTENSORS OF THE LEG.

§ 1223. The leg has four extensors which may very properly be considered as one muscle with four heads, since they are attached to a common tendon. They are situated directly below the fascia lata aponeurosis on the anterior face, and on the sides of the thigh, and form most of its muscular mass. A considerable mucous bursa exists between them and the aponeurosis of the thigh. They are termed the rectus femoris, the vastus internus, the vastus externus, and the cruræus muscles.

A. RECTUS FEMORIS.

§ 1224. The *rectus femoris* muscle, *Ilio-rotulien*, Ch. (*M. rectus femoris*, s. *extensor cruris medius superficialis*), is a strong elongated

(1) Huber, *Act. n. c.*, vol. x. p. 114.—Rosenmüller, *loc. cit.*, p. 7.—Gantzer, p. 14.
(1) Kelch, *loc. cit.*, p. 42, p. xxxv.

pointed muscle situated on the anterior face of the thigh, directly under the fascia lata aponeurosis in most of its length, except its upper part, where it is covered by the sartorius muscle.

It arises by two points from the iliac bone by a very strong but short tendon. In fact, this tendon is divided above into two heads, an *upper* and a *lower* or *external* tendon.

The *upper head*, which goes directly downward, comes from the anterior and inferior spine of the ilium. The lower, which is curved in a semicircle, arises from the upper part of the edge of the cotyloid cavity. These two heads soon unite to give rise to the upper common tendon. This tendon soon disappears on the posterior part of the muscle, but becomes much broader on the anterior, and descends to its centre, gradually becoming thinner.

The central fleshy portion is composed of an outer and an inner layer of fibres, which unite at an acute angle on the median line, so that the arrangement of these fleshy fasciculi resembles in some measure a roof.

The fibres are much longer, and ascend much straighter the nearer they are to its lower extremity. They are attached on both sides to a prolongation of the upper tendon, the direction of which is from before backward, which descends into the substance of the muscle from its anterior face, and gradually diminishes from above downward. It however continues perceptible to near the lower end of the fleshy belly, that is, much lower than the broad and anterior part of the upper tendon descends on its outer face. It is nowhere connected with the posterior and inferior tendon.

The lower tendon is much longer but is weaker than the upper. It ascends on the posterior face of the muscle, much higher than the upper, descends on the anterior, so that the fleshy belly is situated for several inches before and behind between two tendinous expansions. It begins to be visible forward only towards the lower third of the thigh, and is seen first on the two sides of the fleshy belly, which gradually contracts. It is entirely loose after quitting the last fifth of the thigh. When approaching the patella below, it becomes broader, and is attached to the upper edge of this bone, and is intimately united with the tendons of the other extensors.

This muscle extends the leg when the thigh is fixed, and the thigh when the leg is fixed; in the latter case it also bends the pelvis a little and turns its anterior face obliquely to the opposite side.

B. VASTUS EXTERNUS.

§ 1225. The *vastus externus* muscle, (*M. extensor cruris vastus*, s. *externus*),(1) the largest of all the extensors of the leg, although much shorter than the preceding, forms almost solely the muscular mass on the outside of the thigh; at the same time it extends very much

(1) This and the next two muscles are termed the *Trifemoro-rotulien* by Chaussier.

backward and forward. It is considerably thick, but it is broader from before backward than from within outward.

It arises by a slightly concave edge which inclines from before backward, from within outward, and from above downward, from the lower part of the anterior and outer face of the great trochanter. The upper half of its posterior edge, situated along the rough line of the the femur, comes from the inner face of the outer wall of the fascia lata aponeurosis. From all these points it gradually descends forward, becomes narrower, and is finally attached, by an inferior tendon, to the upper and outer edge of the patella. The inner part of this tendon is covered some distance above its insertion by the tendon of the rectus femoris muscle, to which it is even slightly united, although it is easily separated from it as far as where it is inserted in the patella.

The muscular fasciculi go directly downward. The upper tendon extends below the centre of the muscle on its outer face, and the lower only to the centre of its inner face.

The vastus externus muscle extends the knee, and most generally raises the leg at the same time, and turns it a little outward.

C. VASTUS INTERNUS.

§ 1226. The *vastus internus* muscle (*M. extensor cruris*, s. *vastus internus*) is a little shorter and much weaker than the preceding, with which it is blended outwardly in a small portion of its upper extremity. It arises by its upper edge, which descends obliquely inward, from the anterior intertrochanterian line; by a small part of its lower edge, from a part of the anterior face of the femur situated below this line; and by the upper part of its posterior edge, from the upper part of the anterior lip of the linea aspera. Its lower tendon is attached to the inner part of the upper edge, and to the inner edge of the patella. The inner part of this tendon is covered below by that of the vastus externus which passes obliquely over it, and is attached to the patella before it; it adheres to this tendon, but is easily separated from it.

The upper tendon of this muscle descends over almost the whole of the inner and loose face on the posterior half of the muscle, while the lower disappears already below the centre of its outer face, principally at its upper part.

This muscle extends the leg and turns it a little inward.

D. CRURÆUS.

§ 1227. The *cruræus* muscle, (*M. cruralis*, s. *cruræus*, s. *femoræus*) the shortest of the four extensors of the leg, is also nearly as strong as the preceding. It arises by its posterior and inner face, directly below this last, from the larger part of the anterior and the outer face of the femur, excepting a small portion above, and from its lower third. The posterior edge comes from the outer lip of the linea aspera. This muscle covers also most of the anterior and outer faces of the femur. It is attached by its lower tendon behind the vastus internus and the vastus externus to the upper edge of the patella, and usually also at its lower and outer part, by short fibres, to the synovial capsule, and to the outer edge of the patella.

This lower and outer part is generally separated from the others, particularly from their tendon.

The upper edge of this muscle is attached to the bones without any appearance of a tendon. The lower tendon, the loose portion of which is longer than that of the two preceding, begins on the contrary from the middle of the anterior and loose face.

The cruræus muscle is mostly covered above by the vastus externus and the vastus internus ; it is entirely covered below by the rectus muscle, excepting however its outer and lower lateral face, where it is concealed by the vastus internus muscle. Its lower part also is intimately connected with the two vasti, especially the externus.

A capsular ligament exists between its tendon, that of the vastus externus, the capsular ligament and the patella ; this frequently opens into the femoro-tibial articulation.

It extends the knee.

§ 1228. The common tendon of these four muscles, after enveloping the patella, goes to attach itself to the tuberosities of the tibia, where we find a considerable synovial capsule between it and the bone.

E. SUBCRURALIS.

§ 1229. The *subcruralis* muscle is a small triangular muscle, which always exists and is entirely covered by the lower part of the preceding. It arises from the lower fourth of the anterior face of the femur, and is attached to the upper part of the anterior wall of the synovial capsule of the knee. It draws this capsule in the motion of extending the leg, and also prevents it from being injured.

III. FLEXORS OF THE LEG.

§ 1230. The flexors of the leg are situated on the posterior face of the thigh. We number three, two internal and an external ; but the latter arises by two heads. All arise at the side of each other from the sciatic tuberosity, and are attached posteriorly to the bones of the leg. They consequently bend the knee or draw the posterior faces of the thigh and of the leg towards each other. They also extend the coxo-femoral articulation when the leg is extended.

I. INTERNAL FLEXORS.

§ 1231. The two inner or tibial flexors arise from the sciatic tuberosity and are inserted in the upper end of the tibia. They are called the *semimembranosus* and the *semitendinosus*.

A. SEMITENDINOSUS.

§ 1232. The *semitendinosus* muscle, *Ischio-pretibial*, Ch. (*M. semitendinosus*, s. *seminervosus*), is an elongated muscle broader and thicker above than below, partially covering the following, because it is extended more below it and nearer the surface. It arises from the inner part of the posterior face of the sciatic tuberosity by a tendon which is very distinct outwardly, while its summit adheres very intimately to the inner edge of that of the long head of the biceps femoris muscle. This muscle is the most internal of the three flexors, and goes directly downward. Its lower tendon commences on its inner edge, a little below the centre of the fleshy belly; from about the last fourth of the thigh it forms a very strong rounded cord, which passes behind the inner condyle of the femur to arrive at the tibia, and is attached, after enlarging and becoming thinner, to the inner face, directly below the gracilis muscle. It blends with the lower edge of the tendon of this latter muscle, and generally divides below into an upper and a lower slip.

We find a mucous bursa directly near its insertion, between its upper tendon and that of the semimembranosus and the long head of the biceps. There is also another, and sometimes two or three, even between its lower tendon; that of the sartorius, that of the gracilis, and the internal lateral ligament of the knee.

This muscle bends the leg and turns it a little inward; when it acts in an opposite direction it draws the pelvis and the trunk backward, and bends them with the thigh in the same direction.

B. SEMIMEMBRANOSUS.

§ 1233. The *semimembranosus* muscle, *Ischio-popliti-tibial*, Ch. (*M. semimembranosus*), follows a direction to a certain exent directly opposite to that of the preceding. Of the three flexors this arises farther forward, upward, and outward from the outer part of the sciatic tuberosity by a very long, strong, broad, and perfectly distinct tendon, which gradually enlarges and becomes thinner as it descends to the centre of the thigh and to the end of the fleshy belly, to which it is united by an edge oblique from within outward. This belly is elongated, rounded, thicker, but shorter than that of the semitendinosus, and is formed of an internal and an external layer of fibres which are turned upward towards each other, and are attached by radiations to the upper tendon. This latter exists only on the outer face of the upper part of the muscle; but from its centre to its lower end, where it appears externally as a narrow band, it penetrates deeply inward to the centre of its substance. The lower tendon, which proceeds nearly to the centre of the muscle on its anterior face and on its inner edge, passes on the outer face of the inner condyle of the femur, between it and the semitendinosus muscle, and is inserted to the inner part of the inner condyle of the tibia, after passing freely a short distance.

A mucous bursa exists between the upper tendon and the quadratus femoris or the adductor magnus. Sometimes there are two. Another is found between the lower tendon, the upper internal head of the gastrocnemius and the capsular ligament of the knee. This bursa often encloses another which is smaller, and adheres very intimately to the tendon of the semimembranosus muscle.

The action of this muscle is the same as that of the preceding.

II. BICEPS FEMORIS.

§ 1234. The *biceps femoris* muscle, *Ischio-femoro-peronier*, Ch. (*M. flexor cruris externus*, s. *fibularis*, s. *biceps femoris*), arises above by two separate heads, which are attached below by a common tendon.

The long head arises from the posterior face of the sciatic tuberosity by a short but firm tendon, which is inserted between the two preceding muscles. A short distance from its upper extremity this tendon begins to receive the fasciculi of the fleshy belly, and descends along its inner edge. The belly descends at first in a straight line, behind and at the side of the upper part of the semimembranosus muscle; but it then goes outward, passes over the adductor magnus, and thus arrives at the outside of the thigh.

The short head is much smaller, and its form is an oblong square. It arises by very short tendinous fibres from the central two fourths of the outer lip of the linea aspera, directly at the side of the adductor magnus, goes obliquely downward, and is attached to the inner face of the lower tendon of the long head, from the lower fourth of the thigh to near its lower end.

The common inferior tendon, which goes nearly to the centre of the large belly, on its posterior face, descends on the outer face of the outer condyle of the femur, and is inserted at the top of the head of the fibula, where there is a mucous bursa between it and the external lateral ligament of the knee.

The biceps femoris muscle bends the knee, turns the leg a little outward, extends the pelvis, and inclines it slightly downward and backward.

§ 1235. Sometimes the short head does not exist, a remarkable analogy with animals, in most of which it is deficient. But in other subjects we find a third, which is thinner, and comes sometimes from the sciatic tuberosity, and is attached below the common tendon of the muscle,(1) and sometimes arises from the upper part of the long head, descends on the calf of the leg, and is joined by the lower end to the tendo Achillis;(2) this deserves to be remarked because the biceps femoris muscle descends very low in the mammalia.

(1) Gantzer, *loc. cit.*, p. 15.—Sœmmering, *Muskelehre*, p. 276.
(2) Kelch, *loc. cit.*, p. 42, no. xxxvi.

When this anomaly exists the biceps femoris resembles the normal structure of the biceps flexor cubiti, even as the latter, when it presents a third supernumerary head, represents the anomaly, of which the other sometimes gives an instance.

ARTICLE FOURTH.

MUSCLES OF THE LEG.

§ 1236. The muscles of the leg occupy its posterior, external, and anterior faces; but they leave the internal loose, so that on this side the tibia is covered only by the skin. Most of them are attached, by their upper extremities, to the bones of the leg, and by their lower, to those of the feet as far as the toes. Some, however, come from the lower part of the thigh, their lower extremities are inserted in the bones of the leg.

I. POSTERIOR MUSCLES.

§ 1237. The posterior muscles of the leg form two layers, a superficial and a deep layer.

I. SUPERFICIAL LAYER.

§ 1238. The superficial layer of the posterior muscles of the leg is composed of two muscles, the triceps suræ and the plantaris.

A. TRICEPS SURÆ.

§ 1239. The *triceps suræ* muscle (*M. triceps suræ*, s. *gemelli cum soleo*) is extremely strong, and forms most of the muscular mass of the leg; it deserves to be considered as a separate muscle with three heads, since these heads, although entirely separated above, are all attached below to a common tendon.

Two of these heads are in pairs and the third is single. The first two called for this reason the *gastrocnemii* muscles, *Bi-femoro-calcaniens*, Ch. (*M. gemelli suræ*), are situated at the side of each other. They arise by a short, broad, but thin tendon, which terminates above by a semicircular convex edge from the femur, above the upper edge of the posterior face of its inner and outer condyle.

These two bellies are triangular and much narrower above than below. Above there is an interval of about four inches, which is filled by an abundant and very loose cellular tissue and also by the vessels and the nerves of the leg. Their fibres converge from above downward and meet the common tendon a little above the centre of the whole length of the muscle. The upper tendon, which is expanded along the external edge and the posterior face, gradually becomes thinner and descends almost to the lower extremity of the fleshy belly. The latter terminates below in a rounded edge; so that the two bellies unite and form a waved line, very concave in its central part. The inner belly is much stronger and descends much lower than the outer. The lower tendon, in which the two fleshy bellies are inserted, arises far above their anterior face, that which corresponds to the posterior face of the bones of the leg, from the union of the two bellies to the centre of their common lower edge: it forms a broad canal, through which pass the branches of the nerves and vessels which descend on the posterior face of the loose portion of the common tendon.

The third belly, called also the *solæus* muscle, *Tibio-calcanien*, Ch., is much stronger than the two preceding. It is situated below and before them.

It arises by its upper edge, which is fleshy, serrated, and oblique downward and inward, from the posterior part of the head of the fibula, from the lower edge of the poplitæus muscle, and from the posterior edge of the tibia. Its lower edge and a part of its anterior face arise for a considerable distance above from the posterior face and below from the inner edge of the tibia. Finally, its outer edge comes from the upper part of the posterior face and from the outer edge of the fibula.

Its posterior and upper fasciculi go directly downward. The anterior and inferior of the two sides meet each other below and are attached to the anterior face of the common tendon, covering its anterior face to some inches above its insertion, gradually becoming thinner and narrower, so that this belly consequently occupies nearly all the leg, and descends very much lower than its centre.

The tendons by which the two lateral edges of this muscle arise from the fibula and the tibia gradually enlarge, descend on the anterior edge and on the posterior face, and do not stop except at some inches above the lower end of this fleshy belly. Hence most of the latter is enclosed between two aponeurotic expansions.

The common inferior tendon, called the *Achilles tendon* (*tendo Achillis*), from its power, is slightly covered above and behind by the two posterior bellies and before by the third belly. A little above the lower edge of the posterior bellies it divides into an anterior and a posterior tendinous layer. The latter reascends on the anterior face of the gastrocnemius in the manner mentioned above: the other covers the posterior face almost to the upper edge, gradually becoming thinner.

The tendon, considered as a whole, contracts very much from above downward, and also becomes thicker, and is attached by a very narrow edge to the upper part of the posterior face of the tubercle of the calcaneum, between which and its anterior face we find a considerable mucous bursa above its insertion.

The triceps extends the foot in raising the heel: hence why it acts principally in standing on the toes and other similar circumstances.

When the foot is fixed, the two upper heads bend the knee and draw the thigh backward and downward. The lower head, when it contracts toward the heel, extends the foot, because it carries the leg downward.

This muscle corresponds to the supinators and to the pronator quadratus of the fore-arm: the two superficial heads represent the supinators and the deep head is analogous to the pronator.

B. PLANTARIS.

§ 1240. The *plantaris* muscle, *Petit femoro-calcanien*, Ch., arises by a short tendon from the posterior face of the external condyle of the femur, from the external head of the gastrocnemius muscle, to which it is united, and from the posterior wall of the synovial capsule. Proceeding directly behind the capsule, it goes inward and downward and even becomes a long, thin, and flat tendon, which descends along the inner edge of the tendo Achillis, unites with it below, and disappears in the cellular tissue on the inner face of the calcaneum to arrive at the tendinous expansion of the sole of the foot.

This muscle has no very manifest action. We see in it only a rudiment of that which is much more developed in some mammalia and an imperfect imitation of the palmaris brevis of the hand.

§ 1241. It is often deficient and much more frequently than the palmaris.(1)

II. DEEP LAYER.

§ 1242. The deep layer of the posterior muscles of the leg is composed of the poplitæus, the tibialis posticus, the flexor longus digitorum communis, and the flexor longus pollicis proprius.

A. POPLITÆUS.

§ 1243. The *poplitæus* muscle, *Femoro-popliti-tibial*, Ch. (*M. poplitæus*, s. *sub-poplitæus*), is a triangular muscle, which arises from the inferior and posterior part of the outer face of the external condyle of the femur. It is formed of oblique fibres, becomes broader from without inward, and is attached to the upper part of the posterior face of the tibia. It is intimately connected, especially at its upper and outer part, with the posterior wall of the synovial capsule of the knee. We find a mucous bursa between it and the external condyle of the femur on one side, the external semilunar cartilage and the capsular ligament on the other.

(1) Our observations authorize us to assert that Gantzer mistakes in stating that the plantaris is more constant than the palmaris (*loc. cit.*, p. 4).

This muscle corresponds to the pronator teres of the fore-arm.

It turns the leg a little inward, draws the outer semilunar cartilage outward and backward, and contributes to bend the knee.

§ 1244. Sometimes it is double.(1)

B. TIBIALIS POSTICUS.

§ 1245. The *tibialis posticus* muscle, *Tibio-sous-tarsien*, Ch. (*M. tibialis*, s. *tibiæus posticus*, s. *nauticus*), arises between the extensor digitorum communis longus and the flexor longus pollicis pedis (§ 1248). It is the longest of the three muscles of the deep-seated layer and is penniform. It arises in its whole length from most of the posterior face of the interosseous ligament and from the inner face of the fibula; some fibres of its upper part arise also from the outer part of the posterior face of the tibia.

Even as in the two long flexors of the toes, the two layers of fibres are attached to a very strong tendon, which descends inward and forward, is contained within the posterior and fibro-cartilaginous groove of the internal malleolus, thence passes into an analogous groove hollowed along the upper part of the inner face of the astragalus, and thus goes to the inner and lower face of the sole of the foot, opposite the anterior part of the inner face of the astragalus. Its tendon incloses a rounded sesamoid bone and divides into two slips: the internal is shorter, the inferior is longer.

The first is single and is attached to the inner edge of the scaphoid bone. The second divides into several bands, which are inserted in the lower face of the scaphoid, the cuboid, and the three cuneiform bones, at the same time that they blend with the aponeurotic expansion of the sole of the foot and with the tendon of the peroneus longus.

The tendon of this muscle is surrounded with a mucous sheath where it arrives at the sole of the foot.

This muscle corresponds to the radialis internus muscle (§ 1149).

It extends the foot, turns its inner edge a little upward, and the sole inward; it also extends the thigh and draws it backward.

C. FLEXOR LONGUS DIGITORUM COMMUNIS.

§ 1246. The *flexor longus digitorum communis* muscle, *Tibio-phalangettien*, Ch., (*M. flexor digitorum communis longus*, s. *perforans*, s. *profundus*), is a thin, elongated, and penniform muscle; it arises from the summit of the anterior face of the tibia, except its upper part, which is covered by the poplitæus. The fasciculi, by which it arises, and which converge downward are inserted in a strong tendon below, which ascends almost to the upper extremity of the muscle and proceeds along the inner edge. This tendon approaches the surface, descends on the

(1) Fabricius, *De motu locali animalium*, in *Op.*, p. 359.

posterior face of the tibia, goes to the inner face of the tarsus, and enters a fibro-cartilaginous furrow which exists along the upper part of the inner face of the astragalus, and is there kept in its position by a tendinous sheath, and thus goes forward. After leaving this point it turns outward, is covered by the posterior head of the abductor pollicis pedis muscle, on which it continues to go forward, and soon divides into four bands, which go in their turn on the flexor digitorum brevis, which is consequently covered by it.

At the place where the tendon of the flexor longus muscle passes on the flexor brevis, and before it divides into four bands, we see a small muscle attached to its external and inferior part. The form of this muscle is an oblong square. It may be called the *small* or *accessory head* of the flexor longus communis (*accessorius perforantis*).

This small head, which is covered on all sides by the flexor communis digitorum brevis, arises by two slips, the posterior or external, which is longer and stronger and comes from the external anterior tuberosity of the calcaneum, and the anterior or internal, which is smaller and arises from the superficial calcaneo-cuboid ligament (§ 982). Its fibres are oblique. It goes forward and inward, and not only is it fitted by its inner edge to the tendon of the flexor digitorum longus, but contributes much by its anterior tendons to form those of this muscle.

The small head principally forms almost the whole tendon of the second toe. Most usually this tendon is not at all derived from that of the slip of the common flexor, but only from the short head and from the tendon of the extensor longus proprius pollicis, with which the centre of the flexor communis communicates near the anterior extremity of the calcaneum.

The tendons of this muscle have the same relation to those of the short flexor as those of the flexor digitorum sublimis have with those of the flexor profundus. They are situated upon them, perforate them above the second phalanx of the toes, enlarge a little, and are attached to the posterior part of the lower face of the third phalanges.

It is surrounded by a mucous sheath in the place where its tendon passes at the side of the fibula and of the calcaneum. A second envelops this tendon and that of the flexor longus pollicis proprius at the posterior extremity of the sole of the foot.

The tendon it gives to each toe and that of the flexor minimi digiti proprius are surrounded with a proper mucous sheath.

This muscle bends the third phalanx of the toes and brings the leg backward.

§ 1247. Sometimes it is furnished with a fifth tendon, which replaces the fourth of the flexor digitorum brevis, which is then deficient. This tendon proceeds along the inner edge of the fourth tendon of the flexor longus, and divides to allow the latter to pass, and consequently presents the same arrangement as the flexor sublimis.(1) This formation

(1) Brugnone, *loc. cit.*, p. 176.

evidently resembles that of the apes, in which the tendons of the flexor sublimis and flexor profundus are so blended that they are distinguished from each other with difficulty.

D. FLEXOR LONGUS POLLICIS PROPRIUS.

§ 1248. The *flexor longus pollicis proprius* muscle, *Peroneo-sous-phalangettien du pouce*, Ch. (*M. flexor hallucis longus*), is shorter but much stronger than the preceding. It arises by an internal and an external layer of fibres, which converge downward and proceed by fleshy fibres from almost all the lower half of the posterior face and from the outer edge of the fibula, excepting only its lowest portion. These two orders of fibres are inserted in a strong lower tendon, which mostly remains concealed in the midst of the muscular substance and becomes entirely loose only when its fleshy fibres cease. This tendon goes obliquely from without inward and from behind forward, and thus comes on the inside of the tarsus, whence it goes forward along a fibro-cartilaginous groove, which exists at the upper part of the inner face of the calcaneum, directly below the upper edge of this bone, and where it is retained by a special sheath. It is covered by the outer slip of the posterior head of the abductor pollicis pedis muscle and directly by the tendon of the flexor communis digitorum longus which is nearer the surface, and is consequently situated beneath it. It crosses the direction of the latter and sends to it a very strong tendon, which unites principally to that of the second toe.

We may justly say that the tendon of the flexor longus pollicis proprius muscle divides into two slips where it passes under the abductor pollicis pedis, an external for the second toe and an internal for the large toe. The latter is the strongest; it goes inward and forward directly at the side of the abductor pollicis pedis, is situated outward before it, and is partly covered by it. At the anterior end of the metatarsal bone of the large toe it enlarges a little, at the same time becomes thinner, and is attached to the posterior part of the lower face of the second phalanx of the large toe.

This muscle corresponds to the flexor longus digitorum communis in its course and in its attachment to the anterior phalanx of its toe.

There is in fact a short flexor of the large toe; but this muscle has no perforated tendon which is attached to the posterior phalanx. On the contrary, we sometimes see an arrangement analogous to that of the tendons of the flexor brevis perforatus. In fact a strong but narrower tendon, which however gradually enlarges as it advances, extends from the head of the first metatarsal bone to the posterior end of the second phalanx, over the tendon of the flexor longus: this tendon is firmly attached in its whole extent and breadth of its upper face to the lower face of the phalanges, by a fold of the synovial capsule: it contains a single and transverse sesamoid bone: immediately behind its anterior extremity and below the articulation of the first phalanx with the second, it is finally attached to the lower face of the first phalanx, directly behind the tendon of the flexor longus.

This tendon which has no muscle, is not found in the other toes; so that decidedly we should consider it as a rudiment of the flexor longus communis perforatus: it is however but an imperfect rudiment, since it is never perforated, which depends probably on the absence of the second phalanx of the large toe.

The tendon of this muscle is enveloped with a mucous bursa in the canal of the astragalus and os calcis. A second covers its tendon and that of the flexor longus at the posterior part of the sole of the foot. A third incloses its tendon along the metatarsal bone of the first toe.

It flexes the large and small toe.

§ 1249. We sometimes find at the lower part of the posterior face of the leg a small supernumerary muscle, which does not always present exactly the same arrangement. Sometimes it ascends from the calcaneum and from the tendo Achillis, and is attached to the aponeurotic expansion of the leg, acting as its tensor muscle;(1) so that we may then consider it as a fourth head of the triceps. It sometimes arises from the lower part of the fibula, goes downward, and is then lost around the articulation of the foot. It is sometimes attached to a special bone found in this place,(2) or to the lower face of the calcaneum, or finally to the small head of the flexor longus digitorum communis.(3)

The second anomaly is very probably a repetition of the pronator quadratus of the upper extremity, but it is developed lower toward the foot, in accordance with the same law as that to which the other muscles are subjected, especially the flexors and extensors of the toes.

The first corresponds probably to the palmaris brevis; the arrangement of the muscle in the upper and lower extremity differ in the same way as the palmaris brevis and the plantaris, as the latter does not arrive at the aponeurotic expansion of the sole of the foot.

II. EXTERNAL MUSCLES.

§ 1250. The external muscles of the leg are the peroneus longus and the peroneus brevis. They extend from the fibula to the outer edge and to the lower face of the foot.

I. PERONEUS LONGUS.

§ 1251. The *peroneus longus* muscle, *Peroneo-sous-tarsien*, Ch. (*M. peroneus longus*, s. *primus*, s. *posticus*), arises from the upper and smaller half of the anterior face, and by fibres which proceed obliquely from above downward and converge. Its upper tendon arises from the outer edge of the fibula and covers the upper and posterior part of this bone.

(1) Mayer in Heymann, *loc. cit.*, p. 15.
(2) Rosenmüller, *loc. cit.*, p. 8.
(3) Gantzer, *loc. cit.*, p. 15-17.

The lower tendon, which is very long, very strong, flat, and entirely loose from the lower third of the leg, conceals itself partially above this point between the muscular fibres; so that it entirely disappears externally toward the bottom of the upper third of the leg. But it appears again within the muscle, near its upper extremity, as a semicircular band, which gradually diminishes and to which the fleshy fasciculi are attached outward and inward.

This tendon goes behind and on the outside of that of the peroneus brevis, along the outer and posterior face of the leg, and descends behind the external malleolus across a ligament formed of oblique fibres, within which is a sheath which sends prolongations to it. Arrived at the foot, the tendon winds forward and downward, around the outer edge of the cuboid bone, and thus comes on the sole of the foot, where it penetrates; thence it goes inward, covered by all the muscles of this region and directly by the calcaneo-cuboid ligament, which keeps it in place: then gradually enlarging, it is attached to the lower face of the cuboid bone and also to the lower face of the posterior head of the fifth, also of the fourth and third, and particularly of the second metatarsal bones: it sometimes also reaches the first metatarsal bone and the first cuneiform bone before dividing.

At the place where the friction of the tendon is the greatest, especially opposite the external malleolus, the tuberosity of the calcaneum, and the cuboid bone, sometimes also in its plantar portion, we find sesamoid bones or cartilages, the third of which is the largest, while the first is very small and often scarcely perceptible.

There is also a considerable mucous bursa where the tendon of the muscle descends on the outer malleolus and astragalus: this bursa envelops it and also the tendon of the following muscle. We find another below, which extends to the plantar face.

The peroneus longus muscle extends the tibio-tarsal articulation and draws the foot backward and the leg downward: it also turns the foot, making its outer edge the upper and the plantar face look upward.

It corresponds to the flexor carpi ulnaris of the fore-arm.

II. PERONEUS BREVIS.

§ 1252. The *peroneus brevis* muscle, *Grand peroneo-sus-metatarsien*, Ch. (*M. peroneus*, s. *fibularis brevis*, s. *anticus*, s. *secundus*, s. *medius*, s. *semifibulæus*), is an elongated muscle, which terminates above in a point and is formed of two layers of fibres; those of the anterior layer go from before backward and those of the posterior go from behind forward. These two layers converge toward the base: they arise from the second fourth of the anterior face and from the posterior edge of the fibula to near the outer malleolus.

The lower tendon, which is long, strong, and flat, extends within the muscle, and like that of the preceding ascends almost to its upper extremity. It becomes visible externally sooner than that of the peroneus longus, and descends between the fibres of the muscle to arrive at its outer face.

Once disengaged it goes before that of the peroneus longus, behind the outer malleolus, and is retained in the groove which exists there by a ligament, common to it and the preceding muscle. This ligament, called the *retinaculum musculorum peronæorum*, extends from the anterior to the posterior edge of the groove like a bridge. The tendon having thus reached the upper face of the foot goes forward, enlarging along its anterior edge. Near the base of the fifth metatarsal bone it usually divides into two slips, the outer of which is attached to the tuberosity of this bone while the inner is longer, subdivided likewise into two parts, one of which is attached to the centre of the upper face of its body; the second is inserted partly in the outer edge of the fourth tendon of the extensor and partly on the posterior face of the fourth external interosseous muscle.

Besides the common mucous bursa (§ 1229) the tendon of this muscle has a special bursa situated lower on the outer edge of the foot, and which surrounds it.

The peroneus brevis muscle acts like the preceding; it flexes the tibio-tarsal articulation, consequently carries the foot upward, and depresses the leg; it also turns the sole of the foot outward and its outer edge upward, but less so than the peroneus longus.

It corresponds to the extensor carpi ulnaris, and partially also to the extensor brevis minimi digiti.

§ 1253. It is sometimes double.

III. ANTERIOR MUSCLES.

§ 1254. On the anterior face of the leg we find one after another the extensor longus digitorum communis, the extensor longus hallucis proprius, and the tibialis anticus.

I. EXTENSOR LONGUS DIGITORUM COMMUNIS.

§ 1255. The *extensor longus digitorum communis* muscle, *Peroneo-sus-phalangettien commun*, Ch. (*M. extensor digitorum communis longus*), is a very long muscle, occupying almost all the leg. Its fibres descend obliquely from behind forward. It arises above from the outer face of the head of the tibia, and, in the rest of its course, from the anterior face of the interosseous ligament, and also from the anterior edge of the fibula. It is attached to the tendon which commences near its upper extremity and which descends on its anterior edge.

This tendon generally divides below the crucial ligament of the foot into five slips, which separate from each other. The outer is the shortest, and is inserted into the posterior extremity of the upper face of the fifth, and sometimes also of the fourth, metatarsal bone. This slip is sometimes connected with a special fleshy belly entirely distinct from the extensor longus, but which most generally forms only the lower part, and which is called the *small* or *the peroneus tertius* muscle. It is not unfrequently deficient, and is then replaced to a certain extent by the inner part of the tendon of the peroneus brevis muscle: it also frequently forms a small special tendon which is sometimes attached forward to the metatarsal bone, and sometimes unites either to the fourth external interosseous muscle or to the tendon sent by the common extensor to the fifth toe. The four other slips go obliquely forward and outward; they are attached to the dorsal faces of the second, third, fourth, and fifth toes. Arrived at the base of the posterior phalanges they become broader and a little thinner, and give off also, the fourth outwardly, the other three inwardly, a thin triangular prolongation, formed of perpendicular fibres, which go downward, and are attached partly to the base of the first phalanx, and are partly blended with the tendon of the interosseous muscles.

This tendon sometimes assumes the nature of cartilage when passing over the synovial capsule of the first phalangean articulation. On the articulation between the second and third it enlarges or divides more or less completely into two lateral slips, which converge forward, and after uniting are attached to the upper face of the third phalanx, directly before its posterior edge.

We find an oblong mucous bursa on the articulation of the foot, between the tendon of this muscle and the capsular ligament.

The extensor digitorum communis longus raises the four smaller toes, extends them, and with the peroneus brevis muscle, bends the tibio-tarsal joint, and thus raises the foot or draws the leg forward and downward.

This muscle and the preceding act principally in standing on the toes, because they fix the leg.

The extensor digitorum communis longus corresponds to the common extensor of the fingers. The proper extensor of the little finger is represented by the peroneus tertius, and when that is deficient by a part of the peroneus brevis.

This analogy becomes still more evident when the portion of the flexor longus belonging to the little toe, and the peroneus tertius muscle, are entirely separated from the rest of the muscle.(1)

II. EXTENSOR LONGUS HALLUCIS PROPRIUS.

§ 1256. The *extensor longus hallucis proprius* muscle, *Peroneo-sus-phalangettien du pouce*, Ch., is a thin and semipenniform muscle, which arises, by fleshy fibres, from the lower two thirds of the inner face of the fibula, and from the anterior face of the interosseous ligament. It also receives below some fibres from the outer face of the tibia.

Its fasciculi are attached to a tendon which proceeds along the anterior edge of the muscle, gradually becomes broader, passes across a particular groove of the crucial ligament of the back of the foot, goes

(1) Brugnone, *loc. cit.*—We have seen it several times.

inward and forward along the inner edge of the tarsus, and is attached to the upper face of the unguæal phalanx of the first toe.

On the back of the tibio-tarsal articulation the tendon of this muscle is inclosed in a special mucous sheath.

It raises all the first toe.

§ 1257. This muscle is often more or less completely double. In this case we sometimes find another which is smaller, and which arises more externally from the fibula, and from the anterior face of the interosseous ligament, goes to the large toe, and unites to the tendon of this muscle, or is attached to the first metatarsal bone, or finally loses itself in the cellular tissue. Sometimes and most generally another smaller tendon is detached, even in the leg, from the inner edge of the normal tendon, which is inserted in the tibial side of the two phalanges. These anomalies are important because they approximate the formation of the proper extensor of the large toe to that of the proper extensor of the thumb; so too on the other hand, the deficiency of the short extensor of the thumb, or its blending with the large, approximates the formation of the hand to that of the foot.

III. TIBIALIS ANTICUS.

§ 1258. The *tibialis anticus* muscle, *Tibio-sus-tarsien*, Ch. (*M. tibialis*, s. *tibiæus anticus*, s. *catenæ musculus*, s. *hippicus*), is the strongest of the three anterior muscles of the leg; it arises directly at the side of the peroneus longus muscle, and is covered in this place by a broad tendon, which expands on its anterior face from the lower face of the outer part of the head of the tibia, and still lower from the outer face of this bone, nearly to its lower third, so that its fibres gradually come only from the most posterior portion, and even the inner edge of this face in all its course. At the same time it receives some which arise from the periosteum. All these fibres, which go obliquely forward, are attached to an anterior tendon, which is loose only in a very small point of its extent downward, but which extend within the muscle even beyond its centre. This tendon, which is very strong, descends obliquely inward, passes on the anterior face of the tibio-tarsal articulation, comes upon the inner edge of the foot, where it is retained by a ligamentous band, oblique downward and backward, which extends from the scaphoid to the first cuneiform bone, and is finally attached by two short slips to the inner part of the lower face of the large cuneiform bone, and also to the base of the metatarsal bone of the large toe.

Opposite the articulation of the foot its tendon is enveloped in a mucous sheath.

It raises the foot, turns it on its axis, so that its sole looks inward and its inner edge upward.

It corresponds to the radiales muscles of the hand.

ARTICLE FIFTH.

MUSCLES OF THE FOOT.

§ 1259. The muscles of the foot arise from the tarsus and metatarsus, and are all attached to the phalanges of the toes. They are situated on the back of the foot, on its sole, on its internal and external edges. Some are common to several toes, others belong exclusively to some of them, namely to the large and small toes. The latter are only repetitions of those which are divided between several of them.

I. MUSCLES OF THE BACK OF THE FOOT.

§ 1260. Besides the tendons of the extensor digitorum communis longus and of the two peronei muscles, we find also on the back of the foot the extensor communis digitorum brevis.

EXTENSOR COMMUNIS DIGITORUM BREVIS.

§ 1261. The *extensor communis digitorum brevis* muscle, *Calcaneo-sus-phalangettien commun*, Ch. (*M. extensor digitorum pedis communis brevis*, s. *pediæus externus*), is a flat muscle, formed of four elongated and rounded bellies, which arises from the back of the anterior process of the calcaneum, goes forward and inward, its bellies separating from each other, and is attached by four tendons to the four inner toes. These tendons in their course on the metatarsus cross those of the extensor communis digitorum longus, but on the toes they are situated on the outside of them. The outer three are very intimately blended, by their internal edge, with the outer edge of the tendons of the extensor longus, and consequently form their outer half; but the most internal, that which goes to the great toe, does not unite to the corresponding tendon of the flexor longus, but is attached below it to the posterior edge of the back of the first phalanx of the large toe.

This muscle extends the four inner toes and directs them a little outward.

§ 1262. Often and even most generally its inner belly is separated much more from the others than the latter are from each other. Very frequently it forms an entirely distinct muscle, which deserves to be noted because of the more striking resemblance established between the upper and lower extremities by this peculiarity. Sometimes the other bellies and even all are entirely detached from each other, a curious analogy with what exists in birds. Again, the extensor brevis often presents supernumerary bellies. Most commonly a small fleshy fasciculus exists between the internal and what is commonly called the second; its tendon is attached either to the second metatarsal bone or to the tibial face of the second toe. This accessory muscle, mentioned by Albinus,(1) and which we have often seen, is curious, as it must evidently be considered as a repetition of the indicator muscle.

The second belly is also sometimes divided at its anterior extremity into two fasciculi, or sends two tendons to the second toe.

The tendons of the third and fourth bellies are often divided, so that there is for the third toe an extensor muscle or at least a tendon; this arrangement resembles the doubling of the proper extensor of the index finger in the hand for a proper extensor of the third finger.

After this anomaly the one most frequently found consists in the presence of a small special belly for the fifth toe. We have also seen this several times, and it is interesting as an analogy either with the apes(2) or with the extensor proprius minimi digiti.

II. MUSCLES OF THE SOLE OF THE FOOT.

§ 1263. Most of the muscles of this part of the lower extremity are found in the sole of the foot.(3) In fact, besides the short head of the extensor digitorum communis already described (§ 1245), we find the flexor communis digitorum brevis, the adductor and flexor of the large and little toes, the adductor hallucis, the lumbricales, and the interossei muscles.

The adductor hallucis occupies the inner edge of the foot and that of the little toe the outer edge. A great part however of these muscles project likewise in the sole, so that it is best to study them at the same time as the other muscles of the toes, to which they belong, and to consider them as the lower muscles of the foot.

We shall describe first the common muscles, next the special muscles: first, however, their common aponeurosis.

I. PLANTAR APONEUROSIS.

§ 1264. The *plantar aponeurosis* (*aponeurosis plantaris*) is a very firm tendinous layer, formed of longitudinal fibres, which arises from the lower face of the tuberosity of the calcaneum, directly under the skin, with which it is intimately connected. Thence it goes forward, where it enlarges very much. Arrived at the anterior edge of the metatarsus it divides into five slips, which correspond to the five toes, and which are attached to each other by transverse fibres.

This aponeurosis protects and fixes the muscles of the sole of the foot, and at the same time increases the surfaces of insertion of several.

(1) *Hist. musc.*, p. 602.
(2) Meckel, *Beyträge zur vergleichenden Anatomie*, vol. ii. part i.
(3) A. F. Walther, *Tractationes de articulis, ligamentis et musculis incessu dirigendis supplementum tabulamque novam plantæ humani pedis exhibens*, Leipsic, 1731.—D. C. de Courcelles, *Icones musculorum plantæ pedis, sorumque descriptio*, Amsterdam, 1760.

II. COMMON MUSCLES OF THE SOLE OF THE FOOT.

a. Flexor digitorum pedis communis brevis.

§ 1265. The *flexor communis digitorum brevis* muscle, *Calcaneo-sous-phalanginien commun*, Ch. (*M. flexor digitorum pedis communis brevis*, s. *perforatus*, s. *sublimis*, s. *pediæus internus*), is elongated, quadrilateral, thicker behind, and broader but thinner before. It arises by very strong tendinous fibres, which extend on a considerable portion of its lower face from the lower face of the tuberosity of the calcaneum, and by fleshy fibres by almost all its lower face, from the upper face of the plantar aponeurosis, to which its posterior tendon also adheres. Posteriorly it is very intimately united internally with the outer edge of the adductor pollicis, and above with the short head of the extensor communis digitorum longus. Nearly in the centre of the sole of the foot it divides into four very short fleshy fasciculi, which soon become as many single tendons. The latter are attached to the second, third, fourth, and fifth toes. They cover those of the extensor longus and are much smaller. They are arranged in the same manner anteriorly as those of the extensor digitorum sublimis. In fact a rhomboidal fissure begins a little before the posterior extremity of the first phalanx, which extends to before the centre of this bone. The tendons of the extensor communis digitorum profundus pass through these fissures.

The two halves of the tendon which pass through this division unite for a short extent; then again separate, enlarge and diverge from before backward, and are separately attached by straight edges to the centre of the lower face of the second phalanx.

Each tendon of this muscle is attached with the corresponding tendon of the flexor longus, to the lower face of the toes by synovial and fibrous ligaments, exactly like those which retain the tendons of the flexor sublimis and profundus of the fingers.

This muscle flexes the first and second phalanges of the four outer toes.

§ 1266. The fourth tendon is sometimes deficient, and then it is often but not always replaced by a tendon of the flexor longus. In some subjects there seems to be an antagonism between the short extensor and the short flexor of the toes; for we have sometimes found in this case the number of tendons of the second is greater than usual.

Sometimes also another portion of the muscle is deficient; it is usually the most internal or the most external. It is then replaced by other fasciculi which come from the flexor of the large and that of the little toe, which reminds us of the insulation of the internal head of this muscle in apes, and the disappearance of the short common flexor as a separate muscle in all the other mammalia and in all birds.

b. Lumbricales.

§ 1267. The *lumbricales* muscles, *Planti-sous-phalangiens*, Ch., correspond to those of the hand in number, form, and situation. They arise by fleshy fibres from the tendons of the flexor digitorum longus, and are attached, partly by short tendons, to the posterior head of the first phalanx of the four outer toes, and partly by thin tendinous expansions, to the tendons of the extensor digitorum longus.

c. Interossei.

§ 1268. We find in the foot as in the hand seven *interossei* muscles, *Metatarso-phalangiens lateraux*, Ch. (*M. interossei*), which fill the intervals between the metatarsal bones. They arise from the posterior part and from the lateral faces of these bones, and their anterior tendons blend below with those of the extensor communis.

We distinguish them into *external* and *internal*. The first are four and the second three in number.

a. External interossei.

§ 1269. The *upper* and *external* or *dorsal interossei* muscles (*M. interossei externi*, s. *superiores*, s. *dorsales*) are situated directly below the extensor communis digitorum brevis, in the first, second, third, and fourth interosseous spaces.

The first, which is the most internal, differs from the other three in its form and arrangement. In fact it comes only from the tibial side of the second metatarsal bone and is attached forward by a short, broad, and flat tendon to the inside of the first phalanx of the second toe.

It is however almost always divided into two heads, the upper of which is longer and much thinner than the lower.

The second, third, and fourth have two heads each, which are inserted by short tendons on the outer or fibular side of the first phalanx of the second, third, and fourth toes.

The outer head is much larger, arises from the posterior part of the inner face of the metatarsal bone, which is placed directly on the outside of the toe to which the tendon is attached, and descends as deeply as the internal, on the side of the sole of the foot. The inner is the smallest, and arises from the posterior part of the outer face of the metatarsal bone of the toe in which its tendon is inserted, and descends a little lower than the preceding. The fibres of these two heads unite at a very acute angle and are implanted in a common tendon.

The first external interosseous muscle brings the first toe inward; the second, third, and fourth carry the toes to which they are attached outward.

b. Internal interossei.

§ 1270. The *internal*, *inferior*, or *plantar interossei* muscles (*M. interossei interni*, s. *inferiores*, s. *plantares*) are smaller than the external and have only one head. They arise from almost all the posterior part of the inner or tibial face of the third, fourth, and fifth metatarsal bones, and are attached by a considerable tendon to the inner face of the first phalanx of the third, fourth, and fifth toes. This tendon is closely united to the capsule of the metatarso-phalangean articulation, and sends a prolongation to that of the extensor communis.

These muscles direct the third, fourth, and fifth toes inward toward the large toe.

III. PROPER MUSCLES OF THE TOES.

§ 1271. We may consider as proper muscles those of the large and small toes.

a. Muscles of the large toes.

a. Abductor hallucis.

§ 1272. The *abductor hallucis* muscle, *Metatarso-sous-phalangien du premier orteil*, Ch., is the strongest short muscle of this toe. It arises by several slips from the inside of the tarsus and the metatarsus, and is attached to the inside of the large toe. To simplify the description, we may refer these several slips to two heads.

The *posterior* head, which is the larger, arises by two bands, of which the inferior is longer, from the lower part of the inner side of the tuberosity of the calcaneum, and the upper, which is shorter, from the upper and projecting part of the inner face of the body of the calcaneum.

The *anterior* head, which is the smaller, arises by three or four distinct slips from the inner and anterior face of the astragalus, scaphoid, the first cuneiform, and first metatarsal bone. The posterior tendon of these two fasciculi covers them from their origin to near their anterior extremity below. The anterior, which is much stronger, begins near the centre of the posterior belly and is situated on its inner side; so that the fibres of the two bellies which go forward and inward are inserted at acute angles.

This last tendon, after it disappears from the surface, extends very far within the muscle, whence it goes backward and divides into several very considerable slips. Anteriorly, it is sometimes attached by two slips to the lower and inner face of the head of the first metatarsal bone, to the inner face of the capsular ligament of the first metatarso-phalangean articulation, and principally to the inner and lower part of the base of the first phalanx of the large toe, where it adheres intimately to the flexor digitorum brevis.

This muscle brings the large toe inward and flexes it a little.

b. Flexor brevis pollicis pedis.

§ 1273. The *flexor brevis pollicis pedis*, *Tarso-sous-phalangien du premier orteil*, Ch. (*M. flexor hallucis proprius brevis*), is much shorter than the abductor. It arises behind from the tendinous sheath of the peroneus longus, intimately united to the long head of the adductor of the large toe. Most generally its posterior extremity may be divided into an external and an internal belly. Thence it goes inward and forward. It is attached by a short tendon, more or less divided, to the posterior part of the lower side of the base of the first phalanx of the large toe. This tendon is generally united to that of the adductor outward; it contains anteriorly, below the two parts of the head of the first metatarsal bone, two sesamoid bones placed one at the side of the other.

This muscle flexes the first phalanx of the large toe.

c. Adductor pollicis pedis.

§ 1274. The *adductor pollicis pedis* muscle, *Calcaneo-sous-phalangien du premier orteil*, Ch. (*M. adductor hallucis*), is a considerable muscle which has two bellies.

The *posterior* is much stronger than the other and is placed above and outside of the flexor brevis pollicis pedis. It arises from the lower side of the base of the third and fourth and also often of the second metatarsal bone, and from the sheath of the peroneus longus, above the flexor brevis pollicis pedis. Before, on its outer and lower face, are strong tendinous expansions, which unite to give rise to the anterior tendon. This latter is united to the external tendon of the flexor brevis (§ 1212), and is attached to the outer face of the base of the first metatarsal bone.

The anterior head is much smaller and weaker than the posterior, and arises from the lower and inner face of the capsular ligament, between the metatarsal bone and the first phalanx of the fourth and fifth toes, sometimes also from the anterior part of the fifth metatarsal bone.

It goes obliquely forward and inward, directly below the anterior end of the interossei muscles, between these and the tendons of the flexor communis digitorum profundus. It is attached by a thin and short tendon to that of the abductor of the great toe.

b. Muscles of the little toe.

a. Abductor minimi digiti.

§ 1275. The *abductor minimi digiti* muscle, *Calcaneo-sous-phalangenien du petit orteil*, Ch. (*M. abductor digiti quinti*), is the longer of the two muscles of this appendage, has two bellies like the abductor pollicis pedis; the posterior belly is greater.

The posterior belly is covered below and behind by a strong aponeurosis, and arises from the posterior and from a little of the anterior part of the lower face of the tuberosity of the calcaneum.

The *anterior* belly comes from the lower edge of the tuberosity of the fifth toe.

Both are attached outwardly to a broad and strong tendon, which extends far back into the substance of the muscle and which is attached to the outer part of the lower face of the base of the first phalanx.

b. Flexor minimi digiti brevis.

§ 1276. The *flexor minimi digiti brevis* muscle, *Tarso-sous-phalangien du petit orteil*, Ch. (*M. flexor digiti quinti proprius brevis*), is much smaller than the preceding. It arises from the inner part of the lower side of the base of the fifth metatarsal bone and from all the lower face of its body. It may almost always be divided into an outer and inner belly. Most frequently also it is attached by two distinct tendons to the inner part of the lower side of the base of the first phalanx.

§ 1277. The muscles of the large and small toes may be referred to the other muscles of the foot, as we have seen those of the thumb and little finger could be to the other muscles of the hand. The abductor pollicis pedis is the first external interosseous muscle, and the posterior belly of the abductor the first internal interosseous muscle. The anterior belly of the latter represents the first lumbricalis. The flexor brevis digitorum pedis muscle corresponds to the flexor digitorum communis. The abductor minimi digiti is the last external interosseous muscle. Finally, the flexor minimi digiti brevis may be considered as belonging to the flexor digitorum communis, because of the slight development of the fourth tendon of the latter in most subjects.

COMPARISON OF THE MUSCLES OF THE DIFFERENT REGIONS OF THE BODY.

§ 1278. We have already compared the muscles of the different regions of the body with each other in different directions, while describing each one particularly. They also conform to the law that the analogy betweeen the upper and lower halves of the body is more marked than that between the anterior and posterior. In fact we observe, 1st, that many muscles which succeed from above downward are repetitions of one another, as is evident with those between the vertebræ or between these bones and the head; 2d, the muscles of the limbs correspond very evidently, and the differences they present, like those between the bones and the ligaments, depend on the greater solidity of the lower limbs and the greater mobility of the upper, either when considered as a whole and in their relations with the trunk, or when viewed in detail and in regard to the relations of their different parts with each other. An abnormal arrangement of the muscles belonging to the two extremities frequently renders their similitude more perfect and more evident than it is generally; and if we do not err, of all the organic systems, the muscular most frequently presents anomalies in the configuration, which cause an unusual similitude between the anterior and posterior faces of the body and also between its upper and lower portions.

In this respect we often find an anterior sternal muscle, which determines a resemblance between man and animals, and the existence of which is so curious in another respect; and we not unfrequently find a short head of the biceps flexor cubiti and a short extensor of the middle finger.

So too the muscles of the lower limbs are frequently repetitions of those of the upper. The latter however seem to us more disposed to present assimilating anomalies in their configuration, which probably depends on a general law, amply supported by the vascular system, viz. that anomalies in the pelvic members are more frequent than in the pectoral extremities.

GENERAL REMARKS ON THE MOTIONS OF THE HUMAN BODY.

§ 1279. Having described successively the different organs of locomotion, we must now briefly examine the principal motions(1) which result from their joint action.

We must first endeavor to prove *that the erect posture on the lower limbs is natural to man.*

A. ERECT POSTURE.

I. OSSEOUS SYSTEM.

§ 1280. We may also point out in this place the conditions which arise from the other organic systems, not yet described, and which refer to the general form of the body, because the osseous system serves as the basis for all the others.

In considering the body from below upward, we discover successively in the osseous system all the conditions which render the erect posture natural to man.

(1) F. Roulin, *Recherches théoriques et expérimentales sur le mécanisme des mouvements et des attitudes dans l'homme;* in the *Journ. de physiol. exp.*, vol. i. p. 209, 301, vol. ii. p. 45, 156, 283.

1. In the lower extremities.

§ 1281. 1st. The predominance of the bones of the lower over those of the upper extremities.

2d. It is only in the erect posture that the articular surfaces of all the bones are exactly fitted to each other.

3d. The breadth of the foot.

4th. The size of the tarsus and metatarsus in proportion to the toes.

5th. The number and size of the sesamoid bones.

6th. The union of the bones of the leg with the tarsus at a right angle.

7th. The length and the obliquity of the neck of the femur.

8th. The breadth, concavity, and lowness of the iliac bones.

2. In the trunk.

§ 1282. 1st. The lowness, breadth, and curve of the sacrum, and also the curving inward of the coccyx, upon which and also on the arrangement of the iliac bones the peculiar shape of the human pelvis depends, which seems well adapted only for the erect posture.

2d. The breadth and lowness of the vertebræ.

3d. The considerable curve of the ribs, whence results the breadth and convexity of the thorax.

3. In the head.

§ 1283. 1st. The anterior, posterior, and horizontal position of the condyles and foramen magnum of the os occipitis.

2d. The direction of the cavities of the orbits and nose forward in the erect posture and downward in that on the four limbs.

4. In the upper limbs.

§ 1284. 1st. The shortness and feebleness of these members in proportion to the lower.

2d. The forced position of the bones of the fore-arm and of the radio-carpal articulation in walking on all fours.

3d. The mobility of the radius.

4th. The concavity and breadth of the bones of the metacarpus and of the phalanges. These latter circumstances indicate that the bones of the upper extremities are intended to grasp external objects, while the corresponding parts of the lower limbs prove they are designed to support the body.

II. LIGAMENTOUS SYSTEM.

§ 1285. The peculiarities of the ligamentous system are as follow:

1st. The ligaments of the lower extremities are stronger than those of the upper, and this strength increases progressively from below upward.

2d. The looseness of the cervical ligament, although the head is very much developed, in regard to the occipital foramen which is situated farther forward.

III. MUSCULAR SYSTEM.

§ 1286. The muscular system also furnishes several strong arguments:

1st. The greater power of the muscles of the lower extremities.

2d. The extreme force and the arrangement of some of them, viz.

a. The thickness of the peronei muscles in the leg, the lower head of which always draws the leg backward and extends it, while the upper two prevent the body from falling forward.

b. The arrangement of the flexors of the leg compared with that of the flexors of the fore-arm; for one of the three long flexors of the first of these limbs is manifestly developed only in part; so that the number of the corresponding muscles in the fore-arm is much greater than in the leg.

c. The thickness of the glutæi muscles, particularly the glutæus maximus.

d. The multiplication of the muscles of the fore-arm to execute the peculiar motions of the bones of the fore-arm: so likewise the difference between the number and development of the special muscles of the thumb and little finger and those of the large and small toes.

e. The deeper situation of several of the muscles of the fore-arm in the upper extremity, and the foot only in the lower: such are particularly the flexor brevis and the extensor communis brevis.

f. The slight extent of the insertion of the flexors of the leg, which favors the extension of this limb and prevents the continued forced flexion it experiences in quadrupeds.

g. The smallness of the small muscles of the head, which, in connection with the looseness of the cervical ligament and the anterior position of the occipital foramen, forms a very striking character, especially when we regard the great development of these parts in quadrupeds, the head of which is however smaller than that of man.

§ 1287. All these circumstances united prove sufficiently that the erect posture on the lower limbs is natural to man.

We must next examine how the erect posture is preserved in a state of repose, and how the body when erect exercises the motion of progression, or of *standing* and of *walking*, treating of the modifications of each.

B. OF STANDING.

§ 1288. The trunk and the lower limbs act in standing. The part taken by the trunk consists,

1st. In the support of the head by the vertebral column.

2d. In the action of the very strong long muscles of the back which fill the channels between the vertebræ and the ribs. They prevent the body from falling forward, to which it is in some measure disposed from the portion of the pectoral and abdominal viscera before the vertebral column. In fact, they are much more developed in their lower part than at their summit. In this part also we feel fatigue and pain most sensibly after standing a long time and especially after leaning forward.

The trunk is supported by the lower extremities. Whenever the position changes the pelvis presents a broad point of support for its weight, and that of the head which is sustained by the vertebral column. The articulation of the ossa femoris with the iliac bones in front of their union with the spine increases the extent of this base of support.

In standing, the weight of the body passes from this base to the thigh, next to the leg, and finally to the foot, so that the body rests upon the latter.

In the usual position on the two feet, besides the peculiarities relative to the lower extremities and which we have mentioned above, their separation caused by the breadth of the pelvis and the length of the neck of the thigh bones is very advantageous, as it increases the extent of the base of support which falls between the soles of the feet; thus the attitude becomes unsteady and less firm when the breadth is diminished by approximating the feet.

Standing, inasmuch as it depends on the lower limbs, results from the action of all the muscles which arise from the trunk, and from the different sections of these members. These muscles contract from above downward, and thus move the divisions immediately above them, and act in a direction the inverse of that which results in progression, since they approximate the least movable point to that which is most movable. Thus the most active are, 1st, the glutæi, which draw the trunk backward; 2d, the three flexors of the leg, which prevent the pelvis from inclining forward; 3d, the extensors of the thigh, excepting the rectus, which prevent the limb from falling backward; 4th, the lower head of the triceps suræ, which keeps the leg on the foot in a direction intermediate between flexion and extension.

The other muscles, which confine the action of those we have mentioned, have little or no action, and this action is counteracted by that of the others.

Standing on one foot, where the whole weight of the body rests on one of the lower extremities, is practicable, especially by the length of the neck of the femur and the breadth of the sole of the foot. This posture of the body is preserved by the action of the muscles on the outside of the lower limbs, by the broad abdominal muscles, and by the quadratus lumborum, which act from below upward, preventing the body from falling to the opposite side, where it is unsupported.

In standing on the toes there is no change except in the relations of the bones of the leg and the action of its muscles. The toes are extended as much as possible on the metatarsal bones and the foot on the leg, and the weight of the body then rests wholly on the toes and also on the sesamoid bones of the foot, which are numerous and large. This position is caused principally by the simultaneous action of the muscles situated on the anterior and posterior faces of the leg and foot; the tibialis anticus, the peronei, especially the peroneus brevis, the extensors of the toes anteriorly, and the triceps suræ posteriorly, are the principal agents.

At the same time the toes are forcibly pressed against the ground by the action of their flexors, hence they are more firmly fixed and afford a more solid point of attachment to their muscles.

C. OF WALKING.

§ 1289. *Walking* is produced by the displacement of the lower extremities, which move alternately either forward, backward, or laterally, so that a distance exists between them, and consequently the rest of the body is supported by only one of them. Each motion, by which a limb is raised from the ground, separated from the other, and is replaced on the ground, is a *step*.

This motion, in whatever direction it is performed, depends principally on the displacement of the femoral articulation, which is flexed in walking forward or sideways, and, on the contrary, extended in walking backward.

When we walk forward or backward the knee-joint is generally slightly bent, which serves to raise the foot still more. The metatarso-phalangean joint is most generally forcibly extended, articular when the lower limb which is to be moved is behind the other. In walking, the flexion of the haunch carries one of the two limbs more or less before the other; when left to itself, and the coxo-femoral articulation is not bent, the foot falls again to the ground and the step is finished. If we take long steps the pelvis also turns more or less around the limb which remains fixed as around an axis; hence the limb which moves, and the corresponding side of the body, are carried farther forward. This effect is caused partly by the flexion of the other sections of this limb and partly by the extension of the metatarso-phalangean articulation.

It is merely necessary to mention these motions to know the muscles which perform them.

Running is a quick walk, most generally withlarge steps, which differs from the ordinary walk not only by its rapidity, but also because all the lower face of the foot rests on the ground.

Jumping is a sudden movement by which the body rises into the air. In order to perform it all the joints of the lower limbs are flexed and then suddenly extended; from the shock which the body experiences from the soil against which it strikes it is carried upward until its weight exceeds the motion communicated to it, and causes it to return to the earth.

The leap in a straight line is always shorter than the oblique leap because the weight of the body presents more resistance in the first case than in the second.

In *kneeling* the articulation of the foot is flexed by the anterior muscles of the leg, which act from above downward, and the articulation of the knee is changed in the same manner by the action of the upper heads of the triceps suræ muscle.

In *stooping* the gastrocnemii muscles of the leg exercise all their power; at the same time the coxo-femoral articulation is flexed more or less forcibly in order to lean the body forward, and to prevent its centre of gravity from falling behind its base of support, and in this manner to prevent its fall.

§ 1290. The *motions of the trunk*(1) are very limited. This is proved by the vertebræ and also by the pieces of the sternum, which are firmly united. Thus the motions of the trunk in every direction depend but slightly on the displacement of the bones which form it, but almost entirely on the lower limbs, and those in the coxo-femoral articulation, are performed by the muscles which extend from the thigh and leg to the vertebral column and to the iliac bones. The mobility of the ribs is much greater; the changes in their situation produce the continual alternate changes which take place in the capacity of the chest, and which result in inspiration and expiration. The examination of these changes and of those which occur in the capacity of the abdominal cavity will be more in place after describing the pectoral and abdominal viscera than here.

§ 1291. The head moves on the vertebral column; it bends forward, is extended backward, inclines to the side, and turns on its axis.

The last two motions take place almost entirely between the second and first vertebræ, the last of which only accompanies the head. The other two occur between the head and the atlas, and not between the atlas and axis, because the odontoid process and the transverse portion of the crucial ligament almost entirely prevent every displacement in this direction between the first and second vertebræ.

Luxation cannot take place in flexion and extension on account of the firmness of the attachments; but it easily supervenes in the rota-

(1) Winslow, *Sur les mouvemens de la tête, du cou et du reste de l'épine du dos*, in the *Mém. de Paris*, 1730, p. 492-508.

tion of the first vertebra and of the head on the axis, when this motion is performed quickly.

The cervical portion of the vertebral column must always be fixed in order that these different motions may be executed.

§ 1292. The upper limbs are much more movable than the lower both in regard to the trunk and their different sections, which doubtless depends on the arrangement of these bones and the ligaments. The motion of rotation on the axis particularly is much easier in the first than in the second. The greater mobility of the upper limbs, considered as a whole, is also increased by the difference remarked in the mode of articulation, of the first section of the bones of the two extremities, for the iliac bones are almost motionless on each other and on the vertebral column, while the clavicle and scapula on the contrary are very movable both on each other and on the trunk.

Hence the motions of the upper limbs are not performed solely in the scapulo-humeral joint as those of the lower extremities are in the coxo-femoral articulation, but take place at the same time in the scapulo- and sterno-clavicular articulations; hence they are not only more free, but also keep the bones together in the different motions they perform. Hence the bones are much less firm, but they require less strength, since the upper extremities are rarely obliged to sustain such heavy loads as happens for instance in creeping, walking, or standing on the hands.

If we except the fingers and toes, mobility diminishes from the periphery of the limbs to their centres.

A great difference between the partial motions of the two limbs consists in the power of turning the radius on its axis and around the ulna, while the leg cannot move around the thigh, except as a whole, the fibula being immovable on the tibia. The leg is capable only of flexion and extension, while the fore-arm can execute also the motions of pronation and of supination.(1)

Although in the two latter motions the radius is the principal part displaced, the ulna is not however motionless; for it is slightly extended in pronation and a little flexed in supination.

(1) Winslow, *Obs. anat. sur la rotation, la pronation, la supination et d'autres mouvemens en rond*, in the *Mém. de Paris*, 1727, p. 25-33.—Vicq d'Azyr, *Œuvres*, vol. v. p. 343-351.

BOOK IV.

ANGEIOLOGY.

§ 1293. The vascular system(1) is composed of a central part, the *heart*, whence all the blood departs and where all this fluid returns; of vessels which carry it away, the *arteries*; and of vessels which

(1) We have already mentioned (vol, i. p. 280) the most important works on the general conditions of the structure and external form of the vascular system in the normal and abnormal state. We shall now mention the principal descriptive treatises. They are,

I. FOR THE WHOLE SYSTEM.—J. C. A. Mayer, *Anatomische Beschreibung der Blutgefasse des menschlichen Körpers*, Berlin, 1777, 1778.—F. A. Walter, *Angiologisches Handbuch*, Berlin, 1789.

II. FOR THE HEART.—1st. Complete description of this organ in all its parts, both in the normal and the abnormal state; Senac, *Traité de la structure du cœur, de son action et de ses maladies*, Paris, 1747, 1778.—2d. Complete description of it in the normal state; R. Lower, *Tractatus de corde, item de motu calore et transfusione sanguinis*, London, 1669.—J. N. Pechlin, *De fabrica et usu cordis*, Kiel, 1676.—Winslow, *Sur les fibres du cœur et sur ses valvules, avec la manière de le préparer pour le démontrer*, in the *Mémoires de Paris*, 1711, p. 196, 201.—Vieussens, *Traité de la structure et des causes du mouvement natural du cœur*, Toulouse, 1711.—Santorini, *Obs. anat.*, Venice, 1724, ch. viii., *De iis quæ in thoracem sunt.*—Lieutaud, *Obs. anat. sur le cœur*, in the *Mém. de Paris*, 1752, 1754.—3d. Development of the heart; Meckel, *Sur l'histoire du développment du cœur et des poumons dans les mammifères*, in the *Journal complém. du Dict. des sc. médic.*, vol. i. p. 259.—Rolando, *Sur la formation du cœur et des vaisseaux artériels, veineux et capillaires*, same journal, vol. xv. p. 323, vol. 16. p. 34.—Prévost et Dumas, *Développment du cœur et formation du sang*, in the *Annales des sciences naturelles*, vol. iii. p. 46.—4th. Structure of the heart in respect to the arrangement of its fibres; C. F. Wolff, *Dissertationes de ordine fibrarum muscularium cordis*, in the *Act. Acad. Petropol.*, 1780-1781, in the *Nova act.*, vol. i.-viii.—J. F. Vaust, *Recherches sur la structure et les mouvemens du cœur*, Liege, 1821.—S. N. Gerdy, *Mémoire sur l'organisation du cœur*, in the *Journ. compl. du Dict. des sc. méd.*, vol. x. p. 97.—5th. Pathological state; A Burns, *Observations on some of the most frequent and important diseases of the heart*, London, 1809.—Pelletan, *Mémoires sur quelques maladies et vices de conformation du cœur*, in the *Clinique chirurgicale*, Paris, 1810, vol. iii.—Testa, *Delle malattie del cuore, loro cagioni, specie, cura*, Bologna, 1810, 1813.—Corvisart, *Essai sur les maladies et les lesions organiques du cœur et des gros vaisseaux*, Paris, 1818.—Kreysig, *Ueber die Herzkrankheiten*, Berlin, 1814, 1817.—Laennec, *De l'auscultation médiate*, or *Traité du diagnostic des maladies des poumons et du cœur*, Paris, 1819, p. 195-445.—Bertin, *Traité des maladies du cœur et des gros vaisseux*, Paris, 1824.

III. FOR THE ARTERIES.—Haller, *Icones anatomicæ*, Gottingen, 1745, 1756.—A. Murray, *Descriptio arteriarum corp. humani tabulis redacta*, Upsal, 1783, 1798.—J. F. S. Posewitz, *Physiologie der Pulsadern des menschlichen Körpers*, Leipsic, 1795. —J. Barclay, *A description of the arteries of the human body*, Edinburgh, 1818, 8vo. —Tiedmann, *Tabulæ arteriarum corporis humani*, Carlsruhe, 1822, 1824.—Hodgson, *Diseases of the arteries and veins.*

IV. FOR THE VEINS.—Besides the tables of Loder see Breschet, *Sur le système veineux*, now publishing.

V. FOR THE LYMPHATICS.—The works mentioned in the first volume contain also a description of this system.

return it, the *veins* and the *lymphatics*. The last mentioned carry a fluid different from the blood, they are the annexes or appendages of the venous system.

SECTION I.

OF THE HEART.

CHAPTER I.

GENERAL REMARKS.

§ 1294. The *heart* (*cor*) is a hollow muscle irregularly conical or pyramidal, situated in the centre of the chest, between the two lungs, and inclosed in a special envelop called the *pericardium*. Its vessels are numerous, but it has few nerves; it is formed of several cavities, some of which are separated, while others communicate together. Its tissue is formed of fibres united in superimposed layers, and is connected on one side with the large venous trunks of the lungs and body, and on the other with the large arterial trunks of both. Each of these characters deserves to be specially considered.

I. FORM.

§ 1295. The shape of the heart is that of a cone or an irregular pyramid. We distinguish in it a broad and thick *base* (*basis*) and a *summit* (*apex*), which is generally blunt and bifurcated, an upper and anterior face which is concave, and an inferior and posterior which is smaller and flatter; two edges, a posterior which is thick and pointed, the anterior is smaller, shorter, thin, and sharp.

The base of the heart is formed, properly speaking, by that part of the organ directly connected with the veins: we may then term it the *venous portion of the heart* (*pars cordis venosa*). However we generally apply the term *base of the heart* to the upper region of the arterial portion. The venous portion is formed of two auricles. It is separated from the next by a large groove, called the *groove of the base*, the *auriculo-ventricular groove*, or *circular groove* (*sulcus baseos*, s. *atrio-ventricularis*, s. *circularis*). Its form is an oblong square and its breadth exceeds its height.

The succeding portion, which is situated before the auriculo-ventricular groove, is directly connected with the large arterial trunks. We may then term it the *arterial portion of the heart* (*pars arteriosa cordis*). It is formed by the two ventricles. It terminates in a blunt summit, which is usually more or less evidently grooved. This groove is sometimes very large.

The *longitudinal groove* (*sulcus cordis longitudinalis superior et inferior*) exists on both faces of the heart, from its base to its summit, and consequently in all its length.

The principal branches of the nutricious vessels of the organ are situated in these grooves: they communicate on the side of the base by a groove, which descends perpendicularly between the two auricles, and on the summit by the depression observed in this place. They mark the course of the *septum* within the heart (*septum cordis*).

§ 1396. The septum passes also across the venous portion of the heart or the auricles as well as its arterial portion or the ventricles. It separates completely these two synonymous parts, and consequently divides the heart into a *right* or an *anterior* and a *posterior* or *left* half. That part which passes between the auricles is called the *septum atriorum*, and that between the ventricles is called the *septum ventriculorum*. The right part of the heart is called the *pulmonary heart* (*cor pulmonale*), because the pulmonary artery arises from it, or the *heart of the black blood*, from the color of this fluid within it. The left is termed the *aortal heart* (*cor aorticum*), because the aorta arises from it, or the *heart of red blood*, from the color of the blood within it. We employ sometimes also the terms of *first ventricle*, to designate the anterior, and *second ventricle*, to mark the posterior; but these are less convenient.

II. WEIGHT AND SIZE.

§ 1297. The weight of the heart in a fully grown man is about ten ounces; whence it is to that of the whole body as 1 is to 200.

Its length, measured from the centre of the auricles, is between five and six inches; its mean length is five and a half inches, four of which are for the ventricles and one and a half for the auricles. The breadth of the ventricles united is generally three inches at their base and that of the auricles is three and a half inches.(1)

III. SITUATION.

§ 1298. The heart is placed obliquely from right to left, from behind forward, and from above downward; so that its base is nearly opposite

(1) A knowledge of the perfectly normal proportions of the heart in the healthy state is very important to the physician, since without it he can establish no certain diagnosis of the diseases of the central organ of the circulation. We cannot do better than to quote the following passage of Laennec on this subject: "The heart, including the auricles, should be equal to, a little less, or a little larger than the first of the subject. The walls of the left ventricle should be a little more than twice as thick as the walls of the right ventricle; they should not collapse on cutting into the ventricle. The right ventricle, a little larger than the left, presenting smaller fleshy pillars, although its parietes are thinner, ought to collapse after the incision." (*De l'auscultation médiate*, vol. ii. p. 270.) "Reason teaches and observation proves, that in a well formed subject the cavities of the heart are nearly equal; but as the parietes of the auricles are very thin and those of the ventricles are much thicker, it follows that the auricles form only one third of the whole volume of the organ or the half of that of the ventricles." (*Ib.*) F. T.

the eighth dorsal vertebra, from which it is separated by the esophagus and aorta, and its summit corresponds to the cartilage of the sixth rib, or to the interval, which separates it from the next. Its lower face, which is flattened, corresponds to the upper face of the central tendon of the diaphragm, and the upper to the central and left portion of the anterior wall of the chest.

IV. TEXTURE.

§ 1299. The heart is formed of several layers of muscular fibres, situated between two thin, smooth, and polished membranes, the inner and outer membranes of the heart. The latter is the inner layer of the pericardium.

The outer surface of the heart is smooth and uniform in relation to the inner, even when we have removed the outer membrane.

The inner surface is very uneven and reticulated, which arises from its being formed of numerous rounded, flat, and distinct muscles, which intercross continually and which are called *fleshy pillars* (*trabeculæ carneæ*). The mnscular substance of the heart is generally harder, more solid, and more elastic than that of other muscles.

As the arrangement of these fibres(1) differs wholly in the venous portion from what it is in the arterial portion, as it is not exactly the same in the right and left portions, and as it finally differs according to the subject, all that can be said generally may be reduced to the following corollaries :(2)

1st. The directions of the layers are more or less opposite. But in the recent state, far from being entirely separated from each other, they intercross differently ; so that all those of one portion of the heart constantly contract uniformly and diminish the cavity they circumscribe in every direction.

The union of the different layers takes place partly by more or less manifest muscular fibres.

2d. The fibres which form the layers are united in fasciculi of various sizes, which vary more or less in their origin and their direction, and which are often separated by greater or less spaces. These fasciculi are sometimes rounded and sometimes flattened,—a difference which seems to depend on determinate laws, since it is constant in the different regions of the heart. For instance the right and left ventricles

(1) Wolff, *De ordine fibrarum muscularium cordis. diss.* vii. *De stratis fibrarum in universum. In nov. act. petrop.*, vol. iii., 1785, p. 227-249.—Gerdy, *loc. cit.*, p. 101.—Vaust, *loc. cit.*, p. 102, etc.

(2) Gerdy has established a law, that all the fibres, whatever is their extent, situation, and direction, form webs, which are convex toward the point of the heart, and which are nearly superficial at one extremity and deep at the other ; so that for instance the external or internal fibres are the same reversed, and having passed through the thickness of the ventricle. The extremities of these muscular webs are constantly inserted in the base of the heart, around the different auricular and arterial orifices of the ventricles, either directly or by tendons attached to the auriculo-ventricular valves (*loc. cit.*, p. 101). F. T.

are not similar in this respect nor in regard to the arrangement of their fibres, and the same is true of other parts also. Thus the inner layers are generally rounded and form fleshy pillars. The auricular appendages of the auricles are formed of rounded fasciculi, and the auricles of flattened fasciculi.

From this arrangement we may deduce that the *firmest parts are formed of rounded fasciculi*. But the fibres and the fasciculi formed by them are united by intermediate fibres, which may be distinguished with facility.

The fibres and fasciculi are every where interlaced with each other, conformably with all the involuntary muscles. They are united principally in two ways: sometimes the ends of the fibres and fasciculi join, and sometimes they are united by intermediate filaments, which arise from their lateral portions.

In the first case, either the fasciculi go to meet each other and the extremities of those which continue together intermix like the teeth of a saw, as is the case with the digitations of several adjacent muscles, or some fibres are attached obliquely to others at acute angles, as the fibres of the penniform muscles are implanted in their tendons, and finally, as is the case most generally, the fibres or fasciculi which go side by side unite at very acute angles.

The lateral union takes place principally between the insulated fibres and the small fasciculi of fibres, especially in the outer layer. Sometimes it is irregular; so that those fibres which are evidently separated in the rest of their course are placed one against another in a part of this same course, whence the reticulated structure is more or less evident. It is sometimes regular, and we see oblique fibres going from each side, which unite. The redness and determinate form of the intermediate filaments always demonstrate that they are not formed of cellular tissue but of real muscular substance.

The mode in which the filaments are united also presents determinate differences in the different regions of the heart.

3d. In the ventricles, the external layers go obliquely downward, backward, and from right to left. The direction of the central is opposite, and the most internal, which form the fleshy pillars, extend longitudinally from the summit to the base.

On the contrary, the transverse direction predominates in the auricles. The external layer, which is the strongest, proceeds in this direction, while the internal, which forms only insulated fasciculi, has a longitudinal direction.

4th. All the external layers are not equally extended. Generally the external layers are those only which cover all the surface of the ventricles; the central are smaller and occupy only a third of the heart. If we except the most internal, that which forms the fleshy pillars, they diminish in direct ratio to their depth. They disappear first at the summit of the organ, and in reascending from this point to the base of the ventricles, they are deeper and deeper; so that the deepest are found only at the base. Hence this part of the heart is the thickest.

We observe also occasional spaces between the layers, which extend the whole length or all the breadth of the ventricles.

5th. The outer layers differ from the central ones, inasmuch as they are stronger and their fibres are more intimately united together.

Thus the fibres and the fasciculi of the inner layers are more easily demonstrated. But the external forcibly embrace and compress these latter; so that they contribute essentially to the firmness of the heart.

6th. The fibres of the two portions of the heart are not continuous, at least not all of them, with each other, so that the same layers are reflected on the two; but the fibres of the two ventricles terminate in the septum. The upper and lower faces of the heart are not arranged in precisely the same manner: the separation is seen with more difficulty in the first than in the second. We remark also three different arrangements in the upper face. In fact, either we cannot distinguish the least trace of separation and the fibres are uninteruptedly continuous with each other, or two fibres are in fact applied one on the other, but a species of suture serves as a line of demarkation between them, or finally they mingle with each other by digitations.

Wolff states that on the lower face, the fibres of the two ventricles are separated by a distinct and very broad band, formed of longitudinal fibres, and which diminishes insensibly from the base to the summit, to which these fibres are attached on the two sides. But we have usually found but a slight, and often no trace of this arrangement.

7th. The upper extremities of the fibres of the heart are attached to a fibro-cartilaginous tissue,(1) formed

a. Of two oblong, rounded projections or tubercles, usually three or four lines long, little less than a line thick, seen on both sides of the orifice of the aorta.

b. Of a thin band, which surrounds the posterior part of the circumference of the aorta and unites the two tubercles.

c. Of four filaments, placed in the circular groove on the base of the heart, two on the right and two on the left, an anterior and posterior on each side. Below these four filaments the two anterior arise from the tubercles. The right anterior goes into the anterior and upper part of the circular groove; the left into the upper and posterior part. The posterior two arise by a very short common trunk, which is only a few lines long, from the band which unites the two tubercles, near that of the right side, and proceed in an opposite direction to the lower part of the circumference of the circular groove.

These anterior and posterior filaments are situated at the venous orifices of the ventricles. They do not surround the base of the heart

(1) C. D. F. Wolff, *De ordine fibrarum muscularium cordis, Diss.* ii., *de textu cartilagine ocordis, sive de filis cartilagineo-osseis eorumque in basi cordis distributione. In Act. Petropol.*, 1781, vol. i. p. 211.—Gerdy, *loc. cit.*, *du tissu albuginc cardiaque*, p. 97.

and form a complete ring, but terminate near the edges of each orifice and gradually lose themselves in the cellular tissue.

This cartilaginous tissue is surrounded entirely by a thin, firm, but loose sheath, a real perichondrium. It is covered more externally by the outer membrane of the heart and internally by its inner membrane.

The external muscular or superficial fibres arise principally from the cartilaginous tubercles and filaments, and from the cellular tissue between the extremities of the latter; so that the fibres, which come from the tubercles and from the origin of the filaments, adhere to them very intimately, while the others are united only by a cellular sheath which surrounds them.

V. VESSELS.(1)

§ 1300. The blood-vessels of the heart are proportionally very large and are called the *coronary* vessels (*vasa coronaria cordis*). The coronary arteries and veins resemble each other in many respects:

1st. These vessels (the arteries) arise directly from the beginning of the trunks of the vessels of the body, or they (the veins) open directly into the heart.

2d. They turn around the base of the heart in the circular groove, whence they send toward the summit large branches which arise at almost right angles: these go to the ventricles and proceed along the heart, while the others are smaller and follow an opposite direction, proceeding to the auricles.

3d. The large trunks and the large branches extend on the outer face of the organ and ramify internally.

4th. The veins have valves at the places where they open but not in their course. There are two arteries of nearly equal calibers, while we find only a single large coronary vein, which is constant; but beside this last we observe several, which are smaller, which open directly into the heart, but not constantly, except into the right part of the organ, and particularly into the right auricle: they do not open, even, except into the septum, and they do not empty their blood into the left part of the heart,(2) as some anatomists have pretended, and among others Vieussens(3) and Thebesius.(4) In fact, Abernethy has very recently supported this latter opinion, viz. that the venous blood of the heart mixes with the arterial blood which nourishes the body, without passing through the lungs; he has only modified it by saying, that these orifices of the coronary veins in the left portion of the organ serve principally to prevent repletion of the right portion in those cases where the passage of the blood through the lungs is obstructed; because,

(1) Haller, *De vasis cordis propriis*, Gottingen, 1737.—*Iteratæ observationes*, 1739. —Geisler, *Commentatio de sanguinis per vasa coronaria cordi motu*, Leipsic, 1743.

(2) Sabatier, *Sur les veines de Thebesius;* in the *Traité d'anat.*, vol. iii.

(3) *Nouvelles découvertes sur le cœur*, Montpelier, 1706.—*Traité du cœur*, 1715.

(4) *De circulo sanguinis in corde*, Leipsic, 1708.—*De circulo sanguinis per cor*, Leipsic, 1759.

having injected the cardiac arteries and veins in a subject whose lungs were diseased, he has seen the fluid penetrate into the left ventricle by broad openings. But as generally injections, even when very fine, transude on all the inner face, although no venous orifices are perceptible on the left side, we have reason to admit that the openings existing in the cases observed by Abernethy were produced accidentally, either during life or after death, by obstacles to the course of the injection, on account of the feeble resistance of the tunics of the veins weakened by disease, and considerably distended, both by the blood accumulated in these vessels and by the injected mass.

VI. NERVES.

§ 1301. The nerves(1) of the heart are proportionally smaller than those of the voluntary muscles. They arise from the upper and lower cervical ganglions of the great sympathetic nerve, from the cervical portion of the nerve between these two ganglions, or from the central ganglion sometimes found in this place. Some arise directly from the nerve, others from the plexuses formed by the filaments which come from the ganglions and by others sent off by the pneumo-gastric nerve.

The relations of the nerves of the heart with its muscular substance have been the subjects of dispute. Some anatomists, Behrends(2) among others, deny that this substance, and consequently that the heart, possesses nerves, which they pretend are distributed only to the cardiac vessels. Others on the contrary, as Scarpa, Munniks,(3) and Zerrenner,(4) maintain that they really go to the heart as well as to all other muscles.

The partisans of the first hypothesis adduce the following arguments:

1st. Anatomical examination, whence it results that the cardiac nerves, which we cannot follow except to the third ramification of the coronary arteries, do not enter the substance of the heart but go only to the arteries.(5)

2d. The origin of the cardiac nerves; they arise from the great sympathetic nerve, the ramifications of which go only to the arteries.(6)

(1) J. F. Neubauer, *Descriptio nervorum cardiacorum*, Frankfort and Leipsic, 1772. He has figured the nerves of the right side.—E. P. Andersch, *De nervis*; in the *Nov. comm. Gœtt.*, vol. ii., and Konigsberg, 1797. He has represented those of the left side. These figures have been copied in Haase, *Cerebri nervorumque corporis humani repetita*, Leipsic, 1781.—A. Scarpa, *Tabulæ neurologicæ ad illustrandum historiam anatomicam cardiacorum nervorum cerebri, glossopharyngæi et pharyngæi ex octavo cerebri*, Pavia, 1794.

(2) J. Behrends, *Diss. quâ demonstratur cor nervis carere, additâ disquisitione de vi nervorum arterias cingentium*, Mayence, 1792.—A. T. N. Zerrenner, *An cor nervis careat iisque carere possit?* Erford, 1794.

(3) *Observationes variæ. Diss. anat. med.*, Groningue, 1805, 1-17.

(4) Zerrenner, *An cor nervis careat iisque carere possit?* Erford, 1794.

(5) Behrends, *loc. cit*, p. 5, 8.

(6) *Id.*, *ibid.*, p. 8.

3d. The smallness of those nerves which is in direct ratio with the thinness of the fibrous coat of the arteries,(1) and which contrasts on the contrary with this law, that the number and size of the nerves correspond to the power and frequency of the motions of the muscles.(2)

4th. The insensibility of the heart, the motions of which are independent of the nervous system, since it beats regularly although removed from the body,(3) and the excitement of the nerves, whether mechanically or dynamically, by means of galvanic electricity, do not alter its motions,(4) and its pulsations are not deranged when the nervous system is paralyzed as in apoplexy.(5)

5th. The integrity of the motions of the heart, notwithstanding the administration of opium.(6)

But all these arguments can be refuted with greater or less facili'y. In fact:

1st. The manner in which the cardiac nerves are distributed and their proportion both to the muscular substance and to the vessels, do not differ essentially from what is seen in the same respects in the voluntary muscles.(7) Here also the nerves and the ramifications of the vessels are very compactly situated in regard to each other, and we do not see the nerves unite to the muscular subftance. Besides the cardiac nerves are closely connected with the vessels only in their largest branches, and not at all in many animals.

2d. The muscular substance of the heart is only a greater development of the fibrous membrane of the vascular system, so that the distribution of the branches of the great sympathetic nerve within it does not present an aberration from the type of this nerve.

3d. The cardiac nerves possess more medullary substance than those of the voluntary muscles. They arise from the ganglions of the great sympathetic nerve, and through them from all the spinal marrow. Their action is probably favored by the mutual contact of the blood and of the inner face of the heart; very probably also the size of the nerves which go to the voluntary muscles relates to their functions which is to conduct the influence of the will.

4th. The facts cited in the fourth paragraph are explained partly by the smallness and partly by the texture especially the softness and gelatinous nature of the cardiac nerves, and from the circumstance that they arise from the ganglions. Besides they are correct only to a certain extent, since the motions of the heart are not entirely independent of the nervous system. The passions have a marked influence on the number and strength of its pulsations. Impressions of

(1) Behrends, *loc. cit.*, p. 8, 9.
(2) *Id.*, *ibid.*, p. 10.
(3) *Id.*, *ibid.*, p. 11.
(4) *Id.*, *ibid.*, p. 20.
(5) *Id.*, *ibid.*, p. 12.
(6) *Id.*, *ibid.*, p. 11.
(7) Scarpa, *loc. cit.*, § 13.—Munniks, *loc. cit.*, p. 6.

every kind on the nervous system modify its motions more or less sensibly.(1)

In fact several observers, particularly Valli, Volta, Klein,(2) and Bichat, have doubted the influence of electricity on the motions of the heart; but the observations of Fowler, Schmuck, Pfaff,(3) Rossi,(4) Giulio,(5) Humboldt,(6) Munniks,(7) and Nysten, and our own also, prove it to be real.

The non-affection of the heart in paralysis of the brain proves nothing in regard to the relations between the nerves and this organ, since the irritability of the voluntary muscles is not altered in apoplexy. This apparent difference depends only on that between the excitants of the voluntary and involuntary muscles. In fact the excitant of the first is the influence of the brain, and that of the second the substance contained in their cavity, which in the present case is the blood. The motions of the heart continue also in cerebral paralysis, while those of the other muscles are not performed; the activity of these last seems extinct while it is only no longer seen.

5th. The observations of Haller, of Fontana, of Whytt,(8) and of Alexander,(9) prove that the heart, like the voluntary muscles, is sensible to the influence of opium, whether the narcotic acts directly upon it, or is placed in contact with the nervous system or with any organ whatever. These observations and experiments prove that the relation between the heart and the nerves is perfectly like that between the nerves and muscles generally, and more, because the effect of opium upon the heart is much more evident when this substance is placed in relation with the nervous substance than when applied directly to the heart.

VII. VENOUS PORTION.

§ 1302. The characters of the *venous portion* of the heart,(10) the auricles, are,

1st. The muscular substance of its parietes is so thin that the two membranes of the heart touch in several places.

2d. Its form is irregularly quadrilateral.

(1) See on this subject Legallois, *Expériences sur le principe de la vie*, Paris, 1812,—Wilson Philip, in the *Phil. Trans.*, 1815, part i. p. 65-97; part ii. p. 224-246.—Id. *An experimental inquiry into the laws of the vital functions*, London, 1818.

(2) In Pfaff, *Ueber thierische Electricität und Reizbarkeit*, p. 119.

(3) In Pfaff, *loc. cit.*, p. 140.

(4) *Mém. de Turin*, vol. vi.

(5) Voight, *Magazin*, vol. v. p. 161.

(6) *Ueber die gereizte Muskel-und Nervenfaser*, vol. i. p. 340-349.

(7) *Loc. cit.*, p. 115.

(8) In Pfaff, *loc. cit.*, p. 140.

(9) *Memoirs of the Manchester society*, vol. i. p. 98.

(10) Ruysch, *Epist. anat. problemata decima de auricularum cordis earumque fibrarum motricium structura*, Amsterdam, 1725.—A. F. Walther, *De structura cordis auricularum*, Leipsic.

3d. It is composed of a part into which the veins open directly the *cavity of the auricle*, the *sac* (*sinus*), and another upper and anterior, the *auricular appendix* (*auricula*), which projects above the sac.

The exact limits of these two parts cannot be pointed out, or rather anatomists do not distinguish them according to the same principles on the right and left sides. On the left side the appendix is readily distinguished from the sac, because it suddenly forms a very rounded projection, which is much narrower, and has thicker walls on the upper anterior and left angle. On the right side, on the contrary, this name is applied to a part, the walls of which are very thick, which is formed on the left by the confluence of the two venæ cavæ, terminates above in a blunt summit, and which is not sensibly separated from the rest, while, if we remained true to the analogy, this term should be applied only to the small appendix which terminates the auricle above, and which is elevated on the left along the vena cava superior.

4th. It is directly continuous with the venous trunks which open into it.

VIII. ARTERIAL PORTION.

§ 1302. The characters of the *arterial portion* of the heart, the *ventricles*, are,

1st. Their parietes are thicker, so that the internal and the external membranes are every where separated from each other by a muscular substance. The thickness of the parietes of each portion of the heart is then in direct ratio with the extent passed through by the blood it sends forward.

2d. The arterial portion is considerably larger and broader than the venous portion.

3d. Its external form is elongated, rounded, and pyramidal, and determines, properly speaking, the form of the whole heart.

4th. At its upper extremity are two openings, the venous and the arterial, which establish the communication, the first between the ventricle and the auricle, and the second between the ventricle and the artery which arises from it. The venous orifice is almost perpendicular; its direction is from before backward and from right to left; the arterial is almost horizontal and is situated a little above the former farther inward and nearer the septum.

Both are rounded; the venous is broader than the arterial. Its form is elliptical, while the latter is nearly circular.

Neither the venous nor the arterial opening is perfectly loose; both have valves. The valves placed at the arterial opening are very similar in their arrangement to those found in the common veins; they are however much larger and are usually three in number. Their convex and attached edge looks toward the heart while the loose edge, which has two concavities and which is thicker than the rest of the membrane, is turned toward the cavity of the artery. In the centre of the latter we observe a fibro-cartilaginous *tubercle* (*nodulus*). The blood which comes from the ventricle pushes them toward the circumference of the artery and against its parietes. On the contrary the blood which tends from its specific gravity to return from the artery into the ventricle separates them from these same parietes, their loose edges then touch, and they form a horizontal septum between the cavity of the artery and the ventricle, which prevents the reflux of the blood into the latter. The tubercles complete this septum and close the space in the centre of the artery between the three valves.

The valves of the venous orifice differ from those of the arterial opening, and from all other valves, since they are attached much more firmly, hence they close more completely the opening around which they are placed. A narrow cartilaginous ring, which is not however perfect, exists on all the circumference of the venous opening; this sometimes ossifies in advanced age, especially in the left portion of the heart, and is situated deeply between the muscular fibres of the ventricle and those of the auricle.

This is the *cartilaginous tissue* already described as the origin of the external muscular fibres of the heart. The venous valve is attached to this tissue by its posterior edge, but its opposite and uneven edge, unlike that of all the other valves, is not loose; many flat and solid tendinous filaments, which extend from the base to the summit of the heart, arise from the valve, on which they are often united or pass over it and go to the opposite part of the circumference of the heart, soon unite into larger cords, and are attached to the parietes of the heart, and principally to its fleshy pillars. As the latter shorten when the heart contracts, the different parts of the valves then approach each other and the opening is forcibly closed. It is necessary that the loose edge of these valves should be thus attached since they must resist not only the weight of the blood like the other valves, but also the action of the muscular parietes of the heart, which forcibly push forward the arterial blood.

5th. The arterial portion of the heart is divided into an upper and lower half, which are separated by the upper part of the valve of the venous orifice at the upper and posterior parts of the ventricles, and which blend together at the summit of the heart, so that the ventricles, although resembling externally an elongated cone, form in fact two arched canals, convex forward, and the greatest convexity of which corresponds to the summit, and are more extensive in this part than in any other.

6th. The reticulated structure of the ventricles is much more distinct than that of the auricles. Some of the fleshy pillars form rounded, elongated projections, terminating in blunt summits (*musculi papillares*), which go toward the base of the heart, and from the extremity of which several tendinous filaments proceed to attach themselves to the loose edges of the venous valves. Farther, those fleshy pillars which are attached by their two extremities, as well as those which have one end loose, communicate with each other at intervals by tendinous fibres. The direction of the principal fasciculi is longitudinal, the smaller which unite the preceding are oblique. Near the summit the reticulated texture is more and more developed, and the parietes become thinner in the same proportion.

IX. RIGHT AND LEFT PORTIONS.

§ 1303. 1st. The right half of the heart is considerably thinner than the left. This difference is very striking between the two ventricles, where the relation is generally as one to four or to five. Even then we find, as between the auricles and the ventricles generally, that the power of the parietes is in direct ratio with the space passed through by the blood which comes from them. The greater thickness of the walls of the left ventricle determines the form of the whole arterial portion of the heart. The right wall formed only by the septum is convex, and the left appears fitted to it like a sling.

2d. The substance of the right side, especially that of the ventricle, is softer and looser than that of the left side.

3d. The right side is broader than the left after death.(1) This difference also is most marked between the two ventricles, but it is not yet determined if it exists constantly during life or supervenes only after death.

Many anatomists, particularly Lower,(2) Santorini,(3) Weiss,(4) Lieutaud,(5) and Sabatier,(6) have adopted the latter opinion, while most others favor the first.

This hypothesis has been supported sometimes by the result of measurement, and sometimes by the fact that the left ventricle is as much longer as the right is broader, and sometimes by experiments and observations, from which it has been concluded that the right side appears broader after death, only because it is more distended by the blood which remains stagnant in the lungs from their inaction, while previously the passage of the blood from the left ventricle was not obstructed; whence the left ventricle seems to be narrower compared to the right, in proportion to the less quantity of pulmonary blood received by it through the pulmonary veins. In men and animals who have died suddenly from the injury of the large vessels, or of those which communicate with the right portion of the heart, when consequently this cause of the distention of the right ven-

(1) Helvétius, *Sur l'inégalité de capacite qui se trouve entre les organes destinés à la circulation du sang, dans le corps de l'homme, et sur les changemens qui arrivent au sang en passant par le poumon*, in the *Mém. de Paris*, 1718, p. 222-281.

(2) *Loc. cit.*, p. 34.

(3) *Loc. cit.*, p. 144, 145.

(4) *De dextro cordis ventriculo post mortem ampliore*, Altdorf, 1745.

(5) *Essais anat.*, p. 230, 231.

(6) *Sur l'inégale capacité des cavités du cœur et des vassieaux pulmonaires*, in the *Mém de Paris.*

(7) Lieutaud has brought forward this argument.

tricle did not exist, the capacity of the two portions has been exactly or nearly the same.(1) Finally, when the left ventricle is placed in the same condition by means of a ligature as is the right ventricle at the time of death; while on the contrary the blood is removed from the latter by cutting the pulmonary artery, or the vena cava, we find that the relation between the two ventricles is the inverse of that which commonly exists, that is, that the right ventricle is narrower than the left.(2)

The veins appear much larger than the arteries after death, undoubtedly from the same cause.

To these experiments we may add that we sometimes find the right ventricle narrower than the left from the effect of disease, such as ossification or some other malady of the valves of the aorta, in which case the difference must be explained precisely in the same manner. We have before us several preparations in which, beside a considerable dilatation of the left ventricle arising from this cause, there is at the same time a great contraction of the right ventricle, proving that the results drawn from these facts cannot be opposed, by saying that the dilatation of the right cavity of the heart in the usual state of things should extend also to the left portion from the influence which it exercises on the veins and arteries of the body, and consequently that the right half is really larger during life since the left is itself distended. Since the cause of the greater distention of the right portion, that is, the more difficult passage of blood through the lungs, supervenes only at the moment of death, the opinion that the right ventricle is also more capacious during life cannot be sustained.(3)

That the cause above mentioned is that which increases the capacity of the right portion of the heart at the period of death only, is proved by the fact that the difference between the two portions of the organs varies with the cause of death, and that it increases in a direct ratio with the increase of the obstacle to the circulation of the blood in the lungs. Thus, in those animals killed by drowning, hanging, and suffocation, Colman has found the right ventricle generally twice the size of the left, although its proportions commonly mentioned are much smaller.(4) In fact, Haller asserts that in one subject he found it three times as large as the left,(5) but the usual estimates are much less than this. Gordon says the relation is sometimes as 5 : 4,(6) Lieberkühn as 3 : 2,(7) Portal as 7 : 5,(8) Helvetius(9) and Legallois,(10)

(1) Weiss, *loc. cit.*—Sabatier, *loc. cit.*
(2) Sabatier, *loc. cit.*
(3) Haller, *Elem. phys.*, vol. ii. p. 134.
(4) *On suspended respiration from drowning, hanging, and suffocation*, London, 1791.
(5) *Loc. cit.*, p. 133.
(6) *System of human anat.*, vol. i. p. 38.
(7) Hamberger, *Physiologie*, p. 708.
(8) *Mém. de Paris*, 1770, p. 245.
(9) *Loc. cit.*
(10) *Dict. des sc. méd.* vol. v. p. 440.

as 6 : 5, Brown Langrish as 11 : 10.(1) Gordon has found the two ventricles nearly equal in some cases,(2) and Portal asserts that their capacity is the same in young people.(3)

These differences in the estimates of authors furnish a new argument against the common opinion, since we should presume that they depend on greater or less accidental obstacles to the pulmonary circulation.

We cannot however deny but that the capacity of the right portion of the heart is a little greater than that of the left, because the blood brought by the vena cava has received the fluid contained in the thoracic canal. It is also proved by the difference relative to the age in the degree of disproportion, this being, directly after birth, less than at a more advanced period of life.(4)

Legallois has also found the right portion of the heart a little broader than the left in every kind of death, both after strangulation and from the loss of blood.(5) The facts related prove only that the right portion of the heart can contract as much as, and even more than the left, in certain circumstances, and that the left is also susceptible of becoming larger than the right, but not that the capacity of the latter exceeds that of the former during life.

4th. The fibres of the right side, especially those of the ventricle, are not arranged in the same manner as those of the left side.

a. The thinness of the right ventricle is attended also with fewer fibrous layers, a fact already pointed out by Senac,(6) but which Wolff has indicated more precisely in saying that the right ventricle is formed of three layers only, while that of the left side presents six, counting the fleshy fasciculi of its internal face.(7) We have not however been able to find this number of layers. Usually we have observed on each side only three distinct layers, two oblique, and one internal longitudinal.

b. The fibres of the right ventricle are flatter and thinner than those of the left. Thus the former form flattened fasciculi, and the second rounded and thicker fasciculi. The latter ramify more; they are separated by fat, and have spaces between them, while we can hardly distinguish the former from each other except by the direction of their fibres.

c. The fibres of the right ventricle are more oblique and annular, while those of the left are more longitudinal.

d. The layers of the right ventricle, although thinner, are much more distinct than those of the left ventricle ; besides the latter are still

(1) *De part. corp hum. fabric.*, vol. ii. p. 133.
(2) *Loc. cit.*, p. 38.
(3) *Loc. cit.*
(4) Portal, *loc. cit.*
(5) *Tr. du cœur*, vol. i. p. 200.
(6) *De stratis fibrarum cordis in universum*, in the *Nov. act. Petrop.* vol. iii. an. 1785, p. 234-238.
(7) *Loc. cit.*, p. 234.

more similar in regard to direction, which doubtless contributes to make the left ventricle firmer, but proves at the same time that we should exercise some judgment in determining the number and direction of these layers. Such at least is the positive result of our researches. This also is the opinion of Wolff himself, who has studied the arrangement of the heart with too much exactness.

5th. The primitive form of the heart, that of a canal curved on itself, is more evident in the left ventricle than in the right.

6th. The nerves of the left side are larger and more numerous than those of the right side.

CHAPTER II.

SPECIAL REMARKS ON THE HEART.

§ 1304. We usually describe first the right half of the heart; and in order to follow the direction of the circulation of the blood, we begin with the right auricle.

I. RIGHT AURICLE.

§ 1305. The *right auricle* (*atrium anterius*, s. *venarum cavarum*, s. *dextrum*), forms that portion of the base of the heart situated farthest on the right and forward.

Its form is almost square; the vena cava superior descends obliquely from right to left, and from behind forward, towards its upper and right angle, and the vena cava inferior ascends in a contrary direction towards its lower and right angle. Notwithstanding this difference in the direction of the two venæ cavæ, we must admit that they unite and form a single trunk in the cavity of the auricle, for they unite on the right forward and backward, and the absence of the left side of their circumference is only apparent, since this side in fact exists, but is dilated to produce the muscular part of the auricle. The upper and left angle of the latter extends into a small blunt appendage, formed like a rounded square, which is observed before the lower part of the aorta. The lower and left angle is rounded.

We observe transverse fibres on all the circumference of this auricle, directly below the inner membrane of the heart, which, becoming thinner and separating from each other above and below, are prolonged for a small distance around the superior and inferior venæ cavæ. They are thinner where they surround the point of union of the two venæ cavæ forward, and are extended more uniformly, and are smoother on the right side, both on their outer and on their inner face.

But the left part of the posterior face of the anterior and unattached wall of the right auricle, which is the most extensive, is uneven internally. This unevenness depends on much larger and transverse fasciculi, which are united by other smaller oblique fasciculi, so as to present a reticulated appearance. These fasciculi, with which the transverse fibres of the auricle are united, appear between two longitudinal smooth bands which proceed only along its internal face. One of these two bands, the left, descends a short distance from the anterior part of the venous orifice of the left ventricle; the other, the right, situated almost in the centre of the anterior wall, a little however to the right, descends toward the left side, along the union of the two venæ cavæ. These fleshy fasciculi have been called the *pectinæal muscles* (*M. pectinati*).

The posterior wall of the right auricle forms the anterior face of the interventricular septum. We discover in it several remarkable parts, some of which belong to the history of the development of the heart.

On the right side and toward the centre is the *fossa ovalis* (*fossa ovalis*, s. *valvula foraminis ovalis*, s. *vestigium foraminis ovalis*), an oblong and rounded depression, which varies much in size. This fossa is very distinct from the posterior wall of the auricle at its upper part, a little less so on its sides, especially on the right, and is generally blended with it below, particularly on the right side. The more extensive it is, the less evident are the limits which separate it from the other parts of the posterior wall. It however not unfrequently presents a similar arrangement even when it is very small.

Most generally it exactly fills the space between the edges of the projection which surrounds it, and it is very tense, but not unfrequently it is much larger, and forms a valve, the loose edge of which corresponds to the left auricle. We almost always observe a greater or less depression above, between its extremity and the upper part of the projection which surrounds it. Very often also we see in this place one or more openings by which the cavity of the two auricles communicate. This arrangement is not constant, and it is entirely independent of the extent either of the valve or of the depression, although it occurs particularly when the valve is very broad. Even when the openings are large and numerous, they seldom descend below the central part of the projection which surrounds the depression, so that the septum of the auricles is complete in regard to the separation of the blood contained in the two cavities.

This place, especially in its upper part, is the thinnest portion of the septum and of the auricle generally. We however always observe muscular fibres between the two layers of the internal membrane of the heart, that of the right and that of the left auricle.

The projection which surrounds this depression is formed of reticulated muscular fibres. It is called the *ring* or the *isthmus of Vieussens* (*annulus*, s. *isthmus Vieussenii*). Its right portion separates the right and left halves of the septum. Although it does not project at its lower part, it is however complete in this place also.

We observe in its circumference several openings of the cardiac veins, called the *foramina of Thebesius* (*foramina Thebesii*). At the lower end of the inferior edge of the ring a circular fold of the inner membrane of the right auricle commences, this is called the *Eustachian valve*, or the *anterior valve of the foramen ovale* (*valvula Eustachii*, s. *foraminis ovalis anterior*).(1) This fold extends more or less to the right, along the anterior part of the orifice of the vena cava ascendens into the right auricle, so that its lower edge is concave and attached while the upper is convex and loose within the right auricle. It imperfectly separates below the right and left halves of the right auricle.

This valve varies much in regard to size, form, and texture. It is usually more perfect and proportionally larger in the fetus than at any time after birth. In the adult it is often entirely changed, at least at its upper part, into a reticular tissue, and in many cases some filaments only trace the valve, and these frequently do not exist. It usually contains some muscular fibres, but it is often only a simple fold of the internal membrane.

An intimate relation generally exists between the Eustachian valve and the fossa ovalis, the former being more developed in proportion as the septum formed by the latter between the two auricles is less perfect, and *vice versa;* but to this rule there are numerous exceptions.

The valve acts principally in the fetus. At this period of life it conducts the blood of the vena cava superior toward the opening of the septum or the foramen ovale. Hence the relation between it and the valve of this opening.

In the adult it may prevent to a slight degree the reflux of the blood from the vena cava superior, and from the right auricle generally into the vena cava inferior. Directly at the left side of the left branch of the isthmus of Vieussens, between this branch and the venous orifice of the right ventricle, there is a large and rounded opening, the orifice of the *large coronary vein of the heart* (*orificium venæ coronariæ cordis magnæ*).(2) This opening is sometimes divided more or less distinctly into several, and generally is more or less perfectly closed by a valvular fold, which arises at its lower part. This fold, called the *valve of Thebesius* (*valvula Thebesii*), has its upper and concave edge unattached, while its lower and convex edge adheres. Sometimes it does not exist; in other cases it is replaced by one or more imperfect transverse bands; finally, in some subjects there are several, even as many as six, situated one behind another.

(1) Winslow, *Description d'une valvule singulière de la veine cave inferieure, à l'occasion de laquelle on propose un sentiment nouveau sur la fameuse question du trou ovale, in the Mém. de Paris*, 1717, p. 272. *Eclaircissement sur un Mém. de* 1717, *Ibid.* 1725.—Haller, *De valvulâ Eustachii*, Gottingen, 1737.—L. Crell, *De valvulâ venæ cavæ Eustachianâ*, Wittenberg, 1737.—Brendel, *De valvulâ Eustachianâ inter venam inferiorem dextramque cordis auriculam positâ*, Wittenberg, 1738.—Haller, *De valvulâ Eustachii progr.* ii. Gottingen, 1748.—J. M. Diebolt, *De foramine ovali*, Strasburg, 1771.—J. F. Lobstein, *De valvulâ Eustachii*, Strasburg, 1771.—C. F. Wolff, *De foramine ovali ejusque usu in dirigendo sanguinis motu observationes novæ*, in the *N. C. Petrop*, vol. xx. p. 357.—H. L. Leveling, *De valvulâ Eustachii et foramine ovali*, in the *Obs. anat. rar fasc.* i. 1786.

(2) Wolff, *De orificio venæ coronariæ magnæ ;* in the *Act. Petrop.* 1777, p. 234-257.

II. RIGHT VENTRICLE.

§ 1306. The *anterior*, *pulmonary*, or *right ventricle* (*ventriculus anterior*, s. *dexter*, s. *pulmonalis*) is composed of an upper and lower portion, which are separated by the upper part of the venous valve. The former unites directly to the right auricle, the latter to the pulmonary artery, and its walls are thinner than those of the former. It terminates in a conical extremity, which projects upward and backward above the left ventricle and the septum of the heart. The pulmonary artery arises from this part.

The internal or posterior wall is formed by the septum of the heart and is slightly convex; the anterior is still more so. The posterior wall is smoother than the anterior at its upper portion and very often entirely so below the arterial opening. The net-work formed by the projecting muscular fasciculi is much more complete toward its summit than toward its base.

The anterior wall of the pulmonary ventricle is thinnest above toward the septum and thickest below also near the septum. Its thickness when the heart is strong and not very much distended is more than two lines, but less than this in the latter point. The two parts are scarcely a line thick even in those hearts which are neither very much distended nor small.

The quantity of blood in the right ventricle after death varies from one ounce and a half to three ounces.

§ 1307. The *venous valve* of the right auricle arises from the circumference of its venous orifice. It is called the *tricuspid valve* (*valvula triglochis, tricuspis*), because, although it forms a single membrane, it is higher in three points than in the short spaces between them, and thus three slips are formed.

Of these, one, which is the largest, arises from the external and anterior part of the circumference of the venous orifice. The other two are smaller and arise from the inner and posterior part of this circumference, one over the other; so that consequently there is an external and larger slip, and two internal, an upper and a lower slip.

The last two are separated from each other by a space not so deep as those between them and the external. It is then more correct to admit only two slips, an anterior and external and a posterior and internal.

The first is much higher than the second.

The tendinous filaments of the upper extremity of the anterior or external slip are attached to this upper part of the septum. They are few in number. We usually find in the space only one or at most two short muscles, to which are attached those filaments farthest to the left; the others are inserted in its smooth wall. Most of those filaments which come from the central and lower parts of the edge of this slip are attached to the summits of five or six of the fleshy pillars coming from the middle and lower parts of the anterior wall.

The filaments which arise from the posterior slips are mostly attached to the smooth folds of the septum, except a few, which are inserted in two or three small fleshy pillars, all of which except the lowest come from the septum.

The arterial orifice generally extends about three fourths of an inch higher than the venous. The sigmoid valves are thin. Their *tubercles* (*noduli Morgagnii*) are slight swellings, which however are often well marked in the young fetus.

III. LEFT AURICLE.

§ 1308. The *left*, *posterior*, or *pulmonary auricle* (*atrium sinistrum*, s. *posterius*, s. *venarum pulmonalium*, s. *aorticum*) is of an oblong square form, considerably more broad than high.

It is separated below and posteriorly from the left ventricle by a circular groove, upward and to the right from the right ventricle by a similar depression. The pulmonary artery, the aorta, and the vena cava superior are also found upward and outward, between it and the right ventricle; so that the external part of its right and left extremities is alone visible.

Its upper left angle rises into an auricular appendage (*auricula sinistra*), which goes forward to the left and upward, directly behind the pulmonary artery, separating very much from the rest of the auricle. This appendage, which is narrower, longer, and on the whole larger than that of the right auricle, is circumscribed by rougher edges. It curves three or four times and finally terminates in a sharp summit, below and before the pulmonary artery.

The posterior wall of the lower part, the *sinus of the auricle* (*sinus venarum pulmonalium*), receives where it is continuous with the lateral parietes the four pulmonary veins, two on each side, the upper being larger than the lower. One of the two veins of the same side opens directly above the other, while between those of the two opposite sides is the whole breadth of the auricle; so that the two pairs occupy the whole height of the posterior wall.

The parietes of the whole auricle are muscular and formed principally of transverse fibres. They are smooth with the exception of the appendage. We observe in its whole length an anterior and a posterior series of very prominent transverse fasciculi, united by other smaller and oblique fasciculi, which proceed between two longitudinal bands, situated one on the right the other on the left.

The anterior wall is formed by the septum of the auricles and is also, like the posterior face of the septum, irregular in another respect. In fact we there observe a constant semicircular valve, which is however more or less developed. This valve leaves the upper edge of the transparent point which corresponds to the fossa ovalis of the right auricle (§ 1305). It is turned upward and toward the left. Its lower edge is convex and attached, and its upper edge is loose in a greater or less extent. Sometimes there is only a slight projection in its place.

This valve extends behind the interauricular septum. Its lower edge is attached to the posterior face of the centre of the isthmus of Vieussens, and the space between it and this isthmus forms a small cavity (*sinus septi*), which terminates below in a cul-de-sac. This is only the upper part of the valve of the foramen ovale (§ 1305), which in the normal state always ascends on the posterior face of the isthmus. Of this we are readily convinced when it does not adhere to the isthmus in the centre; for then the continuity is totally uninterrupted.

IV. LEFT VENTRICLE.

§ 1309. The *left ventricle* (*ventriculus sinister*, *posterior*, s. *aorticus*) is the strongest of all parts of the heart and forms its figure. Its posterior wall and its anterior wall which forms the posterior face of the septum, are convex externally and concave internally; so that its whole form is oval. The internal face of the posterior wall is very much reticulated; the anterior wall is smooth at its upper part and reticulated in the lower, but less so than the posterior wall. The fleshy pillars are rounded.

The thickness of the parietes is less toward the summit and greater at the base than in all other parts. In the adult it is five or six lines thick at the base and only three at the summit.

The capacity of the left ventricle varies in the adult from eight to twenty drachms.

§ 1310. Before the round venous orifice we find the *mitral valve* (*valvula mitralis*), composed of an upper and a lower slip. The upper arises directly below or rather before the ring of the sigmoid valve of the aorta, and is attached by slips to three or four fleshy pillars, which all come from the internal face of the posterior wall of the ventricle, some above, others below, and among which we distinguish two particularly, an upper and a lower, which are much larger than the others. The inferior and external slip, which is much narrower, is attached by tendinous filaments to a short but very thick fleshy pillar.

All these fleshy pillars arise from the posterior wall of the left ventricle; so that those of the upper slip arise near the summit of the heart, and cover those of the lower, so that we cannot perceive the lower slip until we have removed the upper or have detached it from its fleshy pillars.

The orifice of the artery is situated directly over that of the vein. Its sigmoid valves are thick and are generally supplied with tubercles (*noduli Arantii*), which are very distinct.

V. SEPTUM.

§ 1311. In the normal state the septum of the heart completely separates its two halves, even when the valve of the foramen ovale is not united with the isthmus of Vieussens at its upper part. In the venous portion of the heart it is much thinner than the auricles, which it separates, and is much lower, as they project above it. It is not muscular in every part, and generally there are no muscular fibres in the upper part of the old valve of the foramen ovale.

In the arterial portion, on the contrary, the septum is very muscular and is formed almost entirely by the fibres of the left ventricle. It projects considerably into the right ventricle, while in its posterior face, which forms the anterior wall of the left ventricle, there is a deep depression. Its height equals that of the ventricles. It is triangular and terminates in a point toward the summit of the heart. It is generally from four to five lines thick, and even more than a half an inch thick in those parts where the large fasciculi project above the surface in those subjects which have large hearts. It is thickest below the orifices of the large arterial trunks, and thinnest beyond this point toward the interauricular septum. It is almost always weaker at the summit, where the layers which constitute it are less compact and more easily separated from each other.

CHAPTER III.

OF THE PERICARDIUM.

§ 1312. The *pericardium* (*pericardium*) (§ 1293)(1) is a fibro-serous membrane (§ 354), which entirely envelops the heart and the origin of the large vessels, and unites them with the adjacent parts.

The fibres which strengthen its outer layer and which are very apparent in old men, arise from the central aponeurosis of the diaphragm and extend longitudinally over the serous membrane. They are very much developed, particularly forward and upward.

Its lower face, which corresponds to the lower and flat face of the heart, is intimately united to the upper face of the central aponeurosis of the diaphragm by a very short cellular tissue.

It is covered on the sides and forward by the inner walls of the pleuræ.

Behind, it is attached to the esophagus and to the root of the right lung.

(1) J. M. Hoffmann, *Diss. de pericardio*, Altdorf, 1690.—A. B. Heimann, *De pericardio sano et morboso*, Leyden, 1729.—Lanzoni, *De pericardio;* in *Opp. omn.*, Lausanne, 1738.

§ 1313. The pericardium incloses not merely the heart but also the origins of the large vessels, whence it is reflected on itself in every direction to arrive at the centre of the heart.

When examined from before backward and from above downward, we notice the following arrangement:

It envelops the aorta and the trunk of the pulmonary artery forward for about two and a half inches, unites these two vessels very closely, and passes uninterruptedly from one to the other; so that the corresponding parts of their circumference are retained by a cellular tissue.

The posterior part of these vessels is not covered in the same extent by the pericardium.

From the aorta this membrane passes to the right on the vena cava superior, to about an inch above its entrance into the right auricle, descends obliquely from left to right on its anterior portion, then arrives at the right pulmonary veins, on which it descends to about half an inch from their entrance into the left auricle, then goes on the anterior part of the vena cava inferior, directly below its opening into the right auricle, and wholly surrounds it except a small part of its posterior portion. Thence it goes to the left, on all the surface of the left pulmonary veins, and finally covers the left branch of the pulmonary artery below.

From all these parts the pericardium is reflected on itself. It adheres feebly to the large vessels, but much more strongly to the auricles and ventricles.

As in all other serous membranes, the inner and reflected portion of the pericardium is thinner than the external. It closely envelops the surface of the parts inclosed by the membranous sac, and, except in those parts where it is reflected, it is entirely separated from the outer layer, although they touch; so that the circumference of the heart is perfectly loose and is attached only by its upper part.

CHAPTER IV.

OF THE DIFFERENCES OF THE HEART WHICH DEPEND ON THE DEVELOPMENT AND ON THE SEX.

§ 1314. The differences presented by the heart in regard to its development are considerable.(1) They relate to its *volume*, *situation*, *form*, and *texture*.

1st. *Volume*. The heart is much larger in proportion to the body in the early periods of life than at a more advanced period. The relation

(1) The principal works on this subject are mentioned in Danz, *Grundriss der Zergliederungskunde des ungebornen Kindes in den verschiedenen Zeiten der Schwangerschaft*, vol. ii. Giessen, 1793, p. 185-188.—See also Meckel, *Mémoire sur le développement du cœur*; in the *Journal complémentaire*, vol. i. p. 259.—Rolando, *Memoire sur la formation du cœur*; same journal, vol. xv. p. 323, vol. xvi. p. 34.

between it and the body is as 1 : 120 in the full grown fetus and in the early years of life, while before this period, in the second and third month of pregnancy, it is as 1 : 50.

2d. *Situation.* At first the heart is not oblique, but its summit looks directly forward and a little downward. It is only at the fourth month that it begins to turn slightly toward the left side.

3d. *Form.* The differences in its form are the most important and relate both to the circumference of the whole organ and to the mode of limiting its cavities. Observers have not decided whether there is or is not in the human fetus a period very near its origin, when the heart forms only a single cavity, composed of several compartments placed near each other. But if this period exists, it passes rapidly, since all the external parts are developed in the fetus at the end of one month.

A. OUTER CIRCUMFERENCE.

a. At first the arterial portion of the heart is much smaller in proportion to the venous. The right auricle especially remains for a long time the largest portion of this organ. The permanent relation however begins to establish itself during the last half of uterine existence.

b. The arterial portion is at first flat and rounded: soon however its breadth exceeds its length. Its summit is at first single and blunt; but as it enlarges it bifurcates. This phenomenon depends on the fact that the right ventricle from its situation does not at first concur to form the summit of the heart; but it gradually extends downward and remains separated from the left ventricle by a considerable depression. This groove sometimes continues during life, but almost always disappears after the middle of uterine existence.

c. The right ventricle is at first much smaller than the left: they are soon equal in size: for a certain time the right ventricle is even a little larger, but it becomes smaller during most of uterine existence; so that it is narrower in the full grown fetus and in the young child. The greater size of the right ventricle seems to result from the obstacles which often disturb the pulmonary circulation at an advanced period of life.(1)

(1) This at least has been observed by Portal (*Sur la capacité des ventricules du cœur;* in the *Mém. de Paris*, 1770, p. 244-246). In the heart of a full grown fetus the left ventricle contained seven drachms of water, while the right contained only six and a half. The capacity of the two ventricles was the same in that of a young child; in that of an adult the right ventricle contained eighteen drachms of water, and the left only seventeen. The experiments of Legallois (*Dict. des sc. méd.*, vol. v. p. 440,) prove that we can introduce

		grs. of mercury
In an adult, - - - - - - -	Into the right ventricle,	1172
	Into the left ventricle	1068
In a child, - - - - - - - -	Into the right ventricle,	828
	Into the left, not softened by pressure, - -	658
	Into the left, softened,	822

d. In the early periods of life the upper and pyramidal extremity of the upper part of the pulmonary ventricle is less distinct from the rest of the organ than at more advanced periods: it elevates itself also less above the left ventricle and the septum. This peculiarity is very curious, as precisely the contrary is seen in many mammalia, especially the ruminantia and the hog.

B. INTERNAL ARRANGEMENT OF THE HEART.

The principal difference presented by the heart in this respect is, that its septum is imperfect in the early periods of life, whence its right and left portions then communicate with each other.

a. The interauricular septum is perforated during all fetal existence by an opening called the *foramen ovale*. This foramen is much greater as the fetus is younger; so that we may consider the septum as primitively deficient and the two auricles then form a single cavity. The foramen ovale gradually grows smaller and occupies the lower and central part of the septum. The Eustachian valve is found very early directly before it and on the right, so as to occupy all its height. Hence as it arises from the anterior part of the circumference of the vena cava inferior, it separates the right and left auricle in such a manner, that this vein empties directly into the left auricle only. On the contrary, there is no trace of the closing of the foramen ovale on the left side till the commencement of the third month. But about this period this foramen begins to be obliterated by the formation of its valve, which arises from the posterior part of the vena cava.

		grs. of mercury
In a still-born child, - - - - -	Into the right ventricle,	34
	Into the left ventricle, not softened, - -	37
	Into the left, softened,	78
In a seven months' fetus, - - - -	Into the right ventricle,	23
	Into the left, not softened nor flaccid, - -	34
In another about the same age, - - -	Into the right ventricle,	21
	Into the left, softened,	54

In repeating these experiments, also with mercury, we have obtained the following results:

	R. ventricle		L. ventricle		L. auricle		R. auricle	
	oz.	drs.	oz.	drs.	oz.	drs.	oz.	drs.
In a man 50 years old, - - -	30		10		25		20	
In a woman 46 years old, - -	40		22	4	22		15	
In a woman 40 years old, - -	55		40		41		35	
In a man 34 years old, - - -	32		15	4	21		25	
" 30 " - - - -	32	4	28	4	25		22	4
" 26 " - - - -	28		20	4	20		18	
In a boy 16 " - - - -	41	4	21	4	37		29	
In a girl 7 months old, - - -	2	4	1	4	1	4	1	6
In a new born boy which had breathed,	1	6	2		1	6	1	2
In a still-born boy, - - -	1	4	2		together 4 ounces.			

As this enlarges, the Eustachian valve diminishes and recedes from the septum, while on the contrary that of the foramen ovale approaches it. The latter also becomes narrower and more tense, especially in the latter months of pregnancy; so that it closes the opening more exactly. The termination of the vena cava inferior in the heart suddenly changes, and this vessel empties itself no longer into the left auricle but into the right. This change is also favored by that which takes place in the situation of the heart, which varies so that its summit corresponds to the left; the right auricle is more than usually elevated above the vena cava inferior, at the same time that the Eustachian valve is removed from the septum and is carried forward.

The valve of the foramen ovale increases from below upward along the lateral edges of this foramen. At the sixth month of pregnancy it has already arrived at its upper part; it then passes beyond it; so that the interauricular septum is entirely filled, except a small space, which is no longer an opening but a very short canal, formed forward by the upper part of the ring of the foramen ovale and backward by the upper part of the valve.

b. It is not yet well demonstrated whether the ventricles, like the auricles, form at first only a single cavity without a septum, although the development of the heart in the animal series, and the deviations of formation of this organ lead us to this opinion. We have always found a trace of the interauricular septum at the summit of the heart, even in the youngest fetuses we could examine. During the first two months however, or at least till the middle of the second, this septum presents at its upper part a foramen, at first rather large, but it gradually diminishes, and is found below the origin of the large vessels, so that the two ventricles form only one, which is imperfectly divided into two portions. This opening is obliterated at the period when the artery which arises from the ventricles becomes double, instead of single, as it was at first; that is, when the pulmonary artery, which before was blended with the aorta, becomes a proper and distinct vessel. Its obliteration then much precedes that of the foramen ovale.

4th. *Texture*. The thickness of the parietes is much greater compared to the size of the cavities during the early periods of life than subsequently, and the greatest size of the heart then depends on this cause.(1)

The parietes on both sides are then equally thick. The difference which always exists afterwards, and which is scarcely perceptible even in a full grown fetus, does not begin to be developed till the second half of uterine existence.

The fibrous texture and the different layers of fibres are always more apparent at the early periods of life than at a more advanced age.

(1) Gordon is mistaken in saying that the parietes of the heart are proportionally thinner in the early periods of life than at a more remote period (*System of human anatomy*, vol. i. p. 53.)

5th. *Color.* The color of the heart is much brighter when the subject is younger.

No fat has as yet accumulated on the surface of this organ in the early periods of fetal existence; but this is generally the case with all parts of the body.

The pericardium is then proportionally thicker than at subsequent periods, and its internal or reflected layer adheres less intimately to the heart.

C. SEXUAL DIFFERENCES.

§ 1315. The only sexual difference seen in the heart is that it is proportionally a little larger in males.

CHAPTER V.

MOTIONS OF THE HEART.

§ 1316. The circumstances in the history of the motions of the heart, or in the heart in its active state, which deserve examination, are,

1st. The changes in its form.

2d. The succession and simultaneousness of the motions in its different parts.

3d. The relation between the cavities of the heart in its different states and the blood.

4th. The number of its motions.

5th. The changes in its situation.

6th. The duration of its motions.

7th. The conditions on which they depend.

§ 1317. 1st. The heart diminishes in contraction and enlarges in dilatation in every direction.(1)

2d. The auricles and ventricles contract and dilate alternately, so that the two auricles and the two ventricles execute the same motions at the same time.(2) The auricles in contracting send the blood into

(1) *Sur le changement du figure de cœur dans le style*, in the *Mém. de Paris*, 1731, hist. p. 33, 40.

(2) The motions of the heart have been carefully analyzed by Laennec with the aid of the stethoscope, by which we can study them more correctly than by opening and inspecting living animals (*De l'auscultation médiate*, vol. ii. p. 195-227). From this analysis are deduced numerous important practical facts.

In the motions of the heart we must consider their extent, its impulse, the nature and intensity of the sound and the rythm, according to which the different parts of the organ contract.

1st. *Extent.* In a healthy and moderately fleshy subject, the pulsations of the heart are heard only in the space between the cartilages of the fifth and sixth true ribs, and under the lower part of the sternum. Those of the left cavities correspond principally to the first point, and those of the right to the second. If the sternum is short, we hear the pulsations in the epigastrium also. When the subject is so fat that the ventricles, which then contract on it, and throw it into the arteries at their base. A small quantity of the fluid however always returns from the arteries into the ventricles, from these into the auricles, and thence into the veins which open into them.

3d. The cavities of the heart are almost entirely empty when they contract. However a little blood always remains, which is attached especially to the reticulated surface of their inner face.

4th. When the ventricles contract the apex of the heart beats against the anterior wall of the chest, notwithstanding that the organ shortens. This arises principally because that the auricles are then filled, both by the blood disgorged by the veins and by that which

they cannot be felt by the hand, the space in which they can be heard by the stethoscope is sometimes only about a square inch. In thin persons, when the chest is narrow, and even in children, they always have more extent. They may be heard in the lower third, or even in the three lower fourths, of the sternum; sometimes also, under all this bone, at the left anterior and upper part of the chest to near the clavicle, and sometimes, but less manifestly, under the right clavicle. The subject rarely enjoys perfect health when the extent of the pulsations exceeds these limits, so that they are heard in the left side of the chest, from the axilla to the region corresponding to the stomach; and to a similar extent on the right side, at the left posterior part of the chest; finally, on the right posterior part, a successive progress, which would seem to be constant, and which is attended with a progressive diminution in the intensity of the sound. In this respect we may state as a principle, that the extent of the heart's pulsations is directly as the feebleness and the thinness of its parietes, especially those of the auricles, and inversely as their force and thickness.

2d. *Impulse of the heart.* In contracting, the heart gives a sensation of percussion, raising or repelling the hand, or any other part placed upon the anterior walls of the thorax. In some individuals this impulse is visible, and sometimes causes a very extensive motion, which raises the parietes of the chest, the epigastric region, and even the clothing. It is however but slightly marked when the proportions of the heart are normal, and is often imperceptible in fat people. It is perceptible only during the systole of the ventricles. If the contraction of the auricles sometimes produces a similar phenomenon, it may be distinguished from the first, inasmuch as most generally it consists only in a kind of rumbling, which is heard very deeply in the mediastium. This impulse is generally perceptible only between the cartilages of the fifth and sixth true ribs, or, at most, in the lower half of the sternum, and in some subjects, when the sternum is very short, in the epigastrium. Generally speaking, it is inversely as the extent of the pulsations, and directly, as the thickness of the ventricles.

3d. *Nature of the sound.* On listening attentively we distinguish during the pulsations of the heart two distinct sounds: one, duller and continued; the other, quicker, and more distinct. The first is simultaneous with the pulsations of the arteries and marks the contraction of the ventricles; the second is caused by the contractions of the auricles. That heard at the lower part of the sternum belongs to the right cavities; that distinguished between the cartilages of the fifth and sixth ribs depends on the left cavities. In the normal state, this noise is similar and equal on both sides; and is no where so loud as in the precordial region. It is as much stronger as the parietes of the ventricles are thinner, and as the power of impulse of the heart is less.

4th. *Rythm.* The duration of the sound caused by the auricles is shorter than of that produced by the ventricles; hence, the contractions of the auricles do not continue as long as those of the ventricles. There is a well marked but short interval of rest between these two sounds. This observation proves that the heart, like all other muscles, is alternately in a state of action and of rest. We may admit, that of the twenty-four hours, the ventricles have twelve and the auricles eighteen hours of rest; in supposing also that the cavities of the heart are entirely passive in their dilatation. In fact, Laennec admits that in the most general state of the whole duration of time in which the successive contractions of different parts of the heart, occur, a third at most, or even a quarter, is occupied by the systole of the auricles; a fourth, or a little less, by absolute rest, and a little more than a half by the systole of the ventricles. F. T.

flows back from the ventricles, so that the latter are pushed forward; but it depends also a little on the extension of the arterial trunks at the moment when the arterial blood which is sent from the ventricles passes through them.(1) From not attending to these last two circumstances it was for a long time impossible to explain the pulsations of the heart during its contractions, except by admitting that it lengthened in performing this motion, which is very improbable.

5th. The mean number of pulsations of the heart in the adult is seventy per minute. But it varies much according to the individual. The pulsations are generally more feeble and fewer in the female. If we except the early periods of life when the contractions of the heart are few, the number of its pulsations is much greater the nearer it is to the period of its formation.

6th. We generally consider the heart as that part in which irritability continues the longest. But it follows from the observations of Haller, Zimmerman, and Oeder, that there are exceptions to this law; and the observations of Fontana, Crève,(2) and Nysten,(3) with which our own agree, demonstrate that this is not true, at least to the arterial portion, since the ventricles lose their irritability before the other muscular parts of the body; but the auricles preserve it the longest,(4) and that the right auricle remains irritable longer than the left. Haller has attempted to prove that this latter difference depends on the circumstance that the right auricle is stimulated longer by the blood within it,(5) but we have often seen it in hearts which were removed from the chest and totally destitute of blood. Nysten has observed it also in persons who were beheaded. We then have reason to say it depends on the greater tenacity of life in this part of the heart, and the more as the tenacity increases in animals in a direct ratio with the predominance of the venous system in them.

7th. The conditions of the action of the heart are the same as those of muscular action generally. For this then we refer to the details already mentioned in the first volume.

(1) When the ventricles contract, the point of the heart strikes the left lateral wall of the chest, between the cartilages of the fifth and sixth ribs. The two causes mentioned by the author, the filling of the auricles and the extension of the trunks of the arteries, doubtless contribute to produce this phenomenon; but we may admit also that while the ventricles contract, their moveable point rises, and performs the motion of a pendulum on the base of the heart, which, being more fixed, serves as a point of support. F. T.

(2) *Vom Metallreize*, Leipsic, 1796, p. 100.

(3) *Recherches de physiol. et de chimie*, Paris, 1811, p. 307.

(4) As Davy observed in experiments for another purpose. See his *Researches on nitrous oxide*, London, 1800, p. 352.

(5) *De cordis motu a stimulo nato*, in the *Comm. Gott.*, vol. i.

CHAPTER VI.

OF THE HEART IN THE ABNORMAL STATE.

§ 1318. The anomalies of the heart are divided into two sections, according as they affect the form or the texture of this organ. We shall mention here only the first, having spoken of the latter in the first volume, when treating of the alterations in the texture of the vessels, of the muscles, and of the serous membranes.

§ 1319. The deviations in the formation of the heart embrace anomalies which may exist in number, situation, volume, and figure.

§ 1320. In regard to number, the heart may vary from the normal state in two opposite modes, that is, may be either wholly or partially deficient, or may have supernumerary parts.

The heart is entirely absent only when the upper half of the body is very imperfectly developed, and the head is then usually deficient. However, this rule presents but rarely exceptions of two kinds: for, first, the heart sometimes appears when the head does not exist;(1) and secondly, this organ is sometimes wholly(2) or partly deficient(3) in monsters where the trunk and head are not very much deformed. We shall speak of the partial absence of the heart hereafter.

The plurality of the heart, the body being simple, is infinitely more rare, however common it may be when the body is double, but is not seen constantly even in the latter case. We know of but one instance of a perfect plurality of the heart where the body was single. We are led to this anomaly by the fissure of the ventricles and by the congenital existence of abnormal and hollow appendages to the heart.(4)

§ 1321. The anomalies in the situation of the heart are congenital or accidental. In the first case the organ exists sometimes within, and sometimes outside of the cavity of the thorax.

When found in the chest it may be,

1st. Straight, and then either perpendicular, or horizontal, or finally placed so that its summit looks upward.(5)

2d. Reversed, having its base to the left and its summit to the right, an anomaly which exists singly or which is attended with the more or less perfect inversion of the other organs.(6)

(1) We have collected all the instances of this anomaly in our *Handbuch der pathologischen Anatomie*, vol. i. p. 165.

(2) See our *Handbuch der path. Anat.*, vol. i. p. 414. Besides the cases there mentioned, two have been published since; one by Brodie (*Phil. Trans.* 1811), and the other by Lawrence (*Méd. Chir. Trans.*), vol. v.

(3) Rœderer, in the *Comment. Gott.*, vol. iv.—Meckel, *Handb. der path. Anat.*, vol. i. p. 421.

(4) We have collected all the cases of this anomaly in Meckel, *De duplic. monstrosâ*, p. 53, and *Handb. der path. Anat.*, vol. ii. p. 33-45.

(5) Meckel, *Handb. der path. Anat.*, vol. i. p. 418.—Bertin in his work has figured a heart which was situated transversely in the cavity of the thorax.

(6) One case of this kind now before us has been figured in Meckel, *De conditionibus cordis abnorm.*, Halle, 1802, vol. i.

3d. Deeper than usual.(1)

When it exists out of the chest two cases are possible.

1st. The anomaly being slight the heart hangs loosely outward, either in its usual place(2) or higher than it is generally, in the cervical region.(3) In this case the pericardium is usually but not always deficient. On the other hand it sometimes but very rarely happens that this membrane is not found even when the heart is situated in the chest, and then it is replaced by the pleura.(4)

2d. The anomaly existing in a greater degree which is also still more rare, the heart is found in the abdomen,(5) a deviation of formation to which the very sloping situation of this organ in the pectoral cavity leads.

The accidental anomalies in the situation of the heart depend on the accumulation of solids or liquids within the chest or the penetration of foreign bodies there, and follow no constant and fixed laws.

§ 1322. Anomalies in the volume of the heart are congenital much less frequently than accidental. They however sometimes have the character of a primitive formation, and are even hereditary in many families. The heart is then too small or too large. We often find both of these anomalies in the different parts of the same heart.

The smallness of the heart(6) is much more rare than its excess in volume. It is often carried to an extreme point although the formation of the organ is unchanged.(7)

As to the excessive size of the heart, we must distinguish the pure and simple increase in its mass, the thickening of its parietes,(8) from the thickening of its parietes with an increase in its capacity,(9) and from its simple dilatation or an increase in its capacity(10) with or without a thinness of its parietes, since we find all these states sometimes insu-

(1) Meckel, *Handb. der path. Anat.*, vol. i. p. 417.

(2) *Id. Ibid.* vol. i. p. 406.

(3) *Id. Ibid.* vol. i. p. 98, 99.

(4) See our *Handb. der path. Anat.*, vol. i. p. 110.

(5) Deschamps has mentioned an instance of this in Sedillot, *Recueil pĕriodique*, vol. xxvi. p. 275-279.

(6) We have mentioned several cases in our *Handb. der path. Anatomie*, vol. i. p. 470-472.

(7) Consult also, on the wasting of the heart, Laennec (*De l'ausc. Méd.* vol. ii. p. 291), and Bertin (*Des mal. du cœur*, p. 387). The latter admits two kinds; one where the walls of the heart are collapsed, the other where the same parietes, especially those of the ventricles, are, on the contrary, dilated, and at the same time become thinner; this is the state termed passive aneurism. F. T.

(8) Different instances of the simple increase of the mass of the heart have been reported by Vetter, *Aphorismen aus der pathologischen Anatomie*, p. 99.—Legallois, in the *Bullet. de l'Ec. de Méd.*, 1813, 1814, p. 69.—Morgagni, *Ep. anat. med.*, 30 to 20.—Burns.

(9) We find several cases of it in Morgagni, *Epist. anat.* 18 to 28, and 30.—Corvisart, *Malad. du cœur.* p. 61.

(10) Many instances of this anomaly are mentioned in Burns.—Morgagni, *Epist. anat.*, 18 to 2, and 14.—Dundas, *On a peculiar disease of the heart*, in the *Med. surg. Trans.*, vol. i. p. 37.

lated and sometimes united.(1) The last two are termed *aneurisms of the heart*, which in the first case is called *active*, and *passive* in the second. The active aneurism is more common on the left side and the passive on the right. These two states usually coexist, the left side being dilated actively, and the right side passively, to a greater or less degree.(2) Sometimes the parietes of the left side have only become thicker, and those of the right side are on the contrary thinner, with or without dilatation at the same time.(3) However it often happens that one part or the other is diseased, each in its

(1) This distinction neglected by Corvisart who understands by the terms *active aneurism* and *passive aneurism* only a dilation of the heart with a *thickening* or *thinness* of its parietes, was made by Bertin in 1811, in a memoir presented to the Institute. Bertin admits three distinct *forms of hypertrophy* of the heart, that is, of its total or partial fleshy thickening: 1st, *simple hypertrophy*, in which the cavities of the organ preserve their natural capacity, at the same time that the parietes are more or less thickened: 2d. *aneurismal hypertrophy*, in which the cavities are dilated and the parietes are thickened; this is the *active aneurism* of Corvisart: 3d, *concentric hypertrophy*, in which the thickening of the parietes is attended with a greater or less contraction of the cavities. He also distinguishes two kinds of *aneurismal hypertrophy;* one in which the parietes are thickened, and the other where the parietes preserve their natural thickness, so that the increase takes place in some measure according to the extent and the circumference, or according to the surface. He has also remarked, that in the hypertrophy of the ventricles the thickness often diminishes from the base to the point, but it is sometimes about the same at the point as at the base, and in some cases is more marked in its centre, and diminishes toward the point and even toward the base. It may be equal to fifteen lines, and more, although Laennec asserts that it never exceeds four or five lines. Sometimes we find in the same ventricles one portion which is dilated and thickened, and another contracted and thickened, or one part thin, while the other is thick. We sometimes observe a great difference between the parietes of the ventricles, especially on the right side, and the fleshy pillars, the latter being doubled or tripled in extent, while the parietes are not, or but very slightly, thickened. In other cases, the hypertrophy of the left ventricle seems to take place at the expense of the pillars, which are effaced or are hardly visible. The hypertrophy of the left ventricle is generally attended with that of the septum. We sometimes observe also a hypertrophy of the interventricular septum only. The fleshy pillars of the right ventricle have been found so thickened and intercrossed that there was hardly any cavity. Hypertrophy also often affects both ventricles at once, but not unfrequently they present an opposite state. The point of the thickened ventricle always descends lower than that of the other. The three forms of hypertrophy are observed in the auricles, but the aneurismal is the most common. The thickening is nearly equal in all the extent of the parietes, especially in the left auricle. The muscular fasciculi of the right auricle sometimes increase in volume. Finally, in certain cases, the parietes of this auricle are so much thickened in all their parts, that they imitate those of the corresponding ventricle. Again, whatever may be the form of the hypertrophy, Bertin admits, as its immediate and proximate cause, an irritation applied to the heart, which increases the activity of the phenomena of nutrition in this organ (*Des maladies du cœur*, p. 282). He admits also three kinds of dilatation of the heart, or to proper aneurism: 1st, dilatation, with thickening of the parietes, or *aneurismal hypertrophy;* 2d, dilatation, with thinness of the parietes; the *passive aneurism* of Corvisart, which is more rare than the preceding; 3d, dilatation of the cavities, they being of their usual thickness, or simple dilatation, which has not hitherto been regarded. To these three classes he adds a fourth, which is doubtful; the mixed dilatation, in which the parietes of the dilated cavity are thicker in some parts and thinner in others, and of their natural thickness in the rest. (*Ibid.* p. 368.) Consult also, on hypertrophy of the heart, Lallemand, *Observations pour servir à l'histoire des hypersarcoses du cœur*, in the *Archiv. gen. de méd.* vol. v. p. 520. F. T.

(2) Morgagni, *Ep. anat.*, an. m. 40 to 23.—Testa, *Mal. del cuore*, iii. c. xv.

(3) Morgagni, *Ep. anat.*, m. 30 to 20.

usual manner.(1) The disease does not necessarily effect an entire half. Generally, passive aneurism exists only in the right auricle, and active aneurism only in the left ventricle, whether these two states exist alone, or whether they are both found in the same heart. Sometimes however, but rarely, the right side is entirely or partially thicker than usual, or at the same time dilated ; and then sometimes the left side is also affected and sometimes it is not : sometimes also it presents a passive aneurism, or at least its walls have become thinner. Perhaps the passive aneurism is still more rarely confined to the left ventricle, while all the other parts of the heart are in the normal state.(2)

These affections are confined to one part of the heart only, much more generally than they are extended to the whole of it. Nevertheless, if we except the active aneurism of the left side, combined with the passive aneurism of the right side, which is frequently observed, we sometimes find hearts which are affected equally in every part.(3)

The diseased cavity of the heart is most generally dilated in its whole extent. A partial dilatation in the form of a cul-de-sac rarely exists.

The substance of the heart is sometimes, but very rarely, thicker in some parts from round excrescences which project on its internal face. We know of but one instance of this arrangement, and the specimen is in our cabinet. This is still more curious, as it throws much light on the formation of the polypi of the heart, which are explained with difficulty unless we admit that one or more of these excrescences are detached from their place of origin.(4)

§ 1323. The anomalies in the form of the heart relate either to its external or to its internal arrangement, or finally to both.

They are congenital much oftener than accidental.

§ 1324. The congenital anomalies in the external form are,

(1) We find instances of the active aneurism of the left ventricle in Lancisi, *De rep. mort.*, p. 137.—Lafaye, in the *Mém. de Paris*, hist., p. 29.—Corvisart, *Journ. de méd.* vol. xi. p. 257.—We find cases of the passive aneurism of the right ventricle only in Fleury, *Bull. de l'Ec. de méd.*, 1807, p. 124.—Morgagni, *Epist. anat.*, m. 18 to 6.

(2) We find one case in Corvisart, p. 99.

(3) Different cases which prove this proposition, both in respect to the simple thickening of the parietes, and also to passive aneurism, are mentioned in Vetter, *loc. cit.*, p. 99.—Burns.—Morgagni, *Ep. anat.*, m. 18 to 2, 28, 30, ep. 53 to 9.—Corvisart, p. 61, 87.—Testa, *loc. cit.*, vol. iii. ch. xvi. a. 7, 8, p. 361-367.

(4) Laennec relates several cases of this abnormal arrangement (*De l'auscultation mediate*, vol. ii. p. 344) which he terms *globular excrescences* of the heart, and which he compares to the excrescences of the valves. Meckel's mode of explaining them cannot be maintained. Bertin (*loc. cit.*, p. 444) not only admits with Corvisart, Testa, Burns, Creysig, and Laennec, that *polypi*, or rather *fibrinous concretions*, may form, during life, in the heart, as in all other portions of the sanguineous system; but he also adopts Kreysig's theory, and regards them as resulting from an effusion, which occurs after inflammation of the inner membrane of the heart. These concretions are most generally free from all adhesions, at least organic ; but sometimes also they are perfectly organized, and have numerous vessels injected in bright red or black. This important fact, of which Bouillaud has published two remarkable instances (*Obs. et cons. nouv. sur l'oblitér des veines*, in the *Arch. gén. de méd.*, vol. v.

1st. The form of the *heart* is more rounded; this is sometimes met with alone, but is usually attended with several other anomalies already mentioned, or which remain to be described, as prolapsus, perpendicular position, &c.

2d. The deep fissure of the summit of the heart, to which our remarks on the preceding anomaly apply.

The accidental anomalies in the external formation are principally the *solutions of continuity*, which must not be confounded with those which are congenital, for the latter implicate the inner form, and they consist essentially in anomalies of the connection of the two portions of the heart.

Solutions in continuity of the heart are *fissures* or *wounds*.

Fissures(1) occur most generally after those pathological changes which supervene in the substance of the heart itself, or in the arterial trunks. They less commonly depend on external injuries, which do not directly affect the substance of the heart, but act either on the parietes of the thoracic cavity, or on the organs within it.

1st. The changes in the substance of the heart giving rise fissures, are produced principally by *inflammation*, *ulceration*, and *gangrene*,(2) which soften this substance,(3) and gradually destroy it in one or more parts, so that there is finally a solution of continuity during the systole or the diastole. One can imagine that this species of fissures is equally frequent in all parts of the heart.

2d. Those on the contrary which depend on morbid changes supervening in the arterial trunks occur in some points more frequently than in others, and are probably more common in one sex than in the other.

p. 95, and 101), throws great light on the theory of the formation of polypi of the heart, inasmuch as we can no longer doubt that their organization takes place in the same manner as that of the false membranes, and depends on the same cause. F. T.

(1) Bland, *Mémoire sur le déchirement sénile du cœur*, in the *Bibliothèque médicale*, vol. lxviii. p. 364.—Rostan, *Mémoires sur les ruptures du cœur*, in the *Nouveau journal de médicine*, vol. viii. p. 265.—A. J. L. Bayle, *Observation de rupture du cœur*, in the *Revue médicale*, vol. iii. p. 96.—Carrier, *Observation sur une double rupture des parois du ventricule gauche du cœur*, in the *Journ. univ. des sc. médicales*, vol. xxxv. p. 358.

(2) Although, strictly speaking, gangrene of the heart is not impossible, it is at least so rare that those observers in whom the fullest confidence can be placed have not seen it. Thus Corvisart does not hesitate to say that no well authenticated case of it exists. Most of the facts which have been reported, being stated in a faithless manner, should be received only after strict examination and admitted with distrust. Such is the very wise opinion of Bertin (*Des malad. du cœur*, p. 408), who thinks that these facts should be considered as acute softenings of the heart rather than real gangrenous affections. F. T.

(3) Laennec first called the attention of pathologists to softening of the heart, of which he admits two species, one where the substance of the organ is more deeply colored, and the other where it is discolored, or rather has a whitish or yellowish tinge (*De l'auscultation*, vol. ii. p. 186). He asserts that he has found this softening in all cases of fevers called *essential*, when he has attended to them. He does not however consider this as a character of inflammation. Bertin thinks it is caused by inflammation of the heart, which is acute when it is of a deep red or even brownish, and chronic, when the muscular tissue of the organ is discolored and becomes pale or yellowish. F. T.

Thus the part of the heart most frequently ruptured is the left ventricle, and this accident is more common in the male than in the female, because the ossification of the valves and the contraction of the arterial orifice, which is a consequence of it, are observed in the left more frequently than in the right, and in the male oftener than in the female. When this occurs, the substance of the heart is thinner less frequently than it is thickened and hardened.

The normal difference between the right and left portions of the heart also accounts for the greater frequency of the fissures on the left side, since the right side is less tense and more extensive than the other.

The normal arrangement of the heart explains also why fissures occur in one part of the ventricles rather than in another.

This point is commonly the place where the arterial trunk unites to the ventricle,(1) because there is no continuity in this place between the fibres of the heart and those of the arteries.

The place where fissures occur most frequently, next to this, is the apex of the heart, as there the substance of the organ is thinnest.

Contusions of the chest or the forcible penetration of foreign bodies, as of musket-balls, also tear the heart, even when the parts surrounding this viscus are uninjured.

Besides these fissures, which are visible externally and which pass through the heart entirely, there are others which are much less frequent, and where either the tendons of the venous valves or the fleshy pillars are detached from their points of insertion. The latter almost always result from violent efforts or emotions.(2)

Wounds of the heart are or are not attended with the presence of the wounding body. In both cases they pass through all the substance of the organ or affect only its surface. Wounds attended with the presence of the foreign body are seen principally after musket-wounds, when the ball, not having power enough to pass through the heart, remains within it or probably insinuates itself by degrees, the wound cicatrizing behind it as it advances. In both these cases the individual has sometimes survived so severe an injury, but this is rare.(3)

(1) This assertion is not correct. Ruptures of the heart occur always, or most generally, toward the apex and the anterior part, that is, in the thinnest part. In this respect, Rostan has observed that the disproportion of the diameter is such, that often, when the diameter of the upper part of the ventricle is sixteen or eighteen lines, which he asserts is the greatest development which it can attain, the apex is only two lines thick. Bayle has mentioned, that of nineteen instances of rupture of the heart, fourteen existed in the left ventricle, principally its anterior face near the apex, three in the right ventricle, one in the apex, and the other in the interventricular septum. In most of the cadavers the heart was remarkably soft, and in some cases a brownish color was observed around the perforation. These two circumstances support Bertin's opinion, who (*Des maladies du cœur*) thinks that the preceding erosive inflammation plays an important part in these perforations, as in those of the stomach and intestines. F. T.

(2) Corvisart, *loc. cit.*, p. 256, *De la rupture partielle du cœur.*

(3) We find an instance of the first case in the *Dict. des sc. méd.* vol. iv. p. 217, and one of the second in Penada, *Saggi sc. di Padova*, vol. iii. part 2, p. 59.

Penetrating, cutting, or pricking wounds are always and almost immediately mortal.(1) In order to conceive of a contrary case, we must admit that the wounding instrument penetrates gradually.(2)

§ 1325. Most of the deviations in form in the inner parts of the heart are congenital. They comprise, 1st, those which cause no derangement except in the circulation of the blood; 2d, those which derange the formation of the blood.

§ 1326. The deviations of form in the first class consist principally in the abnormal arrangement of the several orifices of the heart.

Among these are:

1st. *The abnormal narrowness of the venous orifices of the ventricles.*(3) This anomaly occurs most frequently on the left side, and is not rare. The mitral valve is then always thickened, more or less hardened, and often ossified. It is very doubtful if this anomaly ever be congenital. At least it is not so generally.

2d. *The abnormal narrowness of the arterial orifices of the ventricles.* This congenital aberration occurs most frequently on the right side, and almost always results from a contraction, often also from an adhesion of the valves.

(1) Wounds of the heart are generally mortal after a few moments, or at most some hours. Some wounded persons have been known to survive one or five, seven, thirteen, seventeen, and twenty days, after penetrating wounds. See the surgical part of the article *Cœur*, by Begin, in the *Diction. abrégé des sc. médic.*, vol. iv. p. 493. F. T.

(2) Although it did not form a part of our author's plan to speak of the alterations in the texture of the heart, we think it necessary to say a word upon its hardening, the theory of which appears to be intimately connected with that of its hypertrophy, its polypi, and its softening, that is with its irritation more or less approaching to the degree usually considered as inflammation. General hardening of the heart has not yet been noticed; but it may be more or less extensive and sometimes invade an entire half of the heart. It is often confined to the internal or external face, where it is presented under the form of incrustations. The fleshy columns and the septum may also be the exclusive seat of it. It presents several degrees. Simple hypertrophy is the first and ossification the last. There are different shades between these two extremes; sometimes the substance of the heart, of a bright red color and almost healthy in appearance, resembles in hardness a fibro-cartilage, and resists or grates when cut: sometimes it presents a cartilaginous density and solidity: again it is still harder and sounds like horn, as Corvisart says; sometimes it resembles earth or sand (Bertin, *Des mal. du cœur*, p. 401). Ossifications of the heart are not rare in man. Meckel has collected several instances in his *Dissertatio de cordis conditionibus abnormibus*, Halle, 1802, and in his *Manual of Pathological Anatomy*. It is curious that in many animals, especially in the ruminantia, there is very often a bone in the heart. This has long been known in regard to the ox and the stag. See on this subject Keuchen, *Diss. de ossiculis e cordibus animalium*, Groningen, 1772.—Jaeger, *Ueber des Vorkommen eines Knochen im Herze des Hirsches;* in the *Deutsches Archiv für die Physiologie*, vol. v. p. 113.—F. S. Leuckart, *Bemerkungen über den Herzknochen des Hirsches;* same journal, vol. vi. p. 136.—We think it worthy of mention, however, that Masuyer has found 1,7 of phosphoric acid, 2 of uric acid, 3 of animal matter, 5,3 of lime, in twelve grains of the ivory substance coming from the ossification of the valves of the heart, from its external face at the base of the right ventricle, and from the aorta, and also from the large branches which arise from it (*Journal de la société des sciences, agriculture, et arts, de Strasbourg*, 1824, No. 3). The presence of uric acid in this case is remarkable as an analogy with what is seen in arthritic concretions. F. T.

(3) Abernethy, *On a diminution in consequence of disease of the area of the aperture, by which the left auricle of the heart communicates with the ventricle of the same;* in the *Med. chir. trans.* vol. i. p. 27.

3d. *The deficiency or adhesion of the valves*, especially those of the arteries, sometimes occurs, and is not generally congenital but accidental. The absence of the valves is caused by their destruction by suppuration, and their adhesion results from inflammation and ossification.

4th. *An excess or deficieney in the number of the valves,* which is seen particularly, but yet seldom, in the pulmonary artery, and much less frequently in the aorta. We find four valves more commonly than two.

§ 1327. The essence of the deviations in form of the second division is an abnormal communication between the systems of red and black blood. They have no influence on the formation of blood, or when they possess it, the arrangement is such that the black blood becomes less venous or the red blood less arterial. In both cases the abnormal union of both the systems of blood may take place in very different parts.

1st. The abnormal communication of the first kind depends,

a. On the insertion of one, of several, or of all the pulmonary veins in the vena cava superior. We have a case of this kind before us.

b. On the existence of an accessory pulmonary artery, which arises from the ascending aorta.(1)

2d. The abnormal communications of the second kind occur either between the auricles, or the ventricles, or in the large vascular trunks. Many or all these anomalies are not unfrequently combined in the same subject.(2)

a. The most simple form is a single heart, consisting of one muscular cavity.

b. Next follows the formation where only one auricle and one ventricle exist, whence a single vessel, the aorta, arises, from which the pulmonary artery branches off, while the pulmonary veins open into the auricle, or even, by a formation still more abnormal, into the vena cava superior.

The formation is more perfect when the heart is divided by a septum into two halves, and the aorta and the pulmonary artery arise by separate trunks, but the septum is imperfect.

c. In this case the septum of the ventricles and of the auricles is perforated and the foramen ovale is open, which is the case most frequently; or,

d. Only the septum between the ventricles is perforated, a more unfrequent formation; or,

e. Only the foramen ovale is open; this is the most usual.

(1) We have collected all the known cases of this anomaly, in the *De monstrosâ duplicitate*, p. 55, and in *Handb. der pathol. Anat.*, vol. ii. p. 134.

(2) The different degrees and in general most of the species of this class of anomalies are described in our *Handbuck der pathol. Anat.*, vol. i. p. 422-470, vol. ii. p. 133, 134.—Farre, *Pathological researches, Essay* 1, *On malformations of the human heart*, London, 1814.—J. C. Hein, *De cordis deformationibus quæ sanguinem venosum cum arterioso misceri permittunt*, Gottingen, 1816.

The septum of the ventricles is perforated generally in one determinate place, viz. the base; so that sometimes the aorta, sometimes but more unfrequently the pulmonary artery, arises from both ventricles: in the latter case the aorta arises as usual, but forms only an ascending portion, and terminates in the left subclavian artery, and the descending aorta comes entirely from the pulmonary artery.

The interauricular septum is frequently developed imperfectly, that is, its formation has not followed the course mentioned above (§ 1305), but the pressure of the left auricle can then complete it; so that the passage of the blood from this auricle into the right becomes impossible. Sometimes however, but more unfrequently, from the absolute or relative smallness or deficiency of the valve of the foramen ovale, this opening is so large, that the right and left auricles communicate freely. This continuance of the foramen ovale is more unfrequent than the perforation of the septum, although its imperfect closure, produced in the manner stated above (§ 1305), is an anomaly still more frequent than this.

The abnormal arrangements of the large vascular trunks, which render the hematosis imperfect, are,

f. The obliteration or the considerable contraction or deficiency of the pulmonary artery, states which commonly but not always attend one of the anomalies mentioned above.

g. The continuance of the arterial canal, which seldom occurs alone, but is generally attended with one of the anomalies already described or which remain to be mentioned.

h. The existence of a second pulmonary artery, which arises from the right ventricle and terminates in the aorta. Finally,

The transposition of the origins of the arterial or venous trunks, viz.

i. The origin of the pulmonary artery from the left and of the aorta from the right ventricle, while the venous trunks empty themselves in their proper places.(1)

k. The insertion of the veins of the body into the left portion of the heart, or into the pulmonary veins, or frequently into the pulmonary artery. This occurs in different ways. We have before us a preparation where the large coronary vein of the heart, instead of terminating in the right portion, opens into the left auricle of the heart. In another case, the vena azygos is divided near the heart into two branches, one of which goes to the right, the other to the left auricle. Sometimes the pulmonary arteries evidently anastomose with the azygos vein.

The physiological influence and importance of these anomalies are not the same.

In the first point of view, we may state it as a principle, that the first six arise because the formation of the heart is arrested at an early period of development, and because it is a repetition of the formation of the

(1) Tiedmann has described and figured a case of this anomaly in the *Zeitschrift für Physiologie*, ch. i. p. 111, pl. 7, fig. 9.

heart in some of the lower classes of animals, particularly the crustaceous animals, the mollusca, and the reptiles. The others are normal in no period of life, but belong to the class of anomalies which affect the quality of the organs.

Hence also why the former are more frequent. The influence on the hematosis is much more injurious, the greater the mixture of the black and red blood: it is very slight either when the abnormal communication is merely by the small vessels (*k*), or when the communication is interrupted by the arrangement of the parts at the moment when it might be injurious: this occurs in most cases where the foramen ovale becomes open. The derangement is very great in other cases.

The effects which result from them are, frequent recurrence of asthma, extreme weakness of the voluntary muscles, great debility in the nervous system, often a defect in nutrition and development, and a blue color of the body. Death usually supervenes in the early periods of life, although in a few rare cases the patient has lived till the age of fourteen. At certain periods, especially during dentition and at the age of puberty, the symptoms recur more frequently and with greater violence. The cause of these symptoms and the essence of the derangement is, the mixture of venous with arterial blood and the distribution of this mixed blood in the body; they arise sometimes, as for instance when the pulmonary artery is entirely closed or does not exist, or when the pulmonary artery arises from the left ventricle and the aorta from the right ventricle, because the organs of the body receive pure venous blood.

From the blue color of the skin, which depends upon the venous blood not being changed into arterial blood,(1) this disease has been termed *cyanopathia* (*morbus cœruleus*, *cyanopathia*, *cyanosis*).(2)

(1) Bertin has very properly remarked that this explanation cannot be admitted, for three reasons: 1st, because cyanosis did not exist in cases where the right and left heart communicated; 2d, because it did exist in other cases where this communication did exist; 3d, because that if the blue color of the skin was produced by this deviation of formation, it ought to exist also in other parts, which is not the case. Besides, as Fouquier justly remarks, the skin of the fetus, in which only black blood circulates, is not blueish. Bertin thinks then that the blueish color of certain parts, in different individuals where the two hearts communicated, depends on the stagnation of the blood in the right cavity and in the venous system, which is in a manner gorged with it; this explanation seems more rational, inasmuch as this anomaly in the formation of the heart is often attended with a contraction of the orifices or of the pulmonary arteries. F. T.

(2) Kwiatkowski, *Diss. actiologiam morbi cærulei amplificans*, Wilna, 1816.—Hein, *Diss. de istis cordis deformationibus quæ sanguinem venosum cum arterioso misceri permittunt*, Gottingen, 1816.—J. F. Meckel, *Essai sur les vices de conformation du cœur qui s'opposent à la formation du sang rouge*; in the *Journ. complém. des sc. med.*, vol. iii. p. 224-301.—Gintrac, *Observations et recherches sur la cyanose, ou maladie blue*, Paris, 1824.—Louis, *Observationes suivies de quelques considerations sur la communication des cavités droites avec les cavités gauches du cœur*; in the *Archives génerales de medecine*, vol. iii. p. 325, 485.

SECTION II.

ARTERIES OF THE BODY OR OF THE SYSTEM OF THE AORTA.

CHAPTER I.

GENERAL EXPLANATION OF THE SITUATION OF THE TRUNK.

§ 1328. The aorta arises most generally and with but few exceptions by one single stem from the upper part of the left ventricle. At its origin the fibrous membrane is much thinner than in the rest of its extent; but it is not entirely destitute of this membrane, the thinness of which is supplied by the muscular fibres of the heart, which extend some lines over the valves of the aorta, and the triangular spaces which exist between them. At its base are three sinuses, which correspond to the valves. It goes to the right, first its right side, and then the whole artery passing behind the pulmonary artery, which covers its origin: it comes afterwards on the right side of this artery, and describes a curve before the vertebral column, which is called its *arch* (*arcus aortæ*). The transverse portion of this arch, the part between the right and left sides, is situated opposite the third and fourth dorsal vertebræ.

At the origin of the arch the aorta is entirely inclosed in the pericardium; but it gradually leaves this membranous sac; so that most of the arch is entirely loose. We observe on the left the pulmonary artery, which proceeds along the lower part of the arch of the aorta, behind it the right branch of this artery, on the right the vena cava superior, and in front the sternum.

In old age, the lower and ascending part of the arch of the aorta is more or less dilated: it does not form a perfect cylinder; but it advances farther and projects more to the right than in early life. This change probably depends on a mechanical cause,—the continual impulse of the blood.

The central part of the arch of the aorta is situated before the lower extremity of the trachea, and the curve terminates behind the left branch of the pulmonary artery and the bronchia of the same side, in which place the direction of the artery changes and proceeds from above downward.

The ascending part of the arch is situated on the right of the vertebral column, the transverse portion directly before it and the descending portion on the left: the latter is situated in the posterior mediastinum.

The trunk of the aorta remains on the left of the vertebral column in all its extent.

The *ascending* portion of the aorta in the cavity of the thorax, called the *thoracic aorta* (*aorta thoracica*), is directly covered on the left by the inner wall of the left pleura, on the right by the esophagus, and forward first by the left bronchia, then by the posterior part of the pericardium.

At the diaphragm the aorta separates from the esophagus behind, passes through a special opening in this muscle (*hiatus aorticus*)(§ 1072), comes into the abdomen, and is called the *abdominal aorta* (*aorta abdominalis*). The latter descends as far as the fourth or fifth lumbar vertebra, where it divides into two branches. It is attended on the right by the vena cava inferior, rests behind on the lumbar vertebræ, and is covered both before and on the left by the peritoneum.

Above and below, it divides in an analogous but not in the same manner, since it gives off, 1st, at its two extremities, the vessels which go to the extremities; 2d, and besides, at the upper extremity, the carotid arteries; 3d, at the lower extremity those which supply the pelvic viscera with blood.

The vessels of the thoracic and abdominal viscera, and most of those which are distributed to the parietes of the thorax and abdomen, arise directly from the part between its two extremities.

That part of the aorta between its origin from the heart and that of the left subclavian artery (§ 1335), is called the *ascending aorta* (*aorta ascendens*), the remaining, the *descending aorta* (*aorta descendens*).

§ 1329. The aorta rarely varies from this general arrangement. Nevertheless it may, in the following modes :(1)

1st. The slightest aberration is when the aorta goes backward too soon, passing immediately on the right bronchia.

Then it sometimes reaches the left side, gliding behind the esophagus and the trachea, as we have observed ;(2) sometimes it remains on the right in a greater or less extent of the vertebral column, for instance, to the base of the chest.

This anomaly may be considered as the first degree of the lateral inversion of the aorta, in which its arch curves more or less from left to right instead of describing its usual curve from right to left.

The arteries which arise from it are also modified in a similar manner; for we sometimes find four trunks; sometimes an innominata trunk exists on the left side and two other trunks on the right.

2d. The anomaly is greater when the trunk of the aorta tends to divide. This deviation of formation presents several degrees.

(1) O. Bernard, *Diss. de arteriarum e corde prodeuntium aberrationibus*, Berlin, 1818.

(2) This anomaly has been seen also by Abernethy (*Phil. trans.*, 1793, p. 59-63), and twice by Caillot (*Bullet. de l'Ec. de Med.*, 1807, p. 21-28).

a. Sometimes the aorta is single at its origin; but, some inches farther, it divides into two trunks, which pass one before, the other behind, the trachea, and afterwards unite to give rise to the descending aorta, forming in this manner a ring around the air passage. Hommell has described a curious case of this kind.

b. A greater degree of this deviation of formation exists as in the case reported by Malacarne.(1) In fact the aorta is single at its origin; but from this point even, its increased size, its oval form, and its five valves, indicate a division which occurs almost immediately. The two branches on the right and on the left give off, first the subclavian, then the external carotid, and finally the internal carotid, artery; they remain distinct from each other for about four inches, and then they unite to form the descending aorta.

This division of the largest artery of the body is curious in this respect, that it is evidently a repetition of the formation of reptiles, a class of animals in the different orders of which these anomalies constitute the normal state. It leads also to the third kind of anomaly.

3d. In this species of anomaly there is no arch. The aorta divides at its origin into two trunks, one right and ascending, which produces the subclavian and carotid arteries; the other descends and is the pectoral and abdominal aorta.(2)

§ 1330. The aorta presents anomalies not only at its origin, but also in the rest of its course. Thus, the lower extremity of the arch is sometimes very much contracted(3) or entirely closed(4) in a slight extent; and although the artery does not divide in this place into two large trunks, the circulation however continues by collateral vessels, which are very much enlarged.

Similar anomalies are observed also, but less frequently, in the lower part of the aorta. Thus sometimes the artery bifurcates higher than usual, to give rise to the primitive iliac arteries, which, before they divide into two large trunks, communicate by a transverse branch.(5)

CHAPTER II.

ARCH OF THE AORTA.

§ 1331. From the arch of the aorta, or from the ascending aorta, arise first, the coronary arteries of the heart; next, at a certain distance from them, the arteries of the upper extremities and of the head, which come from its upper and transverse part.

(1) *Osserv. di chirurgia*, vol. ii. p. 119, tab. i. f. 1, 2.—*Auctuarium obs. et. icon. ad osteol.* Padua, 1801, tab. iii.
(2) *Abhandlungen der Joseph. Akademie*, p. 1. tab. vi.
(3) Paris, in Desault, *Journ. de. chir.*, vol. ii. p. 107, 110.
(4) Steidele, *Sammlung chirurgischer Beobachtungen*, vol. ii. p. 114, 116.—Graham, in the *Med. chir. trans.*, vol. v. no. xx.—Cooper, in Farre, *loc. cit.*, p. 14.
(5) Petsche, *Syllog. obs. anat. select.*, § 77.

ARTICLE FIRST.

I. CORONARY ARTERIES OF THE HEART.

§ 1332. The *coronary* arteries (*A. coronariæ, cardiacæ*) arise directly above the origin of the aorta, and normally above the upper edge of the semilunar valves, so that their orifices, which correspond to the central part of these valves, are not closed when these valves are pressed against the parietes of the aorta. There are usually two, and not unfrequently three; the third, which is generally smaller than the others, then arises, not above a special valve, but above and very near one of those to which the other two correspond. We once have found four coronary arteries, of which the two supernumerary arteries were much smaller than the others, and only branches prematurely detached from them.

A single coronary artery is much more rare. We have seen this anomaly which however is indicated by the less distance between the origins of the two arteries in some subjects, or in the extreme smallness of one of these vessels, the branches of which are entirely replaced by those of the other.(1) The existence of one coronary artery is curious, as it establishes a relation with the normal formation of the elephant.

But however this may be, each ventricle has a coronary artery which almost exactly corresponds to it.

§ 1333. The *right*, *upper*, or *anterior coronary* artery (*A. coronaria anterior*, s. *inferior*, s. *dextra*) is generally but a very little larger and rarely smaller than the left. It arises from the anterior part of the aorta, above the anterior valve, passes under the pulmonary artery, between the upper part of the right ventricle and the right auricle, being covered by the latter, goes forward to the right, and downward in the groove at the base of the heart, turns around the pulmonary auricle, and thus arrives at the lower face of the heart, and terminates in the inferior groove of its septum.

In its course it gives off at right angles, both on the right and left sides, several branches, which are often very much curved.

The right branches are smaller and are distributed to the right auricle; the left, which are larger, go to the right ventricle, and descend longitudinally on its surface to its apex.

The longest of these descends in the inferior groove of the septum, where it anastomoses by several branches with the left coronary artery.

Other ramifications always exist, which are smaller, and are distributed on the anterior part of the left ventricle, and also commu-

(1) Barclay (*loc. cit.*, p. 6) has seen the right coronary artery so small that it did not extend to the left as far as the septum, and was replaced on this side by the transverse branch of the left coronary artery.

nicate with those of the left coronary artery on the flat side of the heart.

This artery belongs principally to the right half of the heart.

§ 1334. The *left*, *upper*, or *posterior coronary* artery (*A. coronaria sinistra*, s. *superior*, s. *posterior*) is generally smaller than the preceding, and arises between the left auricle and the posterior side of the pulmonary artery, almost always above the left sigmoid valve. It descends on the left, between the auricle and the pulmonary artery, and having attained the groove at the base of the heart divides into two or three larger branches.

Of these one, which is anterior and longitudinal, soon separates into several considerable branches, and descends along the upper groove of the septum to the apex of the heart. In its whole course it gives off branches which anastomose with those of the right coronary artery on the upper face of the right ventricle. Some of the large branches which come from it are distributed on the upper face of the left ventricle.

The second branch, which is transverse, goes backward in the groove at the base of the heart, below the left auricle, and gives several branches, which go to the upper face of the left ventricle. The largest descend along the smooth posterior edge of the heart, some on its upper and others on its lower face.

Finally, the left coronary artery terminates by several small branches, which disappear on the lower face of the left ventricle.

These ramifications, like the preceding, anastomose with the other branches of the left coronary artery and with those of the right which meet them.

ARTICLE SECOND.

OF THE ARRANGEMENT OF THE LARGE TRUNKS WHICH ARISE FROM THE UPPER PART OF THE ARCH OF THE AORTA.

§ 1335. From the upper transverse part of the arch of the aorta arise the trunks which carry the blood to the head, the neck, the upper and anterior part of the chest, the upper extremities, and partly to the pericardium, the mammary glands, and the lungs.

There are usually three trunks, which arise a few lines distant from each other, the *common trunk*, or the *innominata* artery (*truncus communis*, s. *innominatus*), from whence arise the right subclavian and the right carotid arteries, the *left subclavian* and the *left carotid* arteries. The *innominata* artery is situated farther to the right and in front of the others; the left carotid artery in the centre and a little farther back; finally, the left subclavian artery most on the left and farther back than the other two.

After birth, the origin of the left subclavian artery sometimes but not always occupies the highest part of the arch of the aorta, while in the fetus it arises the lowest. So likewise in the fetus the innominata artery occupies the highest part of the arch of the aorta.(1) The innominata artery, in ascending from left to right, is situated in front of the trachea. It is separated from the vertebral column by the longus colli muscle, and from the sternum by the sterno-thyroideus and by the left subclavian artery at its side. It is most generally an inch long, rarely longer: sometimes however it is two inches long, and then the trunk reaches the inferior edge of the thyroid gland.

The left carotid artery arises more perpendicularly on the left side along the trachea.

The right carotid and right subclavian arteries are shorter than the synonymous arteries on the left side.

The diameter of the vessels of the two sides is the same, or at least those of the right side are but little larger than those on the left.

The innominata artery usually arises at the side of the left carotid artery; the left subclavian artery arises from the aorta, at some distance from the latter; but the interval between them is not always very great.

The abovementioned arrangement is the most common; we may then consider it as the normal arrangement. Frequently however, at least once in eight times,(2) the number of the trunks given off from the arch of the aorta varies. This number may be increased or diminished. In the former case, vessels, which are generally branches, arise directly from the arch of the aorta; in the latter case, one of the three primitive trunks or frequently all of them are blended with each other and form but one.(3)

(1) Sabatier first pointed out this difference. (See his *Memoire sur les changemens qui arrivent aux organes de la circulation du fœtus lorsqu'il a commence à respirer*; in the *Mem de l'Institut; sc. phys. et math.*, vol. iii. p. 342.) We are however satisfied, by numerous observations, that it is not by any means constant. Thus most anatomists have disregarded it. Portal even asserts the contrary (*loc. cit.*, p. 185), for he states "that the trunk of the left subclavian artery opens into the aorta a little lower than the other two trunks."

(2) Bichat's assertion that "the arrangement of these arteries is but slightly subject to variation" is incorrect. Haller makes almost the same statement, and with no more foundation. Nor is Barclay more correct in asserting that "the cases are rare where a vertebral artery, a thyroid, a thymic, a pericardiac, or an internal mammary arise from the arch." Only the anomalies of the internal mammary artery are rare.

(3) Besides all insulated descriptions of the anomalies in the trunks which arise from the arch of the aorta, we may consult the following works, in which this question has been specially examined, and in a more or less general relation:—Bœhmer, *De quatuor et quinque ramis ex arcu aortæ provenientibus*, Halle, 1741.—Neubauer, *Descriptio anatomica arteriæ innominatæ et thyroideæ imæ*, Jéna, 1772.—Huber, *De arcus aortæ ramis*; in the *Act. Helvet.*, vol. viii. p. 68-102.—Walter, *Sur les maladies du cœur*; in the *Nouv. Mém. de Berlin*, 1785, p. 57.—Malacarne, *Oss. sopra alcune arterie del corpo umano nello stato preternaturale e nello stato morboso*; in the *Osservaz. di chirurgia*, ii. Turin, 1784, p. 119.—Ryan, *De quarumd. arteriarum in corp. hum. distributione*, Edinburgh, 1810.—Koberwein, *De vasorum decursu abnormi*, Wittenberg, 1810.

§ **1336**. The number of the primitive trunks is increased more frequently than diminished. Most frequently we find four trunks, one more than the normal number.

This anomaly does not always occur in the same manner.

§ **1337**. Our observations on this subject are principally as follow:

1st. Most generally the left vertebral artery, which is normally a branch of the subclavian artery, arises directly from the aorta. This is the most common anomaly.(1). Notwithstanding the abnormal origin of the left vertebral artery from the arch of the aorta, the number of trunks is not increased; because at the same time the left carotid artery passes to the right and becomes a branch of the innominata artery. This arrangement is remarkable, for it announces an effort tending to bring the anomaly to the normal type of formation.

2d. After this variety, the most common is that where the inferior thyroid artery, or a portion of it, which is always the thyroid portion, arises from the arch of the aorta. This anomaly occurs on the right side more frequently than on the left, and this vessel then arises, like the left vertebral artery, between the innominata and the left carotid artery.

Besides these, we sometimes see coming from the arch of the aorta, in no determinate place, and most generally a little before the large trunks, and not on the same line with them,

3d. A *thymic* artery (*A. thymica*), or

4th. An *internal mammary* artery (*A. mammaria interna*).

Less frequently, four trunks arise from the aorta, when the right subclavian artery comes directly from the arch of the aorta. We here find many differences.

5th. The *right subclavian artery* arises farthest to the right, or

(1) Bichat is also incorrect in saying that this anomaly is more rare than an increase in the number of the trunks of the aorta by a most inferior thyroid artery. Sabatier goes even farther, for he does not mention it at all, although he states several other anomalies which increase the primitive trunks of the arch of the aorta (*Anat.*, vol. iii. p. 7). Portal also is silent in regard to it and only mentions the division of the trunk of the innominata among the causes which increase the number of the arteries given off directly by the arch of the aorta (*Anat. med.*, vol. iii. p. 155). In fact, in another place he states that the left vertebral artery arises directly from the aorta; but he adds, contrary to what is the fact, that this arrangement is very rare. Monro does not mention it when treating of the anomalies of the trunks which arise from the arch of the aorta (*Outlines*, vol. iii. p. 276, 278), although he speaks of them when treating of the varieties of the subclavian artery (*loc. cit.*, p. 301). Sœmmerring, on the contrary, very properly seems to regard it as the most frequent anomaly, and mentions it as the first case where four arteries arise from the arch of the aorta. Boyer (*Tr. d'anat.*, vol. iii. p. 41) asserts, that the origins of the left vertebral and of a most inferior thyroid artery are equally common and just as frequent. It has been asserted that this anomaly was more rare in the south of Germany than that of the origin of the right subclavian artery directly from the aorta. We are satisfied from observation that this is incorrect; and we cannot agree to it, because other anatomists of great authority, particularly Haller (*Ic. an. fasc.* vi. p. 1), Neubauer (*loc. cit.*, p. 287), Sœmmerring and Boyer (*loc. cit.*, p. 25), assert exactly the contrary, and it is refuted by comparing the number of known cases which mention the different anomalies in the trunks of the arch of the aorta.

6th. This, which is much more common, arises farthest to the left, below the left subclavian artery.

Between these two formations there are several degrees; for the right subclavian artery arises

7th. Between the right and left carotid arteries; sometimes

8th. Between the left carotid and the left subclavian artery.

Of these five anomalies, in all of which the right subclavian artery is insulated from the right carotid, the second is undoubtedly the most frequent. When it exists, the right subclavian artery generally passes between the esophagus and the trachea, seldom before the latter, and goes to the right arm.

9th. This division of the innominata artery is sometimes attended with the transposition of both carotid arteries; so that

10th. First the left, then the right carotid artery, next the left subclavian artery, and finally the right subclavian artery arise; or

11th. Both of the carotid arteries and the right subclavian artery arise in their normal places, but the origin of the left subclavian artery is farther to the right.

But the separation of the right subclavian artery from the right carotid does not necessarily increase the number of the trunks; for then both carotids are usually blended into one trunk, an arrangement to which may be applied our remarks upon the analogous union occurring when the vertebral artery arises directly from the arch of the aorta.

§ 1338. More rarely five trunks arise directly from the arch of the aorta. When this occurs,

12th. The aorta gives off, besides the usual three trunks, the left vertebral artery, and the right internal mammary artery; (1) or,

13th. It gives off a right inferior thyroid artery, (2) or, the innominata artery divides into the right subclavian and right carotid artery, the former arising farthest on the right; and besides,

14th. The left vertebral artery, (3) or the right inferior thyroid artery, (4) arises directly from the aorta; or,

15th. The right subclavian artery arises below the left, at the same time that the trunk of the innominata is divided into the subclavian and carotid arteries, and that the left vertebral artery arises directly from it. (5) Finally, sometimes, although seldom, instead of three trunks,

16th. We have six. The aorta then gives origin to the right subclavian and carotid arteries, separately; the right vertebral artery arises between them, and the left vertebral artery springs directly from

(1) Bœhmer, *loc. cit.*; in Haller, *Coll. diss.*, vol. ii. p. 453.
(2) We have seen this anomaly twice.
(3) Loder, *Nonnull. arter. variet.*, Jéna, 1781.
(4) Petsche, in Haller, *Coll. diss.*, vol. vi. § 44.
(5) Koberwein, *De decursu vasorum abnorm.*, Wittenberg, 1813.

the arch of the aorta, between the left carotid and subclavian arteries. (1)

§ 1339. The number of the trunks is diminished in several modes.

17th. The left carotid artery is a branch of the innominata, or,

18th. It arises by a common trunk with the subclavian artery of the same side; or,

19th. The first trunk divides into the two carotid arteries, the second into the two subclavian arteries; or,

20th. The right trunk is the right subclavian artery, the left is the common trunk of the left subclavian and the two carotid arteries.

The last anomalies are as rare, as the first is common. Our observations have proved that the latter and the distinct origin of the left vertebral artery, are the most common.

§ 1340. Sometimes, when the number of the trunks is neither increased nor diminished, their arrangement varies from the normal state. Abnormal unions and divisions then exist, of which the principal are

21st. The innominata artery is divided, but the two carotids arise by a common trunk, which is implanted in the arch of the aorta, between the two subclavian arteries.

22d. The innominata artery is divided, on the right side into the subclavian and carotid arteries; but on the left side, both of these arteries arise by a common trunk. The preceding formation leads then to a total inversion of the origin of the vessels.

23d. The innominata artery is divided, but we find a common trunk for both carotid arteries, and 2d, one for the left, and 3d,, one for the right subclavian artery, which then arises farther from the left side than usual, most generally below the left, and goes to the right upper extremity, passing before or behind the trachea, and most commonly the esophagus.

24th. The innominata artery also gives off, besides its usual branches, the left carotid artery; but the left vertebral artery then arises directly from the arch of the aorta, between the other two trunks.

§ 1341. Finally, the least possible anomaly is where only the relative situations of the larger trunks which come from the arch of the aorta are changed: they are,

1st. The trunks arise uncommonly near each other. The left carotid artery then most generally approaches the innominata. This anomaly makes the transition to the union of the two carotids into one. Again, but more rarely, the left carotid artery separates from the innominata, while the left subclavian artery approaches it. This anomaly leads to another case which is rarer, where the left carotid and left subclavian arteries arise by a common trunk.

(1) This anomaly has been seen by F. Muller, formerly demonstrator at Copenhagen, who communicated it to me.

Sometimes also the three trunks are so near each other, that they in fact arise from the same surface, or form but one stem. This anomaly evidently makes the transition to that where the aorta divides, directly after its origin, into an ascending and a descending trunk.

2d. The distance between the origin of the trunks is sometimes unusually great. Thus we have found in a child two years old, the left carotid artery nearly an inch distant from the innominata; the left subclavian artery was also nearly an inch from the left carotid; the arch of the aorta was extremely sharp, and the left carotid artery arose from the angle formed by the union of the right and left portions.

ARTICLE THIRD.

PRIMITIVE CAROTID ARTERY.

§ 1342. The *primitive* or *common carotid* artery (*Carotis primitiva s. cephalica*) ascends along the trachea, which generally separates that of the right and left sides. It usually extends to the upper extremity of the larynx, where it bifurcates, at some distance from the angle of the lower jaw, and seldom behind it. It is situated very superficially, especially its central part, so that it is most easily found there. It is covered before by the sterno-cleido-mastoideus, the sterno-hyoideus and the omo-hyoideus muscles; the internal jugular vein and the pneumogastric nerve are on the outside, and a little in front of it; the latter is situated between the two vessels; inside are the trachea, the larynx, the thyroid gland, and also the esophagus; behind it is the cervical portion of the great sympathetic nerve, the longus colli and rectus capitis major muscles, and the inferior thyroid artery, which separate it from the vertebral column. The inferior thyroid artery seldom passes before it. The primitive carotids are generally situated on the two sides of the trachea, the right a little more forward than the left; but sometimes, particularly at their lower parts, they are placed somewhat before this canal. The right carotid artery assumes this arrangement, especially when the innominata arises unusually far on the left, and the left when it arises from this trunk. In both cases the arteries cross the interior face of the trachea. These anomalies should be known, as they endanger the carotid arteries in the operation of tracheotomy.

The primitive carotid is inclosed with the internal jugular vein and the pneumogastric nerve, in a very firm cellular sheath.

§ 1343. From the primitive carotid artery arise only small and inconstant vessels, which go to the surrounding parts, but sometimes, and not unfrequently, it gives off, especially on the right side, the superior or the inferior thyroid artery, either wholly or partially; the latter is more common. The origin of the inferior is, in this case, towards the lower part; that of the upper, near the upper end of the artery.

§ 1344. The common carotid artery divides, generally as high as the upper edge of the thyroid cartilage, into two branches, one of which, the *internal carotid*, supplies the brain and the eye, while the other, the external carotid, belongs to the upper part of the neck, the skull and the face. It sometimes bifurcates much higher up, opposite the upper extremity of the styloid process, but not till it has given off the larger of the longer branches of the external carotid.(1) This arrangement is very analagous to that where the primitive trunk does not divide into two large branches, but having given off the branches of the external carotid artery.(2) This anomaly consists evidently in the premature division of the trunk, while its branches are given off too soon. In some few cases the division extends much farther, and attains even the trunk of the primitive carotid. This trunk then begins to divide very soon, and it sometimes bifurcates, opposite the sixth cervical vertebra, but the two branches remain connected with each other.(3)

The distance between the place of bifurcation and the thyroid cartilage is the same at all periods of life: (4) but the distance between the bifurcation and the angle of the lower jaw is much greater in the child than in the adult, on account of the development of the teeth, so that during early life the two large inferior branches are loose for some distance.

These two branches ascend almost perpendicularly. Below they are situated directly at the side of each other. The internal is at first more superficial than the external carotid, but it afterwards becomes deeper. Their proportional volume is not always the same. The differences depend partly on the age, partly on the distribution of the external carotid artery.

In the first respect, the internal carotid artery is always larger than the external in infancy, on account of the size of the brain: in the second, the external is larger than the internal carotid in the adult, when it gives off the superior thyroid artery, and smaller than it, on the contrary, when the latter comes from the prmitive carotid.

I. EXTERNAL CAROTID ARTERY.

§ 1345. The *external carotid* artery (*Carotis externa*, s. *facialis*, s. *A. pericephalica*) ascends under the posterior belly of the digastricus muscle of the lower jaw, is situated between the ear and the ascending branch of the lower jaw, where it is entirely covered by the parotid gland, and divides at the neck of the lower jaw into a superficial branch, which is the *temporal* artery, (*A. temporalis*) and a deeper seated

(1) Burns, *Surgical anatomy*, Edinburgh, 1811, p. 95, 96.
(2) Idem, *ibid.*, p. 95.
(3) Idem, *ibid.*, same page.—We regret that the author does not say whether the anomaly existed on the two sides or only on one side, (perhaps the left?)
(4) Idem, *ibid.*, p. 379.

branch, the *internal maxillary* artery. (*A. maxillaris interna.*) But it always gives off large branches, before it bifurcates. These branches generally detach themselves gradually, one after another. Sometimes, however, the external carotid artery forms a short trunk, which divides directly above the bifurcation of the primitive carotid into the large inferior branches, and the broad continuation of the trunk.

§ 1346. Before bifurcating, the external carotid artery gives off branches principally in three directions: forward, backward, and inward.

A. ANTERIOR BRANCHES.

§ 1347. The anterior branches are the *superior thyroid* artery, the *lingual* artery, and the *facial* artery.

1. SUPERIOR THYROID ARTERY.

§ 1348. The *superior thyroid* artery (*A. thyroidea superior*) is the lowest branch of the external carotid artery. Its origin varies: it generally arises some lines above the bifurcation of the primitive carotid; but it not unfrequently detaches itself at the bifurcation, or below, and even from the trunk of the primitive carotid; sometimes an inch below its bifurcation.

Its size also varies, and it is in the inverse ratio of that of the inferior thyroid artery. When the latter is entirely deficient, the superior is much larger than usual; it is on the contrary very small, when the inferior thyroid artery is very large, or when the lowest thyroid artery exists.

Sometimes, but unfrequently, it arises by a common trunk, with the lingual artery, and in some subjects this trunk comes from the primitive carotid.

On the other hand, we not unfrequently find the superior thyroid artery double, because the branches which it generally gives off are detached lower than usual. The arrangement and size of the left and right thyroid arteries vary; sometimes one of them is deficient, while the other is very large.

§ 1349. When the artery does not arise much lower than usual, nor from the primitive carotid, it always descends inward and forward, being at first slightly concave above, and very tortuous. It sometimes gives off a large branch immediately after arising, which detaches itself from its posterior and inferior part, and goes to the sterno-cleido-mastoideus muscle. It then soon divides into an upper and a lower branch. Sometimes it bifurcates near or even at its origin.

The *upper* or *laryngeal* branch (*ramus laryngœus*) arises from the external carotid artery, according to our observations, once in eight times. It goes downward, forward and inward, on the thyroid cartilage, and frequently gives branches to the omo-hyoideus, the sterno-hyoideus, the sterno-thyroideus, the hyo-thyroideus and the crico-thyroideus muscles, which come sometimes from the lower branch, or directly from the external carotid artery: furnishes a large anastomotic vessel which goes across the cricoid cartilage, and unites with the branch given off by the synonymous artery opposite; finally it penetrates within the larynx, passing generally between the hyoid bone and the thyroid cartilage, sometimes, but more rarely, near the upper edge of the latter, by an opening which exists there, or even between the cricoid and the thyroid cartilages.(1) Having arrived at this organ, it distributes itself upon its internal membrane, and also to its muscles, anastomoses very frequently with the synonymous artery of the opposite side, and even sends ramuscules outside of the larynx, which communicate on its surface with those of the other side, and with the ramifications of the thyroid branch.

The *inferior* or *thyroid branch* (*R. thyroideus*) is the continuation of the trunk; it sometimes furnishes many or even all the muscular branches which we have described as coming from the laryngeal branch; but small twigs always arise from it and go to the middle and inferior constrictors of the pharynx and to the crico-thyroideus muscle. After which it descends downward into the thyroid gland, and generally divides, at its upper extremity, into two branches, a posterior and inferior, and an anterior and superior, which soon subdivide. The former penetrates posteriorly into the thyroid gland, and anastomoses along its posterior face with the branches of the inferior thyroid artery; the other proceeds along its upper edge, gives off considerable branches which expand on its anterior face, and anastomose, by very large vessels, with the synonymous branch of the opposite side.

When the superior thyroid artery is divided into two separate trunks it often happens, but not always, as one might think from what several anatomists say,(2) that the laryngeal branch is distinct from the thyroid branch, and situated above it. Sometimes however, but very rarely, the superior thyroid artery gives off only the trunk of the muscular branches and the laryngeal branch.

II. LINGUAL ARTERY.

§ 1350. The second branch is the *lingual* artery (*A. lingualis*, s. *sublingualis*, s. *ranina*), which arises farther inward, most generally a few lines, and sometimes an inch, above the preceding, and rarely by a

(1) We have remarked that this is the most common arrangement; so that our observations in this respect agree with those of Mayer (*loc. cit.*, p. 249), and with Bichat (*loc. cit.*, p. 149), who both say that the laryngeal branch commonly penetrates into the larynx by passing between the hyoid bone and the thyroid cartilage. Murray (*loc. cit.*. p. 11) indicates exactly these three arrangements, but does not say that the first is the most frequent. Sœmmerring (p. 131) entirely neglects this, and speaks only of the two which are less frequent. Sabatier (p. 115) mentions only the third.

(2) Mayer, (*loc. cit.*, p. 49) asserts, but wrongly, that the laryngeal always arises a quarter of an inch above the thyroid artery. Sabatier (*loc. cit.*, p. 15); Sœmmering (*loc. cit.*, p. 131); (Portal, *loc. cit.*, p. 159).

trunk in common with the superior thyroid artery, but more frequently, and nearly once in seven times, with the facial artery. It is generally a little larger than that we have mentioned.

This artery curves considerably, and its convex part looks upward, passes then directly over the large horn of the hyoid bone, goes horizontally forward, glides between the middle constrictor of the pharynx and the hyoglossus muscle, and then ascends towards the base of the tongue, where it recommences, and then goes horizontally forward, along the inferior face of this organ.

From its posterior part arise, 1st, several branches, which go to the hyo-glossus muscle and middle constrictor of the pharynx, and which, having passed through the latter, enter the digastricus and the thyrohyoideus muscles, and the submaxillary gland; 2d, a branch which goes downward and inward, between the genio-glossus and the geniohyoideus muscles directly on the hyoid bone, gives branches to these muscles, especially to the first, and anastomoses with that of the opposite side. It is called the *hyoid* branch (***R.*** *hyoideus*).

From the central ascending part arise one or more *dorsal arteries of the tongue* (***R.*** *dorsales linguæ*), which go downward to the posterior part of the tongue, on the inside of the hyo-glossus muscle, ascend upon the back of this organ, and advance to the epiglottis.

The lingual artery divides, in front of the hyo-glossus muscle, into a ranine and a sublingual artery.

The *ranine* artery (*A. ranina*) is larger than the other, and is a continuation of the trunk. It extends deeply between the lingualis and genio-glossus muscles, proceeds forward, gives off several branches in its course, and finally anastomoses with that of the opposite side, behind the summit of the tongue, at the upper end of its frenum.

The *sublingual* artery (*A. sublingualis*) is more external and more superficial than the preceding. It passes over the mylo-glossus muscle, between it and the sublingual gland, gives off branches to it, to the hyo-glossus muscle, to the lingualis muscle, and to the proper membrane of the mouth, passes over the mylo-hyoideus muscle, and anastomoses with the inferior maxillary branch of the facial artery.

This artery sometimes arises from the facial.

III. FACIAL ARTERY.

§ 1351. The third branch, the *facial* or *external maxillary* artery (*A. facialis, facialis anterior, angularis, maxillaris externa*), varies in respect to its origin, size, and extent; it is commonly the largest of the three anterior branches of the external carotid, and supplies all the anterior part of the face; but sometimes also it extends only to the angle of the mouth, and the other branches are supplied from the temporal artery. There is scarcely a vessel which varies so much as this, even in the two sides of the same body.

It passes under the posterior belly of the digastricus muscle to go to the angle of the lower jaw. In this place it proceeds first horizontally behind and within the inferior edge of the lower jaw, then goes obliquely upward and forward on the inside of this bone and of the upper jaw.

It frequently gives off, directly above its origin, the *inferior* or *ascending-palatine* artery (*A. palatina ascendens*, s. *inferior*), which usually arises from the *ascending* or *inferior pharyngeal* artery (*A. pharyngœa ascendens*); we shall describe it with that.

It then gives small ramuscules to the digastricus and stylo-hyoideus muscles.

Farther on, it gives off considerable branches which go to the submaxillary gland (*R. glandulares*), and goes forward in one of its grooves. Farther onward, it gives off one or more ramuscules to the pterygoideus internus muscle.

It then furnishes the *submental* artery (*R. submentalis*). This arises near the lower edge of the lower jaw, and proceeds along it, directly below the attachment of the mylo-hyoideus muscle, and over the anterior belly of the digastricus muscle, gives ramuscules to both of these muscles, anastomoses with the sublingual artery, and thus goes forward, where it communicates with that of the opposite side, on the centre of the lower edge of the lower jaw. Thence it reascends into the substance of the lower lip, to which it gives twigs, as also to the skin of the chin, and anastomoses with the descending branches of the coronary artery of the lower lip, and also with those of the inferior dentar artery, which emerges from the mental foramen.

When the sublingual artery is a branch of the facial it arises a little, and even in most cases directly before the submental.

The continuation of the trunk, or the proper facial artery, turns upon the lower edge of the lower jaw, generally directly before the anterior edge of its ascending branch, thus attains the outer face of this bone, descends very obliquely between the masseter and the triangularis oris muscles, arrives at the angle of the lips, and gives off in this place several branches, which enter the masseter, the triangularis and the buccinator muscles and the skin.

About the centre of the space between the angle of the mouth and the under edge of the lower jaw, it generally divides into two branches. One, the continuation of the trunk, goes directly upward; the other is smaller, and proceeds more obliquely inward and forward.

The latter is the *inferior coronary artery of the lip* (*A. coronaria labii inferioris*). It passes under the triangularis oris muscle and proceeds toward the lower lip, gives several branches to this muscle, to the levator menti, and also to the membrane of the mouth, and anastomoses both with its fellow of the opposite side and with the twigs of the submental and inferior dentar artery.

This artery is sometimes much smaller on one side than on the other. In some subjects it is even entirely deficient, and is then replaced by that of the opposite side. Sometimes it arises much higher and comes from the superior coronary artery of the lip. In some cases it is double: one of the two then arises much above the other; but the two arteries taken together are not larger than that of the opposite side: sometimes the two branches into which the lower coronary artery of the lips is divided are very small.

After giving off this branch, the facial artery winds tortuously upward and inward. Arrived as high as the angle of the mouth, it generally divides, a little above this point, into two branches.

The larger goes inward and forward, between the fibres of the orbicularis oris, and is called the *superior coronary* artery (*A. coronaria labii superioris*). This artery proceeds directly over the loose edge of the upper lip, gives ramuscules to the orbicularis oris, to the levator labii superioris, to the skin, to the buccal membrane, meets that of the opposite side and anastomoses with it by a broad communication similar to that between the inferior coronary arteries. The two coronary arteries usually anastomose together in two places by large branches: sometimes the anastomosis between the arteries is very small on one side, but is replaced by a very large branch, which arises higher up from the facial and which communicates with the artery of the septum of the nose.

Both coronary arteries are very tortuous, but the upper is more so than the lower. Both anastomose with the synonymous arteries of the opposite side, and these anastomoses are proportionally the largest in the body, when we consider the vessels between which they occur.

The superior coronary artery always gives off from its centre, where it anastomoses with that of the opposite side, a branch, which goes upward toward the nasal septum, which is called the *artery of the septum of the nose* (*A. nasalis septi*). Sometimes this artery is single, sometimes double, and even triple, at its origin: in the last two cases it is frequently given off by the coronary artery of one side; but however this may be, it divides near the septum of the nasal fossæ into at least two branches, a right and a left, each of which proceeds along the lower edge of the septum and the inner part of the corresponding nostril to the end of the nose, and also sends ramuscules, which reascend on the cartilaginous septum.

Besides these branches, the coronary artery gives off sometimes before, more externally and on one side only, or on both, another considerable branch (*R. pinnalis*), which goes to the ala and the outer part of the nostril; but this branch more frequently comes from the next one.

The facial artery, after giving off the superior coronary, consists only of a smaller branch, which may be called the *common external nasal* artery (*A. nasalis externa communis*). This artery is very tortuous, and ascends obliquely forward under the levator labii superioris muscles, to which it gives ramuscules, goes toward the nose, and anastomoses by considerable branches with the infra-orbitar artery. It usually gives off, opposite the nostril, the *lateral arteries of the nose* (*R. pinnales*, s. *laterales nasi*), and also sends off numerous smaller arterial twigs, which anastomose with each other and also with those of the septum and their corresponding ones of the opposite side, which are called the *dorsal* arteries (*R. nasales dorsales*), and which always communicate on the nose by several large or small branches with the ophthalmic artery. Finally, it terminates on the back and side of the nose, and never, even in its greatest degree of extension, goes beyond the upper edge of the cartilaginous portion of this organ.

The two coronary and the common external nasal artery, and more frequently only the superior coronary and the latter, sometimes arise not only from the above facial but also from the transverse facial artery, which then is much larger, while the other is smaller, although the facial artery is not necessarily more developed at its lower part; we likewise observe in other subjects that this artery is very much developed at its upper part, although the lower part does not produce more branches than usual. We have seen the sublingual artery coming from it at least several times, and the facial artery at the same time was as large as usual. In other cases, on the contrary, it gives off neither of the two coronary arteries, while the sublingual artery arose as usual; but the submental artery was uncommonly small.

Hence it appears that the facial artery is always the principal source of communication, 1st, between the superficial and the deep-seated branches of the external carotid by its anastomoses with the infra-orbitar, the nasal, and the dentar arteries; 2d, between the external and the internal carotid arteries by its anastomosing with the ophthalmic artery.

§ 1352. Numerous small branches, which go to the masseter and pterygoidei muscles and to the parotid gland (*R. masseterici, pterygoidei, et parotidei*), arise externally and internally from that part of the carotid artery situated between the ascending branch of the lower jaw and the ear.

A larger anterior branch, the *transverse facial* artery, which will be described hereafter, rarely arises from its upper extremity, directly below its division.

B. INNER BRANCH.

I. ASCENDING OR INFERIOR PHARYNGEAL ARTERY.

§ 1353. Most generally only one branch arises from the inner face of the external carotid artery; this is the *ascending* or *inferior pharyngeal* artery (*A. pharyngæa ascendens*, s. *inferior*, s. *posterior*), which comes sometimes from the bifurcation of the primitive carotid, sometimes from the origin of the internal carotid, but more frequently from the occipital artery,(1) and is sometimes replaced by the branches of the facial artery.

If it is a branch of the external carotid, it arises very deeply, most generally above the inferior thyroid artery; so that it is the second branch from the trunk. but sometimes it comes higher up and even above the facial artery.(2)

It is sometimes double: then the two inferior pharyngeal arteries rarely come from the external carotid; one arises from the latter, and the other from one of the secondary branches above described, or from the internal carotid artery.(3)

It is always the smallest branch of the external carotid artery.

It goes perpendicularly upward, on the inside of the external carotid artery, and in the same direction with it, between it and the pharynx.

It gives off first the descending branches to the constrictors of the pharynx, and to the anterior and lateral muscles of the neck.

A little farther it divides into two branches, one of which, the *pharyngeal* branch, (*R. pharyngæus*) is distributed principally to the constrictors of the pharynx, and communicates with the pharyngeal branches of the superior thyroid artery; the other is termed the *posterior meningeal* artery, (*A. meningæa posterior*) ascends through the posterior foramen lacerum of the skull, or through a special opening near the occipital condyle, and is distributed to that part of the dura mater which lines the lower part of the skull.

C. POSTERIOR BRANCHES.

§ 1354. The posterior branches of the external carotid artery are, 1st the *occipital*, and 2d the *posterior auricular* artery.

1. OCCIPITAL ARTERY.

§ 1355. The *occipital* artery (*A. occipitalis*) is a considerable branch, but much smaller than the three anterior branches, which usually arise opposite the lingual or the facial artery; seldom or never above or below them. It rarely comes from the internal carotid artery. It is very deeply situated; goes upward and backward, often gives off, soon after arising, branches which go to the posterior belly of the digastricus muscle of the lower jaw, then a descending branch, which

(1) Sœmmerring states that it sometimes arises from the superior thyroid artery. We have never seen this, nor is it mentioned by any other anatomist. Sœmmerring, it is true, quotes Mayer; but the *laryngo-pharyngean* artery (*A. laryngo-pharyngæa*) described by Mayer, is the laryngeal branch of the superior thyroid artery, and describes the inferior pharyngeal artery as the posterior artery of the throat.

(2) Bichat asserts that it arises between the facial and lingual arteries. Our observations lead us to think that Sœmmerring is more correct in saying that it rarely arises higher than the lingual. Murray places it behind the facial, but adds that its origin is near that of the lingual. Portal also places it nearly opposite this latter, as do Sabatier and Mayer. Boyer states that it arises opposite the facial.

(3) Sœmmering asserts that when it is double, the lower trunk arises from the prim tive carotid, and the superior from the internal carotid. This arrangement exists sometimes, but it is not the law. That mentioned by us is much more common.

goes to the sterno-cleido-mastoideus muscle and the upper lymphatic glands of the neck, higher up, gives off wholly or partially the ascending pharyngeal artery, then extends below and deeply between the transverse process of the first cervical vertebra and the mastoid process of the temporal bone, continues its course backward, passing under the complexus minor muscle, then assumes a horizontal direction, gives branches to the upper extremity of the sterno-cleido mastoideus, to the complexus minor, to the transversalis colli, to the small lateral and posterior muscles of the head, and then ascends on the occipital bone, covered by the upper part of the splenius muscle, to which it gives branches. It is then called the *superficial occipital* artery, proceeds directly below the skin, on this bone to the vertex, terminates in a large anastomosis, formed by its branches with each other and with those of the frontal, the superficial temporal and the synonymous artery of the opposite side.

At the place where the occipital artery leaves the space between the transverse process of the first cervical vertebra and the mastoid process of the temporal bone, to pass on the obliquus capitis major muscle of the head, it always gives a deep or descending branch. This branch being sometimes very considerable, and nearly as large as the continuation of the trunk, we may then admit that the artery divides at this place into a *superficial* and *deep-seated* branch. When this is the case, it descends to the middle of the back, between the splenius, complexus, digastricus and transversalis colli muscles. Sometimes, however, it is very small, and then it is distributed in the small posterior muscles of the head.

The deep-seated branch anastomoses many times with the vertebral artery, and with the cervical branches of the inferior thyroid artery.

From the superficial occipital artery constantly arise one or several branches, which pass into the cranium through the mastoid foramina; more rarely through the large occipital foramen or the foramen lacerum, which are distributed to the posterior and inferior part of the dura mater. They are termed the *posterior meningœal* arteries. (*A. meningeæ posteriores ab occipitali.*)

2. POSTERIOR AURICULAR ARTERY.

§1356. The *posterior auricular* artery (*A. auricularis posterior*) is generally much smaller than the preceding, and arises a little above it, in the substance of the parotid gland, and is generally separated from it only by the stylo-hyoideus muscle. Sometimes it arises from this artery, and rarely somewhat higher, directly below the division of the external carotid artery into the superficial temporal and the internal maxillary artery. It goes upward, at the side and behind the trunk of the external carotid artery, and passes through the parotid gland, near the mastoid process. There it gives, 1st at its lower posterior part, branches which go to this gland, to the posterior belly of the digastricus muscle, to the stylo-hyoideus and to the upper part of the sterno-cleido-mastoideus muscles; 2d, from its superior and anterior part, an ascending branch, the *stylo-mastoid* artery (*A. stylo-mastoidea*), which furnishes ramuscules to the auditory passage, penetrates into the canal of the facial nerve through the stylo-mastoid foramen, distributes itself to the mastoid process, to the tympanum, and also to a portion of the labyrinth, and anastomoses with a branch of the middle meningeal artery. The trunk of the artery then divides at the level of the mastoid process into two branches, an *inferior* or *muscular* and a *superior* or *auricular* branch.

The inferior branch goes transversely outward, over the upper part of the splenii muscles, gives ramuscules to these muscles, to the trapezius and to the skin, anastomoses with the superficial occipital artery, and advances toward the occiput.

The superior branch goes upward and backward. It usually divides into two or three branches, one of which, the more transverse, goes backward to the mastoid process, and gives branches to it, also to the occipitalis muscle; while the other, or the others, attain the posterior part of the concha, distribute the small arteries to the retrahentes auriculæ, and to the transversus auriculæ muscles, then pass over the concha, and thus come on its internal face, where they lose themselves in the skin and the mucous membrane.

D. TERMINATION OF THE EXTERNAL CAROTID ARTERY.

§ 1357. The external carotid artery terminates at the neck of the lower jaw in two trunks, a superficial, the temporal artery; the other deep-seated, the internal maxillary artery.

I. TEMPORAL ARTERY.

§ 1358. The *temporal* artery (*A. temporalis*) is smaller and more superficial than the internal maxillary, and continues in the direction of the trunk. It goes upward and outward. Its branches may be divided into *anterior* and *posterior*.

The anterior branches are principally the following:

1st. The first branch is often the *upper masseteric* artery (*A. masseterica superior*) which penetrates sometimes to the external and sometimes to the internal layer of the masseter muscle, but frequently comes from the next.

2d. The *transverse facial* artery (*A. transversa*, s. *transversalis faciei*)(1) is the second, often the first branch of the artery, and arises

(1) Sœmmering (*loc. cit.*. p. 196) mentions it as arising from the external carotid artery, before it bifurcates, and says also that it sometimes comes from the internal carotid artery, and cites as authorities Mayer, Murray, and Walter. But Murray states expressly that it is the fourth branch of the external temporal artery (p. 17).

directly above the bifurcation of the external carotid artery. Sometimes, but unfrequently, it arises from the external carotid artery, and most generally from the bifurcation. It goes forward, with the canal of Stenon, on the masseter muscle, directly below its upper edge, gives off the superior masseteric artery, when this does not come from the temporal artery, sends several ramuscules to the skin, penetrates forward into a greater or less portion of the orbicularis palpebrarum muscle, and anastomoses, by a considerable number of ramifications, with the facial artery, which it meets, and with the infra-orbitar artery. Sometimes this gives off all the upper part of the facial artery.

In some subjects its ascending ramuscules extend much higher, and reach the outer extremity of the edge of the orbit.

The *middle temporal* artery (*A. temporalis media*) generally arises some lines above the transverse facial artery, a little below the malar bone, a considerable branch, which proceeds first from below upward, gives off one or several ramuscules to the upper part of the masseter muscle, then curves backward at a right angle, between the trunk and the temporal muscle, and terminates partly in small twigs, which penetrate into the substance of the muscle where they anastomose with those of the deep temporal artery, and partly in superficial branches, which are distributed on the auditory passage, where they communicate with those of the posterior auricular artery.

After giving off this artery, the trunk of the temporal artery goes upward and forward, on the temporal muscle, directly under the skin, and describes a considerable arch, which is convex posteriorly and terminates as the *anterior temporal* artery (*A. temporalis anterior*), anastomosing several times with the superciliary artery, and giving branches to the frontalis muscle, and to the skin of the forehead.

Small inconstant branches come from the anterior and concave part of the arch which it describes, these go forward into the outer part of the orbicularis palpebrarum muscle, and communicate with the ascending branches of the transverse facial, and also with the upper ramuscules of the anterior temporal artery.

The posterior branches of the superficial temporal artery are,

1st. The *anterior inferior auricular* arteries (*A. auriculares anteriores inferiores*), usually three or four in number, which arise directly above one another from its lower part, and are expanded in the inferior and anterior part of the concha.

2d. The *anterior* and *superior auricular* artery (*A. auricularis anterior superior*) which is often single, rarely double; it arises nearly opposite the preceding branches, and goes to the upper and anterior part of the concha, and to the attollens auriculæ muscle.

Mayer describes it as the tenth branch of the external carotid artery (p. 84), but asserts positively that it arises about a line above the internal maxillary artery. The descriptions of Portal (p. 186), Boyer (p. 42), Bichat (p. 152), and Menon (p. 267), agree, like that of Murray, with the results of our observations.

3d. Two or three larger branches usually go backward, inward, and upward, and anastomose with each other and with those of the opposite side, and with the superficial occipital artery, which sometimes partly replaces them. They are called the *posterior temporal* arteries (*A. temporales posteriores*), and they are usually wrongly considered as forming, in opposition to the anterior temporal artery, but one branch.

II. INTERNAL MAXILLARY ARTERY.

§ 1359. The *internal maxillary* artery (*A. maxillaris interna*, *A. orbito-maxillaris*) is larger than the preceding, but differs more from the direction of the primitive trunk, and is situated more deeply, so that it cannot be seen entirely till the zygomatic arch and the outer part of the body of the upper maxillary bone is removed.

Its direction changes several times in its course. First, it goes transversely inward and a little forward, behind the neck of the jaw; then it goes directly inward, and passes between the two pterygoidei muscles, or curves again a little forward. Arrived at the pterygoid process, it goes perpendicularly upward, over the pterygoideus externus muscle, and is reflected on itself as high as the floor of the orbit, so that its direction becomes horizontal. Thence it divides into several branches which descend more or less, by which it terminates, distributing itself on one side on the inner and posterior part of the nose, on the other to the outer part of the face.

Proceeding in this manner, it distributes the blood to the dura mater, to the internal ear, to the pterygoidei muscles, to the temporalis muscle, to the teeth, to the interior part of the nose, to the upper part of the pharynx, and to a part of the face, and communicates with several branches of the external and internal carotid, by the following branches, which are successively given off. It usually sends one or two to the ear, viz:

a. The *deep-seated auricular* artery (*A. auricularis profunda*), which goes to the organ of hearing.

b. The *artery of the tympanum* (*A. tympanica*), which is distributed to the temporo-maxillary articulation, and then penetrates into the cavity of the tympanum, through the fissure of Glaser. These two branches often arise from the external carotid artery, or from the facial or temporal artery.

c. The *small meningeal* or the *external pterygoid* artery (*A. meningea parva*, s. *pterygoidea externa*) is an inconstant branch, which often arises from the middle meningeal or from a pterygoid artery; it gives branches to the pterygoidei muscles, to the muscles of the soft palate, and to the dura mater, near the sella turcica, and sometimes penetrates into the skull through the foramen ovale.

d. The *middle*, or *great meningeal*, or *spheno-spinal* artery (*A. meningea media*, s. *magna*, s. *spinosa*),(1) is the largest branch of the internal maxillary artery.

It arises from the upper part of the origin of the internal maxillary artery. It goes directly upward and gives off branches to the pterygoidei muscles, to the upper constrictor of the pharynx, to the temporal muscle, and to the muscles of the soft palate; these are sometimes, although rarely, deficient. When they do not exist they are replaced by the small meningeal artery.

The artery then, either simple or divided, enters through the spheno-occipital hole of the sphenoid bone, into the skull, and then gives off some ramifications posteriorly, which glide into the fissure of Fallopius, penetrate into the cavity of the tympanum and the canal of the facial nerve, are distributed to the membrane of the tympanum, to these nerves, and to the muscles of the tympanum, and anastomose with the stylo-mastoid artery. Others, which are anterior, sometimes penetrate into the orbit, through the malar bone or the large wing of the sphenoid bone, and to the lachrymal gland. But this trunk, covered on the outer face of the dura mater, above which it projects, and of which it is the largest artery, expands principally in the anterior and central part of this membrane. It arises, near the anterior edge of the parietal bone, at the median line of the skull, and gives off, forward and backward, numerous branches, which anastomose with the other branches of the middle, and also with those of the anteiior and posterior meningœal arteries.

Besides, these branches communicate also with those of the temporal and occipital arteries.

As they project above the dura mater, and follow the grooves of the skull-bones, these indicate their course very well.

e. The *inferior maxillary* or *inferior dental* artery (*A. maxillaris*, s. *alveolaris*, s. *dentalis inferior*), which sometimes arises from the middle meningœal artery, and always comes from the lower point of the origin of the internal maxillary artery, descends between the two pterygoidei muscles, to which it gives twigs, and also sometimes to the temporal muscle; penetrates into the dental canal, through which it passes forward, gives ramifications to all the teeth and to all the lower dental nerves, which occupy the same canals as they do, then emerges from the mental foramen, and anastomoses above with the inferior coronary or labial, and below with the submental artery, and produced, like the preceding, by the facial artery.

(1) Some anatomists, as Sabatier, Boyer, and Bichat, state that it is the first branch of the internal maxillary artery. We have always seen it preceded by one or more of those we have mentioned, and we have never found it, as Mayer states, arising directly from the bifurcation of the external carotid artery. According to our observations, it does not normally arise before the inferior dentar artery, as Sœmmering, Murray, and Munroe assert. We have seen that Portal was correct in saying that it is given off as frequently after it or at least opposite to it.

This emerging branch most commonly arises at some distance from the mental foramen, within the dental canal, and on a level with the small malar teeth, at the place where the inferior maxillary artery bifurcates to produce it and the continuation of the trunk.

f. g. Two or more *deep-seated temporal* branches (*R. temporalis profundi*) arise from the upper part of the maxillary, and are distributed to the buccinator and the pterygoidei muscles, and especially to the temporal muscle; penetrate also into the orbit, where they send branches into the lachrymal gland and the eyelids, and anastomose extensively with the ophthalmic artery.

h. The *masseter* artery (*R. massetericus*) is not constant, and arises sometimes from the external temporal, or even the external carotid, or finally from one of the deep pterygoid arteries. It passes over the semicircular notch of the lower jaw into the upper part of the masseter muscle. It gives branches also to the temporal muscle, and to the two pterygoidei muscles, especially to the external.

i. The *buccal* artery (*A. buccalis,* s. *buccinatoria*) is a very constant branch, although it often arises from the deep temporal artery, or from one of the following branches. It comes from the lower part of the inferior maxillary artery, goes downward and forward, along the outer face of the body of the upper jaw, distributes its branches in the buccinator muscles, the muscles of the upper lip, the lower part of the orbicularis palpebrarum muscle, the buccal membrane, sometimes also the anterior teeth to which it comes by several openings which exist in the upper part of the superior maxillary bone, and anastomoses with the branches of the facial, and also with those of the infra-orbital, artery.

k. The *superior maxillary* or *alveolar* artery (*A. maxillaris superior,* s. *alveolaris*) arises sometimes from one of the deep temporal or from the infra-orbital artery. It is larger than the preceding, goes a little downward and forward, turns on the upper maxillary bone, and sends off numerous large and small branches, one of which is termed the *superior dental* artery (*R. dentalis superior*) into the teeth of the upper jaw. These branches nourish the dental capsules, the periosteum, the germ, the buccinator muscle, the zygomaticus major muscle, and anastomose with the branches of the facial and infra-orbital arteries.

l. The *infra-orbital* artery (*A. infra-orbitalis*) is generally smaller than the preceding, and arises near the bottom of the orbit. It soon engages itself in the infra-orbital foramen, and the infra-orbital canal, sends some branches into the orbit and the maxillary sinus, emerges by the infra-orbital foramen, behind the levator labii superioris, thus comes on the front of the face, and terminates in a great many ramuscules, some of which go to the muscles of the upper lip, while the others anastomose with the upper dental artery, the dorsal artery of the nose, the orbitar and the palatine artery.

Finally, at the upper end of the zygomatic fossa, the internal maxillary artery divides into an ascending and a descending branch, which goes inward.

m. The *superior palatine* artery (*A. palatina suprema*, s. *descendens*, s. *pterygo-palatina*) gives off, first, the *superior* or *descending pharyngeal* artery (*A. pharyngæa suprema*, s. *descendens*). This passes through the pterygo-palatine foramen, and expands in the pterygoid process of the bone, and the Eustachian tube and the upper part of the pharynx. Sometimes it arises from the internal maxillary artery by a distinct trunk. The superior palatine artery descends in the pterygoid canal and divides into several ramuscules, which pass through different openings, to go to the soft parts of the palate. The trunk passes through the posterior palatine canal, comes on the palatine arch, rests directly on its lower face, describes a right angle to go forward, forming numerous curves, in its course gives off twigs to the mucous membrane of the palate and to the muciparous glands, and anastomoses forward with that of the opposite side, and sends its latter branches through the anterior palatine foramen into the nasal cavity, where they extend to the lower turbinated bone, communicating with the branches of the artery of the septum and of that of the dorsum of the nose which arise from the facial artery.

n. The last branch, the *posterior nasal* or *spheno-palatine* artery (*A. nasalis posterior*, s. *spheno-palatina*), enters through the spheno-palatine hole into the posterior part of the nasal fossa, and divides into two branches, an external and an internal, and sometimes into three.

The internal branch, the *posterior artery of the septum of the nose* (*A. septi narium posterior*), descends along the posterior part of the septum of the nose, sends ramuscules to the upper part of the pharynx, and penetrates into the posterior cellules of the ethmoid bone, and also into the upper turbinated bone.

The external branch descends along the outer edge of the posterior opening of the nasal fossæ, and usually divides into two ramuscules, which go, the upper to the middle, and the lower to the lower turbinated bone. These ramuscules are distributed principally in the posterior part of the nasal fossa and of the maxillary sinus.

II. INTERNAL CAROTID ARTERY.

§ 1360. The *internal carotid* or *anterior cerebral* artery (*A. carotis interna*, s. *cerebralis*, s. *cerebralis anterior*, s. *encephalica*) is usually smaller than the external, ascends behind it, before the internal jugular vein, on the outside of the pneumo-gastric nerve, directly before the vertebral column, to the lower orifice of the carotid canal. It does not generally bend much, although it is sometimes very tortuous, and it is rarely straight.

It seldom gives off branches in this course. It rarely in fact furnishes one of the internal or posterior branches of the external carotid or of the occipital artery. The latter comes from them less frequently than the others. Upward it gives off sometimes a small branch, which goes to the palatine region and to the velum palati.

Immediately below its entrance into the carotid canal it is generally almost horizontal, or at least goes obliquely upward and forward. At the lower part of this canal it goes vertically upward. It afterwards goes forward at nearly a right angle, and becomes almost horizontal, although it ascends a little. After leaving the canal it resumes its primitive direction upward, but proceeds at the same time forward and inward, and thus comes on the side of the sella turcica. At the posterior part of this excavation it curves a second time at a right angle, goes horizontally in the lateral carotid groove, going outward and a little downward. In this part of its course it accompanies the cavernous sinus of the dura mater, both being inclosed in the same portion of the dura mater, but separated by its proper membrane from the blood which it contains. At the anterior extremity of the lateral face of the sella turcica, below the anterior clinoid process, it describes a third right angle, and goes upward, backward, and inward. In its course it gives off very trifling branches to the internal ear, to the dura mater, and to the third, fourth, fifth, and sixth pairs of nerves. Opposite the internal extremity of the upper orbitar fissure it divides into two branches, the continuation of the trunk which goes to the brain, and the ophthalmic artery.

Thus it changes its direction five times at least, and this arrangement retards the course of the blood much more, inasmuch as all the curves are sudden and do not occur on the same plane.

The internal carotid artery is intimately united by a very short cellular tissue to the canal through which it passes and which it almost entirely fills.

I. OPHTHALMIC ARTERY.

§ 1361. The *ophthalmic* artery (*A. ophthalmica*) is a very considerable branch, which exceeds in volume all those hitherto mentioned. It is always single. It leaves the skull through the optic foramen, usually on the outer and lower side, rarely at the upper part of the optic nerve, penetrates into the orbit, sends numerous branches to all parts of the eye, and also larger or smaller branches into the nasal fossæ and the face.

Having come into the cavity of the orbit, it soon ascends on the optic nerve, goes upward and inward, passes between this nerve and the rectus superior muscle of the eye, and thus arrives at the inner part of the orbit and goes forward to the internal angle of the eye.

Its branches vary surprisingly in respect to their origins, their number, and their volume. The principal are:

1st. Usually but not always an *external posterior ciliary* artery (*A. ciliaris posterior*), which arises from the outer side of the ophthalmic artery, goes forward along the optic nerve on its outer and lower side, and penetrates the sclerotica directly before the anterior extremity of this nerve.

2d. The *lacrymal* artery (*A. lacrymalis*) arises from the upper part of the ophthalmic artery, generally far backward and sometimes very far forward. It rarely arises from the middle meningeal artery, in which case it enters into the orbit, through the upper orbicular fissure, or through a special opening either in the malar bone or in the large wing of the sphenoid bone. It proceeds outwardly under the rectus superior muscle, to which it gives branches, and also to the rectus externus and to the levator palpebrarum muscles. It sometimes sends several through the malar bone into the temporal muscle, where they anastomose with those of the deep temporal artery. In some subjects one or several ciliary arteries arise from it. It then passes across, above or below the lacrymal gland, leaves the orbit at the external angle of the eye, anastomoses with the palpebral artery given off by the ophthalmic artery to form the palpebral arch, and terminates in the orbicularis palpebrarum muscle, the skin of the eyelids, and the tunica conjunctiva.

3d. The *posterior upper ciliary* artery (*A. ciliaris posterior, superior*) is distributed in the same manner as the external, but gives off no branch after passing through the tunica sclerotica. Sometimes all the posterior ciliary arteries arise after the posterior ethmoidal artery; but they always proceed very tortuously on the surface of the optic nerve, and after dividing into numerous branches, pass through the posterior part of the sclerotica to enter the eye, where they are distibuted in the manner stated in describing that organ.

4th. Next, a small inconstant branch arises and goes to the posterior part of the rectus superior muscle.

5th. The *posterior* or *middle ethmoidal* artery (*A. ethmoidalis posterior, s. media*) is also inconstant, and often arises from the lacrymal artery, from the anterior ethmoidal, or from the supra-orbitar artery.(1) It gives first branches to the origin of the obliquus superior, rectus internus and externus muscles, then goes inward over the obliquus superior muscle, passes through the ethmoidal or posterior internal orbitar foramen, comes into the nasal fossæ, and is distributed to the posterior ethmoidal cellules, the sphenoidal sinus, and the antrum Highmorianum; it anastomoses with the branches of the posterior nasal or spheno-palatine artery and with the anterior ethmoidal artery, then reenters the skull through a small canal in the ethmoid bone, gives ramuscules to the periosteum which covers the anterior and central fossa of the base of the skull, and terminates by again passing into the nasal fossæ through the openings in the cribriform plate.

6th. The *central artery of the retina* (*A. centralis retinæ*), arises farther back, directly from the ophthalmic artery, or from the preceding, or from the lacrymal artery, or from one of the two muscular branches;

(1) But it is not always the smallest, as Bichat asserts; we have remarked several times that it was one of the largest branches and much larger than the anterior.

it goes into the optic nerve, proceeds forward along its axis, and distributes itself to the retina, as we shall mention in describing the eye.

7th. The *inferior muscular* artery (*A. muscularis inferior*), is a considerable and rather constant branch, which sometimes gives off the central artery of the retina and one or more of the ciliary arteries, goes inward, sends branches to the rectus internus and inferior muscles of the eye, and penetrates even into the nasal fossæ.

8th. The *superior muscular* or *supra-orbitar* artery (*A. muscularis superior*, s. *supra-orbitaria*) is less constant than the preceding, but it comes from the lachrymal less frequently than from the ophthalmic artery. It proceeds forward directly below the orbitar plate, leaves the orbit through the supra-orbitar foramen, gives off branches to the frontal bone, to its periosteum, to the supraciliaris and orbicularis palpebrarum muscles, and to the skin of the forehead, and anastomoses with the other branches of the ophthalmic and with the temporal artery.

The *anterior ciliary* arteries (*A. ciliares anticæ*) arise from this branch and from the preceding; they divide into fewer branches than the posterior, and enter the sclerotica much farther forward than the latter, near the transparent cornea.

The branches we have described generally arise near the floor of the orbit, not far from each other; hence why they are generally long. After giving them off, the ophthalmic artery is usually smaller and proceeds along the internal wall of the orbit, describing numerous curves. Towards the anterior opening of the orbitar cavity it gives off,

9th. The *anterior ethmoidal* artery (*A. ethmoidalis anterior*), which goes directly inward, passing over the obliquus superior muscle, and penetrates through the ethmoidal or anterior internal orbitar foramen into the nasal cavity, where it is distributed to the anterior ethmoidal cells and the frontal sinuses, and anastomoses with the other nasal arteries. It also sends off branches to the anterior region of the dura mater.

The ophthalmic artery now proceeds a short distance within the orbit, afterwards leaves this cavity at the inner angle of the eye, and terminates in giving origin to,

10th. The *palpebral* arteries (*A. palpebrales*). These arise sometimes by a common trunk (*palpebralis communis*) and sometimes separately, the superior a little before the inferior, and go outwardly. They are distributed partly to the conjunctiva, partly and particularly to the eyelids, in which they disappear between the skin and the orbicularis muscle. They divide there principally into two branches, one of which proceeds near the edge (*ramus marginalis*), while the other goes obliquely outward along the base of the eyelid.

The superior palpebral artery anastomoses in this place with the lachrymal, the superciliary branch of the frontal, and even some branches of the anterior temporal artery. It also forms a single or double *superior palpebral arch* (*arcus tarseus superior*), which communicate with each other by numerous ramuscules, and thus form a net-work.

The *inferior palpebral arch* (*arcus tarseus inferior*) is produced in the same manner, by the anastomosis of the inferior palpebral with the infra-orbitar, the lachrymal and the nasal arteries.

All the parts of the eyelids are abundantly provided with vessels by these arterial branches.

11th. The *frontal* artery (*A. frontalis*), which also ascends soon after arising, usually divides immediately into three branches, the ***supra-ciliary*** artery (*A. supraciliaris*), the ***superficial*** or ***subcutaneous frontal*** artery (*A. frontalis subcutanea*), and the *deep frontal* artery (*A. frontalis profunda*). By this division it is distributed, 1st, to the upper part of the orbicularis palpebrarum and corrugator supercilii muscles; 2d, to the frontalis muscle and to the skin of the forehead; 3d, to the frontal sinus. It extends to the coronal suture and to the temporal region, where it anastomoses with the branches of the external temporal artery; it also communicates in other parts with those of the supra-orbitar and lachrymal arteries.

12th. The *nasal* artery (*A. nasalis*) varies much in volume. Sometimes it is a very small branch, terminating at the root of the nose; sometimes it forms the continuation of the trunk of the ophthalmic artery, descends very low, contributes with the lateral nasal branch of the facial artery to produce the dorsal artery of the nose, extends to the end of the nose, proceeding on the side of this organ, always anastomoses with the inferior palpebral and the facial artery, and gives ramuscules to the integuments and to the nasal bones, to the frontalis muscle, to the internal part of the orbicularis palpebrarum, to the muscles of the nose, and even to the pituitary membrane.

II. CEREBRAL ARTERIES.

§ 1362. After giving off the ophthalmic artery, the internal carotid artery is distributed entirely to the cerebrum, particularly to its anterior portion, the posterior being supplied with blood from the vertebral artery. It properly deserves then to be called, from this point, the *anterior cerebral* artery (*A. cerebralis anterior*).

§ 1363. It gives off, first, small ramuscules, which go inward, and are designed for the posterior part of the optic nerve, for the infundibulum, for the pituitary gland, and for the third ventricle.

§ 1364. It then gives off four branches; these are the *communicating* artery, the *choroid* artery, the *anterior cerebral* artery, and the artery of the *corpus callosum*. The first two generally arise directly after each other; and the carotid artery bifurcates farther on to give rise to the last two. Sometimes, but more rarely, three or all of these branches arise from the same point.

§ 1365. The first, or the *posterior communicating* artery (*A. communicans posterior*), goes backward and inward. It approaches that of the opposite side, opens into the posterior cerebral, which comes from the vertebral, artery, or if we prefer it anastomoses with a branch analogous to it, which it meets.

This anastomosis gives rise to the posterior part of the *circle of Willis* (*circulus Willissii*).

The size of this communicating artery varies extremely. It is generally considerable, and only about one half smaller than one of the succeeding branches, into which the internal carotid artery divides. It is sometimes however very small; in this case the anastomosis between the internal carotid and the vertebral artery, frequently but not always takes place by means of another and larger branch of the anterior cerebral artery, which opens more outward into the posterior. The communicating artery is sometimes larger on one side than on the other.

Sometimes this artery is a branch of the anterior cerebral.(1) It arises more rarely not from this but directly from the basilar artery, when the posterior cerebral artery does not come from it, and it is given off by the internal carotid.

But the anastomosis almost always exists; and it is constantly simple or at most double, on each side, when it occurs by considerable branches, although we find others which are accessory and smaller in the cerebral peduncles.

We consider its total absence as one of the rarest anomalies. We have never yet seen it, and Barclay alone mentions one case where the injection penetrated neither from the carotid into the vertebral artery, nor from the vertebral into the carotid.(2)

Several vessels arise from the communicating artery and go to the pia-mater or to the floor of the third ventricle, to the mamillary eminences, to the posterior part of the optic nerves, to the thalami optici, to the cerebral peduncles, to the inner face of the anterior part of the large cerebral lobe, and to the choroid plexuses.

§ 1366. *b.* Above the communicating artery, the internal carotid always gives off a special branch, the *choroid* artery (*A. choroidea*) which also arises from its posterior part.(3) This artery goes a little backward and outward, along the posterior edge of the origin of the optic nerve, ascends above the upper part of the cerebral peduncle, and expands partly in the pia-mater of the anterior part of the posterior

(1) This anomaly, however, is proportionally very rare. Portal then estimates incorrectly, the relation between the rule and the exception, in saying that the internal carotid artery usually divides into two branches, the smaller of which is the artery of the corpus callosum, the larger the anterior lobate artery; the latter giving off the communicating artery, which sometimes arises directly from the internal carotid. Hilderbrandt seems to think that the two cases are equally frequent, which is just as false.

(2) *Loc. cit.*, p. 47.

(3) We have always found this branch very constant, although several anatomists particularly Mayer, Murray, Portal, Hilderbrandt, and Sœmmerring, do not mention it. Haller states (*Ic. anat.*, vol. vii. p. 5) that it *sometimes* exists. Sabatier, Boyer, and Bichat assert that is *constant*, which agrees with our remark. But Bichat errs in saying thatthe choroid is *always* smaller than the communicating artery. This case frequently occurs, since, as we have observed, the communicating artery is usually large; but we have often found, when this was small, that the choroid artery was as large or even larger than it.

cerebral lobe and of the thalami optici, and partly also penetrates through the anterior opening of the lateral ventricle, into this cavity, where its ramifications expand in the choroid plexus.

§ 1367. The internal carotid now divides, at a very obtuse angle and at the anterior extremity of the fissure of Sylvius, into two unequal branches; these are the artery of the corpus callosum and the anterior cerebral artery.

§ 1368. The artery of the *corpus callosum* (*A. callosa*, s. *corporis callosi*, s. *anterior cerebrica*, s. *anterior hemisphæri*, s. *mesolobica*) is always smaller than the posterior branch. It goes forward and inward, directly before the union of the optic nerves, proceeds to meet that of the opposite side, towards which it converges very much, and after giving off superiorly generally several ramuscules for the posterior extremity of the anterior lobe, for the olfactory and for the optic nerves, it anastomoses with it between the posterior extremities of the first two lobes by the *anterior communicating* artery (*A. anterior communicans*, s. *anostomotica*). This branch is generally very short; sometimes however, it is three or four lines long; it is generally much larger in the former case and often very narrow in the second. Its direction is always transverse. Sometimes it is entirely double; and we not unfrequently find it double in one half its extent.(1) It gives off, particularly when longer than usual, ramuscules, which go upward and backward, into the septum lucidum, the fornix, and the corpus callosum.

The trunk also generally sends off one or more small branches which proceed forward and outward to the inner part of the inferior face of the anterior lobe of the cerebrum. After this, it is situated directly near that of the opposite side, turns on the anterior extremity of the corpus callosum, ascends to the inner face of the cerebral hemispheres, and divides into several branches, the anterior of which enter into the circumvolutions of this internal face, while the posterior proceed on the corpus callosum, as far as its posterior extremity, where they begin to change their direction and to go upward. All these branches extend to the upper face of the cerebrum and anastomose with those of the succeeding artery, and with those of the posterior cerebral artery, given off by the vertebral artery.

Besides these large branches, into which the artery of the corpus callosum divides above, it also gives off, from its lower and concave part, numerous smaller branches, whtch distribute themselves in the corpus callosum.

Rarely, a large posterior branch is detached on both sides at the place where the two arteries of the corpus callosum meet, and the anterior anastomosing branch becomes the single trunk of the anterior part of the artery of the corpus callosum, which shortly divides into two large branches, a right and a left, or the two arteries arise

(1) Bichat is incorrect in stating that this arrangement is very rare.

from a common trunk, and do not give off a branch posteriorly. This arrangement is remarkable because of the analogy it establishes with the union of the two vertebral arteries into one, the basilar, which is situated on the median line.

§ 1369. The *anterior* or more properly the *middle cerebral* artery (A. *cerebri anterior*, s. *media*, s. *hemisphœrica media*, s. *fossœ Sylvii*, s. *sylviana*), the last and the most posterior branch of the internal carotid, is always much larger than the preceding. Soon after its origin it goes outward, and only a little inward; it enters the fissure of Sylvius, gives off, at its upper and posterior part, numerous, generally small, ramuscules, some of which penetrate into the anterior extremity of the posterior lobe, others into the posterior extremity of the anterior lobe, and afterward divides generally about half an inch from its origin into two, three, or four large branches. The largest of the latter are turned backward, soon bifurcate, and proceed, closely against each other, into the bottom of the fissure of Sylvius, where they go upward and backward. The anterior attain the posterior and external part of the anterior lobe, and the posterior the anterior central part of the posterior lobe, gliding in the circumvolutions of the posterior face of the first and the anterior face of the second, but penetrating mostly into their substance, through their outer face, and thus extend to the upper edges of the hemispheres, where they anastomose with the ascending branches of the anterior and posterior cerebral arteries.

§ 1370. The anterior and middle cerebral arteries are not always arranged symmetrically. The two large middle arteries not unfrequently arise (as Haller states and as we have verified) from the right carotid only, and the anterior, which is smaller, from the left carotid, an arrangement which deserves to be remarked as indicating the predominance of the right side over the left.

Sometimes also only the left anterior artery comes from the internal carotid of the same side, and the other three come from the right. We have seen this anomaly in several subjects.

If we add the union of the arteries of the corpus callosum at their origin, which we mentioned above, we here find a remarkable repetition of several of the varieties to which the origins of the trunks coming from the arch of the aorta are subject.

ARTICLE FOURTH.

ARTERIES OF THE UPPER EXTREMITIES.

§ 1371. The arteries of the upper extremities, for which we cannot find a better term than that of the *brachial* arteries(1) (*A. brachiales*),

(1) This term is generally applied only to that portion of the artery which corresponds to the arm, and which might more properly be termed the *humeral* artery.

arise on each side by a single trunk, generally called the ***subclavian*** artery (*A. subclavia*).

I. SUBCLAVIAN ARTERY.

§ **1372**. The two ***subclavian*** arteries (***A. subclavia***) arise from the ascending aorta, and extend to the scaleni muscles. They differ in their mode of origin; for the left subclavian artery arises directly from the arch of the aorta, while the right proceeds indirectly from it, as it is the external branch of the trunk of the innominata (***truncus communis innominatus***), which bifurcates and gives origin to it and to the right primitive carotid.

This at least is the most common arrangement. Sometimes, but rarely, the subclavian arteries arise directly from the arch of the aorta. We may there find two principal differences. Sometimes in fact the trunk of the innominata gives off the right subclavian and the carotid, the subclavian artery arising on the right, outside of the carotid, which is the least but also the rarest anomaly. Sometimes the right subclavian artery arises more to the left, until it is the extreme left trunk of those which arise from the arch of the aorta, below the left subclavian artery, and goes to the right, towards the corresponding limb, passing behind the other trunks, rarely directly, more frequently between the trachea and the esophagus, and still more frequently between the esophagus and the vertebral column.

§ **1373**. The first branches of the subclavian artery are never constant. They often and in fact almost always arise from its upper extremity, directly before its passage between the scaleni muscles. But sometimes the artery gives off much sooner, and even near its origin, considerable branches, which go to the thymus gland, to the upper part of the pericardium, also to the trachea, to the bronchiæ, and to the esophagus (*A. thymicæ, pericardiacæ superior, anterior et posterior, bronchicæ, œsophageæ, broncho-œsophageæ*), but they rarely or never belong to these parts alone, although they distribute branches to all. Even when these branches arise from the subclavian artery (which occurs on the left side more frequently than on the right, because it descends deeper) its course is no shorter, but it gives off no branch until just before passing between the scaleni muscles. Here, however, several large branches arise from it. These may be distinguished generally speaking into the ***upper*** or ***posterior*** and the ***lower*** or ***anterior*** branches; and they vary much, for, 1st, the same twigs do not always arise from the same branches, so that the latter are not always of the same caliber; 2d, small branches sometimes arise from the subclavian artery, by a common trunk, whence their number varies; 3d, they do not always emerge from the same point of the subclavian artery, the inferior arising sometimes farther forward, and the superior farther backward than usual.

A. UPPER POSTERIOR BRANCHES.

§ 1374. The most constant of the upper and posterior branches are two, the *vertebral* artery and the *inferior thyroid* artery.

I. VERTEBRAL ARTERY.

§ 1375. The *vertebral* artery (*A. vertebralis*) is generally the first and largest of the two upper branches of the subclavian artery. Shortly after arising, it enters the arterial canal of the cervical vertebræ, and goes from below upward. This artery shows a great disposition to change its origin, and to arise directly from the arch of the aorta. We shall remark, 1st, that this anomaly, however common it may be, is seldom seen on the right side (at least to our knowledge), and that it rests always on the left;(1) 2d, that when it occurs, the vertebral artery is almost always inserted between the left carotid and the left subclavian arteries. If this branch arises directly from the arch of the aorta more frequently than the others, it may be attributed, we think, to the following facts: 1st, in the normal state it is the first branch of of the subclavian artery; 2d, the vertebral vein normally empties itself into the common trunk of the subclavian and jugular veins. The other fact, that the anomaly appears almost entirely on the left side, seems to us to depend on this, that the division of the trunk into branches characterizes the left side of the ascending aorta even in the normal state, since the subclavian arteries there arise separately, and are not blended in a single trunk, as on the right side. The greater length of the left trunk of the innominata vein may contribute to it, since this anomaly should be considered, as we have remarked, an imitation of the arrangement of the venous system. Finally, the situation of this artery between the left carotid and the left subclavian arteries probably depends on its arising, in the normal state, from the internal and posterior side of the subclavian artery.

We sometimes but rarely find on the right side a similar anomaly where the vertebral artery arises from the bifurcation of the trunk of the innominata; this is still more curious, because in comparing this arrangement with that on the left side we have a new proof that the anomaly does not destroy in the two sides the character of the normal type.

We know of only one case where the right vertebral artery arose from the arch of the aorta; but that of the left side also presented the same anomaly.

(1) This might be easily proved by numerous quotations. Of all the authors who mention this variety Mayer is the only one who asserts the contrary; for, without speaking of the left vertebral artery, he asserts only that the right sometimes arises directly from the arch of the aorta. This assertion is so contradictory to observation that it can be explained only by considering it as a typographical error.

A second anomaly of the vertebral artery consists in its division into several trunks. Sometimes then one of the trunks arises directly from the arch of the aorta; the other, which is generally smaller, from its usual place;(1) or both come from the subclavian artery, at a greater or less distance from each other. Perhaps the first arrangement also is found only on the left side; at least in a specimen before us, and where the anomaly exists on the right, the two vertebral arteries are branches of the subclavian artery. In both cases one of the trunks, particularly the largest, enters the vertebral canal higher than usual. Sometimes it unites with the other, which enters at the normal place; sometimes it unites with it before entering this canal; sometimes, finally, the smallest branch extends into the vertebral canal after passing over one or more vertebral foramina.

Even when the vertebral artery is normal in respect to its origin, it enters the vertebral canal at several different points. Its proper place is the vertebral foramen of the sixth cervical vertebra.(2)

In extremely rare cases this artery enters through the vertebral foramen of the seventh cervical vertebra.(3) Even when it arises lower than usual, from the arch of the aorta it however enters into the hole of the sixth cervical vertebra, and we have frequently seen it in this case not enter the vertebral canal until it reaches the fifth vertebra.

More frequently, although not very often, the vertebral artery, even if not double, enters through the vertebral foramen of the fifth, fourth, third, or even the second cervical vertebra. We know of no case in which it has been found entirely out of the vertebral canal, and we have never known it to leave this channel lower than the upper vertebra, or to leave a vertebra, pass through a certain extent on the anterior face of the transverse processes, and enter again into the vertebral canal.

Finally, the vertebral artery of one side is very frequently much larger than that of the other, although according to our observations the sides of the body have no effect on this disproportion.

This anomaly confirms the general rule that the synonymous arteries which go to the single organs on the median line of the body often differ in volume and enlarge on one side at the expense of the other.

(1) Henkel, *Anmerkungen von weidernatürlichen Geburten, zweite Sammlung*, p. 10, 11.—Huber, *De arcus aortæ ramis;* in the *Act. Helv.*, vol. viii. p. 68-102.

(2) We have always observed this, except in a very few instances. Haller (*Ic. anat. fasc.* ii., *explic. icon.* 2, *art. thyr. infer.*, *not.* c) and Sœmmerring (p. 177) are then correct in saying that this arrangement is normal. Mayer mistakes in saying (p. 110) that there is for the vertebral artery a special opening, through which it enters into the vertebral canal, sometimes in the seventh and sometimes only in the sixth cervical vertebra. This opening always exists except in a very few instances in the seventh cervical vertebra; but the vertebral artery rarely or never passes through it and always enters through the sixth. What Mayer considers the normal state is a rare anomaly, and *vice versâ*. Monro (*Outlines, &c.*, vol. iii. p. 301) is also mistaken in thinking that the artery enters through the seventh cervical vertebra as often as it does through the sixth.

(3) Bichat (p. 193) is correct in saying that it sometimes but rarely enters through a similar foramen of the seventh cervical vertebra. This arrangement is rare, as Haller, Murray, and Sœmmerring have not spoken of it, although they mention the next.

§ 1376. The vertebral artery ascends in an almost straight line to the second cervical vertebra; but at this point it becomes tortuous and describes several curves, four of which are very remarkable. First, it penetrates into that part of the canal which belongs to the transverse process of the second vertebra, forming a right angle, assuming an entirely horizontal direction, and going transversely outward; then passing through this opening, it describes another right, acute, or obtuse angle, resumes its first direction, and becomes perpendicular again at the upper cervical vertebra. When it has passed through the vertebral foramen it inclines again at a right angle, resumes a second time a horizontal direction, and goes backward and inward, turning around on the articular process of the first cervical vertebra, along its posterior groove. From the posterior extremity of the articular process it goes gradually and at an obtuse angle inward and upward, and soon enters the cranium, passing through the dura mater and the large occipital foramen directly above the occipital condyle. Having entered the skull, it is situated first on the side, then on the lower face of the medulla oblongata, and ascends forward and inward on the basilar process of the occipital bone. There the two arteries approach each other, and after passing usually more than an inch within the cavity of the skull, they unite at an acute angle, either a short distance behind the posterior edge of the pons Varolii, or on this edge, or even in its centre. They always, as far as we know, unite and give origin to a single trunk, the *basilar* artery (*A. basilaris*), which is much smaller than the two branches which produce it. In size it nearly equals the internal carotid artery after it gives off the ophthalmic artery. It proceeds forward to the centre of the lower face of the pons Varolii, and divides at its anterior extremity into two large branches, a right and a left.

§ 1377. In this course the vertebral artery generally gives off no branches, or at least but small and inconstant ones. These branches are distributed to the anterior deep muscles of the neck. In this respect the vertebral artery resembles the internal carotid.

§ 1378. From the portion within the vertebral canal several small branches pass forward, outward, and backward, generally between every two vertebræ, and go to the vertebræ, to the intertransversarii, to the multifidus spinæ, to the anterior deep muscles of the neck, and to the small muscles of the head.

Internal branches, which are also very small, pass through the intervertebral foramina, either alone or attended with small arterial twigs from the other branches of the subclavian artery, penetrate the vertebral canal and are distributed partly to the nerves, others to the anterior and posterior sides of the dura mater and to the pia mater of the spinal marrow. They anastomose with those of the opposite side and with the anterior and posterior spinal arteries.

Considerable branches arise from that part of the vertebral artery between the first and the second cervical vertebræ, and also between the latter and the occipital bone. Some go outward, are expanded in the transversalis colli and the complexus minor muscles, and anastomose with the branches of the ascending cervical artery, and sometimes entirely replace it. The others proceed backward and outward and are distributed in the posterior and lateral small muscles of the head. Some go inward and anastomose with the synonymous branches of the other side. Finally, many enter the tissue of the dura mater.

§ 1379. The largest branches arise from that part of the vertebral artery within the skull. From the difference of caliber between the branches which it sends out of the cavity of the skull, this part is frequently much larger on one side than on the other, although both have primarily the same diameter at their origin and although the side of the body has no necessary influence upon this difference.

The branches which arise before the two vertebral arteries unite are the *anterior spinal* artery, the *posterior spinal* artery, and the *inferior artery of the cerebellum*.

§ 1380. The *posterior spinal* artery (*A. spinalis posterior*) is the smallest, and often comes from the inferior artery of the cerebellum. It arises the lowest and from the outside of the vertebral artery, goes inward on the posterior face of the spinal marrow, and descends on each side along the posterior spinal groove to the end of the spinal marrow. The two arteries are very tortuous and are parallel to each other. They are always enlarged by the accessory ramuscles of the vertebral, the deep cervical, and the intercostal arteries which pass through the intervertebral foramina, and anastomose by numerous transverse branches, which generally correspond to the intervertebral spaces; so that each portion of the spinal marrow between two vertebræ has its special vascular circle, even as the four cerebral arteries form one by their anastomoses.

§ 1381. The *inferior artery of the cerebellum* (*A. inferior cerebelli*) also arises from the outer side of the vertebral artery and is usually double on both sides.

One, the *posterior inferior* artery of the cerebellum, arises farther backward, and goes backward, upward, and inward, proceeds on the lateral parts of the medulla oblongata, distributes its branches to the tela choroidea of the cerebellum and to the floor of the fourth ventricle, and ascends between its two hemispheres to its vermiform eminence and to the inner face of its two hemispheres. This branch often exists on one side only, and then it is observed particularly when the inferior artery of the cerebellum arises very far forward.

The *anterior inferior* artery of the cerebellum sometimes arises at the origin, sometimes also at the extremity of that portion of the vertebral artery within the skull. In some subjects, particularly when the vertebral arteries unite early, it comes from the basilar artery. These varieties are observed even on both sides of the body at once. The anterior inferior artery of the cerebellum not only frequently exists alone but it is generally much larger than the posterior. It is sometimes much smaller on one side than on the other. It proceeds very tortuously outward and backward to the lower face of the cerebellum, where it passes on the grooves which it crosses and divides into branches, some of which go backward and others forward. These branches also cross the direction of the grooves of the cerebellum; the small ramifications alone become parallel and finally penetrate into them.

§ 1382. The *anterior spinal* artery (*A. spinalis anterior*) generally commences a short distance from the lower edge of the pons Varolii, even when the two vertebral arteries unite much higher than usual. It arises from the internal part of the trunk and soon unites with that of the opposite side in a single trunk on the median line, which descends along the anterior groove of the spinal marrow. Generally, particularly when the two vertebral arteries unite higher than usual, we find a small anterior and superior spinal artery, which is sometimes single and arises from the top of the angle of union, and sometimes double, which blends likewise with that of the opposite side, and which, proceeding also from above downward, soon anastomoses with the lower. The single trunk of the latter, which corresponds to the median line, is often divided in its course and thus forms considerable islands. Its upper part receives also from all or most of the intervertebral foramina considerable branches, which are given off by the vertebral or the other cervical arteries to the anterior face of the spinal marrow and anastomose with it. During its course, which is very tortuous, it sends off on each side numerous branches to the spinal marrow.

II. BASILAR ARTERY.

§ 1383. The *basilar* artery (*A. basilaris*, s. *meso-cephalica*) is constant, and arises, proceeds, and varies in the manner mentioned above. We however sometimes remark in its arrangement a tendency to a want of union or to the separation of the vertebral arteries, since it forms islands, especially at its posterior part. This artery is however the only one in which we have observed this arrangement. It very soon divides into two parts, which almost immediately unite. We consider this anomaly as very rare, not only because we have never seen it but twice, but because it is not mentioned by the most correct angeiologists.(1) It is curious not only as an anomaly, but because it increases the analogy between the basilar and the anterior spinal arteries, which are already so similar. It is not unimportant to say, that in the two subjects which presented this unusual arrangement the anterior communicating artery of the two internal carotids presented analogous

(1) An arrangement has been figured by Heuermann (*Physiologie*, vol. ii. tab. 8) where the two vertebral arteries were connected behind their union by a large transverse branch, to give rise to the basilar artery, which seems to have some relation with this anomaly; but more probably it consisted only in the union of the anterior spinal arteries, since the two vertebral arteries are not yet united behind this branch.

divisions. In the latter however this anomaly is much more common than in the basilar artery.

From both sides of the basilar artery numerous branches arise, generally at right but sometimes at angles slightly acute, backward, which vary much in number and volume and do not correspond perfectly on both sides. The smallest enter into the pons Varolii and the nerves which come from it; the largest, even when the usual inferior arteries of the cerebellum do not exist, proceed even to the lower face of the cerebellum.

Some branches, the *internal auditory* arteries (*A. auditivæ internæ*), enter into the internal auditory foramen, expand in the labyrinth, and anastomose with the branches of the internal and of the external carotid arteries which enter into this organ.

§ 1384. At its anterior extremity, in the middle of the anterior edge of the pons Varolii, the basilar artery usually divides into four branches, two on each side, the superior artery of the cerebellum and the posterior cerebral artery.

§ 1385. The *superior artery of the cerebellum* (*A. cerebelli superior*) which is almost as large as the inferior, is rarely deficient on one side, in which case it is replaced by a branch of the following. It is more frequently double; and then the vertebral artery divides into five branches, of which the two superior arteries of the cerebellum are situated very near each other: sometimes but much more rarely, it arises some lines behind the anterior extremity of the vertebral artery. It goes transversely outward and upward, directly behind the anterior edge of the pons Varolii, then proceeds a little backward, turns upon the pons Varolii to arrive at the anterior edge of the cerebellum, and divides into superficial and deep branches. The first proceed backward on the ridge of the cerebellum to its posterior edge, where they anastomose with the branches of the inferior artery of the cerebellum; the others penetrate upward into the anterior lobes.

§ 1386. The two anterior branches, the *posterior* or *deep cerebral* arteries, *Lobaires posterieures du cerveau*, Ch. (*A. cerebri posteriores*, s. *profundæ*), are much larger than the superior arteries of the cerebellum. They arrive at an acute angle, separate much from each other, and go forward and outward. They usually give off near their origin and at their upper and external part several branches, some of which are considerable and go to the cerebral peduncles, to the thalami optici, to the tubercula quadrigemina, and to the valve of Vieussens. After proceeding a short distance they divide into two branches, the communicating artery and the continuation of the trunk.

The *communicating* artery is situated inward, and is smaller than the other. Its direction is outward and forward and it proceeds to meet the anastomosing branch of the internal carotid artery, with which it unites.

The continuation of the trunk of the posterior cerebral artery, which is usually the smallest of the three proper cerebral arteries, sometimes arises from the internal carotid artery, previous to its bifurcation, and sometimes also from the union of the anastomosing branches given off by the internal carotid and the vertebral arteries. It goes outward and upward, before the third pair of the cerebral nerves, and turns on the cerebral peduncle, to the lower face of which it gives some ramuscules, which thus arrive at the thalami optici and the tubercula quadrigemina, penetrate into the third ventricle, and are distributed principally to the choroid plexus. Finally, it goes on one side to the posterior part of the cerebrum and of the corpus callosum, and also to the thalami optici on the other, particularly to the lower face of the cerebral hemispheres. It anastomoses very frequently with the anterior or central arteries and with the arteries of the corpus callosum, which arise from the internal carotid artery.

§ 1387. The peculiarities presented by the arteries of the brain have been described before or will be mentioned when we speak of the encephalon.

II. INFERIOR THYROID ARTERY.

§ 1388. The *inferior thyroid* artery (*A. thyroidea inferior*, s. *sacrothyroidea*, *Barclay*) arises from the subclavian artery, more outward and forward than the vertebral artery, from which however it is not always the same distance. It most generally gives off the inferior thyroid branch and several twigs, which go to the muscles and to the skin of the neck, the back, and the shoulder.

This artery is large, particularly in the child, where it is equal to the subclavian or even the carotid artery. Its size however varies much, because that one or more branches which it commonly furnishes frequently arise from other trunks, but the arteries which generally come directly from the subclavian artery are rarely given off by it. This is true for instance of the internal mammary artery, and the former is true in regard to the branches which go to the muscles of the neck, shoulder, and back. Sometimes it goes only to the thyroid gland. In other cases it is uncommonly large, because it gives off not only the usual branches but also the internal mammary artery. In rare cases, on the contrary, it does not deserve its name, because it gives branches only to the muscles and the inferior thyroid arises from the common carotid artery, or does not exist as a separate vessel, but is blended with the superior thyroid artery. This anomaly is curious, as it is a repetition of the normal formation of most mammalia.

Another and somewhat similar anomaly is when the inferior thyroid artery is uncommonly small, either on one or both sides, and one or both of the superior thyroid arteries are larger in the same proportion, or finally when beside the two common thyroid arteries, there is also a third (*A. thyroidea ima*, s. *Neubaueri*), which arises lower down either from the arch of the aorta on the right of the left carotid or from the common trunk of the carotid and the subclavian artery, when the anomaly occurs on the right side, or from the common trunk of the carotids of one side only, or finally from both sides at once, sometimes higher and sometimes lower.

We must also mention here the rare anomaly where the inferior thyroid artery is totally deficient on one side, while on the other, in the usual place, particularly on the right, instead of the two inferior thyroid arteries, we have a common trunk,(1) which arises sometimes from the aorta and sometimes from its usual place. We have twice observed a case resembling this, where the inferior thyroid artery arose from the arch of the aorta, between the trunk of the innominata and the left carotid arteries.

III. SUPERIOR SCAPULAR ARTERY.

§ 1389. In most cases the inferior thyroid artery, immediately after arising, gives off the *superior scapular* artery (*R. transversus scapulæ*, *s. scapularis transversa*, s. *scapularis superior*, s. *cervicalis superficialis*), which however sometimes arises from the subclavian artery, sometimes singly, and sometimes by a common trunk with the following. It goes transversely backward and outward behind, and a little above the clavicle between the scalenus anticus and the scalenus medius; gives branches to the sterno-thyroideus, the sterno-hyoideus, the omohyoideus, the scaleni, the trapezius, and the supraspinatus muscles; passes between the spine and the glenoid cavity of the scapula, and enters the infraspinalis fossa. There it divides into several branches, the smallest of which usually pass through the semicircular notch to the anterior face of the scapula and to the subscapularis muscle, while the largest are distributed on the posterior face of this bone, to which it gives one or more nutritious twigs, and terminates in the infraspinatus muscle. Another branch arises from this point and goes forward between the proper and common ligaments of the scapula, distributes itself in the articular capsule of the shoulder and to the upper and anterior part of the deltoides muscle, and anastomoses by several large branches with the anterior circumflex artery of the arm and with the great thoracic artery.

IV. TRANSVERSE CERVICAL ARTERY.

§ 1390. The *transverse cervical* artery (*A. cervicalis superficialis*, s. *cervicalis transversa*, s. *colli transversa*), which is generally as large as the preceding, arises from the inferior thyroid artery, a little higher and at some distance from it outwardly; it often arises directly from the subclavian artery. It goes transversely outward and backward. It is situated at first on the side of and a little behind the superior capsular artery, and it gives off in this course branches to the scaleni muscles,

(1) Burns, *loc. cit.*, p. 331.

and divides into two large branches on a level with the upper edge of the shoulder. The ascending branch becomes the principal branch of the trapezius and also sends some ramuscules to the levator scapulæ muscle; the other descends along the base of the scapula, between the rhomboidei and the serratus magnus muscles, in which course it gives off twigs to these muscles and also to the lower part of the trapezius muscle.

§ 1391. A little higher, one or more small branches (***R. thoracici***) arise very constantly from the inside of the inferior thyroid artery; these go upward and inward to the lower part of the longus colli muscle, penetrate also the spinal canal through the intervertebral foramina, but go particularly to the trachea and to the esophagus. The latter are termed the *bronchial* and the *esophagœal* arteries (*A. branchiales, œsophageæ*, s. *broncho-œsophageæ*).

§ 1392. After passing through rather a long course upward without giving off any branch, the inferior thyroid artery divides into two branches, the ascending cervical artery, which is generally much smaller and goes upward and outward, and the thyroid artery, which may be considered as the proper continuation of the trunk.

V. ASCENDING CERVICAL ARTETY.

§ 1393. The *ascending cervical* or the *superior dorsal* artery (*A. cervicalis ascendens*, s. *dorsalis suprema*) is a very constant branch of the inferior thyroid artery and sometimes but rarely arises from the subclavian artery; this happens particularly when the branches already described arise separately from the proper thyroid artery. Sometimes also it arises from the internal mammary artery. It ascends along the transverse processes of the cervical vertebræ, between the longus colli and the scaleni muscles. In its course it gives off backward, outward, and upward several considerable branches, which are distributed in the upper part of the trapezius, the levator scapulæ, the serratus magnus, the serratus posticus, the scaleni, and the splenii muscles, and the skin of the neck: the trunk generally goes backward, below the transverse process of the third cervical vertebra, penetrates deeply between the transversalis colli and the complexus minor muscles, and having thus come upon the posterior face of the neck, it terminates in two principal branches; the smaller ascends behind the transverse processes of the cervical vertebræ, gives ramuscules to the complexus minor muscle and to the posterior small muscles of the head, anastomoses with the vertebral and occipital arteries, and finally penetrates into the spinal canal between the first and second cervical vertebræ, where it terminates in the dura mater. The other is larger and is the continuation of the trunk: it goes outward between the fasciculi of the complexus major muscle, and terminates in this muscle and in the digastricus and the posterior muscles of the head.

§ 1394. The *thyroid* branch (*R. thyroideus*) sometimes arises singly from the subclavian artery, from the aorta, the innominata, or from the common carotid artery. It is sometimes entirely deficient in some subjects, but is generally the largest branch of the inferior thyroid artery. It is very tortuous and curves very much in ascending toward the thyroid gland. It usually passes behind, sometimes but rarely before, the primitive carotid, in order to arrive at this gland. Before reaching it, it divides into several branches, which enter this organ principally on its lower edge and lower face and anastomose with each other and with those of the superior thyroid artery.

The thyroid branch also gives in its course smaller ramuscules to the longus colli muscle, to the pharynx, and particularly to the larynx. The latter is termed the *inferior laryngeal* artery (*A. laryngea inferior*).

VI. LOWEST THYROID ARTERY.

§ 1395. Besides the branch described (§ 1364), another branch called the *lowest thyroid* artery (*A. thyroidea ima*) arises, sometimes from the primitive carotid or from the innominata, from the arch of the aorta or from the subclavian artery, by a trunk in common with that of the opposite side.

This anomaly occurs on the right side more frequently than on the left;(1) we have never observed it on the latter side, although we have frequently seen it on the other. In one case only, where the origin of the inferior thyroid artery was abnormal, it did not arise from the left side of the arch of the aorta, but from the right side, between the innominata and the left carotid artery; thence it passed before the trachea to go to the left side of the thyroid gland, while the origin and direction of the right was normal. This anomaly then seems properly to belong to the right side, even as the similar anomaly of the vertebral artery appears exclusively on the left side.

Finally, whether this abnormal artery forms a part or the whole of the inferior thyroid artery, whether it arises from the innominata, or from the arch of the aorta, or deeply from the primitive carotid artery, it always passes on the anterior face of the trachea to go to the thyroid gland, into which it enters from below upward. It cannot then escape being wounded in the operation of laryngotomy.

(1) We have found it nine times on the right. Hubert (*loc. cit.*, p. 84) has seen the lowest thyroid artery arise four times from the common trunk, three times on the right and only once on the left side. Neubauer has also seen the right coming from the aorta (in Erdmann, *Descrip. art. thyr. imæ*, Jena, 1772). Ramsay (*Account of an unusual conformation of some muscles and vessels*, in the *Edinb. Med. and Surg. Journ.*, vol. viii. p. 281-283, tab. 1, fig. 2) has found it arising from the innominata trunk. Loder has twice seen it arising from the aorta, between the right carotid and the subclavian arteries: the innominata trunk did not exist in these two cases (*De nonnullis arteriarum varietatibus*, Jena, 1781).

VII. DEEP CERVICAL ARTERY.

§ 1396. The *deep cervical* artery (*A. cervicalis profunda*) often forms a special trunk, which arises from the back side of the subclavian artery, a little more externally than the preceding, but frequently by a common trunk with the superior intercostal artery. It is rarely given off by the inferior thyroid or even by the vertebral artery; in the latter case its origin is generally a little below that of the vertebral artery. It more rarely comes from the upper part of the latter, in which case it sometimes descends between the first cervical vertebra and the occipital bone, and is afterwards distributed as usual, but so that its lower branches are almost always supplied by the other branches of the subclavian artery.

It goes obliquely upward and outward, passes backward between the transverse processes of the sixth and seventh cervical vertebræ or the latter and the first dorsal vertebra. It ascends between the transversalis colli, the spinalis colli, and the semispinalis dorsi muscles on one side, and the digastricus and the complexus muscles on the other. It also distributes branches to the scaleni, the complexus minor, the cervicalis descendens, the trapezius, the splenii, and the small posterior muscles of the head, and anastomoses, especially above, near the occipital foramen, with the branches of the vertebral and occipital arteries. It also sends ramuscules into the spinal canal through the intervertebral foramina, which anastomose there with the spinal arteries given off by the vertebral artery.

B. INFERIOR BRANCHES.

§ 1397. The *inferior branches* of the subclavian artery are the internal mammary artery and the superior intercostal artery.

I. INTERNAL MAMMARY ARTERY.

§ 1398. The *internal mammary* artery (*A. mammaria interna*, s. *sternalis*, s. *substernalis*) is much smaller than the vertebral and the inferior thyroid arteries. It arises ordinarily and very constantly by a distinct trunk from the anterior or inferior side of the subclavian artery, nearly opposite the inferior thyroid artery. It however in some rare cases, one of which is now before us, arises by a common trunk with the latter, or on the right side from the innominata,(1) or even from the arch of the aorta.(2)

It generally goes downward and inward, but sometimes also ascends a little before taking this direction, which it long preserves. It

(1) Neubauer, *loc. cit.*, p. 33.

(2) Bœhmer, *De quat. et quinq. aortæ ram.*; in Haller, *Collect. diss. anat.*, vol. ii. p. 452.

descends almost in a straight line to the posterior face of the anterior wall of the chest, on the costal cartilages between the intercostales and the triangularis sterni muscles, nearer its internal than its external extremity, consequently not far from the two edges of the sternum, which it also approaches a little below.

Besides several branches which go from its upper part to the lower part of the anterior muscles of the neck, it sometimes gives off a superior bronchial artery, the thymic, and a branch which is distributed to the pericardium and also to the anterior mediastinum. But its upper part constantly gives off a branch which accompanies the diaphragmatic nerve, called the *superior diaphragmatic* artery (*A. diaphragmatica superior*, s. *pericardio-diaphragmatica*). This branch sends ramuscules to the pericardium, to the internal wall of the mediastinum, and to the esophagus, and expands in the anterior and middle portion of the diaphragm, where it anastomoses with the inferior diaphragmatic artery.

In its course along the sternum the internal mammary artery gives off external and internal branches.

The external branches, the *anterior intercostal* arteries, (*A. intercostales anteriores*), are usually larger and more numerous than the internal. Their number is not exactly the same in every part, but they equal in number the intercostal spaces, over which the internal mammary artery passes. They generally proceed along the lower, rarely along the upper edge of the ribs, and almost always in the latter case one intercostal space contains two of them. They go backward between the intercostales interni and externi muscles, and anastomose with the intercostal arteries given off by the descending aorta and with the thoracic arteries which arise from the axillary artery.

One of these branches, the fifth, sixth, or seventh, has been called the *musculo-diaphragmatic* artery (*A. musculo-phrenica*). It is usually very considerable, sometimes as large as the trunk, of which it seems even to be a continuation. It is distributed not only to the anterior part of the diaphragm but also it arrives at the upper part of the broad abdominal muscles, whence its name, where it anastomoses with the epigastric artery.

The internal branches, which are smaller and fewer than the preceding, go, some to the internal face of the sternum, others to the anterior face of the pericardium, and some, viz. the deepest, to the anterior part of the diaphragm; finally, others leave the pectoral cavity through the intercostal spaces and are distributed in the upper part of the abdominal muscles.

The trunk of the internal mammary artery commonly divides into two principal branches of different sizes, an external and an internal. This bifurcation occurs sometimes higher and sometimes lower, and occasionally it is seen opposite the anterior extremity of the fifth rib, and sometimes only opposite the eighth.

The external branch goes obliquely outward, along the costal cartilages, above the intercostal spaces. It terminates by the lowest of the anterior intercostal arteries and by small branches which enter the anterior edge of the diaphragm and the upper part of the broad abdominal muscles. It is also called the *superior epigastric* artery (*A. epigastrica superior*).

The internal branch proceeds perpendicularly downward, passes between the anterior and internal digitations of the diaphragm, and comes upon the posterior wall of the rectus abdominis muscle, where it soon divides into several branches, which descend vertically and anastomose as high as the umbilicus with the ascending branches of the epigastric artery and also with the ramifications of the external branch.

II. SUPERIOR INTERCOSTAL ARTERY.

§ 1399. The *superior intercostal* artery (*A. intercostalis suprema*, s. *prima*) arises more externally than the preceding, and is given off from the posterior part of the subclavian artery. It is the smallest and the most external of the four constant branches of the latter, and varies in size. Sometimes it is very small; in this case it arises almost always directly from the subclavian artery. It is rarely given off by the inferior thyroid artery, and it frequently arises by a common trunk with the deep cervical artery.

The distribution of this artery varies very frequently, especially in regard to its extent. It however always goes downward and outward, passing on the neck, and gives upward and downward branches, of which the lower are much larger than the upper.

The superior branches go to the transversalis colli muscle and send branches to the deep muscles of the back.

The inferior, which are a continuation of the trunk, divide into external and internal or posterior branches.

The *external* or *intercostal* branches (*R. interossei*) proceed along the lower edge of the first and second ribs, between the intercostales interni and externi muscles. They generally do not extend very far forward and divide into two ramuscules, an upper and a lower, which follow, the former the lower edge of the upper rib and the second the upper edge of the lower rib, and are distributed in the posterior part of the intercostales muscles between which they proceed, and anastomose before with the superior anterior intercostal arteries (§ 1397). Sometimes we find two branches in the same intercostal space, one of which gives off two twigs.

The *posterior*, *internal* or *dorsal* branches (*R. dorsales*) usually arise more or less opposite the external and divide like them into two ramuscules, the internal of which is almost always larger than the other, and enters into the spinal canal through the intervertebral foramen, is distributed to the spinal membranes and the spinal marrow, and anastomoses with the spinal arteries which arise from the vertebral artery; while the external, proceeding between the ribs goes backward, where it enters the deep muscles of the back, the multifidus spinæ and the spinalis dorsi.

When the superior intercostal artery is very small, it is distributed only to the first intercostal space, but its branches generally extend to the second.

It more rarely gives origin, as we have already said, to the deep cervical artery, and it also gives off very near its origin an ***esophageal*** or ***bronchial*** artery (*A. œsophagea et bronchialis*), which varies in size and turns inward and forward, sending branches to the lower part of the trachea, also to the centre of the esophagus, and likewise gives them to the bodies of the upper dorsal vertebræ, and communicates by broad anastomosing branches with the other esophageal and bronchial arteries.

§ 1400. The subclavian artery gives off those branches only which we have described. Sometimes however it sends from its lower and anterior side a considerable branch to the lymphatic glands in the upper region of the chest. It also gives off above the lower extremity of the scalenus anticus others, which go outward to some of the axillary glands.

§ 1401. The artery of the upper extremity then assumes a transverse direction, separates from the trunk, goes downward and outward between the scalenus medius and anticus, and is called the axillary artery.

II. AXILLARY ARTERY.

§ 1402. The *axillary* artery (*A. axillaris*) extends from the scaleni muscles to the lower extremity of the axilla. It is situated between the chest and the arm, its upper part being nearer the former, while its lower part approaches the latter because it proceeds obliquely downward and outward. For a short space its upper part is covered only by the skin and the platysma myoides muscle; below we find the clavicle before it, as it passes behind its centre the subclavius muscle, and still lower the outer part of the pectorales muscles. Backward and outward we observe, above, the brachial plexus, then the subscapularis muscle, the scapulo-humeral articulation, and the tendon of the latissimus dorsi muscle. On its inside it has, above, the first two ribs, below, the serratus magnus muscle.

It is imbedded in a very loose cellular tissue, and is surrounded by the axillary glands, and is attached but feebly to the adjacent parts, excepting a small portion of its upper part. As in this place it rests on the first and second ribs, it may easily be compressed whenever an operation near or within the scapulo-humeral articulation requires.

§ 1403. Several branches, which are not very constant, arise from this artery. The principal, regarded from above downward, are the external thoracic arteries, the inferior scapular artery, and the circumflex arteries. These branches vary in respect to volume, number, and origin, because sometimes many of them arise by a common trunk, and again sometimes one or more come much lower than usual from the brachial artery, or finally in some cases by a trunk in common with the deep brachial artery.

Besides these branches the axillary artery also gives off, in part or entirely, far outward above, one or more of the external thoracic arteries, the transverse scapular artery, so that the principal portion of this latter artery arises at its usual place, but its smallest branch distributes itself to the subscapularis muscle. This anomaly is very remarkable, because it gradually leads to another, which is much greater, where the transverse scapular artery is entirely deficient, or at least is very small; so that the branches usually given to the muscles of the scapula come from the superficial scapular artery.

I. EXTERNAL THORACIC ARTERIES.

§ 1404. The *external thoracic* arteries (*A. thoracicæ externæ*, s. *alares*) vary in number from three to six.

Some arise from the inside, others from the outside of the axillary artery.

§ 1405. The former are usually smaller than the latter. They go principally to the superior external intercostal muscles, to the pectoralis minor muscle, to the axillary and thoracic glands, and go downward and forward even to the skin. Sometimes we find only one, and again there are two, which are then much smaller. One of these two arteries, and when there is only one, that one usually arises highest from the trunk of the axillary artery; it is then termed the *superior external thoracic* artery (*A. thoracica externa suprema*, s. *prima*), and is also called the *small external thoracic* artery (*A. thoracica externa minor*), because it is always smaller than the others.

§ 1406. The second external thoracic artery is rather constant and is called the *acromial* artery (*A. acromialis*). It arises from the outside of the axillary artery and is sometimes single and sometimes double. In the latter case, some of the branches usually given off by the single trunk generally arise very near each other, from the axillary artery.

This artery gives off, first, upward and forward and upward and outward, small branches which go to the subclavius muscle; second, others below, which go to the inner part of the upper edge of the deltoides muscle and also to the upper part of the capsular ligament of the shoulder, where they anastomose below the acromion process with the branches of the superior scapular artery.

Larger and more numerous branches arise forward, inward, and downward, above and below the pectoralis minor muscle; they enter this muscle and also the pectoralis major muscle from within and without, and are distributed principally in them.

Others, which pass on the pectoralis minor muscle, go outward and forward toward the anterior and internal edge of the deltoides muscle, intc which they penetrate from below upward, and extend to the capsular ligament of the scapulo-humeral articulation, on the surface of which they anastomose with the preceding and also with the branches of the inferior scapular artery and the anterior circumflex artery. They penetrate also to the posterior muscles of the scapula and to the subscapularis muscle.

A constant branch descends along the inner edge of the deltoides muscle, between it and the pectoralis major muscle, at the side of the cephalic vein. This branch is always considerably large, and it arises sometimes directly from the axillary artery, but then it comes below all the others from which it is very remote, and no longer proceeds between the deltoides and the pectoralis major muscles, but descends below the latter, between the coraco-brachialis and the two heads of the biceps flexor muscle, and gives off considerable branches to these two muscles.

Other branches, which are still lower, go to the axillary glands, to the serratus magnus, and sometimes to the trapezius muscle.

§ 1407. The third, or, when the first or the second or both are double, the fourth or the fifth *external thoracic* artery, the *long thoracic*, or the *external mammary* artery (*A. thoracica externa longa, mammaria externa*) is given off so constantly by the subscapular artery that it should never be described as a separate artery. We shall mention it hereafter.

§ 1408. Not unfrequently two branches, which arise from the subscapular artery, come directly from the axillary artery and form a third, fourth, or fifth external thoracic artery, which is distributed to the subscapularis muscle.

II. SUBSCAPULAR ARTERY.

§ 1409. The *subscapular* artery, the *inferior* or *common scapular* artery (*A. subscapularis, scapularis inferior, infra-scapularis, scapularis communis*) is generally the largest branch of the axillary artery and sometimes equals this trunk in size. It arises near its inferior extremity, at the lower edge of the tendon of the subscapularis muscle; so that its origin is covered by the brachial plexus. It is rarely given off lower down.

Its origin is very constant, and when it arises from the inferior thyroid artery it is one of the rarest anomalies, and occurs certainly only in regard to its upper part.

The volume and number of its branches vary. In its greatest development it gives off, first, the final external thoracic arteries, which we have already described, which are its first branches, and which go upward and backward and are distributed in the infraspinatus muscle; 2d and 3d, one or two circumflex arteries of the arm; 4th, even the deep brachial artery in whole or in part; 5th, the long external lateral thoracic artery (§ 1407), more rarely the second, third, and the fourth branches, usually the first and the fifth.

After giving off the first subscapular branches, the artery proceeds inward and downward and divides into two branches, an inferior descending branch and a superior, which is larger, goes backward and is the continuation of the trunk, and is called the *circumflex* artery of the scapula (*A. circumflexa scapulæ*).

The circumflex artery of the scapula, shortly after giving off the ascending branch, sends off several beside, some of which are large and others small, to the outer edge of the subscapularis muscle, to the teres minor and major muscles, to the axillary glands, the skin of the axilla and of the back, and to the subscapularis muscle. It afterwards curves around the neck of the scapula, passes on its posterior face, where it is called the *dorsal* artery of the scapula (*A. dorsalis scapulæ*), when it is very much developed, penetrates partly into the bone, and ascends partly also upward and inward into the subscapularis muscle, advances on the neck of the scapula, and anastomoses with the acromial and with the superior scapular arteries; finally, when the latter is smaller or deficient, it re-ascends below the spine of the scapula into the supraspinalis fossa, and distributes branches to the supraspinatus and likewise to the trapezius muscle.

When it is less developed it does not penetrate deeply between the scapula and the infraspinatus muscle, but only into the posterior part of the deltoides muscle, and anastomoses with the preceding arteries on the acromion process and on the anterior edge and even in the substance of the infraspinatus muscle.

The descending branch goes inward, backward, and downward, along the external wall of the chest, in the broad muscles of the back, the lower part of the serratus magnus muscle, the intercostales muscles, the thoracic glands, the lower part of the subscapularis muscle, and several of the axillary ganglions.

The portion of this branch which is distributed in the serratus magnus muscle is the *long external thoracic* artery, which very rarely arises from the trunk of the axillary artery.

III. CIRCUMFLEX ARTERIES OF THE ARM.

§ 1410. There are two *circumflex* arteries of the arm (*A. circumflexæ, s. articulares humeri*), an *anterior* and a *posterior*.

a. Anterior circumflex artery of the arm.

§ 1411. The *anterior circumflex* artery of the arm (*A. circumflexa anterior humeri, s. articularis anterior*) often arises a little higher than the posterior, sometimes also much higher, in some cases at the same height, and sometimes still lower.

It is always much smaller than the latter, but it rarely arises from it or from the subscapular artery(1). It comes very constantly from the outer and anterior side of the axillary artery, a little above the upper

(1) We have never seen it arise from the deep brachial artery, of which Mayer (p. 123) asserts it is sometimes a branch.

edge of the tendon of the latissimus dorsi muscle. It goes outward on the anterior part of this tendon, directly on the humerus, below the common tendon of the biceps flexor and of the coraco-brachialis muscles, to which it gives ramuscules, and also to the periosteum, and divides into upper and lower branches. The latter are fewer and smaller than the former; they turn inward, some go partly to the internal portion of the deltoides muscle, where they anastomose with the posterior circumflex artery, while the others pass downward on the tendon of the latissimus dorsi muscle, to which they give branches, and anastomose with the recurrent branches of the superficial brachial artery.

The upper branches are larger and more numerous, and proceed directly on the humerus; they ascend toward the upper part of the humerus and give ramifications to this bone, expand in the scapulo-humeral articulation, penetrate to the supraspinatus and the infraspinatus muscles, and anastomose with all the arteries of the shoulder which arise from the subclavian and the axillary arteries.

Sometimes another analogous artery exists, which distributes its branches principally to the latissimus dorsi, to the upper part of the biceps flexor, and to the brachialis internus muscles. This artery is frequently only a branch of the anterior circumflex artery.

b. Posterior circumflex artery of the arm.

§ 1412. The *posterior circumflex* artery of the arm (*A. circumflexa humeri posterior*) is always much larger than the preceding. It arises from the subscapular or from the deep brachial artery by a common trunk, which varies in length but is never very long, more frequently than from the axillary artery. It very rarely forms a common trunk with the anterior circumflex artery, and when this anomaly occurs, the subscapular artery also arises from this trunk. In the former case it arises no higher, or at most not much higher, than when it comes directly from the axillary artery. But when it comes from the axillary artery it is lower than usual by the length of the whole tendon of the latissimus dorsi muscle, sometimes by about two inches; for in all the cases at least where we have observed this arrangement (which, so far from being rare, is perhaps the most common), the deep brachial artery arose as usual. The posterior circumflex artery is then reflected from below upward, behind the tendon of the latissimus dorsi muscle, and ascends between the two heads of the biceps flexor muscle until it comes a little above the upper edge of this tendon, that is, until it rises as high as its normal origin. It then goes backward to turn on the humerus. We have sometimes seen the deep brachial artery arise very high and near the posterior circumflex artery; but we have never found that it then came from the same trunk as the latter, which has led us to think that when these two vessels arise from a common trunk we must not consider the deep brachial artery as a branch of the posterior circumflex artery, as Murray(1) and Sœmmerring(2) have done, but we must regard the posterior circumflex artery as a branch of the deep brachial.(3)

The posterior circumflex artery is reflected outward and forward on the neck of the humerus, between this bone and the long head of the triceps extensor muscle. Proceeding onward, it distributes branches to this long head, to the capsular ligament of the scapulo-humeral articulation, to the teres minor and to the outer head of the triceps muscle. After giving off these branches, which are proportionally very small, it proceeds inward on the inner face of the deltoides muscle, in which it is entirely lost, and of which it is the principal artery. It anastomoses behind and above it with the anterior circumflex, the subscapular, and the superior scapular arteries.

The axillary artery sometimes gives off, above or below these two arteries, some small branches, which enter the biceps flexor, the long head of the triceps, the teres major, and the latissimus dorsi muscles.

III. BRACHIAL ARTERY.

§ 1413. When the artery of the upper extremity leaves the axilla at the upper edge of the tendon of the latissimus dorsi muscle, it is called the *brachial humeral* artery (*A. brachialis*, s. *humeraria*). It goes between the insertions of the teres major and latissimus dorsi muscles and the coraco-brachialis, which it covers, to the inside of the biceps flexor muscle and to the inner face of the arm; so that it crosses the direction of the humerus and becomes more superficial the farther it descends, since toward its lower extremity it is covered only by the brachial aponeurosis and the median vein and the skin. Its upper part rests directly on the humerus, and the lower on the brachialis internus muscle. It usually extends to the anterior face of the humero-cubital articulation, near which it terminates in most subjects. It not unfrequently however terminates higher, and sometimes does not exist at all, and then the branches usually given off in the elbow arise in the axilla.

The largest and uppermost branches go inward; they form the deep brachial artery or arteries. The origin of this artery, especially when it gives off branches which usually come from the axillary artery, as particularly the posterior circumflex artery of the arm or the subscapular artery, may often be considered as a point where the brachial artery divides into two branches, a superficial, which is the continuation of the trunk, and a deep branch.

§ 1414. The *deep brachial* or *external collateral* artery, *Grand musculaire du bras*, Ch. (*A. profunda humeri*, s. *brachii*, s. *collateralis*

(1) *Descript. art. in tab. redacta*, p. 41.
(2) Sœmmerring, *Gefässlehre*, p. 206.
(3) This remark has not escaped Mayer, who says (*loc. cit.*, p. 123) that one or even both the circumflex arteries arise from the deep brachial artery in rare cases.

magna, s. *superior*), usually arises below the lower edge of the latissimus dorsi muscle, above the small head of the triceps extensor muscle. It accompanies the radial nerve, which it almost always covers, penetrates between the three heads of the triceps muscle, to which it gives branches, turns from within outward upon the humerus, so that its lower extremity is situated on the outside of this bone, and commonly terminates at the articulation of the elbow, where it is distributed to the supinator longus and the extensor carpi radialis muscles. It also sends branches to the brachialis internus and to the anconeus muscle, supplies the nutricious artery of the humerus near the centre of its course, and having come to the outside of the elbow, it penetrates into the anconeus muscle, where, termed the *collateral radial* artery (*A. collateralis radialis*, s. *communicans radialis a profunda*), it anastomoses with the recurrent branch of the ulnar artery. One of these branches, which sometimes arises from the brachial artery, always lower than it but directly under it and sometimes a little distance from it, and which is always smaller, goes farther forward, descends between the long and short portions of the triceps to which it gives branches, anastomoses with the inferior lateral branch of the brachial, and communicates, under the name of the *collateral ulnar* artery (*A. collateralis ulnaris*, s. *communicans ulnaris a profunda*), with the recurrent branch of the interosseous and ulnar arteries, on the inner and posterior face of the humero-cubital articulation.

Thus the deep brachial artery is distributed principally to the extensor muscles of the fore-arm. It anastomoses above with the subclavian and below with the trunk of the brachial artery and with the arteries of the fore-arm.

§ 1415. Below or above the deep brachial artery, when it is single, or even between it and the collateral ulnar artery, when the latter forms a distinct trunk, we usually see arise a branch, which goes to the longer portion of the triceps muscle and which anastomoses with the posterior circumflex artery of the arm. This branch sometimes arises from the deep brachial artery. The brachial artery then gives off, forward, outward, and backward, at right angles, about twelve very short differently sized branches, which penetrate into the biceps and the brachialis internus muscle. Some of them go only to one of these muscles, but most of them are common to both. One of the largest, which arises from the posterior and internal part of the brachial artery, about two inches above the elbow, is called the *large anastomotic* or *internal collateral* branch, or more properly the *inferior anastomotic* branch, or the *inferior deep brachial* artery (*R. anastomoticus magnus inferior*, s. *A. profunda inferior*); the first of these terms is applied to it because it establishes a communication between the trunk of the brachial artery and the arteries of the fore-arm. It proceeds inward, passing on the brachialis internus muscle, to which it gives ramuscules, as also to the pronator teres, unites first by a transverse branch with the ulnar branch of the deep brachial artery, which connects it with the recurrent branch of the ulnar artery; then anastomoses on the posterior face of the articulation of the elbow with the radial branch of the deep brachial artery, and thus forms the *dorsal arch of the elbow* (*arcus dorsalis articularis cubitalis*), and communicates in this manner with all the anastomosing branches of the fore-arm.

This branch sometimes comes from the radial artery when the latter arises much higher than usual, but its origin is not constant, and then it is sometimes supplied by the continuation of the trunk of the brachial artery—an arrangement which Bichat(1) erroneously considers as a general law in such cases. This branch comes from the ulnar artery much less frequently when the latter is given off much higher than usual. It rarely sends off from its outside, above the articulation of the elbow and directly above where the brachial artery bifurcates to give rise to the two arteries of the fore-arm, a considerable branch, which ordinarily comes from the radial artery, and which is called the *recurrent radial* artery (*A. radialis recurrens*).(2)

The two large anastomoses which we have described permit the application of a ligature upon all parts of the brachial artery, without causing any derangement in the circulation and nutrition of the fore-arm.

IV. ARTERIES OF THE FORE-ARM.

§ 1416. The brachial artery usually divides a little below the elbow, where the tendon of the biceps penetrates between the muscles of the fore-arm, into two branches, the *radial* and the *ulnar* artery. This bifurcation rarely and perhaps never takes place much lower, while it not unfrequently occurs higher than usual. Of the two trunks of the fore-arm, the radial is the continuation of the brachial artery as respects its direction, but in most cases it is smaller than the ulnar artery, at whatever height the brachial artery divides. It is nearer the surface than the latter and arrives at the lower extremity without giving off any considerable branches except one, which arises from its upper part. The ulnar artery, on the contrary, soon divides into two branches, one of which is the proper continuation of the trunk, and the other the interosseous artery.

I. ANOMALIES IN THE ORIGIN OF THE ARTERIES OF THE FORE-ARM.

§ 1417. The brachial artery not unfrequently divides unusually high (§ 1416).(3) This anomaly varies in its *mode* and *degree*. The principal laws in both these respects are as follow:

(1) *Anat. descrip.*, vol. iv. p. 230.

(2) This arrangement is very rare. We have seen it but once only, and we cannot find it mentioned by any writer. It does not affect the anastomoses around the elbow joint, because in this instance the recurrent radial artery did not arise much higher than usual.

(3) See our *Mémoire sur les différentes variétés qu'on observe dans la distribution de l'artère brachiale*; in the *Journ. compl. du dict. des sc. méd.*, vol. iii. p. 31.—We

a. In regard to *mode*, we observe three principal differences. In fact, the artery which arises unusually high is sometimes the radial, sometimes the ulnar, and finally sometimes the interosseous artery. Observation confirms what might be admitted on conjecture, that the first of these three anomalies is the most common and the last the rarest; which evidently depends on the fact, that in producing the first, nature conformed to the primitive type in this respect, that the artery which is generally given off first, that is the radial artery, generally arises higher than usual. In the second anomaly, although the division takes place higher than usual, there is also an inversion, since the interosseous artery comes from the radial artery and the ulnar artery arises above the latter. Finally, in the third the anomaly is still greater, since a vessel usually given off by a branch of the brachial artery, the ulnar artery, arises directly from the trunk.

The ulnar and radial arteries are distinguished from each other when they arise higher than usual, because the former is commonly more superficial than the latter, and it then is frequently situated between the aponeurosis and the skin, an arrangement which, judging from our observations, is not always constant.

But in whatever manner this abnormal division of the brachial artery above its usual point occurs, the vessel which it thus prematurely produces is always situated in the arm, directly at the side of the superficial brachial artery.

b. In regard to the *degree*, we may consider the anomaly either in itself or in relation to the whole vascular system.

First, considered in regard to itself, it presents several differences, of which the principal are as follow:

1st. The first degree consists in the existence of *abnormal vessels* (*vasa aberrantia*), greater or less branches, which arise from the upper part of the superficial brachial artery, and empty into its lower part, or, as is more common, into an artery of the fore-arm, particularly the radial artery. In this case both the normal and the abnormal division exist, and the artery of the fore-arm, into which the abnormal vessel empties, arises in fact by an upper and a lower root. The normal type gradually passes to the abnormal formation by the increase of the first of these roots and the diminution of the second, until the latter type is perfect, when the lower root entirely disappears.

2d. A second degree is when the brachial artery divides more or less above its usual place. This division occurs in fact in all parts between the axilla and the humero-cubital articulation. The three arteries of the fore-arm differ from each other in this respect, that although the radial artery arises unusually high much more frequently than the ulnar artery, still when the anomaly exists, the ulnar artery comes from a higher point, particularly from the axillary artery itself, while the

have there given our own observations and the principal of those collected by other authors.

radial artery is given off near the middle of the arm. When the interosseous artery is abnormal in this respect, it arises either from the angle of the bifurcation as usual or from a higher point.

Second, considered in regard to the whole vascular system, this anomaly exists on one side only or on both sides at once. Bichat asserts that he has seen the first case oftener than the second, but our own observations and those of other anatomists prove the contrary.

This anomaly however is by no means the same on both sides in regard to the manner and the degree, and we more commonly observe differences in one or the other of these two relations than the contrary, or a perfect similitude between the two sides of the body. We cannot yet say if the anomaly is observed on the left side more frequently than on the right when it is seen only on one side, and if it is more distinct on this side than on the other when it occurs on both sides, although this seems very probable, reasoning from the difference between the formative types of the two sides, and also from other anomalies, and from the observations which we have been able to collect.

All these anomalies are equally important in a physiological or surgical point of view. They concern physiology, because they imitate the two superficial veins of the arm. The surgeon ought always to observe them carefully, because they increase the chance of injury to the arteries of the arm, and because, when the course of the blood in the brachial artery is in any manner interrupted, it re-establishes the circulation in the upper extremity more easily.

II. RADIAL ARTERY.

§ 1418. The *radial* artery (*A. radialis*) is usually much smaller and nearer the surface than the ulnar artery; but in considering its direction only, it is a continuation of the trunk of the brachial artery. It is much smaller when the recurrent radial artery arises from the brachial artery. Less frequently still it is larger, which occurs when the interosseous artery arises from it instead of coming from the ulnar artery as usual.

This artery descends a little obliquely from behind forward, along the radius, to the radio-carpal articulation, where it glides under the tendons of the extensor digitorum communis muscle, and penetrating into the palm of the hand, between the first and second metacarpal bones, it anastomoses with the ulnar artery.

§ 1419. The first branch of the radial artery is generally the *recurrent radial* artery (*A. recurrens radialis*), when the latter does not come from the brachial artery, which rarely happens. It arises as rarely from the ulnar artery, which we have observed only a few times, when the radial artery arose much higher than usual; even then the recurrent radial artery can be considered only as divided into two portions, for the radial artery gives off a muscular branch, which is detached higher than usual. In the most frequent cases, in fact, the brachial artery divides into three trunks and gives off the recurrent branch at the place with the two others; but this artery constantly arises very high from the radial artery, which even in the adult passes through but a very few lines before it is sent off. It is always the largest branch which this artery gives to the fore-arm; so that we may say that the radial artery, as soon as it arises, divides into two branches, one of which continues to proceed in the direction of the trunk and is the proper radial artery, and the other is smaller and is the recurrent artery. The latter gives branches to the pronator teres, the supinator longus, the supinator brevis, and the extensor carpi radialis muscles, to the capsular ligament, to the inner portion of the triceps extensor, and is reflected from below upward, between the supinator longus and the extensor carpi radialis longus, to anastomose with the recurrent radial artery given off by the deep brachial artery on the inner tuberosity of the humerus.

At the same place, sometimes a little higher, the radial artery gives off a small recurrent branch, which goes into the lower part of the inner portion of the brachialis internus muscle. It then gives off from its outer and inner sides, and at right or nearly right angles, and very near each other, small branches, almost uniform in size, and at least forty in number. Of these, the internal are distributed to the pronator teres, the flexor carpi radialis, the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus muscle, and the capsule of the radio-carpal articulation; while the external are distributed in the pronator teres, the pronator quadratus, and the extensor carpi radialis.

§ 1420. Toward the lower end of the radius, the radial artery constantly gives off a branch, which passes on the radial edge of the carpus, enters into the palm of the hand, and is called the *superficial palmar* artery (*A. superficialis volæ*). This branch is always situated below the palmar aponeurosis, and proceeds toward the ulnar edge of the hand to meet the ulnar artery. This branch is sometimes and not rarely so large, that we have reason to say that the radial artery bifurcates in the place where it arises to produce it and also the continuation of the trunk which goes on the back of the hand. When this branch is small, it is frequently but not always distributed only to the small muscles of the thumb. When it is considerable, it usually but not always anastomoses with the ulnar artery to form the *superficial palmar arch* (*arcus volaris superficialis*), and contributes as much as the latter to produce it.

Sometimes the superficial palmar artery arises much higher than usual and proceeds in the same direction as the radial artery, with which however it cannot be confounded, as it is more superficial and less fixed in its situation.

It is essential to remember this circumstance, in order not to be in error when we wish to ascertain the state of the pulse by feeling the radial artery.

§ 1421. When the superficial palmar artery concurs to form a superficial palmar arch, it gives off very distinctly some *digital palmar* arteries (*A. digitales volares*). In two preparations now before us it gives off the *digital palmar artery of the thumb* (*A. digitalis volaris ulnaris pollicis*) and the *digital palmar artery of the index finger* (*A. digitalis volaris radialis indicis*).

Usually, when the superficial palmar artery is not very small, the superficial palmar arch is double, because, beside the large anastomosing anterior twig of this branch, we find another, which is smaller and more transverse and posterior.

However small the superficial palmar artery may be, and even when it does not contribute to form the superficial palmar arch, it however is never entirely deficient, and always anastomoses with the continuation of the trunk of the radial artery at the bottom of the palm of the hand. We have never seen it arise except under the pronator quadratus, or at least toward its posterior edge, and constantly below the place where the radial artery rests almost directly on the radius. We must except some but not all those cases, where the radial artery arises from the brachial artery extremely high, and, imitating the type of the latter, bifurcates unusually high, for instance near the elbow.

§ 1422. After giving off the superficial palmar artery, the continuation of the trunk of the radial artery goes usually on the back of the hand, passing between the styloid process of the radius and the os trapezium; but sometimes it is reflected higher on the outer face of the radius and of the fore-arm, and produces the following branches:

1st. Branches which go to the ligaments of the carpus and also to the flexor brevis pollicis and the abductor pollicis proprius.

2d. The *dorsal artery of the thumb* (*A. dorsalis pollicis*), which arises from its outside, extends along the radial edge of the metacarpal bone of the thumb and of all the phalanges of this finger, anastomoses with its digital palmar artery, and rarely arises from the superficial palmar artery given off by the radial artery.

3d. The *dorsal artery of the carpus* (*A. dorsalis carpi radialis*) arises from the inside of the radial artery, more or less opposite the preceding, goes transversely toward the ulnar edge of the hand, and passing under the tendons of the extensor muscles, directly on the dorsal ligaments of the carpus, anastomoses with some small branches of the radial artery which were given off higher than the latter, then with the extremity of the interosseous artery, finally with the dorsal branch of the ulnar artery, and thus forms the *dorsal arch of the carpus* (*arcus dorsalis carpi*), which resembles an arch less than a net-work with large meshes.

§ 1423. The *dorsal interosseous* arteries (*A. dorsales interosseæ*) arise principally from this arch. They proceed from behind forward in the spaces between the metacarpal bones from the second finger to the fifth, go to the external interosseous muscles, and are continuous, first, forward, with the corresponding digital arteries between the posterior extremities of the first phalanges, in the place where the trunk of these arteries bifurcates; second, with the inferior metacarpal arteries, whence results a large circle of anastomoses between the dorsal and the palmar branches of the arteries of the fore-arm.

§ 1424. Next come smaller ramifications, which enter the abductor indicis proprius muscle and the ligaments of the carpus ; then, between the posterior extremities of the first two metacarpal bones, arise the *dorsal cubital artery of the thumb* (*A. dorsalis ulnaris pollicis*) and the *dorsal radial artery of the index finger* (*A. dorsalis radialis indicis*), which arise sometimes separately and sometimes by a separate trunk.

§ 1425. When the radial artery has given off these branches, it enters into the palm of the hand between the first two metacarpal bones and the adductor indicis muscle, goes transversely toward the ulnar edge, and anastomoses with the ulnar artery, which meets it so as to form a *deep palmar arch* (*arcus volaris profundus*), and contributes to produce it more than the latter. When passing on the posterior extremity of the metacarpal bone of the index finger, it gives rise to the *large artery of the thumb* (*A. princeps*, s. *magna pollicis*). The latter divides sometimes into the *palmar radial* and the *palmar ulnar artery of the thumb* (*A. volaris pollicis radialis et ulnaris*), sometimes furnishes only one of these two branches, while the other arises near the superficial or from the deep palmar arch ; but it always anastomoses by one or two large branches with the radial and the ulnar dorsal arteries of the thumb, even when the corresponding palmar arteries do not arise from it.

The radial artery rarely divides, when passing through the first interosseous space, into two branches, one of which is the continuation of the trunk and goes into the palm of the hand, while the other is smaller, passes over the internal belly of the first external interosseous muscle, and anastomoses with the superficial palmar arch, giving origin to the *palmar cubital artery of the thumb* (*A. volaris ulnaris pollicis*), where it divides into this artery and the *palmar radial artery of the index finger* (*A. volaris radialis indicis*), which formation is remarkable because it strengthens the resemblance with the arteries of the other fingers, as this dorsal branch then represents the first dorsal metacarpal artery, which is the largest. Sometimes but very rarely these arteries do not arise from the large artery of the thumb, but from the superficial palmar arch and directly from the superficial palmar radial artery. In this case the palmar and the large arteries of the thumb, which are proportionally smaller, give off only the dorsal arteries of the thumb. Nevertheless, we have never seen this arrangement except when the radial and the palmar radial arteries arose unusually high.

Even at the place where the large artery of the thumb arises, and only little more on the anterior side of the radial artery, a very constant branch arises, which however varies in size ; this goes inward and passes directly on the palmar face of the second metacarpal bone, gives branches to the adductor pollicis muscle, and contributes more or less to form the palmar arteries of the index finger. This however is not always the case ; so that the radial artery of this finger always comes from the branch of which we were speaking, as Sœmmerring pretends; for we have sometimes seen, notwithstanding the considerable size of the latter, the radial artery of the index finger coming from the superficial palmar arch. We may then, in order to express the analogy between it and the large artery of the thumb, term this branch the *large artery of the index finger* (*A. princeps indicis*).

Wo shall describe the deep palmar arch when speaking of the ulnar artery.

III. ULNAR ARTERY.

§ 1426. The *ulnar* artery (*A. ulnaris*, s. *cubitalis*) is generally the largest of the two branches produced by the bifurcation of the brachial artery; it goes toward the ulna sooner after arising, passes below the pronator teres, and proceeds toward the hand, along the ulna, between the flexor ulnaris and the flexor digitorum profundus muscles, and is always situated deeper than the radial artery. It gives off near its origin a small or large branch, the *anterior recurrent ulnar* artery, which penetrates to the lower extremity of the inner portion of the triceps extensor and also into the upper extremity of the pronator teres, and corresponds to a similar branch given off by the radial artery.

§ 1427. It then sends off the *recurrent* or the *posterior recurrent ulnar* artery (*A. recurrens ulnaris*, s. *cubitalis*), which is generally much larger than the preceding, and proceeds from below upward between the flexores digitorum sublimis and profundus and the flexor ulnaris, distributes branches to these muscles, penetrates through the latter, and ascends between the inner condyle of the humerus and the olecranon process, and unites with the inferior and internal collateral artery which comes from the brachial artery, and thus forms the largest anastomosis which exists around the humero-cubital articulation. This artery always arises much lower than the recurrent branch of the radial artery. It comes very constantly from the ulnar artery, when the latter arises as usual from the brachial artery; at least we have never seen it arise directly from the humeral artery, as does the recurrent radial artery, which undoubtedly must be attributed to its arising so low. On the contrary, in all those cases where the ulnar artery ascended unusually high, the recurrent artery was not given off by it but by the interosseous artery; so that then even the anomaly approached as near as possible the normal formation.

§ 1428. Soon after giving off this branch, the ulnar artery divides into two others, the *proper ulnar* artery and the *interosseous* artery (*A. interossea*), which is usually smaller than the other. The latter is rarely given off by the brachial artery, either at the usual place of its bifurcation(1) or above this point.(2) When the ulnar artery arises

(1) Barclay, *Description of the arteries of the human body*; in the *Edinb. Med. and Surg. Journ.*, vol. viii. p. 468.

(2) Monro, *Outlines of Anatomy*, vol. iii. p. 304.

unusually high, the interosseous artery is a branch of the radial artery, whence it arises in the same region of the fore-arm, although it comes from a different artery.

From these two causes the ulnar artery is much smaller than usual when it arises uncommonly high. This diminution of caliber is sometimes observed in it, although its origin is not abnormal, because the interosseous artery, although very rarely, arises from the radial.

The interosseous artery gives off near its origin one or two very constant branches, which descend into the upper part of the flexores digitorum sublimis and profundus, into the flexores carpi radialis longus and brevis muscles, and the pronator teres. Lower down it divides into two branches, nearly equal in size, one of which is a little larger and is a continuation of the trunk, and descends on the anterior face of the interosseous ligament, while the other passes above the upper edge of this ligament to go to the dorsal face of the fore-arm. This branch is the *superior perforating* artery (*A. perforans prima suprema*), which soon divides into two branches. The smaller, which is however considerable, is called the *recurrent interosseous* artery (*A. recurrens interossea*), reascends above the extensor carpi ulnaris muscle, between the radius and the ulna on one side and the anconeus muscle on the other, and empties into the dorsal arch of the articulation of the elbow. The larger descends between the origin of the extensor longus and the abductor pollicis longus on the one side, the extensor digitorum and the extensor carpi ulnaris on the other, along the ulna to its lower extremity, and in its course gives off numerous branches to the muscles which we have mentioned.

§ 1429. The trunk of the interosseous artery descends in most of its extent on the anterior face of the interosseous ligament, between the two bones of the fore-arm, a little nearer the ulna than the radius, gives small twigs to all the flexor muscles, and also supplies six or seven branches, the *inferior perforating* arteries (*A. perforantes minores inferiores*), which pass through the interosseous ligament, glide on the posterior face of the fore-arm, and are distributed in the extensor muscles. The arterial trunk terminates in passing above the upper edge of the pronator quadratus to the dorsal face of the fore-arm, where it divides into three or four branches, nearly equal in size. One or two of these branches are distributed partly in the extensor and the abductor pollicis and partly also pass under the tendons of these muscles, resting directly on the bone, turn on the radius, and anastomose with the branches of the radial artery. The second or the third, which retrogades on the ulna, anastomoses with the superior perforating artery. The third or the fourth, which is the continuation of the trunk, descends between the two bones of the fore-arm and forms the *dorsal arch of the carpus* (*arcus dorsalis carpi*) on the back of the carpus, and divides into a middle and at least two lateral ramuscules, which communicate with the carpal branches of the radial and ulnar arteries.

§ 1430. The trunk of the interosseous artery rarely gives off a long branch, which descends between the flexor muscles of the fingers to the hand and contributes to form either the superficial palmar arch or the arteries of the thumb. This is seen particularly when the ulnar artery arises higher than usual, a very remarkable circumstance, as it shows an effort to approximate the anomaly to the normal formation.

§ 1431. The ulnar artery, after giving off the interosseous artery, sends off like the radial, at short intervals, numerous ramuscules, which are distributed to the muscles between which it descends, the flexors of the fingers, and the extensor carpi ulnaris muscle. Near the lower extremity of the ulnar and about an inch above the radial artery, it divides into two branches, the larger of which is the continuation of the trunk, while the other is smaller and is called the *dorsal ulnar* artery (*A. dorsalis ulnaris, ramus dorsalis ab ulnari*). The latter is reflected above the tendon of the flexor ulnaris muscle, on the lower extremity of the ulna, sends branches to the flexor ulnaris and to the pronator quadratus muscle, also to the ligaments of the carpus, anastomoses with the dorsal branch of the radial and with the interosseous artery, gives rise to the dorsal arch of the carpus, and terminates in the fourth internal interosseous muscle, also in the muscles of the index finger, especially the abductor muscle.

§ 1432. After giving some small branches to the palmar ligament of the carpus, the ulnar artery divides, near the posterior extremity of the fifth metacarpal bone, into two branches, the *superficial* and the *deep palmar* artery (*ramus volaris superficialis et profundus.*)

IV. PALMAR ARCHES.

§ 1433. There are two *palmar arches* (*arcus volæ*), a superficial and a deep.

The superficial palmar branch of the ulnar artery is usually much larger than the deep. It passes above the tendons of the flexor muscles which previously covered the ulnar artery, advances immediately below the palmar aponeurosis toward the radial edge of the hand, and anastomoses with the superficial palmar branch of the radial artery, which it always exceeds in volume, even when the latter is unusually large. These two branches join and form the *superficial palmar arch* (*arcus superficialis volæ*). This arch is not unfrequently formed entirely by the ulnar artery, which does not then anastomose with the palmar branch of the radial artery, or communicates with it only by some trifling ramuscules.

The *collateral arteries of the fingers* (*A. digitales*) arise from the superficial palmar arch, but not constantly in the same manner. The only rule which we can establish in this respect is, that most of the digital arteries arise directly or indirectly from the superficial arch, from the deep arch, or from both at once, and always arise two and two from a single trunk ; so that this single trunk extends from the arch to the extremity of the first phalanx and there divides into two branches, which are unequal and often disproportional in size, which always belong to two different fingers and never to one only. These branches proceed on the palmar face of the fingers, along the radial edge of one and the ulnar edge of the other. Each finger thus receives two collateral arteries, the ulnar of which is always the larger.

The little finger usually receives a proper or special ulnar artery, the first branch of the superficial palmar arch which goes to it, proceeding along the flexor minimi digiti brevis muscle, to which it sends numerous ramuscules.

Some distance from this branch, and very near each other, arise three very constant arteries, the second, the third, and the fourth collateral arteries, which go, the first to the radial side of the fifth finger and the ulnar of the fourth, the second to the radial side of the fourth and the ulnar side of the third finger, and the last to the ulnar side of the second and to the radial side of the third.

Farther, we generally find a fourth common collateral artery, which divides into the artery of the radial side of the index finger and the artery of the ulnar side of the thumb.

This arrangement presents only a few unimportant anomalies, the principal of which are:

Sometimes the second collateral artery, the ulnar branch of the fifth finger, belongs not so much to the superficial as to the deep palmar arch, of which it is the posterior part,—that by means of which this arch communicates with the other; so that it must be considered as an anastomosing branch between the two arches. The fourth collateral artery, which goes to the radial side of the third and the ulnar side of the second finger, sometimes presents the same anomaly. These two differences arise because the two arteries always communicate with the deep arch by large anastomosing branches, while the other two middle collateral arteries are more insulated and more independent.

The union of several digital arteries in a common trunk, which is always very short, forms a second anomaly. To this there is a gradual transition by a case which is sometimes observed, viz. the approximation of two branches to each other.

Thus we have often seen coming from a common trunk the first and second, the third and fourth, or the fourth and fifth, which then went only to the radial side of the index finger. When the artery of the little finger does not form a small distinct trunk, but comes from the second, the common trunk is a little longer than that which appears when the branches are united, and the second goes almost always to the ulnar side of the fourth finger and the radial side of the fifth.

§ 1434. The *deep* or the smallest ulnar artery turns deeply from behind forward on the flexor minimi digiti brevis muscle, goes always outward toward the radial side of the hand, so that it proceeds transversely on the internal interosseous muscles to meet the deep palmar artery, with which it anastomoses, and forms the *deep palmar arch* (*arcus palmaris profundus*). This arch is sometimes larger and sometimes smaller than the superficial, but smaller more frequently than larger, and its caliber is always greater on the radial than on the ulnar side, because the radial artery concurs to form it more than the ulnar artery. It is always situated farther back than the superficial arch, and is placed directly before the posterior extremity of the metacarpal bones.

§ 1435. The deep palmar arch produces,

1st. From its anterior side or its convexity, the *palmar interosseous* arteries (*A. interosseæ volares*), or the *inferior perforating* arteries (*A. perforantes inferiores*), which are the largest of all its branches.

These arteries go to the internal interosseous muscles in the spaces between the metacarpal bones, give branches to the muscles in these regions, and one or the other at least, and sometimes all, anastomose at their anterior extremity with the collateral arteries of the fingers, where the latter bifurcate, and also with the superior interosseous arteries.

They correspond to the collateral arteries of the fingers, but are usually much smaller. The first however is generally much more developed than the others. Hence we have proposed to term it the *large artery of the index finger* (*A. indicis princeps*) (§ 1425). Sometimes however other arteries among the inferior interosseous arteries are unusually large; so that they are as large or nearly as large as the common trunks of the collateral arteries which arise from the large arch, and the digital arteries also arise as much and even more from the deep than from the superficial arch.

Sometimes but more rarely they exceed almost all the collateral arteries of the fingers in volume, and the palmar arteries of the fingers arise more than they from the superficial arch, as is frequently the case with the index and little finger.

2d. The *superior* or *posterior perforating* arteries (*A. perforantes, s. posteriores, s. superiores*) arise from the convexity of the deep palmar arch. They penetrate between the posterior extremities of the metacarpal bones, give ramifications to the posterior part of the lumbricales muscles, and come on the back of the hand, where they anastomose with the anterior part of the dorsal arch of the carpus and with the superior metacarpal arteries, which are given off by this arch less frequently than by them (§ 1432).

§ 1436. Thus the two palmar arteries concur simultaneously to produce the digital arteries. The superficial arch contributes most to the origin of the palmar branches of the third, of the fourth, fifth, and of the ulnar side of the index finger; the deep, on the contrary, assist more in forming the palmar branches of the thumb and of the radial side of the index finger. Sometimes however the latter arise entirely from the superficial arch, but this is true of the radial artery of the index finger and the ulnar artery of the thumb more frequently than of the radial artery of the thumb. In this case the two branches arise by a common trunk. When all the digital arteries, not excepting those of the thumb, come from the superficial palmar arch, this divides sometimes at the lower part of the hand into two large principal branches, one of which gives off the twigs which usually arise from the superficial arch, and the other bifurcates to give rise to the principal artery of the thumb and the radial branch of the index finger, which deserves to be remarked, as it shows that nature endeavors to approximate to the normal type even in the greatest anomaly. The superficial palmar artery of the radius does not then exist or is very slightly developed. It sometimes, on the contrary, contributes more than usual to produce the superficial palmar arch, and then it gives off also all the digital arteries; but the ulnar and the radial arteries are not then always connected, except by a small anastomosing branch, which is sometimes entirely deficient, and each of the two arteries produces only the branches which go to the corresponding side of the hand.

The two palmar arteries anastomose at the bifurcation of the digital arteries and produce the two collateral arteries. They communicate by long branches, which are usually much smaller than the common trunks of the digital arteries. The largest and most constant of these branches are situated between the ulnar artery of the little finger and the common artery of the second and third.

The dorsal arch of the carpus and the deep palmar arch communicate by the posterior or superior perforating arteries and the dorsal interosseous arteries. The last and the inferior interosseous arteries establish a communication between these two arches and the superficial palmar arch.

V. DIGITAL ARTERIES.

§ 1437. Although the digital arteries arise in most cases from the superficial arch (§ 1433), we may however say, that the deep arch (throwing out of view what happens more or less frequently, that some are given off by this latter alone) and the dorsal arch of the carpus contribute to produce them; so that the obliteration of one of these sources may be easily replaced by the enlargement of the other.

Each finger receives at least four constant branches, two palmar and two dorsal; the latter are smaller than the others. The two palmar branches anastomose on the palmar side, either on one phalanx only, or on several, or even on all, by one or more transverse branches, the convexity of which is turned a little forward. However, among these anastomosing branches, the only ones which are constant are those which are very much developed on the lower face of the third phalanx and which are usually double. Besides, the palmar branches anastomose with the dorsal by an arch on the back of the phalanges, especially the third. Each palmar artery gives off in its course at least ten or twelve branches, which go to the nerves, tendons, ligaments, and skin. It also gives, from the arch it forms at the extremity of the finger, by anastomosing with that of the opposite side, at least as many ramuscules, which go to to the skin.

CHAPTER III.

THORACIC PORTION OF THE AORTA.

§ 1438. From the *thoracic portion of the aorta* or from the *pectoral aorta* (*aorta thoracica*) (§ 1329) arise numerous but very small arteries, and hence the aorta after giving them off is not sensibly smaller than when proceeding along the chest after the three trunks have arisen from its arch.

Many of these branches are constant, but others are not; and they frequently arise totally or at least in part from other arteries.

The former arise from the lateral parts or from the posterior side of the pectoral aorta in its whole length; the others come principally from its upper and central part and from its anterior side.

A. ANTERIOR BRANCHES.

§ 1439. The *anterior branches* of the thoracic artery are principally the *inferior bronchial* (*A. inferiores bronchiales*), the *esophageal* (*A. esophageæ*), and the *posterior mediastinal* arteries (*A. mediastinales posteriores*).

The *inferior bronchial* arteries which arise from the aorta vary much in number and origin.

They vary in number from two to four. There are commonly two on each side for each bronchia. The inferior are a little larger than the superior. The largest and most constant generally arise an inch below the extremity of the arch of the aorta. The right is almost always a branch from the first intercostal artery of the aorta, which gives it off after coming on the right side of the vertebral column, passing behind the esophagus. But sometimes it arises directly from the aorta, and the latter frequently gives off on the right a second inferior bronchial artery when the usual one arises from the first intercostal branch of the aorta, or even when the left bronchial artery sends ramifications to the right bronchia. The left, on the contrary, arises directly from the aorta, and passes before the esophagus to go to its bronchia; but as it is larger than that on the right side, it commonly gives also some branches to the bronchia of the right side.

The small superior bronchial arteries, which are less considerable and inconstant, belong generally speaking more to the left than to the right bronchia.

Besides these ramuscules, which may be called the *middle bronchial* arteries, each bronchia receives from the subclavian artery (§ 1372) or from the corresponding internal mammary (§ 1398), branches, called the *superior bronchial* arteries, which are expanded in its upper part and communicate by large anastomoses with the middle and inferior bronchial arteries.

Sometimes the aorta gives off only one bronchial artery, which often arises from it in common with the right superior intercostal artery.

The bronchial arteries are distributed not only to the bronchiæ but also in the esophagus, the aorta, the pericardium, and the thymous gland.

§ 1440. The aorta gives off, generally below these arteries, from its anterior part, several esophageal arteries, which vary in number from two to seven and which are always smaller than the bronchial arteries. These arteries communicate with the esophageal branches which arise from the bronchial arteries and also with others, which are given off by the inferior diaphragmatic arteries, with the latter, and with the arteries of the stomach. They anastomose extensively and always by very large branches.

1441. The *posterior mediastinal* arteries are always small and very numerous. They are distributed partly in the esophagus and particularly in the parietes of the thoracic aorta, and anastomose with each other, and also with the esophageal arteries, and with the branches of the internal mammary artery.

B. LATERAL AND POSTERIOR BRANCHES. INTERCOSTAL ARTERIES.

§ 1442. The *inferior and posterior aortic intercostal arteries* (*A. intercostales posteriores, inferiores*, s. *aorticæ*) are the lateral and the posterior branches of the thoracic aorta. We find an arterial branch in each intercostal space, but the aorta does not give off as many as there are spaces; for, 1st, the first and second, or at least the first, usually receive their vessels from the superior intercostal artery, a branch of the subclavian artery (§ 1399).

2d. Several intercostal arteries, particularly the upper and the lower, and sometimes also the middle, although then the upper and lower do not participate in the anomaly, arise by common trunks, both the opposite arteries of the right and left sides, which correspond in respect to the intercostal space into which they penetrate, as well as those which are situated one above the other on the same side. This last anomaly is more rare than the first. When two intercostal arteries arise by a common trunk, we have always observed hitherto that the inferior is the continuation of the trunk and proceeds in its direction, while the superior generally passes before and more rarely behind the neck of the rib to arrive at the intercostal space, in which it is then distributed as usual.

A common trunk usually divides only into two secondary branches, but sometimes also it gives off several, of which the superior aortic intercostal artery(1) gives frequent examples.

(1) In opposition to the superior intercostal, which arises from the subclavian artery.

The fact that the superior and inferior intercostal arteries generally arise by a common trunk, is curious in two respects :

1st. Because it furnishes a new instance of the resemblance between the upper and the lower extremities of the same region.

2d. Because the superior aortic intercostal artery and the superior intercostal which arises from the subclavian artery, especially correspond.

The two arrangements are then a repetition, in the central portion of the vascular system, of the resemblance demonstrated between the upper and the lower part of this system, when we consider the diaphragm as the line of demarkation between the two portions.

Finally, the two series of intercostal arteries are not perfectly similar, and the two intercostal spaces of one side frequently receive their vessels from a common trunk while on the other side they arise separately.(1)

We generally find on each side eight(2) aortic intercostal arteries because the upper intercostal artery gives them to the first two intercostal spaces, and the third and fourth receive the blood from the branches of the first aortic intercostal artery.

The number of the intercostal arteries is very rarely increased by one, which happens when the upper intercostal artery, usually furnished by the subclavian, arises directly from the pectoral aorta.(3) This is more frequently the case than that the first aortic intercostal artery is distributed only in the third intercostal space.

The number of these arteries is then one less, and is reduced to seven. Then sometimes the first goes to the second, third, and fourth intercostal spaces ; sometimes, and more frequently, two of the inferior arise by the same trunk.

All the intercostal arteries generally come more from the back side of the aorta than from its lateral part, they arise near each other, and the right and the left at the same height.

They are all detached from the aorta at slightly acute angles, and go upward toward the intercostal space to which they correspond, passing on the bodies of the vertebræ and the necks of the lower ribs.

The distance between their origin and their intercostal space is much greater, and the angle which they make with the trunk is more acute above and more obtuse below in the upper than in the lower. They never, not even the lowest, form a right angle with the aorta.

(1) Bichat is mistaken in saying that, considered on the two sides, these arteries are almost perfectly similar (*An. descript. vol.* iv. p. 252).

(2) Bichat asserts erroneously, that there are usually nine. Murray and Sœmmerring are also mistaken in saying there are never less than eight. Mayer is still more in the wrong; he admits that there are usually eleven aortic intercostal arteries on the right side, and ten on the left.

(3) Monro seems to regard this formation as equally common with the rule (*Outlines*, p. 322); but it is in fact very rare, a circumstance which is not uninteresting, inasmuch as the pectoral aorta seems to have, directly above the origin of the intercostal artery, a great tendency to contract very much or to close entirely.

These arteries become smaller in proportion as they are lower. It is however necessary to say something more exact on this subject. In fact the first intercostal artery is much larger than the others, partly because it is distributed to a greater number of intercostal spaces, and because on the right side at least it gives rise either partly or wholly to the right bronchial artery.

The right intercostal arteries, from the situation of the aorta on the left side of the vertebral column, are longer than the left, by all the right portion of the vertebræ on which they pass.

Near their origin they give ramifications to the esophagus and generally to all the parts contained in the posterior mediastinum, and divide usually near the head of the ribs into two branches, a *posterior* and an *anterior*.

The *posterior* branch (*R. posterior*, s. *dorsalis*) passes through the intercostal space to go backward, gives some ramuscules to the vertebræ, also sends some to the spinal marrow, through the intervertebral foramina, but is distributed principally to the posterior muscles of the trunk situated in the groove between the vertebral column and the ribs, the multifidus spinæ and the longissimus dorsi. Its superficial ramifications reach even to the skin, and it anastomoses by ascending and descending branches with the adjacent superior and inferior dorsal branches.

The *anterior*, *thoracic*, or *intercostal* branch (*R. anterior*, *thoracicus*, *intercostalis*) is generally much larger than the dorsal, which exceeds it particularly in volume in the superior intercostal arteries, and which, from its direction, may be considered as the continuation of the trunk; it proceeds first between the pleura and the posterior part of the intercostalis internus muscle, to which it is feebly united, then passes between the intercostales interni and externi muscles, and soon divides into two branches.

The *inferior* branch (*R. costalis inferior*) is much smaller than the other, goes forward, along the upper edge of the lower rib, soon passes on the internal face of this bone, gives ramifications to its periosteum, furnishes some, although very few, to the intercostales muscles, and terminates by anastomosing with the upper branches of its trunk and of the intercostal artery which come directly after.

The *upper* branch (*R. costalis superior*) is the continuation of the trunk, and proceeds below the upper rib of its intercostal space in the groove, on its lower edge, goes forward, gives ramuscules to the ribs, to the intercostales, the abdominal, and the dorsal muscles and to the diaphragm, and anastomoses with the anterior intercostal arteries which come from the internal mammary artery, and also with the epigastric and the external iliac arteries.

The first intercostal artery is distinguished from the others by the characters we have already mentioned. It supplies several, and sometimes even three intercostal spaces.

The right and left differ, as the first usually gives off the right bronchial artery while the second is distributed more frequently than it in a third intercostal space.

Although this latter arrangement is not constant, we have never seen the first two intercostal arteries correspond in regard to the former.(1)

Next to the first the last is largest of any, and sometimes exceeds it in size. It arises behind the lumbar portion of the diaphragm; after giving some branches to this muscle it passes almost entirely below and before it, and, proceeding outward and forward, behind the upper portion of the quadratus lumborum muscle, it divides into several large branches, which are distributed in this muscle and also the broad muscles of the abdomen, then descend to the crest of the ilium, and anastomose frequently with the lumbar and with the circumflex iliac arteries.

The two inferior intercostal arteries often arise by a single trunk, which comes from the posterior part of the aorta. They are sometimes deficient on one or on both sides; they are then replaced by the first lumbar artery.

CHAPTER IV.

ABDOMINAL PORTION OF THE AORTA.

§ 1443. The abdominal aorta gives off in fact fewer branches, but most of them are larger than those which arise from the thoracic aorta. The reason of this is that the abdomen is larger than the chest, and the organs which it contains are also much larger. A farther reason is that all these organs receive their arteries from the abdominal aorta, while those of the thoracic viscera do not all come from the thoracic aorta.

The branches of the abdominal aorta may be divided into anterior, lateral, and posterior. The anterior and the posterior are however, at least in great part, sometimes more and sometimes less lateral than usual.

I. ANTERIOR BRANCHES.

§ 1444. The *anterior* branches of the abdominal aorta belong almost exclusively to the digestive organs. There are usually three, the *cœliac*, the *superior*, and the *inferior mesenteric* arteries. Some-

(1) As Sœmmerring seems to admit (p. 249), since he thinks that the first two intercostal arteries are large because they give off the bronchial arteries. Bichat agrees with us (p. 250) on this subject.

times however we find only two, the first two arising by a common trunk. But they oftener exceed three.

The aorta on coming into the abdomen, having passed through its opening in the diaphragm, usually gives some small branches to the pillars of this muscle, to the thoracic canal, and to the renal capsules.

It seldom gives off the inferior diaphragmatic arteries, either separately or by a common trunk. These arteries more frequently arise from the cœliac artery, consequently they will be treated of when speaking of that artery.(1)

I. CŒLIAC ARTERY.

§ 1445. The *cœliac* artery, *Opistrogastrique*, Ch. (*A. cœliaca*),(2) is usually the largest, and arises the highest, as it comes off at a right angle from the aorta, between the pillars of the diaphragm.

Usually and in fact almost always, when its trunk is not exceedingly short, it gives off first, from its upper side, the ***superior diaphragmatic*** arteries (*A. diaphragmaticæ*, s. *phrenicæ majores*, s. *principes*, s. *inferiores*), which arise sometimes separately and sometimes by a very short common trunk. Sometimes one of these arteries comes from the aorta and the other from the cœliac artery; more rarely one or both of them are given off by one of the branches of the cœliac, or even by the renal, or finally by the inferior capsular artery. They ascend directly on the pillars of the diaphragm, to which they give off branches, and also supply the ***middle capsular*** arteries (*A. suprarenales mediæ*), which go to the renal capsules; and when they have arrived at the upper extremity of the pillars, divide into an anterior and a posterior branch.

The *posterior* branch, which is the smaller, is sometimes, at least on one side, given off wholly or partially by the aorta. Even when the principal trunk arises from the cœliac artery, it sends considerable branches to the renal capsules; these are called the ***superior capsular*** arteries (*A. suprarenales superiores*). It then goes outward, below and behind the tendinous centre of the diaphragm, to be distributed principally in the lumbar portion of this muscle.

The anterior branch is much larger, and must be considered as the continuation of the trunk; it goes forward, along the esophagœal opening, before which it divides into two branches, an anterior and internal, and transverse which is much smaller, and is distributed to the central portion of the diaphragm, and anastomoses with that of the

(1) Monro is mistaken in saying that these arteries arise from the aorta (vol. iii. p. 333). Mayer (p. 656) also seems to think this is the most common arrangement. Murray (p. 61) and Sœmmerring (p. 252) think that they arise from the aorta as frequently as from the cœliac artery. Bichat is more correct (p. 283) in saying that they arise from the cœliac artery more frequently than from the aorta. This remark was made long before him by Haller (part 2, notes to vol. i. p. 6).

(2) A. F. Walther, *De arteriis cœliacis*, Leipsic, 1729.

opposite side, while the external is much larger, goes outward, and gives ramuscules to most of the costal portion of the diaphragm.

The inferior diaphragmatic arteries go principally to the lower face of the central portion of the diaphragm. They communicate with the external which arise from the internal mammary, with the inferior intercostal, and the lumbar arteries; also pass through the diaphragm, enter the chest, and give off, in this cavity, the pericardiac and the inferior mediastinal arteries.

§ 1446. The cœliac trunk after and sometimes also before giving off the inferior diaphragmatic arteries divides most generally into three branches; these are the coronary arteries of the stomach, the hepatic and the splenic artery. These three branches form the *tripus Halleri*.

§ 1447. The *coronary artery of the stomach*, *Stomogastrique*, Ch. (*A. coronaria ventriculi*, s. *gastrica superior*, *major sinistra*, *gastro-hepatica sinistra*), is usually much smaller than the other two branches of the cœliac artery. Sometimes, but rarely, it arises from the aorta before the latter, either alone or by a trunk which is common with it, sometimes with only one of the inferior diaphragmatic arteries, particularly that of the left side, and sometimes with both.

It proceeds first upward and forward, then to the left, and gives off,

1st. Several *inferior esophagœal* arteries (*A. esophageæ inferiores*).

2d. Several *posterior cardiac* arteries (*A. cardiacæ posteriores*), which are distributed around the superior orifice and on the large curvature of the stomach, and descend principally on its posterior face.

3d. Very frequently, and even almost always, the left hepatic artery.(1)

The anterior and superior gastric and the other inferior esophagœal arteries, arise from this artery or from the following branch.

4th. The *gastric* branch (*R. gastricus*). When the coronary artery of the stomach gives off the left hepatic artery, it bifurcates to give origin to it and also to the gastric branch. The latter usually divides into several large *anterior* and *posterior* ramuscules, which are distributed on the anterior and posterior faces of the stomach, and anastomose with each other and with the preceding. It always gives off a greater or less anastomosing branch, which follows the small curve of the stomach, and goes toward the right side, where it anastomoses with the pyloric artery.

§ 1448. The *hepatic* artery (*A. hepatica*) is larger than the preceding. Sometimes it does not give off the usual number of branches. The anomaly may then occur in several different ways. In fact the hepatic artery is sometimes divided into two trunks, which arise one from the cœliac artery as usual, the other from the coronary artery of the stomach, or from the superior mesenteric artery, or more rarely from

(1) Hence the term *gastro-hepatic* which has been applied to it. In this case the coronary artery of the stomach is not, as generally, much smaller than the other two branches of the cœliac artery, but it is often as large as the hepatic, especially when it gives off at the same time one or both of the inferior diaphragmatic arteries.

the aorta; sometimes there are three trunks, one of which arises from the cœliac, a second from the superior mesenteric artery, a third from the aorta.

Sometimes but more rarely the hepatic artery arises entirely from the aorta. The rarest anomaly is that where it comes entirely from the superior mesenteric artery.(1)

The trunk of the hepatic artery proceeds transversely to the right side; it then goes a little obliquely forward and upward, entering into the transverse fissure of the liver.

Just before arriving at the liver it divides into two branches, the right gastro-epiploic artery and the hepatic branch.

§ 1449. The *right gastro-epiploic* artery (*A. gastrica dextra inferior, coronaria ventriculi dextra inferior, gastro-epiploica dextra, pancreatico-duodenalis*), which is much smaller when only one hepatic trunk exists, but which in other cases is as large as the hepatic branch, goes downward, and to the left, toward the origin of the duodenum, passes below this intestine, between it, the pylorus, and the pancreas, reaches the great curvature of the stomach, proceeds along it from right to left, and anastomoses with the left inferior gastro-epiploic artery.

In its course it gives off the following branches:

1st. Before arriving at the duodenum and passing under this intestine, one or two considerable branches, the *pancreatico-duodenal* arteries (*A. pancreatico-duodenales*), which descend along the concavity of the duodenum, give to it numerous ramuscules, and also give origin to one or two retrograde *pyloric* arteries (*A. pyloricæ inferiores*); the latter, which are distributed around the pylorus, give off other considerable branches to the head and to the right portion of the pancreas, and anastomose extensively with the branches of the superior mesenteric artery.

One or more of these anastomosing branches are sometimes so large that we might consider the right gastro-epiploic artery rather as a branch of the inferior mesenteric than as arising from the cœliac artery.

2d. The continuation of the trunk proceeds along the large curvature of the stomach, gives a great number of ascending branches to the two thirds on the right of this viscus, and sends others, which are less numerous and which descend between the two layers of the large epiplöon, where they form the *right* and *middle epiploic* arteries (*A. epiploicæ dextræ et mediæ*). These branches anastomose with each other and with those of the left gastro-epiploic artery by large arches.

Near the commencement of the left third of the stomach the trunk of the right gastro-epiploic artery gradually diminishes and becomes very small, so that we can easily perceive the limit which separates it from the left gastro-epiploic artery, with which it anastomoses in this place.

(1) Haller, *Ic. anat.*, part viii. p. 36.

§ 1450. From the *hepatic* branch (*R. hepaticus*), sometimes also from the trunk of the hepatic artery, before it gives off the right gastro-epiploic artery, arises a smaller branch, called the *superior pyloric* artery (*A. gastrica dextra superior, coronaria ventriculi dextra superior, pylorica superior*). This branch descends towards the pylorus and anastomoses with the inferior pyloric, and with the branches of the left gastro-epiploic by small arches.

Soon after the hepatic branch divides into a right and left.

The *right hepatic* artery (*A. hepatica dextra*) is larger than the left. It is distributed to the right lobe of the liver and to the gall-bladder.

This soon divides into two branches; the smaller goes to the middle part of the liver (*A. hepatica dextra minor, A. hepatica media*); this sometimes arises directly from the aorta, although the origins of all the other branches are normal; the other is greater and is the continuation of the trunk. The latter goes to the vena-porta, enters the transverse fissure of the liver, where it divides into numerous ramifications, and almost always gives off, just before entering, one or two *cystic* arteries (*A. cystica*).

The right hepatic artery, either alone or with the right gastro-epiploic artery, not unfrequently arises from the superior mesenteric artery, an arrangement always indicated by the large anastomoses between these two arteries by means of the pancreatico-duodenal arteries. The left hepatic artery, not unfrequently, is separated from the right, and arises from the tripus Halleri by a common trunk with the coronary artery of the stomach.

§ 1451. The *splenic* artery (*A. splenica*, s. *lienalis*) is the largest of the three branches of the cœliac artery in the adult, and goes to the left soon after arising, proceeding below and behind the stomach in the transverse fissure of the pancreas.

In this course it gives off,

1st. From its lower side the *middle* and the *left pancreatic* arteries (*A. pancreaticæ mediæ et sinistræ*), which vessels are usually large and arranged in an arch; they go from right to left on the pancreas, and from their convexity arise numerous anterior and posterior branches which penetrate from below upward into the pancreas.

2d. More to the left, five or six *short gastric* arteries arise (*A. gastricæ breves*, s. *fundi ventriculi*). These almost always make a part of the numerous branches into which the trunk of the splenic artery divides before entering the spleen.

These vessels retrograde toward the left large extremity of the stomach and communicate on its two faces, by numerous anastomoses, with the coronary and right gastro-epiploic arteries.

We observe a lower branch, which is large; this is the *left gastro-epiploic* artery (*A. gastrica*, s. *coronaria sinistra inferior, gastro-epiploica sinistra*); this descends along the great curvature of the stomach, usually anastomoses very evidently with the right gastro-epiploic artery, and gives off large branches, the left epiploic arteries, to the large epiplöon.

II. SUPERIOR MESENTERIC ARTERY.

§ 1452. The *superior mesenteric* artery (*A. mesaraica*, s. *mesenterica superior*) is generally a little and often considerably larger than the cœliac artery, when the latter arises partly from the aorta or from the superior mesenteric artery, and generally comes from the trunk of the aorta directly below the cœliac trunk. It not unfrequently arises with it by a common trunk, which is sometimes nearly an inch long,(1)—a curious arrangement, as it resembles the formation of the tortoise.

The artery is covered first by the pancreas, and descends perpendicularly behind it on the lower part of the duodenum. It passes between the two layers of the mesentery and near its centre describes a considerable curve, the convexity of which looks forward and downward to the left while its concavity is turned to the right backward and upward. The centre and upper part of this curve is much farther from the small intestine than its lower portion; it gradually diminishes and terminates on the right and downward in the right lumbar region.

All the constant branches of the superior mesenteric artery arise from this curve, which furnishes blood to a part of the pancreas, to all the small and most of the large intestine, especially to its right and transverse portions. The first branches go to the pancreas and to the duodenum; the next go to the large intestine; and the inferior to the small intestine. The first ansstomose with the hepatic artery, more rarely also with the coronary artery of the stomach.(2)

The *arteries of the small intestine* (*A. intestinales*), which come from the convexity of the curve of the superior mesenteric artery, deserve to be mentioned before the others,(3) because the first of them arises higher than those which come from the concavity, and the study of the latter naturally leads to that of the branches which come from the inferior mesenteric artery.

The superior intestinal arteries are usually the longest; the first is however a little shorter than the following, but the last or the lowest are shorter than the others and also the smallest.

We generally number from sixteen to twenty; but we must reduce this number to ten or eleven, as it is more correct to consider the lowest, not as distinct trunks, but as secondary branches of the last branch,

(1) Haller considers this arrangement as a rare anomaly, because he has observed it only once; (*Ic. anat.*, part viii. p. 35, No. 11). We however think it more common, for we have seen it five times, although we did not look for it particularly in the cadavers we examined.

(2) Barclay, *loc. cit.*, p. 182.

(3) This method has been followed correctly by Mayer (*Ang.*, p. 170), and Monro (*Outlines*, p. 335); but not by Murray (p. 68), Sœmmerring (p. 267), and Bichat (p. 267).

which in going from left to right and from below upward anastomoses with the last of the branches which arise from the concavity.

If we follow the usual method, the intestinal arteries are almost always more than twenty in number, and the last eight or nine are extremely small and short.

These arteries diminish from above downward in respect to their diameter; we however find among the largest some which are very small, although they also arise from the trunk of the mesenteric artery.

They all proceed between the two folds of the mesentery to the intestine, distributing in their progress numerous branches to this membrane and also to the mesenteric glands. They usually divide into an upper and a lower branch. This division occurs sooner or later, in proportion as the branches are shorter or longer. These branches anastomose with the opposite branches of the adjacent arteries and form a large arch, composed of as many smaller arches as there are intestinal arteries; the convexity of this arch always looks toward the concavity of the small intestine. The two branches do not suddenly unite, but anastomose at a proportionally short distance from the intestinal canal.

Numerous secondary ramifications arise from the convexity of these arches; these are very compactly situated and very frequently anastomose. Hence results a much more extensive external arch, composed of a still greater number of small arches, whence arise numerous ternary branches. These also bifurcate two or three times, and anastomose in the same manner, at least where the intestinal arteries are larger.

These vessels represent by their division a very coarse net.

Finally, from the external surface of this net arise numerous arterioles, which are divided into an anterior and a posterior series, which go to the intestinal canal and are distributed on its internal membrane after still more subdivisions and anastomoses.

A minute description of their distribution in the intestine will be given after that of the intestinal canal more properly than in this place.

§ **1453**. From the concavity of the curve of the superior mesenteric artery, nearly opposite the place where the third, fourth, fifth, and sixth intestinal arteries arise, and about an inch from each other, are constantly given off at least two, and almost as often or at least not very unfrequently three branches, which belong exclusively to the colon, particularly to its right portion; these may be called the *right colic* arteries (*A. colicæ dextræ*). Of these branches the centre is usually smaller than the other two, and generally it arises nearer the superior.

§ 1454. The lowest, which goes to the right outward and downward, is called the *inferior right colic* or the *ileo-colic* artery (*A. colica inferior dextra, ileo-colica*). Some distance from its origin it sends downward a branch, which anastomoses with that which we have considered as the last intestinal artery and which is generally regarded as the trunk of the superior mesenteric artery, uniting with this artery a little before it terminates, partly also proceeds as the artery of the *cæcal appendix*

(*A. appendicalis*) to the vermiform appendage of the cœcum, along which it reascends to its extremity, giving off from its convexity a great number of branches, which arise at acute angles.

It afterwards immediately divides into an ascending and a descending branch.

The descending branch, the *cœcal* artery (*A. cœcalis*), sends a large anastomosing ramuscule to the last intestinal artery or to the extremity of the curve of the superior mesenteric artery, and afterwards divides into two other secondary branches, the *anterior* and the *posterior cœcal* artery, which are distributed in the corresponding parts of the cœcum and anastomose with the artery of the cœcal appendix.

The *ascending* or *anastomosing branch* (*R. ascendens*, s. *anastomoticus*) ascends at a short distance from the concave part of the intestinal canal along the ascending colon, to which it gives off numerous branches, not however equal in number to those of the intestinal arteries, which also anastomose less frequently. These branches divide near the colon into ramuscules, forming an anterior and a posterior series, all of which are distributed to the parietes of this intestine.

§ 1455. The *middle right colic* artery (*A. colica dextra media, colica dextra, colica dextra inferior*) is always the smallest of the three branches which arise from the concavity of the curve of the mesenteric artery, and often comes from the superior. Sometimes but very rarely it is given off by the inferior right colic artery.(1) It usually commences very near the superior colic artery.

When it is given off by the latter, it generally arises at the place where it anastomoses, when it comes from the mesenteric artery, with the superior colic artery by a short but very large branch; so that when it forms a distinct trunk we should consider it as an anastomosing branch between the superior right colic artery and the trunk of the superior mesenteric artery.

When it is a branch of the superior mesenteric artery, it divides some distance from its origin into a superior and an inferior branch.

The superior ascending branch is much shorter and anastomoses with a similar branch from the superior right colic artery.

The inferior descending branch is much larger, goes along the concavity of the ascending colon, and anastomoses by a large arch with the ascending branch of the inferior right colic artery.

This artery supplies the middle part of the ascending colon with blood.

§ 1456. The *superior right colic* artery (*A. colica superior dextra, colica media*, s. *anastomotica dextra*) generally arises some inches below

(1) Bichat seems to doubt this fact, but wrongly. He says that the inferior colic artery is constantly distinct. Murray and Mayer do not mention it, although they very correctly state that the two superior right colic arteries not unfrequently form one trunk. Sabatier and Sœmmerring are more correct in saying that the two inferior right colic arteries rarely arise together. Others, as Portal and Monro, mention only the cases where the three arteries form three distinct trunks.

the origin of the trunk and as high as the transverse meso-colon. It afterward enters between the two layers of the peritoneum, goes directly forward toward the centre of the transverse colon, and divides into a right and a left branch.

The right branch is generally a little smaller than the other, is also shorter, and anastomoses with the ascending branch of the middle right colic artery, which it sometimes replaces entirely (§ 1455).

The *left branch* (*R. anastomoticus magnus*) passes behind the left and largest portion of the transverse colon, communicates with the ascending branch of the left colic artery given off by the inferior mesenteric artery, and forms with it the largest anastomosis found in the adult. This anastomosis is seldom deficient.

This artery is distributed to the upper part of the ascending, and to the central and right portions of the transverse colon.

§ **1457**. One branch of the superior mesenteric artery, which exists only in the early periods of life, is the *omphalo-mesenteric* artery (*A. omphalo-mesaraica*), which generally arises from this trunk, but in no determinate place; this artery, accompanied by the veins of the same name, leaves the mesentery, passes on the lower part of the small intestine, arrives at the umbilicus, comes from the abdomen with the intestine, enters into the umbilical sheath before the end of the second month of pregnancy, and extends to the umbilical vesicle, and distributes its ramifications on its surface. This branch constantly exists until the end of the second month, after which it is almost always obliterated and is visible only in the mesentery and near the umbilicus. Sometimes it continues, always preserving rather a large caliber, and extends with its accompanying vein to the umbilical ring or even into the cord. Sometimes it is obliterated, but extends from the intestine to the umbilicus. These two cases occur principally when the intestinal canal, either alone or with other organs, is arrested at one of the first degrees through which it passes successively in its formation. The omphalo-mesenteric artery is undoubtedly the largest of those in the fetus.

III. INFERIOR MESENTERIC ARTERY.

§ **1458**. The *inferior mesenteric* artery (*A. mesaraica*, s. *mesenterica inferior*) comes from the aorta, generally some inches lower than the preceding, and usually about an inch above the bifurcation of the trunk of the aorta where the two primitive iliac arteries arise.

The only exceptions are when several renal arteries existing, one of them arises very low and the mesenteric artery is constantly given off from the aorta above the latter; its description however should precede theirs, because it comes from the anterior part of the trunk of the aorta, and because it is distributed to the intestinal canal, as are all the other arteries which arise in like manner from the anterior side of the abdominal aorta.

Still more rarely it comes from the primitive iliac artery,(1) which happens when the aorta bifurcates higher than usual.

It is always a little smaller than the renal arteries, proceeds obliquely to the left and upward under the peritoneum, penetrates immediately between the layers of the iliac meso-colon, and divides into several branches, which belong only to the left portion of the colon and to the rectum, the upper of which may be called the *left colic* arteries (*A. colicæ sinistræ*), to distinguish them from the right (§ 1456) which arise from the superior mesenteric artery, while the lower go to the rectum and are called the *upper hemorrhoidal* arteries (*A. hemorrhoideæ superiores*).

This artery is rarely deficient(2), a remarkable anomaly, which resembles the normal formation of many animals, viz. birds and reptiles, in which the posterior mesenteric artery gradually diminishes and entirely disappears.

§ 1459. The *left colic* arteries (*A. colicæ sinistræ*) arise from the upper convex part of the inferior mesenteric artery. We sometimes find two or three, a superior, middle, and an inferior. The middle is sometimes blended with the superior and sometimes with the inferior. The first case is more common.

The *superior left colic* artery (*A. colica sinistra superior, anastomotica sinistra*), generally the larger, proceeds along the descending colon and divides into two branches. This division occurs sometimes immediately, when it gives off the middle colic artery, sometimes later, when this arises separately from the mesenteric artery or by a common trunk with the inferior.

In the second case one branch goes to the right, the other to the left side. The latter anastomoses with the left branch of the superior right mesenteric artery, behind the left portion of the transverse colon, and thus forms a large arch (*arcus anastomoticus magnus*), (§ 1456) to produce which however it but slightly contributes. This anastomoses, in front of the upper part of the descending colon, with the ascending branch of the middle left colic artery.

The *middle left colic* artery (*A. colica sinistra media*) sometimes forms the lower branch of the preceding; and then arises from it very early, but more frequently is a distinct trunk, which soon after divides into two branches, the larger of which ascends along the left colon, and anastomoses with the descending branch of the superior left colic artery; and the inferior communicates with the ascending branch of the inferior left colic artery.

The *inferior left colic* artery (*A. colica sinistra inferior*), which is distributed to the lower part of the descending colon, divides still sooner into two branches, which anastomose, the ascending with the descending branch of the middle left colic artery, and the descending with the ascending branch of the superior hemorrhoidal artery.

(1) Petsche, *Syll. obs.*; in Haller, *Coll. diss.*, vol. vi. p. 761.
(2) Fleischmann, *Leichenöffnungen*, 1815, p. 239.

§ 1460. The *superior hemorrhoidal* artery (*A. hemorrhoidea superior*, s. *interna*) arises from the concavity of the curve described by the inferior mesenteric artery. It would then be more correct to consider it as the inferior of the two branches, into which this artery often divides, and the upper of which furnishes the left colic arteries.

It goes to the right, and descends behind the rectum, distributing its branches to most of this intestine. It usually divides into two branches, the upper of which is smaller, and the lower larger, and is the continuation of the trunk. Each branch immediately divides, although at some distance from the rectum, into a right and left, which open together downward and beside each other by considerable anastomoses, and are distributed to the rectum, where their branches usually communicate with those of the vesical and uterine arteries.

We shall mention the difference in the arrangement of the arteries of the small, and those of the large, intestine, when treating of the intestinal canal.

II. LATERAL BRANCHES.

§ 1461. The lateral branches of the abdominal aorta are the *middle capsular*, the *renal*, and the *spermatic* arteries.

I. MIDDLE CAPSULAR ARTERIES.

§ 1462. The *middle capsular* arteries (*A. capsulares mediæ*) are one, two, and sometimes even three, in number, and arise from the aorta very near each other, usually above, sometimes below, and a little in front of the renal arteries. In some subjects they come from the cœliac or from the renal arteries. They go to the right and left, passing on the bodies of the vertebræ, and arrive from below upward on the posterior face of the renal capsules, but at the same time they send branches to the pillars of the diaphragm, and to the lymphatic glands in the lumbar region.

II. RENAL ARTERIES.

§ 1463. The *renal* or *emulgent* arteries (*A. renales* s. *emulgentes*) come entirely from the side of the aorta, directly below the superior mesenteric artery. They arise at a right or at an almost right angle; they proceed from before backward and from within outward, directly on the lateral faces of the bodies of the first or second lumbar vertebra, and, arrived at the kidney, penetrate into its fissure after dividing, most frequently near this organ, into several and generally into three branches, which also subdivide before entering its substance.

They arise almost opposite each other; the right however is a little lower than the left, because the kidney of this side is lower than that of the other. To this law however there are exceptions. We remark particularly that when the right renal artery is double, the superior usually arises a little higher than the single renal artery of the left side.

These arteries are very large, but not, as Bichat says, the largest in the abdomen, since they are smaller than the cœliac or the superior mesenteric artery.

§ 1464. The renal arteries present many anomalies. The most usual affect their number. We generally find only one renal artery on each side. This number however is frequently, in fact often, increased by reducing the branches into distinct trunks, which arise directly from the aorta. The transition to this arrangement is marked by that where the single renal artery early divides into branches: this early division is not unfrequent, and often occurs only on one side; the renal artery of the opposite side being already divided into several separate trunks.

This anomaly of the renal arteries differs,

1st. In the conditions of its occurrence; 2d, in the number of divisions it produces; 3d, in its occurrence on one or both sides; 4th, in its being more frequent on one side than on the other; 5th, in the proportional size of the separate trunks; 6th, in their place of origin; 7th, in their insertion; 8th, in their relation with the renal veins.

1st. The conditions in which the number of the renal arteries is increased are,

a. An unusual size of the kidneys.

b. Their unusual length, although their size is not much increased. In this case their central portion is often strangulated.

c. The union of the two kidneys.

d. Their unusually low situation in the pelvis.

2d. In respect to number. The renal arteries are increased by one more commonly than by many.

Sometimes however there are three, four, and even five on one side.

3d. In regard to the simultaneous existence of several renal arteries on both sides at once, we remark generally that when there are not more than two, the anomaly occurs on one side as frequently as on both. When however this increase is more than two, it is rarely confined to a single side, although it very seldom occurs on both sides in the same degree. This rule however is not general, since four renal arteries sometimes exist on one side and only one on the other.

4th. The anomaly does not seem to affect one side of the body more than the other. This remark is the result of our own observations; it however is confirmed by the difference in the assertion of authors on this subject. Some say that the anomaly is more frequent on the left and others on the right side.

5th. The anomaly is the least possible when one of the two renal arteries is much smaller than the other. The larger then is generally but not always the upper; it forms the normal trunk. In fact the supernumerary renal arteries not unfrequently have the same caliber, each of them, considered separately, being a little smaller than the normal artery, except when one kidney is larger than the other.

6th. The supernumerary renal arteries also vary much in their origins. The nearest to the normal formation is where the second renal artery arises directly at the side of the normal artery; but they are frequently very distant from each other, so that one or some of them not only arise from the aorta, below the inferior mesenteric artery, but also come from the primitive iliac or even from the hypogastric artery; the last two cases however usually occur only when the kidneys are blended together or are situated very low. But if we except those cases where the kidney is situated very low, one renal artery generally arises from the usual place, however remote may be the origin of the others.

When more than two renal arteries exist, one generally arises very far from the rest. Sometimes they are situated at equal distances from each other. Sometimes also when four occur two of them arise very high, and two very low.

7th. The place of insertion is more abnormal, the lower the origin of the renal arteries, and the greater the anomaly in the form and situation of the kidneys. If the arteries are given off very low, although the situation of the kidneys is normal, they frequently do not enter its fissure, but are inserted at its lower extremity. If the kidney is situated very low, the vessels usually converge from all sides to enter it.

8th. The relation between the renal arteries on one side, and the emulgent veins and the vena-cava on the other, may be regarded in two points of view:

1st. In regard to their simultaneousness and frequency. A series of careful observations permit us to establish as a principle that the veins divide much more rarely than the arteries, and consequently the veins are not always abnormal, in this respect, when the arteries are, although this is somewhat common, even when the arteries exist, in regard to these two orders of vessels at the same time; the number of renal arteries nevertheless frequently exceeds that of the emulgent veins, although sometimes, but rarely, the veins alone are abnormal.

2d. Usually, particularly when more than two renal arteries exist, the relation of the situation with the veins is changed in this respect, that one or both of them pass before and not behind the vena-cava inferior to go to the kidney. One easily perceives that this rule can apply only to the renal arteries of the right side.

The two renal arteries much more rarely arise from the anterior face of the aorta by a common trunk which, in the only case of this anomaly known to us, was inserted very near the mesenteric artery.

Other anomalies relate to the side of the vascular system whence the renal vessels arise. Each renal artery generally goes to the kidney of the same side. The only exception to this rule is when the kidneys exist in the pelvis; one of the renal arteries then not unfrequently arises from the primitive iliac, or from the hypogastric artery of the opposite side.

§ 1465. Beside these slight and inconstant differences between the renal arteries of the two sides, in respect to the height at which they arise, they are constantly distinguished from each other by their length; that of the right side being longer than the other, and more so because the aorta is situated more to the left. In its course to the kidneys it usually passes behind, but not unfrequently before the ascending vena-cava.

The renal arteries belong particularly to the kidneys and enter almost wholly into the fissure. Proceeding however they always give several greater or less branches. These are,

1st. The *inferior capsular* artery (*A. suprarenalis inferior*) almost constantly arises from the renal artery, or at least comes very rarely from the aorta itself with the middle capsular arteries. This artery is even sometimes double, since, beside the usual artery, that which directly arises from the origin of the renal artery, a smaller one exists, which comes from one of its branches.

This inferior capsular artery is not unfrequently very large. In this case it gives off branches to the lumbar portion of the diaphragm, and sometimes the whole inferior diaphragmatic artery comes from it.

2d. The branches which go to the pelves of the kidneys and to the ureters.

3d. Rarely, and most generally on the left, and even then usually only where several renal arteries exist, the *spermatic* artery, which in this case constantly arises from the inferior renal artery. We have however satisfied ourselves that when the renal artery divides into several branches, the spermatic artery is by no means always inserted in one of the latter.

4th. Some branches to the renal capsule. These ramifications enter into the substance of the kidney, and there are likewise some small branches which go from the substance of the kidney to the capsule.

5th. More rarely the right renal artery sends a branch to the lower part of the liver.

III. SPERMATIC ARTERIES.

§ 1466. The *spermatic* arteries (*A. seminales*, s. *spermaticæ*) are usually single but not unfrequently double. They generally arise a little but sometimes far above the renal artery. They rarely originate opposite each other; one is frequently detached much higher than the other and much more before it, and most generally before the middle capsular arteries, making with the aorta an acute angle. Frequently also the spermatic artery on one side (§ 1464) arises from the renal, or from the inferior or middle capsular artery. More rarely it arises from the lumbar, from the external iliac, from the hypogastric, or even from the epigastric artery of its side. It generally extends vertically downward, but sometimes also it turns on the renal vessels before assuming its downward and outward direction, which it follows and keeps it directly behind the peritoneum, and before the ureter, which it crosses. That of the right side also passes before the vena cava inferior.

The spermatic artery is much shorter in the female than in the male, since it does not leave the abdomen, and is distributed to the ovaries, and also to the Fallopian tubes, to the round ligaments, and to the upper part of the uterus, communicating with the uterine arteries by numerous anastomoses.

In the male on the contrary it leaves the abdomen through the inguinal ring, forms with its corresponding vein and the lower part of the vas deferens the spermatic cord, gives branches to the common membrane of the cord and testicle, and is distributed principally in the latter organ.

In its course it gives upward branches to the duodenum, the liver, the transverse meso-colon, the renal capsules, the lymphatic glands in the lumbar region, and to the ureter, and frequently anastomoses with the branches of the mesenteric and lumbar arteries.

III. POSTERIOR BRANCHES. LUMBAR ARTERIES.

§ 1467. The *lumbar* arteries (*A. lumbales*) are the posterior rather than the lateral branches of the abdominal aorta, since they usually arise nearer the centre of the posterior face than the sides of this artery. In this respect there are different degrees between the entire lateral insertion of these arteries and the origin of those which correspond on the right and on the left by a common median trunk often several lines in length, before dividing into the right and left lumbar arteries.(1) All the lumbar arteries of the same subject are arranged in this respect after the same type.

These arteries correspond to the intercostal arteries and are also formed on the same level as they, both generally and particularly. But they are usually larger. Soon after arising, they go outward in the groove of the vertebræ, between the fasciculi of the psoas magnus muscle, to which they give numerous branches, as also to the quadratus lumborum and lumbar vertebræ, gradually arrive at the transverse processes of the latter, and always divide at their base, opposite the intervertebral foramina, into a posterior or dorsal and an anterior or lumbar branch.

(1) Sœmmerring (p. 277), who follows Murray (p. 75) in this, does not mention that the right and left lumbar arteries arise by a common trunk, but speaks only of the fourth. Others, as Mayer, Boyer, Sabatier, Hildebrandt, and Monro, do not speak of it at all. Portal is more correct when he states in a general manner that the synonymous lumbar arteries of the two sides sometimes arise by a common trunk. We have found that this anomaly is not unfrequent, and that, as we have already remarked, it usually affects all the lumbar arteries. Its frequency, compared with the proportional rarity of a similar arrangement in the intercostal arteries, is worthy of remark, as it coincides with the less marked development of the abdominal parietes.

The *posterior* or *dorsal branch* (*R. dorsalis*) is usually the smaller, and gives off a branch called the *spinal lumbar* artery (*A. spinalis lumbalis*), which passes into the spinal canal through the intervertebral foramen, is distributed on the dura-mater and the pia-mater, descends to the cauda equina, anastomoses with the synonymous branch of the opposite side and also with the anterior spinal artery, and is distributed also to the lower part of the muscles of the back.

The *anterior* or *lumbar branch* (*R. lumbaris*) goes forward between the broad abdominal muscles, within which it anastomoses with the branches of the epigastric artery.

There are usually as many lumbar arteries as there are lumbar vertebræ, viz. five. In general however there are not five which arise by separate trunks, but many of them, especially the two or three lower ones, often arise by a common trunk, which soon bifurcates. Sometimes this union of the two lumbar arteries on the same side, situated one above the other, coincides with that of the synonymous branches on the right and left, on one or on both sides, which we have already mentioned.

Most generally even only the four superior lumbar arteries arise from the aorta, and the fifth is given off by the anterior branch of the fourth.

Thus we usually observe at most but four aortic lumbar arteries.(1)

Finally, there is no symmetry in this respect between the lumbar arteries of the two sides of the body.

§ 1468. The *first lumbar* artery is frequently deficient, and in most subjects it arises from a trunk in common with the last intercostal artery or it is replaced by the branches of the latter. It is always small, so that when this arrangement exists and while at the same time the inferior lumbar artery arises by a secondary branch, which is much more common, we observe only three of these arteries.

Even when it is separated from the last intercostal artery, it proceeds a short distance below the lower edge of the last rib, under the insertion of the diaphragm. Sometimes its anterior branch curves between the transversalis abdominis muscle and the peritoneum along which it descends.

The *second lumbar* artery usually arises between the second and the third lumbar vertebræ; it goes first a little from below upward, then from before backward, and from within outward in the groove of the second vertebra. Its anterior branch is distributed principally in the quadratus lumborum and transversalis abdominis muscle.

The *third lumbar* artery arises between the third and fourth lumbar vertebræ, and descends on the first of these two bones. Its anterior branch is very large and passes between the psoas magnus and the

(1) This assertion cannot be disputed, when we speak of the trunks which arise directly from the aorta. Boyer (p. 127) and Portal (p. 290) have adopted it. But it is very incorrect to consider, with Haller and Sabatier, the inferior intercostal as the first lumbar artery, and consequently to admit six lumbar arteries, although the first lumbar not unfrequently arises from the last intercostal artery, or is replaced by its branches.

quadratus lumborum muscles, to which it gives branches, descends toward the anterior part of the crest of the ilium, and directly above this place goes through the abdominal muscles to the glutæi, where it ramifies and anastomoses with the gluteal artery.

The fourth *lumbar* artery arises on the fourth lumbar vertebra, or between the fourth and the fifth. Its anterior branch passes before the quadratus lumborum muscle, proceeds forward on the crest of the ilium, through the muscles of the back, to enter, like the preceding, into the glutæi muscles.

The fifth *lumbar* artery is a branch of the sacral artery; we shall therefore describe it when speaking of the latter.

CHAPTER V.

ARTERIES OF THE PELVIS AND THE LOWER EXTREMITIES.

§ 1469. The aorta usually divides on the fourth lumbar vertebra, or between the fourth and fifth, into two or three trunks. Two are much larger and more constant, and are the *arteries of the lower extremities* (*A. crurales*, Barclay) being called at their origin the *primitive iliac* arteries; they separate from each other at an acute angle and go outward. The third trunk is much smaller and inconstant, and is called the *middle sacral* artery.

I. MIDDLE SACRAL ARTERY.

§ 1470. The *middle sacral* artery (*A. sacra*, s. *sacralis media*), although very small, being no larger than a lumbar artery, is very remarkable, first, because from its situation and distribution it in fact represents the continuation and the end of the trunk of the aorta; secondly, because it adds to the analogy already existing between the distribution of the upper end and that of the lower part of the aorta.

When it arises from the aorta, it comes from its posterior side, directly above the origin of the two primitive iliac arteries. It is not unfrequently given off by the latter, especially that of the left side, from which it generally then arises very high, directly below its origin.

It descends more or less exactly on the centre of the anterior face of the body of the last lumbar vertebra, and of those of all the false vertebræ of the sacrum and coccyx, directly upon the surface of these bones, and curves frequently.

It gives off only lateral branches.

The first and largest is usually the *fifth* or the *last left lumbar* artery (§ 1469), which is sometimes larger than the continuation of the trunk, and then the middle sacral artery seems to arise from the inferior lumbar artery.

This branch, like all the lumbar arteries, goes backward and outward. It divides, before the intervertebral foramen, between the fifth lumbar vertebra and the first false vertebra of the sacrum, into two branches, a *posterior* or *dorsal*, and an *anterior*, which is much larger. The first is distributed as usual; it goes outward, under the psoas magnus muscle, and sometimes, when the fourth lumbar artery does not descend so low as usual, it proceeds on the crest of the ilium, and goes to the quadratus lumborum muscle, through which it passes into the broad abdominal, and also into the glutæi muscles; sometimes when these branches arise from the fourth lumbar artery, and the ilio lumbar artery is not as much developed, it penetrates into the psoas magnus and the iliacus muscles.

Two transverse branches more or less tortuous than usually arise from the lateral parts of the middle sacral artery on each false vertebra of the sacrum; these go outward, give numerous ramifications to the periosteum and to the substance of the sacrum, anastomose with the branches of the lateral sacral arteries which go to meet them, penetrate with them into the spinal canal, through the anterior sacral foramina, then emerge from the posterior sacral foramina, and are expanded in the inferior part of the multifidus spinæ muscle.

The middle sacral artery finally terminates at the end of the coccyx, in the lower extremity of the rectum and in the fat which surrounds this intestine.

This artery is not always single; it sometimes divides into two branches, which anastomose with each other and with the lateral sacral arteries.

There is constantly an inverse relation between the middle and the lateral sacral arteries in respect to their development, when one or the other is unusually large.

II. PRIMITIVE ILIAC ARTERIES.

§ **1471.** The *primitive iliac* arteries (*A. iliacæ primitivæ*, s. *communes*, s. *pelvi-crurales*, s. *crurales lumbales*, s. *cruri-lumbares*) separate at an acute angle, go outward, downward, and forward, on the last two lumbar vertebræ, and on the first false vertebra of the sacrum, the right after passing on the left primitive iliac vein, the left proceeding directly before and at the same time on the outside of the synonymous vein, and divide as high as the sacro-iliac symphyses, into two considerable trunks, the *hypogastric* and the *external iliac* artery.

The primitive iliac arteries usually have about the same length and caliber on both sides. The right however is most generally a little higher than the left, because the aorta occupies the left side of the vertebral column as the primitive iliac arteries, nevertheless, both arise at the same height. The left descends a little more vertically than the right. Those authors who mention some difference between the two primitive iliac arteries, especially Mayer, and after him Sœmmerring, indicate only this relation, which in fact is most frequently observed. These anatomists also assert that the right primitive iliac artery is a little smaller than the left.

We have never observed this last difference, but rather the contrary. The first in fact generally occurs, although we have sometimes but very rarely remarked an inverse arrangement, and even in a much more evident manner, although the aorta ascend as usual on the left of the vertebral column.

In one case of this kind now before us the right primitive iliac artery is nearly a third shorter than the left, and bifurcates between the fourth and fifth lumbar vertebræ.

The most usual arrangement is remarkable, because it adds still more to the analogy between the upper and lower halves of the body, since the greater length of the right primitive iliac artery resembles the innominata of the right side, and that of the left side the origins of the left carotid and subclavian arteries by two distinct trunks. The latter arrangement however is only indicated at the lower extremity of the aorta, where a perfect repetition has not yet been found, at least to our knowledge.

The rarest arrangement corresponds to the inversion of the right and left trunks of the arch of the aorta, which has been sometimes observed, although the aorta presented no other anomalies.

The primitive iliac arteries usually give off in their course small branches, which go to the psoas and the iliacus muscles, the ureters, the vena-cava, and the lymphatic glands of this region. They rarely give off a part or the whole of the ileo-lumbar artery, and still more rarely they supply a renal or a spermatic artery.

ARTICLE FIRST.

I. HYPOGASTRIC ARTERY.

§ 1472. The *hypogastric* artery (*A. hypogastrica* s. *iliaca interna*, s. *posterior pelvica*, s. *hypoiliaca*) descends a little forward and inward, soon penetrates, almost vertically, into the cavity of the pelvis, where it always divides, near its origin, into several branches, which vary in size, and are not always arranged exactly in the same manner, and do not arise from it constantly. It thus distributes the blood to all the parts within the pelvis, to its parietes, and to the muscles which surround it. It is always more or less evidently divided into two branches, a *posterior* and an *anterior*.

§ 1473. The posterior branch gives constantly the *gluteal*, the *ileo-lumbar*, the *lateral sacral*, and the *obturator* arteries. From the anterior arise the *ischiatic*, the *umbilical*, and the *internal pudic* arteries, which usually give off the *middle hemorrhoidal*, the *uterine*, the *vaginal*, and the *vesical* arteries. Frequently however the secondary branches, particularly those of the posterior branch, arise from the trunk of the hypogastric artery, or from the anterior branch; the first is true, particularly of the ileo-lumbar, and the second of the obturator artery; the two latter not unfrequently do not arise from the hypogastric artery but very far from the usual place, either from the primitive iliac or from the crural artery.

I. ILIO-LUMBAR ARTERY.

§ 1474. The *ileo-lumbar* artery (*A. ileo-lumbalis*) is usually the first, which arises from the posterior branch of the hypogastric artery, and is frequently divided into several, sometimes into three or four, trunks, which come from different points. Not unfrequently it partially or wholly arises from the primitive iliac, from the trunk of the hypogastric artery, from the anterior branch of the latter, or from the crural artery, or, as happens particularly on the left side, from the middle sacral artery, or, finally, it forms a common trunk with the lastl umbar artery. Its volume is by no means always the same.

It goes almost horizontally outward and backward, and soon divides, usually near the sacro-iliac symphysis, into an ascending and a descending branch.

The *ascending* branch ascends between the psoas and iliacus muscles, to which it sends ramifications, anastomoses with the inferior lumbar artery, which it sometimes entirely replaces, or which in other cases takes its place, and either alone or with the latter, sends branches into the spinal canal through the last intervertebral foramen of the lumbar region.

The *inferior* branch is more or less transverse, although a little oblique from above downward; it goes outward, and divides into superficial and deep branches.

The former are distributed on the anterior face of the psoas and iliacus muscles. The others between the latter and the os ilium, enter the muscle through its attached face, and thus penetrate into the substance of the bone through several foramina of nutrition.

All these branches proceed outward and forward, and frequently communicate with those of the circumflex iliac artery.

The anterior branches are distinct, and usually arise from the anterior branch of the hypogastric artery; they are small, and go to the iliacus and psoas muscles. When the ilio-lumbar artery divides into two large branches it often gives off only an ascending and a descending branch; but the superficial portion of the descending branch is frequently a part of the superior, and the anterior is formed only by the deep branches.

II. LATERAL SACRAL ARTERY.

§ 1475. The *lateral sacral* artery (*A. sacra lateralis*), is perhaps more frequently double than single, and is sometimes given off by the trunk of the hypogastric or by the ileo-lumbar artery ; in some subjects it is the first artery of the posterior branch of the hypogastric when the preceding artery arises from another point. It is rarely given off by the primitive iliac artery. It goes backward and inward and descends on the anterior face of the sacrum, before the anterior sacral foramina.

In this course it divides into internal and posterior branches.

The *internal* are distributed on the anterior face of the false vertebræ of the sacrum, to which they give their branches, and anastomose with the lateral branches of the middle sacral artery (§ 1470).

The *posterior* or *external* penetrate in the anterior sacral foramina and soon divide into branches, an anterior, distributed on the posterior face of the body, and a posterior, which emerges from the posterior sacral foramen, and is distributed in the lower part of the muscles of the back.

All these branches give twigs to the lumbar and sacral nerves, also to the membranes of the spinal marrow, and anastomose with the anterior spinal artery.

When the lateral sacral artery is double, the upper portion, which goes only backward, is usually separated from the lower ; but in this case it does not always come from the trunk of the hypogastric or from the ileo-lumbar artery ; it as often arises above the inferior portion, before the posterior branch of the hypogastric artery.

III. OBTURATOR ARTERY.

§ 1476. The *obturator* artery (*A. obturatoria*) is very inconstant in its origin. It usually arises from the posterior branch of the hypogastric artery, whence it comes directly or by a trunk in common with the ileo-lumbar artery, but frequently, at least once in ten times, is given off at another part.

The general character of all these differences in its origin is, that it arises farther outward and forward.

The anomaly is least when the obturator artery arises from the hypogastric artery above and before the place where the latter divides into an anterior and a posterior branch.

Next come the cases where it arises from the anterior branch of the hypogastric artery.

The anomaly is still greater when it arises from the primitive iliac artery. The latter gives it off either within or without the cavity of the pelvis, sometimes directly and sometimes indirectly.

It arises from different parts of the inner and outer portion of the primitive iliac artery.

Sometimes it is given off by the superficial femoral artery, two inches below Poupart's ligament.

When it is not a direct branch of the crural artery, it arises by a trunk in common with the epigastric artery. The most usual case, which is almost as common as that where the artery arises from the hypogastric artery, is, according to our observations, as 16 : 1, in respect to its frequency with that where it arises directly from the crural artery.

The common trunk varies in length from two lines to two inches, but it is usually short and its origin is no higher or lower than usual; in both cases however its length exceeds the rule.

But in all these anomalies, however remotely the obturator artery may arise from its usual place, it always passes on the horizontal branch of the pubis to enter into the cavity of the pelvis and be distributed as usual, and emerges from this cavity through the obturator foramen. This peculiarity is an important argument in support of the law, that when the organization presents an anomaly it always approximates as much as possible to the normal state.

Between the cases where the obturator artery arises from the hypogastric artery and where it comes from the crural artery, we find an intermediate case, where it arises from the union of two branches nearly equal in size, an anterior and a posterior, which arise, the former from the epigastric or the crural artery, the other from the hypogastric artery, and which anastomose at an acute angle.

It is pleasant to observe that these differences are indicated in the most normal formation, since a smaller or larger anastomosing branch always passes above the horizontal branch of the pubis, extends from the obturator artery given off by the hypogastric artery to the crural or to the epigastric artery. Consequently the internal obturator artery always arises to a certain extent from an anterior and a posterior branch. When the posterior is more developed, the artery seems at first view to come principally from the hypogastric artery, while, when the anterior branch is larger than the other, we are led to conclude that the obturator artery arises from the femoral or from the epigastric artery.(1)

(1) These anomalies in the origin of the obturator artery are common, as we have already remarked. Portal, although he asserts that the origin of this vessel is very inconstant, brings forward as proof only the cases where it arises from the trunk or from the branches of the hypogastric artery, but when describing this or the epigastric artery, he mentions those only where it arises from the latter or from the crural artery. Mayer only remarks that the obturator artery is sometimes given off by the crural or by the epigastric artery. Hildebrandt does not mention, when speaking of the obturator or of the epigastric artery, the anomaly which occurs when the first arises from the second, although this is more common than when it arises from the crural artery. He only says that it comes from the hypogastric or from the crural artery, and thus he at least indicates the frequency of the latter arrangement. Monro says that it is sometimes given off by the epigastric artery (p. 353). Sabatier (p. 108) and Boyer (p. 134) remark that it arises in some subjects from the epigastric or from the crural artery. Murray mentions only those cases where it arises from the epigastric artery. Haller, Sœmmerring, Bichat, Hardrops, Burns, Cooper, and Monro

This arrangement of the obturator artery is not necessarily the same on the right and left side, any more than are the varieties of any other artery. It follows however, from our observations, that it is more common or at least as common to find both sides of the body formed after the same type as to find this type only on one side. Thus in most of the preparations before us, the obturator artery comes on both sides from the hypogastric; in four, it arises by a trunk in common with the epigastric artery, and there are five only in which it arises from the epigastric artery on one side, and on the other, directly from the crural artery by a trunk in common with the epigastric artery.

When the obturator artery arises from the epigastric only on one side, this variety generally occurs on the left. At least our observations have shown that the cases in which it arises from the left epigastric artery are to those where it comes from the right as 10 : 1. We do not think that sex has any influence in this respect; we have not observed that the origin of the obturator artery outward is more common in the female than in the male, as Hesselbach asserts.

§ 1477. Most commonly, when the obturator is a branch of the hypogastric artery, it goes outward and forward, directly below the upper edge of the cavity of the pelvis, gives off in its progress some inconstant ramuscules to the levator ani and obturator internus muscles, to the glands of the pelvis, and to the obturator nerve which accompanies it, passes through the upper and tendinous part of the obturator internus muscle, at the upper part of the obturator foramen, and emerges from the

have written the best upon this artery. Haller says (*Ic. fasc.* x. *expl. tab.* i. *not.* 9): *Non tamen perpetuum est, eam arteriam a pelvis truncis nasci, cum novies viderim ex epigastrica ortam.* Sœmmerring expresses himself with much exactness. This artery, he says, is not constant in its origin; it sometimes arises from the crural and often from the epigastric artery (p. 294). Bichat also mentions the frequency of this last origin. Wardrop says he has observed it in many subjects. The details on the origin and distribution of this artery given by Burns are most correct; they perfectly agree with our own observations. He says the obturator artery is usually regarded as a branch of the internal iliac artery, but we have as good right to assert that it arises from the trunk or from one of the branches of the external iliac. We have often seen it come from this vessel, an inch above Poupart's ligament. It frequently arises by a trunk in common with the epigastric artery. These details are given in his treatise on diseases of the heart. Farther (*Observations on the structure of the parts contained in crural hernia*; in the *Edinb. Med. and Surg. Journ.*, vol. ii. p. 272), he says that the obturator and the epigastric arteries often arise by a common trunk; perhaps however this arrangement may be considered as a rare anomaly, but he has observed it more than twenty times. Cooper (*The anatomy and surgical treatment of crural and umbilical hernia*, 1807, *Edinb. Med. and Surg. Journ.*, vol. iv. p. 231) also states, when speaking of the origin of the obturator and epigastric arteries by a common trunk, that it is not rare. Monro (*Anat. of the gullet*, p. 429) establishes the relation between this case and those where it does not exist as 1 : 10. Bekkers also mentions (*Diss. de hernia inguinali*, Paris, 1813) three cases observed by himself, in which these two vessels arose in common from the external iliac artery. We have mentioned these cases, which support our observations, because Hesselbach (*Neueste anatomisch-pathologisch Untersuchangen über den Ursprung und das Fortschreiten der Leisten-und Schenckelbrüche*, Wurzburg, 1815) is wrong on this subject. He maintains, which seems impossible in so distinguished an anatomist, not only that this variety is very rare but adds, that, as to his knowledge the lesion of this artery has been observed only in females, the injury of the obturator artery in the male is not to be feared.

pelvis to be distributed to the upper and internal part of the thigh. It usually gives off also, before leaving the pelvis, a branch, which anastomoses with a corresponding branch of the opposite side on the symphysis pubis, and always gives origin to a branch, which varies in size and anastomoses with the epigastric artery above the horizontal branch of the pubis

In or directly before the obturator foramen, the obturator artery usually divides into two branches, an *external* and an *internal*.

The *internal* branch is smaller and passes above the obturator externus muscle, gives branches to it and also to the adductor brevis and longus, to the gracilis, to the pectineus, and to the skin of the internal part of the thigh, the scrotum or the labia pudenda, commonly anastomoses with the internal circumflex artery of the thigh, and with the external branch on the circumference of the obturator foramen, and with the external pudic artery in the scrotum and the labia pudenda.

The *external* branch descends deeply outward between the obturator internus and externus muscles, gives branches to these muscles in which it sometimes terminates, is reflected from within outward on the articular capsule and the inner part of the articulation to emerge from the obturator foramen, and passing behind the quadratus femoris muscle goes transversely to the posterior part of the extremity; then it is distributed to the quadratus femoris, to the gastrocnemii, to the adductor longus and brevis, to the upper extremity of the flexors of the leg, finally, to the substance of the external condyle of the femur; anastomoses with the internal branch on the circumference of the obturator foramen and with the ischiatic artery above, and within with the internal circumflex and the internal hemorrhoidal arteries.

§ 1478. The varieties in the origin of the obturator artery are very important to the surgeon. When this artery arises at the usual place from the hypogastric or from the crural artery within the pelvis, and even from the epigastric artery, but far above the crural arch, it is not exposed to be wounded in any of the common operations. But when its origin is situated very low, and it comes either from the crural artery or by a trunk in common with the epigastric artery, as it then always re-enters the pelvis over the branch of the pubis, it is exposed to wounds in the operation for crural hernia.

When the common trunk of this and the epigastric artery is short, it is generally thrown outward toward the ischium in crural hernia, so that it would be divided if the incision should be made in this direction.(1)

When, on the contrary, this same trunk is long and the obturator artery consequently goes farther inward, it is pushed down by the crural hernia and proceeds before the neck of the tumor inward.(2)

(1) See a case of this kind figured in Monro, *Morbid anatomy of the human gullet*, Edinburgh, 1811, tab. xiv. fig. 1.

(2) Wardrop has figured a case of this kind (*Edinb. Med. and Surg. Journ.*, vol. ii. p. 203), and points out the means of avoiding the obturator artery in this case. See

We must however in this case determine whether the crural hernia is situated more or less outwardly.

If an external and an internal crural hernia exist on one side, the obturator artery sometimes passes to the inside of the external tumor, even when the common trunk of this vessel and of the epigastric artery is short, and enters the cavity of the pelvis between the two tumors. This has been observed by Burns.

If the obturator artery rises far below the usual place and from the crural artery, either directly or by a trunk in common with the epigastric artery, it generally proceeds deeply, along the pectineus muscle, on the inside of the crural vein, so that, being situated behind the tumor, in case of crural hernia it cannot be wounded in the operation.

But if it was nearer the surface, it might be situated also on the anterior face of the tumor. We have never seen this latter arrangement. Burns and Monro have observed only the first.

IV. GLUTEAL ARTERY.

§ 1479. The *gluteal* or *posterior iliac* artery (*A. glutea*, s. *iliaca posterior*, s. *externa*), the largest artery of the posterior branch of the hypogastric artery, which may be considered as its continuation, arises very often by a trunk in common with the ischiatic artery. Sometimes it furnishes the lateral sacral, the obturator, and all the other arteries which usually come from the posterior branch of the hypogastric artery. It goes downward, forward, and outward, toward the lower part of the ossa ilia, usually sends off, in this course, branches to the iliacus inturnus muscle, to the obturator internus, to the pyriformis, to the levator ani, and to the os pubis, then emerges from the pelvis through the ischiatic notch, between the pyriformis and the gluteus minimus muscle, is reflected from below upward, penetrates between the gluteus medius and minimus muscles, and divides into numerous branches, which are distributed to the pyriformis and to the three glutei muscles and anastomose above with the epigastric, the last lumbar, and ilio-lumbar arteries, below with the ischiatic and with the external circumflex artery.

§ 1480. The anterior branch of the hypogastric artery gives off, first, the ischiatic artery, the internal pudic, and the umbilical arteries. The vesical, uterine, and vaginal arteries come from one of the latter; sometimes also they arise by a common trunk.

V. ISCHIATIC ARTERY.

§ 1481. The *ischiatic* artery (*A. ischiadica*) arises separate from the internal pudic artery less frequently than by a trunk, which varies in length, in common with the latter, and often by a trunk in com-

Burns, *Observations on the structure of the parts contained in crural hernia*, in the *Edinburgh Med. and Surg. Journ.*, vol. ii. p. 273, fig. 1.

mon with the gluteal artery. It descends before the latter, but at the ischiatic notch it turns backward, continuing still to descend, and emerges from the pelvis, below the pyriformis muscle.

The common trunk of the ischiatic and of the internal pudic arteries frequently does not bifurcate, except in this place, to give origin to two arteries; and from its portion within the pelvic cavity arise branches which are distributed to the pyriformis, to the obturator internus, and to the levator ani muscles.

On emerging from the pelvis the ischiatic artery sends, to the posterior part of the ilio-femoral articulation, branches which anastomose with the circumflex arteries. It afterward goes backward, toward the gluteus maximus muscle, into which it penetrates from within outward, and within which it is almost entirely distributed.

It often gives off the middle hemorrhoidal, the uterine, the vaginal, and the vesical arteries, especially when it arises by a long trunk, in common with the internal pudic artery.

It not unfrequently gives off an inferior lateral sacral artery when the usual artery of this name does not descend very low, and is unusually small.

It constantly anastomoses by large branches, above, with the ischiatic artery, and with the circumflex arteries below, around the coxo-femoral articulation of the large trochanter.

VI. INTERNAL PUDIC ARTERY.

§ 1482. The *internal pudic* artery (*A. pudenda interna*, s. *communis*, s. *circumflexa*, s. *pudica pelviena*, s. *hæmorrhoidea externa*) descends into the pelvis, directly before the ischiatic artery, which is generally larger than it, and when it is not given off in this place or even afterward by the latter, emerges with it from the cavity of the pelvis, between the pyriformis muscle and the large sacro-sciatic ligament, between the latter and the small sacro-sciatic ligament, afterward re-enters the pelvis, where it continues to the symphysis pubis, descends along the posterior edge of the descending branch of the ischium, on its internal face, to the tuberosity of the ischium, then reascends, always on the inner side of the bone, along its ascending branch and the descending branch of the pubis, between the obturator internus and the levator ani muscles, and having come above the symphysis pubis, terminates in the external organs of generation.

Thus the pudic artery usually emerges from the pelvis through the sciatic notch, and re-enters it between the two sacro-sciatic ligaments to leave it a second time below the symphysis pubis; but not unfrequently, especially in the male, it always continues in the cavity of the pelvis, and then, proceeding on the lower and lateral portion of the bladder, it goes forward, across the upper part of the prostate gland, where Burns remarks it may be wounded in the operation of lithotomy particularly when the summit of the prostate gland is cut.

It often gives off within the pelvis one or several vesical arteries, the middle hemorrhoidal, the vaginal, or the uterine, and even the obturator arteries. It also sends smaller branches to the internal parts of the genital and urinary apparatus. In its course along the descending branch of the ischium, besides several small branches which go to the bone, to the obturator internus muscle, to the upper extremity of the flexor muscles of the thigh, to the lower part of the rectum, and to the sphincter ani, it gives off others also, of which the principal are,

1st. A considerable branch which goes outward, between the large trochanter and the ischium, divides into several branches, descends on the neck of the femur and the capsule of the ilio-femoral articulation, between the obturator internus and externus muscles, gives ramuscules to these muscles, and also to the quadratus femoris and to the gemelli muscles, and anastomoses with the circumflex arteries.

2d. One or more rather large internal branches, which go to the inferior part of the rectum, also to the anus, and form the *external* or *inferior hemorrhoidal* artery (*A. hæmorrhoidea externa*, s. *inferior*).

A little above the tuberosity of the ischium, the internal pudic artery divides into two branches, an internal transverse, and an external anterior ascending branch.

The *internal* branch, the *perineal* artery (*R. internus*, s. *transversus*, s. *superficialis*, *arteria perinæa*, s. *transversa perinæi*) is smaller than the external. It goes inward and a little forward along the transversalis perinei muscle, usually between it and the skin, distributes branches to these parts, and also to the other muscles of the penis, and to the constrictor vaginæ in the female; gives some branches to the lower part of the rectum, and to the sphincter ani, which are termed the *external* or *inferior hemorrhoidal* arteries (*A. hæmorrhoidales inferiores*, s. *externæ*,) and sends others also to the skin of the perineum, labia pudenda, and scrotum.

The *external*, *anterior*, *superior*, or *deep* branch (*R. anterior*, s. *superior*, s. *profundus*, s. *pudendus*) is called the *artery of the penis* (*A. penis*) in the male, and the *artery of the clitoris* (*A. clitoridea*) in the female. When the internal pudic artery gives off considerable branches within the pelvis, this artery not unfrequently arises mostly from the other adjacent branches of the hypogastric artery, especially from the obturator artery, less frequently from the external iliac artery, particularly from an external pudic artery, an anomaly which is indicated in the normal state by the more or less manifest anastomoses between the internal and the external pudic arteries.

This artery is much larger in the male than in the female on account of the greater proportional size of the parts to which it is distributed.

In both sexes it proceeds from below upward, around the inner face of the pubis and ischium, between the bone and the corpus cavernosum of the penis and clitoris, and distributes branches to the vagina and prostate gland, the labia pudenda, and the scrotum, finally to the clitoris and the penis, which branches are arranged after the same type.

The branches which go to the prostate gland and the scrotum in the male, to the vagina and to the labia pudenda in the female, are given off the first, directly above the sciatic tuberosity.

After these the trunk descends along the ischium and the pubis, covered by the *erector penis* (*levator penis, clitoris*), and thus comes into the triangular space below the symphysis pubis, where the roots of the corpus cavernosum of the penis in the male, and of the clitoris in the female unite.

In both sexes, the artery then divides into two branches, the superficial and the deep branch.

The *superficial* or the *dorsal* branch, the *dorsal artery of the penis or clitoris* (*R. dorsalis*, s. *superficialis penis vel clitoridis*), passes through the suspensory ligament. It is very tortuous when the penis is not erected, and proceeds under the skin at the side of the synonymous artery of the opposite side, with which it sometimes unites, after a very short course, advances thus on the back of the penis, and gives branches to its skin and its fibrous membrane, and sends off others which descend into the scrotum. At the groove behind the glans, it forms a crown around it, and finally penetrates into its substance.

The *deep* branch or the *cavernous* artery (*A. profunda*, s. *cavernosa penis*, s. *clitoridis*) passes through the fibrous membrane of the corpus cavernosum of its side, thus penetrates into the substance of this body, and soon divides into several branches. These proceed from behind forward, along the penis, expand in the corpus cavernosum of both the penis and urethra, and frequently anastomose with those of the opposite side.

The two deep branches often unite in a single common trunk.

Sometimes the internal pudic artery terminates much sooner than we have mentioned, in the transverse perineal artery, and the dorsal artery of the penis or clitoris arises wholly or in great part from the obturator artery.

VII. UMBILICAL ARTERY.

§ 1483. The third artery of the anterior branch of the hypogastric artery, the *umbilical* artery (*A. umbilicalis*), is before birth the continuation not only of the trunk of this artery, or even of the primitive iliac artery, but is larger than the hypogastric and femoral arteries, and is the continuation of the aorta.

At all periods of life the umbilical artery goes a little obliquely forward and inward, toward the upper part of the lateral wall of the bladder, to which it is attached by mucous tissue. Thence it proceeds along this wall, toward the posterior face of the anterior wall of the abdomen, and thus goes from behind forward and from below upward to the umbilicus.

In the fetus it is open in its whole extent, but soon after birth it is gradually obliterated after leaving the umbilicus, so that finally it affords a passage to the blood only in the part between its origin and the bladder, the rest of it being changed into a full and solid ligament, enveloped by a fold of the peritoneum, and which may be generally traced to the umbilicus.

During fetal existence, the lower and anterior part of the umbilical artery which is convex, gives off not only the branches of the hypogastric artery, which we described above, but also, first, the inferior vesical, then the vaginal, next the uterine, and finally one or more superior vesical arteries, which generally are very distinct from each other. But as it is gradually obliterated, and as at the same time the lower extremities and their vessels are developed, these arteries approach each other, and seem to be in part the upper arteries of the anterior branch of the hypogastric artery.

These branches arise in the following order, which we adopt, since in following it the arteries to be described, correspond from behind forward to those already mentioned.

VIII. VESICAL ARTERIES.

§ 1484. The *vesical* arteries (*A. vesicales*) are distinguished into inferior and superior.

The *inferior* are larger than the superior, and generally there is only one. They arise from the umbilical or from an anterior branch of the hypogastric artery, which is usually the internal pudic, or from the trunk of the hypogastric artery; they go downward and forward to the lower and posterior part, and also to the neck of the bladder, the commencement of the urethra, to the prostate gland and to the vesiculæ seminales in the male, and to the lower part of the vagina in the female.

The *superior* are generally smaller and more numerous; they always arise from the lower part of the umbilical artery, consequently from the most anterior part or from the extremity of the hypogastric artery, and go to the middle and superior part of the bladder.

IX. MIDDLE HEMORRHOIDAL ARTERY.

§ 1485. The *middle hemorrhoidal* artery (*A. hæmorrhoidea media*) often follows the inferior vesical artery from below upward, and from behind forward; but frequently also it arises lower than it, being even sometimes deficient, and is given off by the ischiatic or by the internal pudic artery. Sometimes it arises from the upper or lower hemorrhoidal arteries, with which it always anastomoses, and is distributed on the anterior face of the rectum and also on the posterior part of the bladder, where it communicates with the proper vesical arteries.

X. VAGINAL ARTERIES.

§ 1486. One or two *vaginal* arteries (*A. vaginalis*) usually follow the inferior vesical artery. But this artery is frequently deficient, and it is then replaced by the ramifications of the vesical, the hemorrhoidal, or the uterine arteries. Sometimes also, even when it forms a distinct branch, it does not arise in the order mentioned, but comes from some one of the arteries of the anterior or of the posterior branch of the hypogastric artery.

It goes forward, inward, and downward. Its branches are distributed to the inferior and middle regions of the lateral part of the bladder and of the vagina.

XI. UTERINE ARTERY.

§ 1487. The *uterine* artery (*A. uterina*) generally succeeds the vaginal artery, but it frequently varies from this order. It is however constant.

It goes inward, toward the upper part of the vagina, to which it gives off some branches, as well as to the bladder; it then reascends in the broad ligament along the lateral wall of the uterus. In its course which is very tortuous, it gives off numerous ramifications which are also curved, to the anterior and posterior faces of the uterus. Some of these ramifications are distributed on the surface and others in the substance of this organ.

Its upper part expands by several branches in the folds of the peritoneum; they go to the internal organs of generation, to the Fallopian tubes, and to the ovaries, where they frequently anastomose with the spermatic arteries.

§ 1488. In man, the vessels which correspond to the uterine or the vaginal arteries are small secondary branches of the vesical and of the external hemorrhoidal arteries.

ARTICLE SECOND.

EXTERNAL ILIAC ARTERY.

§ 1489. The *external* or *anterior iliac* artery (*A. iliaca externa*, s. *anterior*, s. *cruralis iliaca*, s. *femoralis*), from its origin, descends from within outward, on the inside of the psoas magnus muscle, sends numerous small branches to this muscle, and also to the lower part of the iliacus muscle.

It usually gives off, at a greater or less distance from the crural arch, two large branches, the epigastric artery, and the circumflex iliac artery, which are very important in a pathological and surgical point of view on account of inguinal and crural hernias.

The first usually arises a little and sometimes much higher than the second, and even above the crural arch; besides, it always comes from the inside of the iliac artery, while the other constantly arises from its outside.

I. EPIGASTRIC ARTERY.

§ 1490. The *epigastric* artery (*A. epigastrica*) is rarely a branch of the common or deep crural artery,(1) but it often arises by a trunk, in common with the obturator artery, so that we may consider it as giving off this latter(2) (§ 1476), although, for all this, its origin is not necessarily displaced and carried higher than usual. It is often given off, sometimes higher and sometimes lower, from the external iliac artery, so that the place where it arises varies to the extent of two inches, although the obturator artery is not necessarily one of its branches.(3) Thus we may consider erroneous the opinion of Hesselbach, who asserts that this artery rarely varies in its origin and in its course,(4) and also that of Mayer,(5) who, like Burns, asserts that it always arises directly below the crural arch. The latter case exists very seldom, for the epigastric artery almost always arises above Poupart's ligament. On the contrary, the place where it detaches itself from the external iliac artery varies much, although it never comes from any other vessel.(6) It however generally arises directly above the crural arch,(7) and its origin is normal when situated one inch or even two inches above this arch.(8).

(1) Monro, *Morbid anatomy of the human gullet*, Edinburgh, 1811, p. 426.

(2) At least we have never found in this case that the epigastric was a branch of the obturator artery, although we have often seen both arise by a common trunk, and have now several cases of the anomaly before us. Hesselbach, (*Ueber den Orprung und das Fortschreiten der Leisten-und Schenkelbrüche*, Wurtsburg, p. 17) and Bekkers (*loc. cit.*, p. 315), mention in fact one case where the epigastric arose from the obturator artery. But it is evidently wrong, as it follows from the description of this anomaly given by the former, in saying that the obturator artery came from the inside of the crural more than an inch above the crural arch; since it follows from it we say that the common trunk arose, as is commonly seen in this case, from the external iliac, and not from the internal iliac, or hypogastric artery, as would be the case provided the expressions of Hesselbach were correct. This anomaly however may sometimes occur. Monro (*loc. cit.*, p. 427) seems to have observed it, for he says that in one preparation before him the epigastric arose from the obturator artery, and afterward went upward and inward, toward the rectus abdominus muscle.

(3) Which Hesselbach seems to think necessary.

(4) Hesselbach, *loc. cit.*, p. 17-52.

(5) Mayer, *Beschreibung der Blutgefasse des menschlichen Körpers*, p. 206.

(6) Monro is very correct in saying (*loc. cit.*, p. 254) that the epigastric artery varies much in its origin.

(7) As has been correctly stated by Bichat (*loc. cit.*, p. 311) and Murray, (*loc. cit.*, p. 89).

(8) Outlines, p. 354.

(9) According to Sœmmerring, *loc. cit.*, p. 307.

When the epigastric artery arises unusually high it descends near the crural arch, sometimes very low, even below this arch, and always passes behind the commencement of the spermatic cord, above the inguinal ring, so that it is situated on the inside of this cord. There it suddenly curves and reascends vertically on the posterior face of the rectus abdominis muscle, first between this muscle and the peritoneum, then between it and the posterior layer of the sheath.

Soon after it is reflected around the spermatic cord, it gives off, directly above the inguinal ring, a constant branch, which divides into two branches; one goes downward and backward and anastomoses with the iliac artery, the other is transverse and goes inward, proceeds along the horizontal branch of the pubis, behind the inguinal ring, and communicates with that of the opposite side. It also sends to the spermatic cord or to the round ligament of the uterus, some ramifications which penetrate to the scrotum and the labia pudenda, and anastomose below with the spermatic arteries, and above with the uterine arteries in the female. These ramifications, which go to the spermatic cord and to the round ligament of the uterus, sometimes come from the trunk of the external iliac, even above the epigastric artery, when the latter arises lower than usual. This arrangement coincides with the very high origin of the spermatic arteries notwithstanding the sloping situation of the testicles and of the ovaries, since it manifestly depends on the spermatic cord being situated at first higher and more internally.

The trunk of the epigastric artery divides below into two branches, the external, which is generally the larger, and the internal, the smaller; it then ascends on the posterior face and in the substance of the rectus abdominis muscle, sends off several branches outwardly, one of which is frequently larger than the others, in the internal part of the broad abdominal muscles, gives branches to these, the recti, and to the pyramidales muscles, and to the peritoneum, and terminates near the centre of the abdomen, by anastomosing with the branches of the external thoracic, the inferior intercostal, and the internal mammary arteries.

The epigastric artery is situated on the outside of the tumor in internal inguinal hernia, and on the inside in external inguinal hernia; so that in the former case it is wounded when the incision is carried outward and in the latter case when the bistory is directed inward. It is rarely so far distant from the inside that it is raised with the umbilical artery or with the remnant of this vessel, and consequently proceeds on the inside of the tumor, even in an internal inguinal hernia.(1) In crural hernia it is usually found outward, so that we run the risk of opening it when we cut in this direction. It is however difficult to wound it when it does not arise lower than usual, while this is easy when it comes from the crural artery, in which case it sometimes

(1) Bekkers, *loc. cit.*, p. 316.

ascends on the outside of the inguinal ring, sometimes passes before this opening to go to its inside; it may also be divided, when, although it does not arise lower than usual, it descends first superficially and resumes its situation afterward to go toward the umbilicus.

§ 1491. Sometimes a considerable branch arises from the inside of the iliac artery, below this artery, the following, or finally the crural arch. This is half as large as the epigastric artery, and ascends outside of the inguinal ring, between the external face of the obliquus abdominis muscle and the skin, gives branches to this muscle, particularly to the integuments, extends to the umbilical region, anastomoses below with the epigastric artery, and may be considered as the second epigastric artery. When this branch exists, it is also found on the outside of the tumor in an external inguinal hernia, and it is wounded if the bistory is carried in that direction.

II. CIRTUMFLEX ILIAC ARTERY.

§ 1491. The *circumflex* or *anterior iliac* artery (*A. abdominalis*, s. *circumflexa iliaca externa*, s. *iliaca externa minor*, s. *epigastrica externa*) usually arises on the outside of the iliac artery, opposite the epigastric artery, which is generally a little larger than it. As however it is more constant in its origin than the latter, it is not unfrequently placed more or less below it. It frequently comes from above the epigastric artery, although the latter arises at its usual place. In some subjects it even arises from the crural artery, directly below the crural arch, but always at least from its outside. It goes directly outward and upward toward the iliac crest, frequently sends branches to the tensor fasciæ latæ and sartorius muscles, always give them to the iliacus muscle, and following the direction of the crest of the ilium, proceeds from before backward and from within outward, in the lower and middle part of the broad abdominal muscles, between which its principal branches penetrate. The latter anastomose with the ileo-lumbar and epigastric arteries. Others, which go outward, toward the great trochanter and the sartorius muscle which they accompany, communicate with the ramifications of the crural artery.

This artery is not unfrequently divided into two trunks, one of which generally arises a little below the epigastric artery.

The external branch is generally much larger than the other, but sometimes becomes a small branch, while the principal branches of the artery go obliquely inward and upward. In this case, when one or more of these branches are considerably large, the operation of paracentesis might give rise to a formidable hemorrhage.(1)

(1) Ramsay, *Account of some uncommon muscles and vessels*, in the *Edinb. med. and surg. journ.*, vol. viii. p. 282, tab. 1, fig. 1.

ARTICLE THIRD.

CRURAL ARTERY.

§ 1493. The external iliac artery after emerging from the crural arch, under the centre of which it passes, is called the *crural* or *femoral* artery (*A. cruralis*, s. *femoralis communis* s. *cruralis inguinalis*, s. *cruri-inguinalis*). It is situated in this place on the neck of the femur, almost directly below the skin, covered only by the fascia lata aponeurosis, the fat, and the lymphatic glands of this region, over the vein which accompanies it, and occupies nearly the centre of the space between the symphysis pubis and the anterior and superior spine of the ilium, between the adductor muscles of the thigh on one side, the rectus anticus and the sartorius muscles on the other.

Beside the small inconstant ramifications which it distributes to the skin, to the muscles, and to the lymphatic glands of this region, it gives off, sometimes higher and sometimes lower from its inside, one, two, and even three *external pudic*, *scrotal*, or *vulvar* arteries, the upper, the lower, and the lowest (*A. pudendæ externæ*, *superior*, *inferior et infima*, s. *tertia*).

These arteries, which proceed directly under the skin, go from without inward in the integuments and the fat of the pubis and of the lower part of the abdomen, the inguinal glands, the scrotum, and the labia pudenda, where they form the *anterior scrotal* and *labial* arteries (*A. scrotales et labiales anteriores*). To this is referred the second epigastric artery mentioned above.

§ 1494. The crural artery has not always the same extent. Its length is principally determined by the origin of the deep femoral artery, which always arises from its posterior and inner side, so as to be covered by it. This branch is generally given off from the trunk one or two inches below the crural arch, rarely higher,(1) but sometimes also it arises directly below the arch or even, which is always very rare, above it. On these differences depend also those in the size of the superficial and deep crural arteries or of the continuation of the trunk. When the crural artery arises very high it is usually much larger than common, nearly equal to the superficial in size, and then it frequently gives off the upper branches of the latter, particularly the external pudic arteries, but more frequently still the circumflex arteries, which we shall mention directly. Sometimes the latter and the deep crural artery arise from a common trunk and at the same place.

(1) Burns has already corrected the error made by Bell, who asserted that this division usually occurred four inches above the crural arch.

I. DEEP CRURAL ARTERY.

§ 1495. The *deep crural* artery (*A. cruralis*, s. *femoralis profunda*) gives off frequently, not far from its origin, two branches, called the *circumflex arteries of the thigh* (*A. circumflexæ femoris*), which are distinguished into external and internal. This however is not always the case. Sometimes, but very rarely, these two arteries (more frequently one of them, particularly the internal, and very rarely the external) arise from the common crural or even from the superficial crural artery, below the origin of the deep femoral artery.

I. CIRCUMFLEX ARTERIES.

§ 1496. The *internal circumflex* artery (*A. circumflexa femoris interna*) generally arises higher than the external. Its origin is sometimes two or three inches above that of the latter; hence it comes more frequently than the other from the common crural artery, directly below the crural arch and the epigastric artery, higher even than the three external pudic arteries, and it is thus sometimes given off by the external iliac artery. It generally comes from the inside, but in some subjects from the outside of the common crural artery. In this case it gives one or more branches, which go outward and upward, into the inguinal glands, the iliacus and the sartorius muscles, and anastomose with those which arise from the crural artery. The trunk goes inward, passing in the second case below the crural artery, and at the same time descending a little when not unusually high. It gives branches to the lower part of the psoas and iliacus, the pectineus, to the short and long adductor muscles, afterward goes deeply inward and backward, below the pectineus muscle, and immediately around the neck of the femur, and divides behind the pectineus into two branches, a superior or anterior and an inferior or posterior.

The *superior* is smaller and soon subdivides into two branches; the *external* and *smaller* is called the *artery of the cotyloid cavity* (*A. acetabuli*); it goes to the capsular ligament and to all parts of the articulation, turns on the head of the femur, anastomoses by a large ramuscule with the obturator artery, and distributes branches to the obturator externus muscle. The *internal* is larger, passes behind the adductor longus and brevis, and is expanded in the upper part of the adductor magnus muscle.

The *inferior* branch is much larger than the preceding, and is the continuation of the trunk. It descends backward, behind the adductor magnus muscle, is distributed principally to the gracilis muscle, the three long flexors of the leg, the long head of the biceps femoris, the semimembranosus and the semitendinosus, and finally becoming sometimes one, sometimes two branches, called the *trochanterian*, which are distinguished into an *upper* and *lower* (*R. trochantericus superior et infe-*

rior), it is reflected from before backward, on the inner part of the femur, then outward and upward, to arrive at the great trochanter, ascends before the gemelli and quadratus femoris muscles, between them and the obturator externus muscle, gives branches to these muscles, and also to the tendon of the obturator internus and pyriformis, and anastomoses with the external circumflex, the gluteal, the ischiatic the inferior hemorrhoidal, and the obturator arteries. This inferior branch is sometimes smaller, and is distributed only to a portion of the adductor magnus and to the gracilis muscles; all the other ramifications, especially the anastomotic, arising from the superior.

Beside the anastomoses between the external and the internal circumflex arteries at the posterior part of the thigh, these two arteries often unite by a very large transverse branch on the anterior face of the bone, which, added to their communication with the crural artery, completes the circle of anastomosis.

By all these anastomoses the internal circumflex artery is the principal channel through which the blood comes to the lower extremity when the external iliac artery is tied. It is consequently one of those vessels which are considerably dilated after this operation.(1)

§ 1497. The *external circumflex* artery (*A. circumflexa femoris externa*) arises still more frequently than the preceding, although not always from the outside of the deep crural artery. It comes sometimes from the place where this latter is given off from the common femoral artery, and sometimes much lower.

It goes obliquely outward, turning on the anterior face of the femur, directly on the upper part of the cruræus muscle, gives small branches to the lower extremity of the iliacus muscle, and soon divides into an *ascending* and a *descending* branch.

The *descending* branch which arises sometimes wholly, sometimes partially, from the superficial or from the deep femoral artery, gives ramuscules to almost all the outer part of the triceps extensor, also to a small portion of the rectus femoris muscle, and sends upward, across this muscle, a transverse vessel which goes to the large trochanter, penetrates into its substance, and forms a net work on its surface by anastomosing with the ramifications of the internal circumflex artery.

The *ascending* branch penetrates from before backward and from within outward, principally into the gluteus medius muscle, passes above the great trochanter, and anastomoses in this place with the internal circumflex, the gluteal, and the ischiatic arteries.

These anastomoses are also very much dilated when the external iliac artery is tied.

II. PERFORATING ARTERIES.

§ 1498. The deep femoral artery after giving off the circumflex arteries goes backward, inward, and downward, so that it descends

(1) A. Cooper, *Account of the anastomoses of the arteries of the groin; Med. Chir. Trans.*, vol. iv. p. 424.

on the inside of the femur, between the vastus internus externally, the adductor longus and brevis internally, and the superficial femoral artery forward. In this course it generally gives off some anterior and several posterior branches; the latter are larger and more constant.

The *anterior* generally arise very high from the outer and inner sides of the artery. Sometimes there is only one and sometimes we find several on each side. The *external* goes to the vastus internus and penetrate also to the crurales muscle. The *internal* go to the adductor magnus and adductor brevis muscles, and, passing between these two muscles, arrive at the upper and middle part of the gracilis internus muscle, of which they are the principal nutritious vessels.

Properly speaking, the trunk of the deep femoral artery divides to give rise to the posterior branches, since it penetrates much farther back, to the posterior part of the thigh behind the femur.

These branches have been termed the *perforating* arteries (*A. femoris perforantes*), because they pass through the adductor magnus muscle to the parts behind it.

They vary in number from one to five; for sometimes the whole trunk, or at least that part from which the perforating arteries generally arise, goes backward, after passing through the summit of the adductor magnus muscle, and then descends behind this muscle, while in other cases it proceeds before it, and gradually gives off branches, which pass through it to arrive at the posterior part of the thigh. This difference is sometimes observed in the two lower extremities of the same subject.

The *saperior* or *first perforating* artery commonly divides into two branches, an upper which ascends, and a lower which descends.

The *superior* branch ascends toward and around the great trochanter, on which it anastomoses with the ramifications of the external circumflex artery, and penetrates into the lower part of the gluteus maximus muscle, where it communicates with the gluteal artery.

The *inferior* branch turns around the femur forward and outward; it is distributed to the vastus externus and to the rectus, and to the long head of the biceps muscles. It also gives off the *nutritious artery of the femur* (*A. nutritia ossis femoris*).

The *second and third perforating* arteries sometimes arise opposite each other, one from the outside the other from the inside of the femoral artery. The external goes to the triceps extensor muscle, the internal is distributed to the biceps, the semitendinosus, and the semimembranosus muscles.

Sometimes we find also two other perforating arteries, an external and an internal, which are distributed in the same manner.

In some subjects the upper branch, then unusually large, is the only one which passes through the adductor magnus muscle. It divides into two branches, an ascending which gives all the internal ramifications to the flexor muscles; the inferior is larger, and gives off all the external ramifications except the first. The latter is not visible externally, but directly where the adductor magnus muscle is inserted it passes through this muscle to empty itself from within outward, in the vastus externus and the rectus femoris muscles.

The sciatic nerve also receives considerable branches from the perforating arteries.

A large branch, the anterior extremity of the trunk of the deep femoral artery, always descends before the adductor magnus muscle, between it, the adductor longus and brevis muscles, distribute branches to these muscles, and near the centre of the thigh give off the inferior nutritious artery of this bone.

Many of these branches, especially the lower, sometimes arise from the superficial, and not from the deep femoral artery. They all anastomose with each other. Farther the superior, as we have already observed, communicate with the external femoral and the gluteal arteries. The lower and the middle are connected by large anastomosing branches with recurrent branches, which arise from the lower part of the superficial femoral and the popliteal arteries.

Thus when the common or superficial artery is obliterated to a greater or less extent, the perforating branches of the deep femoral artery, and generally all its ramifications, are very much dilated, larger even than the trunk, as is proved by the observations of Deschamps,(1) Dupuytren,(2) and Astley Cooper.(3)

The deep femoral artery supplies the blood to most of the muscles of the thigh, to almost all the skin of this extremity, and to its bone; it also gives origin to the accessory vessels for the circulation of the blood in the lower extremity.

II. SUPERFICIAL FEMORAL ARTERY.

§ 1499. The *superficial femoral* artery (*A. femoralis superficialis*, s. *cruralis femoralis*, s. *cruri-femoralis*, s. *femoro-tibialis*), after the origin of the deep, penetrates a little farther, between the vastus internus on one side and the adductor longus and brevis on the other, passes below the sartorius, to arrive at the inner side of the thigh, proceeds before the adductor muscles to the commencement of the lower fourth of the thigh, enters in this place the tendon of the adductor magnus muscle, and thus comes on the posterior face of the limb, where it is called the popliteal artery.

In its course it gives off branches, of which the principal are the internal and the external; but it also sends off anterior and particularly posterior branches, especially at its lower part.

The internal branches are distributed in the adductor, the gracilis and the sartorius muscles.

(1) *Observ. anat. faites sur un sujet opéré suivant le procédé de Hunter, d'un anévrysme de l'artère poplitée*; in the *Mém. prés. á l'Instit.*, 1805, vol. i. p. 251.

(2) *Journ. de Corvisart*, vol. vii. p. 536.

(3) *Dissection of a limb, on which the operation for popliteal aneurysm had been performed*, in the *Med. chir. trans.*, vol. ii. p. 250.

The external are distributed in the latter, to the rectus, and particularly to the vastus internus; the deep pass behind the femur, and go to the vastus externus.

The anterior distribute blood to the sartorius muscle and to the skin, to which also go some ramifications of the other branches.

The posterior go to the vastus internus, but particularly to the lower part of all the flexors of the leg, and as they turn around the femur they also penetrate into the vastus externus and extend to the skin. They anastomose by large branches above with the perforating arteries, below with the superior and inferior articular arteries.

The superficial femoral artery deserves its name, because, during its whole course, it is situated near the skin. It is covered for a short distance by the sartorius muscle which crosses it. We may then easily find it in operations. The place where it is exposed in Hunter's operation for aneurism is directly below the lower edge of the sartorius muscle at the inner part of the anterior side of the thigh.(1) The objection that when we operate in this place the articular arteries are lost and the circulation cannot continue is unfounded,(2) since when the superficial femoral artery is entirely obliterated, the anastomoses of the branches of the deep femoral artery with the lower branches of the superficial, and with those of the popliteal artery, supply channels which are large even in the normal state, and through which the blood may pass from the branches of the deep femoral into the articular arteries, and into all the parts below the ligature.

III. POPLITEAL ARTERY.

§ 1500. The *popliteal* artery (*A. poplitæa*, s. *cruri-poplitæa*, s. *femoro-poplitæa*) is the lowest portion of the femoral artery, and descends into the calf of the leg, inclining a little from within outward; it extends from the beginning of the lower fourth of the femur to the summit of the upper fifth of the leg. Sometimes it is much longer, because the superficial femoral artery penetrates the adductor magnus higher, and also divides a little higher.

It is separated at its upper part from the femur and from the posterior face of the capsular ligament of the femoro-tibial articulation at its central part, by an abundance of fat and cellular tissue. The tibialis posticus muscle separates it below from the tibia.

Behind, it is separated at its upper part from the skin by the sciatic nerve and the popliteal vein, by fat and by mucous tissue; in its lower part, by the muscles of the calf of the leg, and the plantaris muscle.

Above, it is separated by abundance of fat and cellular tissue, outward from the biceps femoris muscle, and inward from the semitendi-

(1) Home, *An account of Hunter's method of performing the operation for the cure of popliteal aneurysm*, in the *Trans. of anass. for the improv. of med. and surg. knowl.*, vol. i. no. 4. *Additional cases*, &c. ibid. vol. ii. no. 19.

(2) Deschamps, *loc. cit.*, vol. i. p. 254.

nosus and the semimembranosus muscles. The two upper heads of the triceps extensor muscle closely envelop it at its lower part. It is then looser and also nearer the bone above and below, but is every where surrounded with an abundance of fat and cellular tissue. This circumstance, added to the prominence of the flexor muscles of the tibia and of the fibula, renders it difficult to fix it and to compress it.

§ 1501. Beside certain inconstant branches which, when it passes through the tendon of the adductor magnus muscle higher than usual, appear near its origin, on the posterior face of the thigh, it gives off,

1st. From its upper part or crural portion, particularly from the posterior and inner side of this portion, several branches, which go to the lower part of the flexor muscles of the tibia.

2d. Lower down *three superior articular* arteries (*A.* s. *rami articulares superiores*), which are distinguished into internal, external, and middle, which sometimes, even usually, all, or at least two, arise by a common trunk from the anterior side of the popliteal artery. Some of these arteries are double in some subjects, then only one is detached from the trunk before the other, and the superior anastomoses with the muscular branches mentioned before. The internal and external are usually larger than the middle.

§ 1502. The *external superior articular* artery (*A. articularis genu superior externa*) rests directly on the tibia, and passes between this bone and the common tendon of the biceps muscle, usually goes from below upward, but always from behind forward and from within outward, and gives off, in its course, ramifications to the inferior belly of the biceps muscle, also to the lower part of the vastus externus, is distributed on the outer condyle of the femur, penetrates into the articular capsule, gives branches to all the ligaments of the keee, and communicates, by a very large anastomosing branch which proceeds across to the anterior face of the femoro-tibial articulation, on the common tendon of the extensors of the thigh, on one hand, both on the side and forward with the ascending branches of the external inferior articular artery on the other, on the median line and forward, with a similar branch of the internal superior articular artery.

§ 1503. The *internal superior articular* artery (*A. articularis genu superior interna*) varies more than the external and the middle in respect to its origin, for it not only forms a distinct trunk much more frequently than the latter, but it also not unfrequently, in fact almost normally, arises very high, as it sometimes comes from the superficial femoral artery, and then descends along the inner edge of the vastus internus muscle, to which it distributes ramifications. In this case, we find at the most normal place of its origin, a small artery, which is sometimes a branch of a common trunk of the articular arteries, and sometimes arises directly from the popliteal artery, and anastomoses with the superior internal articular artery. When the origin of the latter is placed low, it goes a little from above downward, like the external, before it proceeds inward and forward. It divides into one or several muscular branches, which go to the lower part of the vastus internus muscle; another median artery is situated lower, and passes behind this muscle and the common tendon of the extensors of the thigh, goes into the inner condyle of the femur and to the inner part of the ligaments of the knee; finally, a third, which is superficial; this proceeds on the anterior face of the femoro-tibial articulation, directly under the skin, anastomoses below with the branches of the internal inferior articular artery, and outwardly and transversely with the transverse branch of the external superior articular artery.

Both the external and the internal superior articular arteries give off considerable and recurrent branches, which communicate with the branches of the deep and superficial femoral arteries.

§ 1504. The *middle articular* artery (*A. articularis genu media azygos*) very rarely forms a distinct trunk, and is generally given off by the external superior articular artery. It goes forward and downward, penetrates from behind forward between the two condyles of the femur, and is distributed near the centre of the knee, in the femoro-tibial articulation, to the crucial ligaments, to the articular fat, to the posterior and middle part of the capsular ligament, and anastomoses with the branches of the inferior and also of the other two superior articular arteries.

§ 1505. Some small external and internal ramifications arise from the middle and inferior part of the popliteal artery and of its crural portion; these are not constant and go to the lower part of the flexor muscles of the tibia and fibula. This portion then gives off the arteries of the gastrocnemii muscles and the inferior articular arteries.

§ 1506. The *arteries of the gastrocnemii muscles* (*A. gemellæ*) usually arise, at least in part, above the inferior articular arteries and come from the posterior side of the popliteal artery. They are generally two, an external and an internal, one for each of the two upper heads of the triceps suræ muscle. They rarely arise opposite each other. We frequently find also several other smaller gemellæ arteries, which however do not always exist. These vessels furnish the blood to the plantaris muscle, which however sometimes receives a proper and distinct branch.

§ 1507. The *inferior articular* arteries (*A. articulares genu inferiores externa et interna*) are usually two, an *external* and an *internal*, which generally form two distinct trunks. They arise from the anterior and lateral side of the popliteal artery, rarely at the same height. Sometimes one and sometimes the other is higher. Generally they are of the same size.

§ 1508. The *external* sends branches to the lower and middle head of the triceps suræ muscle. These branches however sometimes arise, at least in part, from a special branch of the popliteal artery. The artery then, passing directly above the external head of the tibia, below the external lateral ligament of the knee, and on the capsular ligament of the articulation, goes thus from behind forward. In its course it gives branches to the articular capsule, and anastomoses on one side by ascending lateral branches with the descending branches of the external superior articular artery, on the other by a large transverse branch, which passes above the lower part of the anterior face of the tendon of the extensors of the thigh, below the patella, with a similar transverse branch from the internal inferior articular artery.

§ 1509. The *internal* usually proceeds a little downward, goes from behind forward and from without inward, below the internal head of the triceps suræ muscle, directly surrounds the inner condyle of the tibia, gives numerous branches to the popliteus muscle, sends downward other branches, which anastomose on the internal face of the tibia with the recurrent branches of the posterior tibial artery, gives also others, which are larger and transverse, which communicate directly above the insertion of the common tendon of the extensors of the thigh with the recurrent branches of the anterior tibial artery, and finally goes upward and forward on the external anterior face of the ligament of the patella, where it anastomoses by several ramifications with the internal superior and with the external inferior articular arteries.

§ 1510. Besides these two inferior articular arteries, we sometimes find a *middle articular* artery (*A. articularis inferior media*, s. *azygos*), which however arises oftener from the internal, and which penetrates from behind forward in the femoro-tibial articulation, on the median line, between the two condyles of the tibia.

The popliteal artery generally gives off no other branches than those which have been described; it is then the principal source of the anastomotic articular branches, by which, from the communication established between the upper and the posterior branches of the deep femoral artery, or between the inferior and recurrent branches of the arteries of the knee, the circulation of the blood may continue regularly in the leg, even when the superficial femoral and the popliteal arteries are obliterated. Thus these vessels are very much dilated after an operation for popliteal aneurism, where the superficial femoral and the popliteal arteries are obliterated.

ARTICLE FOURTH.

ARTERIES OF THE LEG.

§ 1511. The popliteal artery generally, after passing an inch without giving off any branches except those which go from its lower part into the soleus or to the third head of the triceps suræ muscle, divides about an inch below the knee, very rarely higher and opposite the articulation, into two branches, called the *tibial* arteries (*A. tibiales*, s. *cnemiales*, Barclay). Of these two branches, the posterior is the larger, and may be considered from its direction as the continuation of the trunk, and is the common trunk of the *posterior tibial* and *peroneal* arteries; the anterior is smaller, separates from the trunk, and is the *anterior tibial* artery. The common posterior trunk is always larger than the anterior; sometimes it exceeds it greatly in size, in which case the latter is arrested in the middle of the leg, and all the branches which it generally gives off then arise from the posterior tibial and from the peroneal artery.

It sometimes divides very high. Thus, in a case observed by Sandifort,(1) the crural artery divided directly below Poupart's ligament. Portal(2) has also found it to divide higher than usual. Ramsay(3) has seen it bifurcate, not in fact above the knee, but at least above the popliteus muscle; the anterior tibial artery passed before this muscle, between it and the tibia, and was there compressed by him.

I. ANTERIOR TIBIAL ARTERY.

§ 1512. The *anterior tibial* artery (*A. tibialis antica*, s. *rotularis*)(4) describes a slightly acute angle to go forward above the upper edge of the interosseous membrane. On the anterior face of the leg it divides into two branches, the smaller of which is the ascending or recurrent branch; the other is the continuation of the trunk; the latter descends on the anterior face of the limb and is distributed on the tibial side of the leg and foot.

§ 1513. The *recurrent* artery (*A. recurrens*) gives branches to the tibialis posticus muscle, and is situated directly on the outer face of the upper extremity of the tibia; it proceeds from below upward, to be distributed partly in the head of the tibia, partly also to the external and lower part of the ligaments of the knee and the common tendon of the extensor muscles of the leg. It anastomoses with the inferior articular artery, and by means of it with the superior and likewise with the ramifications of the femoral artery. We must place it among the accessory vessels of the lower extremity.

§ 1514. The trunk of the anterior tibial artery descends on the anterior face of the interosseous membrane, between the peroneus brevis muscle, the extensor digitorum communis longus, and the extensor longus pollicis proprius, and is covered by the two latter. It gives outward and inward numerous short and small branches, some of which are distributed in these muscles, while others pass through them to go into the peronei muscles and even to the skin.

(1) *Obs. anat. path.*, book iv. p. 97. The crural artery divides there into an anterior and posterior tibial artery, and we cannot admit that there is any doubt in regard to its high division into a superficial and a deep crural artery, since Sandifort expressly says, that on the left side the division occurred as usual in the calf of the leg.

(2) *Anat. méd.*, vol. iv. p. 230.

(3) *Account of an unusual conformation of some muscles and vessels*; in the *Edinb. Med. Journ.*, vol. viii. p. 283.—Barclay, *loc. cit.*, p 263.

(4) We describe this artery first, although from its direction and its small size it is not the continuation of the trunk, because it corresponds to the radial artery in its distribution.

When the posterior tibial or the peroneal artery is unusually large, the anterior tibial artery terminates on the back of the foot or in the leg. Sometimes it does not exist as a separate trunk, and is replaced in the leg by the perforating branches of the posterior tibial artery and on the back of the foot by the peroneal artery. In some subjects also it is obliterated at the articulation of the foot, while above and below this part it admits the blood and is distributed as usual.(1) It generally furnishes the dorsal arteries of the foot and those of the large toe.

Near the lower end of the leg, it gives off the two *malleolar* arteries (*A. malleolares*), an external and an internal, which vary much in their size and place of origin.

§ 1515. The *external malleolar* artery (*A. malleolaris externa*) often arises a little higher than the internal, then descends from behind forward between the tibia and the fibula, resting directly on these bones and below the tendon of the peronei muscles, goes outward, expands on and in the external malleolus, frequently sends branches also to the anterior part of the lower end of the tibia, gives ramifications to the extensor hallucis brevis and abductor minimi digiti muscles, and anastomoses by a large branch with the recurrent branches of the tarsal artery on the anterior face of the articulation of the foot, and also with the anterior branches of the peroneal artery on the outside of the os calcis. This branch is constant, but it varies in size, and when large it partially or wholly gives off the dorsal artery of the foot. Sometimes it does not arise from the anterior tibial but from the peroneal artery, when the latter is unusually large. It is rarely given off by the peroneal artery, and arises still less frequently from the posterior tibial artery.

§ 1516. The *internal malleolar* artery (*A. malleolaris interna*) usually arises a little below the preceding. It not unfrequently divides into several branches, which are given off from the anterior tibial artery, one on the tibia and the other on the tibio-tarsal articulation.

It proceeds from without inward, under the tendons of the tibialis anticus and the extensor digitorum longus muscles, resting directly on the tibia and in the second case on the capsular ligament, arrives at the internal malleolus, distributes branches to this eminence, to the capsule of the articulation of the foot, to the astragalus, and anastomoses with the branches of the tarsal and posterior tibial arteries.

When two internal malleolar arteries exist, they communicate with each other.

This artery also sometimes arises, but more rarely than the preceding, from the peroneal or the posterior tibial artery.

§ 1517. After giving off the malleolar arteries, the trunk of the anterior tibial artery passes under the tendons of the extensor digitorum communis longus, on the outside of the extensor hallucis proprius, and comes on the back of the foot, giving off right and left small branches,

(1) This arrangement does not necessarily arise from the primary formation; it may, as Burns correctly remarks (or Barclay, *loc. cit.*, p. 293), be accidental and be produced by compression. This ougnt also to be admitted in the second case.

which go into the periosteum, the dorsal ligaments of the tarsus, and the tendons of the extensor and peroneus brevis muscles. In this place it is called the *dorsal artery of the foot* (*A. pediæa*). The latter is rarely the continuation of the trunk of the peroneal or of the posterior tibial artery.

§ 1518. Internal and external branches arise from the dorsal artery of the foot. The latter are more numerous, larger, and more constant than the internal. We observe two particularly, the tarsal and the metatarsal artery.

The *tarsal* artery (*A. tarsea*) arises from the outside of the dorsal artery of the foot, sometimes higher and sometimes lower on the back of the foot, even above the lower extremity of the tibia, in which case the external malleolar artery is very small; this vessel is considerable, and its caliber almost equals that of the continuation of the trunk of the anterior tibial artery; thus it would be more convenient to term it the *external tarsal* artery (*A. tarsea externa*), in opposition to another branch which corresponds to the inside.

This tarsal artery goes transversely outward on the astragalus and os calcis, gives branches to these bones and also to the external part of the ligaments of the tibio-tarsal articulation and to the tarsus, sends off toward the external malleolus a large branch which anastomoses with the external malleolar artery (§ 1515), communicates on the outside of the os calcis with the branches of the peroneal artery, gives off forward other branches which unite to those of the metatarsal artery, penetrates to the cuboid bone, to the posterior extremity of the fifth metatarsal bone, anastomoses also with the external plantar artery on the outer edge of the foot, and distributes branches to the extensor digitorum brevis and to the abductor minimi digiti muscles.

§ 1519. Next comes the *metatarsal* artery (*A. metatarsea*), which also arises from the outside of the dorsal artery of the foot, and varies so much in regard to its origin that it is sometimes a branch of the tarsal artery, and sometimes arises several inches distant from it, and from the dorsal artery of the foot, directly behind the anterior edge of the tarsus.

It is generally smaller than the preceding. Its direction, like that, is from within outward, assuming a course more transverse as it arises farther forward, and is always situated below the extensor digitorum brevis muscle. It is more or less evidently convex forward, and forms an arch, which is completed outwardly by the anastomosis constantly existing between it and the tarsal artery. This arch, on the outer edge of the tarsus, is changed by the smaller but constant branches of the tarsal artery into a vascular net-work, which covers most of the back of the foot. When this artery arises far backward, we usually find a second, which is smaller and proceeds on the anterior edge of the dorsal face of the tarsus, and which communicate with the posterior by very analogous longitudinal branches, which correspond in number and situation to the three external interosseous spaces. This second artery is not so much a branch of the dorsal artery of the foot as the result of anastomoses between these longitudinal branches and the dorsal interosseous arteries.

Sometimes there are even three metatarsal arteries, a third existing between the two we have mentioned.

A transverse arch, the convexity of which looks forward, constantly forms on the anterior part of the dorsal face of the tarsus or on the posterior part of the metatarsus. This arch contributes more or less but constantly with the posterior perforating arteries given off by the inferior tibial artery to form the *dorsal interosseous* arteries (*A. interosseæ dorsales*),

This vascular net-work is termed the *dorsal arch of the tarsus* (*A. dorsalis tarseus*). It varies much in extent and complexity.

A *dorsal interosseous* artery proceeds in each space between two metatarsal bones. These arteries are always very large and sometimes of an enormous caliber. They are four in number; but the first or the most internal, comprised between the first and second metatarsal bones, is considered as the continuation of the trunk and is called very improperly the *external dorsal artery of the large toe* (*A. hallucis dorsalis*).

All these dorsal interosseous arteries are similar in the following respects:

1st. They anastomose by their posterior extremity with the posterior perforating arteries.

2d. They communicate with the anterior perforating arteries by their anterior extremity, between the bases of the first phalanges of the toes.

3d. They give off, outward and inward, branches, by which they anastomose with each other on the back of the tarsus, and which are distributed in the external interosseous muscles, the bones of the metatarsus, the abductor pollicis longus, and the skin of the dorsal face of the tarsus and of the toes. The branches which go to the toes, each of which receives at least two, the *tibial* and the *peroneal*, are called the *dorsal arteries of the toes* (*A. digitales dorsales tibiales et peroneæ*).

These superior interosseous arteries sometimes divide anteriorly into two branches, the *tibial* and the *peroneal*, each of which always goes to a different toe.

From the outer part of the tarsal arch a branch usually arises, which is also connected with the superior interosseous arteries, but which goes to the abductor minimi digiti muscle, and sometimes arises from the fourth interosseous artery, or, according to the usual way of numbering them, from the third. This last also most generally gives off another branch to the fibular side of the little toe, the dorsal peroneal branch of this appendage, while itself gives off the dorsal tibial branch.

Sometimes but rarely the second superior interosseous artery, generally called the first, does not arise from the metatarsal artery, but from the continuation of the trunk of the dorsal artery of the foot, and then the latter corresponds more than usual to the middle of the dorsal face of the tarsus.

§ 1520. The internal branches of the dorsal artery of the foot are smaller than the external. They are generally as numerous, but usually there is only one very large. That arises about the centre of the tarsus, a little before the anterior extremity of the astragalus. It is well called the *internal tarsal* artery (*A. tarsea interna*).

This artery proceeds obliquely from without inward and from behind forward, distributes branches to the internal half of the bones of the tarsus and also to the first metatarsal bone, to part of the extensor digitorum brevis and of the abductor pollicis pedis, and anastomoses with the dorsal artery of the back of the foot on the dorsal face of the tarsus, with the first interosseous artery, with the internal plantar artery on the inner edge of the foot, finally with the internal malleolar artery, and thus contributes to form the dorsal arch of the tarsus.

§ 1521. The trunk of the dorsal artery of the foot divides, between the posterior extremities of the first and second metatarsal bones, into two branches: one is the continuation of the trunk, the *first metatarsal* artery, usually termed the *dorsal artery of the great toe* (*A. dorsalis hallucis*); the second, the *deep anastomosing branch* (*R. anastomoticus profundus*), passes directly to the sole of the foot, between the two bones, and forms with the external plantar artery the *deep plantar arch* (*A. plantaris profundus*), whence arise most of the *plantar arteries of the toes* (*A. digitales plantares*).

The *dorsal artery of the large toe* usually proceeds from behind forward on the back of the foot, along the external edge of the toe, and there divides into two branches, which become, one the *common dorsal artery of the large toe*, the other the *dorsal tibial branch of the second toe*.

It anastomoses most generally either at its place of origin or by one of its two branches with the plantar artery of the large toe.

II. POSTERIOR TIBIO-PERONEAL ARTERY.

§ 1522. The *common trunk of the posterior tibial* and *peroneal* artery, called also the *tibio-peroneal* artery, or simply the *posterior tibial* artery (*A. tibio-peronea, s. tibialis postica, s. tibialis poplitea*), descends vertically behind the interosseous membrane, covered by the heads of the peronei muscles, and generally, soon after the origin of the anterior tibial artery, gives off two considerable branches, an *external* and an *internal*.

The *internal* branch sends off small twigs to the popliteus muscle, penetrates principally into the tibia as the *upper nutritious* artery (*A. nutritia tibiæ superior*), and gives off from behind forward, into the periosteum of this bone, ramifications which anastomose on its internal face with those of the inferior and internal articular artery (§ 1509).

The *external* branch gives off ramuscules to the lower or middle head of the triceps suræ muscle, proceeds below it, around the upper extremity of the fibula, sends off ramifications to the upper part of the peroneus longus muscle, and anastomoses both with the anterior tibial (§ 1511) and with the descending branches of the external inferior articular artery. These two branches consequently contribute to enlarge the system of the accessory vessels of the leg.

§ 1523. After giving them off, the tibio-peroneal trunk, which sends only inconstant branches to the soleus muscle, divides generally from one to two inches below the origin of the anterior tibial artery into two branches, the *peroneal* artery and the *posterior tibial* artery.

I. PERONEAL ARTERY.

§ 1524. The *peroneal* artery (*A. peronæa*, s. *fibularis*) generally but not always arises at the place mentioned. Sometimes, but much more rarely, and only when the popliteal artery divides unusually high, it arises above, more frequently below, this point, and in the second case it is smaller in proportion as its origin is lower. Sometimes, in fact often, it does not exist, and it is replaced by the branches which are successively given off from the posterior tibial artery. Independently of its point of origin it varies very much in respect to its volume, a circumstance in regard to which it increases and diminishes inversely with the anterior tibial artery. It is generally smaller than the two tibial arteries; but sometimes when one of the latter is deficient it is much larger than usual.

It descends on the posterior face of the interosseous ligament, covered by the soleus muscle, on the inside of the flexor longus digitorum communis muscle, gives its largest branches to these two muscles and also to the peronei, usually sends off, near the lower extremity of the leg, rather a large branch, which, passing under the posterior tibial artery, is called the *posterior internal malleolar* artery (*A. malleolaris interna posterior*) and goes to the internal malleolus, on the surface of which it frequently communicates with the anterior internal malleolar artery furnished by the anterior tibial artery (§ 1516), and terminates on the outer face and the tuberosity of the os calcis by ramuscules, which enter partly into this bone, and partly by large branches by which it anastomoses with the posterior tibial artery, thus forming the *inferior plantar arch*.

§ 1525. At various heights of the leg, but generally toward its lower extremity, it gives off a branch which also varies much in size and which goes to the anterior face of the limb, passing between the two bones. When this branch is considerable it is termed the *anterior peroneal* artery (*A. peronæa anterior*). It proceeds, near the surface, on the outer and anterior face of the leg, frequently descends to the external face of the tarsus, unites to the external malleolar artery, given off by the anterior tibial (§ 1515), concurs to form the dorsal arch of the tarsus, anastomoses with the branches of the external plantar artery, and distributes twigs to the tendons of the extensor digitorum communis, to the posterior part of the extensor minimi digiti muscle, to the external malleolus, to the astragalus, and to the cuboid bone.

This branch does not always arise from the peroneal artery; it is then generally very small, and does not descend to the lower extremity of the leg or is entirely deficient. It is normally replaced by a branch of the anterior tibial given off by the external malleolar artery (§ 1515) less frequently, although more commonly than when it arises from the peroneal artery, it comes from the posterior tibial artery, and then it passes, at the usual place, on the anterior face of the leg.

The anterior peroneal artery much more rarely not only arises higher than usual, sometimes even not far from the middle of the anterior face of the leg, so that it sends off in this place ramifications to the peronei and to the extensor digitorum communis muscle, but it is also so large that it gives off the external malleolar artery; and the dorsal artery of the foot is even the continuation of its trunk, and then the anterior tibial artery is very small, terminates on the back of the tarsus, and anastomoses with it.

Not more frequently the peroneal artery, extends farther than usual in the sole of the foot, and gives off the external and the internal plantar arteries. We have before us only one specimen of this anomaly. At the same time the anterior tibial artery is extremely small; it stops at the middle of the leg, and all the branches it generally gives off below this point arise from the posterior tibial artery, which passes to the anterior face of the limb, about the level of its lower fourth.

II. POSTERIOR TIBIAL ARTERY.

§ 1526. The *posterior tibial* artery (*A. tibialis postica*) is generally much larger than the peroneal artery, but its direction varies more than that of the primitive trunk, and it proceeds slightly inward. It is generally a little larger than the anterior tibial artery and sometimes very much exceeds it in size. It descends, covered above by the third head of the triceps suræ muscle, between this muscle, the flexor longus digitorum communis and the tibialis posticus, and is entirely loose at its lower part, being covered only by the crural aponeurosis and the skin and the posterior face of the tibia, on the inside of the tendo-Achillis. In its course it gives off posteriorly numerous small branches to the soleus muscle and the tendo-Achillis, and anteriorly to the tibialis posticus on flexor longus digitorum communis muscles. At the lower part of the leg it sends off several larger branches both outward and inward; these anastomose frequently, on the two malleoli, with the internal and external malleolar arteries, given off by the anterior tibial artery.

The posterior tibial artery, proceeding between the tendons of the flexor longus digitorum communis and the tibialis posticus muscles, situated on its inside, and that of the extensor pollicis pedis on the outside, so that it passes on the latter, leaves the posterior face of the leg, and arrives at the sole of the foot, where it is situated on the posterior face of the os calcis.

Very rarely it passes from the posterior to the anterior face of the leg, thus becoming the dorsal artery of the foot. It most generally sends off, at the place where it enters the sole of the foot, a considerable branch, which goes into the os calcis and also into the lower extremity of the tendo-Achillis; this branch anastomoses on the tubercle of the os calcis, before this tendon, with the final branches of the peroneal artery, and by means of them with the external malleolar artery; thus a vascular plexus is formed which may be termed the ***inferior*** or ***plantar tarsal arch*** (*rete*, s. *arcus tarsus plantaris*).

Not unfrequently another external and large branch goes to the posterior part of the abductor pollicis pedis muscle.

The posterior tibial artery then divides below the internal malleolus, about the centre of the inner face of the calcaneum, but a little behind it, into two branches, the *external* and *internal plantar* arteries.

These two branches, and the two branches described previously, very rarely arise from the peroneal artery, which happens when the posterior tibial artery replaces the lower portion of the anterior tibial artery (§ 1525).

III. PLANTAR ARTERIES.

I. INTERNAL PLANTAR ARTERY.

§ 1527. The *internal plantar* artery (*A. plantaris interna*) is always smaller than the external, and varies in size less than the latter. It follows the direction of the trunk and goes forward, under the tendons of the flexor digitorum longus muscle, above the long head of the abductor pollicis, not far from the inner edge of the foot. In its course it sends superficial branches to the abductors and the flexor pollicis brevis, and to the flexor communis digitorum brevis, gives deep branches to the inner half of the plantar face of the ligamentous envelop of the tarsus, to the os calcis, to the astragalus, and to the scaphoid bone; anastomoses, in several places above the inner edge of the foot, with the branches of the internal artery of the tarsus and of the dorsal artery of the foot, and gives off anteriorly, between the first and second toes, generally one, often also two, branches, which form the plantar artery of the large toe, and frequently anastomoses, by an external branch, with the deep plantar arch.

II. EXTERNAL PLANTAR ARTERY.

§ 1528. The *external plantar* artery (*A. plantaris externa*) is deeper than the internal. It varies in size more than this latter. It is often scarcely visible, and again is sometimes three times the size of the internal. These differences depend principally on those in the size of the dorsal artery of the foot (§ 1517), for there is always an inverse relation between the caliber of these two vessels.

The external plantar artery immediately goes far outward. It proceeds between the abductor pollicis pedis and the flexor digitorum brevis below, and the accessory muscle above, toward the outer edge of the sole of the foot, where it extends forward, on the inner edge of the abductor minimi digiti muscle, gives branches to all the muscles mentioned, and anastomoses, by several branches which reascend above the outer edge of the foot, with the arteries of the tarsus and metatarsus.

At the posterior extremity of the fifth metatarsal bone it goes inward, and gives off, either in this place or a little before, a considerable branch, the *peroneal plantar artery of the fifth toe* (*A. digitalis plantaris peronea digiti quinti*), which goes forward on the flexor minimi digiti muscle, along the fibular edge of the toes to the anterior extremity, sends branches to its flexor muscle, to the third internal interosseous muscle and to the skin, and finally anastomoses, on the ungueal phalanx of the little toe, with the tibial branch.

The deep or internal plantar artery then goes almost transversely forward and inward, between the internal interossei and the other muscles of the sole of the foot, and anastomosing with the deep anastomotic branch of the dorsal artery of the foot, between the first and second metatarsal bones, forms the *deep plantar arch*, which is concave backward and convex forward, and is situated very deeply on the posterior extremities of the metatarsal bones.

III. PLANTAR ARCH.

§ 1529. The *digital* arteries and the *anterior* and *posterior perforating* arteries arise from the deep palmar arch.

a. Digital arteries.

§ 1530. The *digital* arteries (*A. digitales*) arise forward, from the convex part of the arch.

Their general characters are,

a. They are situated deeply in the sole of the foot, and proceed from behind forward, on the square belly of the flexor digitorum longus communis, and the transverse belly of the adductor hallucis.

b. Between the posterior extremities of the toes they divide into two branches, which go one to the tibial side of the outer, the other to the peroneal side of the inner toe.

c. The two branches unite on the ungueal phalanx, and also anastomose with each other and with the dorsal branches.

d. They anastomose forward with the superior and inferior metatarsal arteries at their bifurcation.

But they differ very much in regard to their origin. The deep arch most generally gives rise to the deep plantar arteries of the three outer and the peroneal branch of the second toe, less frequently to the tibial branch of this and the plantar branch of the large toe.

The peroneal branch of the little toe often comes directly from the plantar arch, and even farther behind it, from the external plantar artery (§ 1528), but it not unfrequently arises, by a common trunk, with the tibial branch of the fifth toe and the peroneal branch of the fourth. We have never observed that when this first digital artery gave off also the tibial branch, it was destined solely for the fifth toe, and did not proceed at the same time to the peroneal side of the fourth. Even when the peroneal branch of the fifth toe forms a distinct and separate trunk, it generally communicates by large anastomosing branches, both on the metatarsus and on the first phalanx of the toe, with the second digital artery, and the tibial branch of the fifth toe.

The *second digital* artery when it does not form a trunk with the preceding, goes to the tibial side of the fifth toe and to the peroneal side of the fourth.

Next comes the third, which goes to the tibial side of the fourth toe and to the fibular side of the third. Sometimes this artery is double as far as the arch from whence it arises to the anterior part of the metatarsus; but its two trunks there unite in one, which soon divides into two branches, the tibial branch of the fourth and the peroneal branch of the third toe. This arrangement occurs particularly when the usual number of digital arteries is diminished in any manner whatever, as, for instance, by the union in one trunk of the peroneal branch of the fifth toe and of the two following branches.

Next comes usually a fourth, which divides in the same manner for the second and third toes.

The fifth constantly forms the tibial branch of the second toe. Sometimes, when the anterior tibial artery is much smaller and the posterior on the contrary is larger than usual, it forms the *common plantar artery of the large toe*, from whence the tibial branch of the second also arises.

The plantar artery of the large toe and the tibial branch of the second vary the most in their origin and arrangement.

This artery is generally the continuation and termination of the trunk of the dorsal artery of the foot, which comes to the first phalanx of the large toe, goes to its plantar face, and gives origin to all the plantar and dorsal branches of this toe, sending off first the peroneal dorsal branch, then the peroneal plantar branch, next the tibial plantar branch, and finally the tibial dorsal branch, which anastomose as usual.

More rarely the continuation of the trunk of the dorsal artery of the foot divides, soon after giving off the deep anastomosing branch to the sole of the foot, into two branches, a superior, which becomes the common trunk of the dorsal artery of the large toe and the tibial branch of the second; an inferior, or the common trunk of the two plantar arteries of this toe, which bifurcates near the centre of the plantar face of the large toe, to give rise to two plantar branches. But we must remark that here we find a similarity between the anomaly and the normal or more common arrangement first described, since the two branches communicate at the base of the first two toes by a large anastomosing branch.

The superficial internal plantar artery given off by the posterior tibial artery always contributes to form the two plantar branches of the large toe and the inner branch of the second; since it constantly anastomoses near the anterior extremity of the first metatarsal bone with the trunk of these branches, and thus forms the *superficial plantar arch* (*arcus plantaris superficialis*).

When the anterior tibial artery is smaller than usual, it sometimes but not always gives off only the dorsal artery of the large toe; sometimes too it sends off in part the tibial artery of the second. On the contrary, the trunk from which the plantar branches of the large toe and the plantar branch of the second arise, the *internal plantar* artery, is unusually large, and is always increased by a branch, which varies in size; this arises from the deep plantar arch, and communicates with it toward the extremity of the first metatarsal bone.

Finally, sometimes but rarely all the arteries of the first and second toe arise only from the posterior tibial artery, particularly from the deep arch. The anterior tibial artery, which is very small, then terminates simply by a deep anastomosing branch in the deep plantar arch, and a large branch arises from the latter, which soon divides into two: one is deeper and larger, and is the continuation of the trunk; it goes from behind forward on the first metatarsal bone, and is also enlarged by one or two branches arising from the internal plantar artery, which is also in this case unusually large, and bifurcates to give rise to the common plantar artery of the large toe and also to the tibial artery of the second; the other is smaller and more superficial, ascends to the back of the foot between the first two metatarsal bones, gives off the dorsal branches of the large toe, and becomes, with a second digital artery given off by the deep branch, the common trunk of the tibial branch of the third toe and of the peroneal branch of the second.

b. Anterior perforating arteries.

§ 1531. The *anterior perforating* arteries (*A. perforantes anteriores*) arise on the anterior part of the deep plantar arch, sometimes between the digital arteries. They are small and go only to the interosseous muscles, to the transverse head of the adductor hallucis muscle, and the metatarsal bones. A part of its ramifications communicate anteriorly with the digital arteries and the dorsal artery of the foot.

c. Posterior perforating arteries.

§ 1532. The *posterior perforating* arteries (*A. perforantes posteriores*) arise from the posterior and upper surface of the deep plantar arch. They give branches to the posterior part of the interosseous muscles, and also recurrent branches to the anterior part of the tarsal ligaments and bones, and passing through the posterior extremities of the interosseous spaces, come on the back of the foot, where they anastomose with the upper interosseous arteries.

These arteries are generally small, and can be considered only as the anastomoses between the dorsal and plantar arches. However, as these latter and the dorsal interosseous arteries are generally much larger than their corresponding parts in the hand, the posterior perforating arteries are sometimes unusually developed; so that the transverse tarsal artery sends only small anastomosing branches to their posterior extremities, in the place where they appear on the back of the foot. But in this case they are not the only origin of the dorsal interosseous arteries, which arise also from the plantar arteries of the toes and are much larger than the common trunks of the digital arteries, and which give all the digital branches commonly arising from the anterior side of the deep arch.

In this case the usual anterior branches of the plantar arch still exist, but they are merely branches for the deep muscles of the sole of the foot and the anterior perforating arteries; so that they are as slightly developed as the dorsal interosseous arteries generally are.

There are many degrees between this state of the dorsal interosseous arteries and the common one; so that for instance many or all the dorsal interosseous arteries contribute equally to form the digital arteries, and thus the dorsal and plantar arteries have about the same size, although it does not necessarily follow that the dorsal interosseous arteries arise from the deep plantar arch, as in the anomaly described. On the contrary, they sometimes become unusually large, but are however only the branches of the dorsal arch.

SECTION III.

OF THE VEINS OF THE BODY.

§ 1533. The *veins* of the body generally unite in three large trunks, which open into the right auricle (§ 1305), the *large coronary vein of the heart* and the two *venæ cavæ*.

CHAPTER I.

OF THE VEINS OF THE HEART.

I. LARGE CORONARY VEIN.

§ 1534. The *large coronary vein of the heart* (*vena coronaria maxima cordis*) opens into the right auricle, on the left and lower side of the interauricular septum, a little way from the venous orifice of the right ventricle. It rarely empties itself into the left subclavian vein,(1) in which case the veins of the body do not unite except in two large trunks.

It arises from all the extent of the left ventricle by four or five considerable branches, which proceed downward from the summit to the base of the heart, and among which we observe three which are larger and longer than the rest.

The upper branch follows the upper groove of the convex face of the heart, which marks the upper edge of the septum. The second proceeds along its blunt edge, and the third near the inferior groove.

The smallest branches, which do not descend as low as the preceding, are situated between them.

All correspond to ramifications of the arteries, and empty at right angles into the trunk of the coronary vein, which proceeds in the transverse groove between the left ventricle and left auricle, first downward, then from behind forward to the place where it opens into the right auricle.

II. SMALL CORONARY VEIN OF THE HEART.

§ 1535. The ***small coronary vein of the heart*** (***V. coronaria cordis minor***, s. ***Galeni***) belongs principally to the right auricle. It arises from the summit of the heart, proceeds in the lower longitudinal groove, or a little to the right, along the posterior and inferior edge of the right ventricle, receives the branches which come on the lower face of this ventricle, and almost always empties into the preceding, directly behind its opening. It rarely opens into the auricle, a little before the large coronary vein.

III. SMALL ANTERIOR VEINS OF THE HEART.

§ 1536. Besides these two large veins, others also, which are smaller and may be termed the ***small anterior veins of the heart***, arise from the anterior ventricle, from the aorta and the pulmonary artery, and open separately into the anterior part of the right auricle. They extend from the summit to the base of the heart, proceeding before and above the preceding.

IV. SMALLEST VEINS OF THE HEART.

§ 1537. The ***smallest veins of the heart*** (***V. minimæ cordis***) convey the blood in every direction, even in the left half of the heart, but especially into the right auricle, through the *foramina of* ***Thebesius*** (*foramina Thebesii*).

(1) Le Cab, in the *Mém. de l'ac. des sc.*, 1738, *Hist.*, p. 62.

CHAPTER II.

VEINS OF THE HEAD AND UPPER EXTREMITIES.

§ **1538**. The *veins of the head and of the upper extremities* all unite in the descending vena-cava.

ARTICLE FIRST.

VEINS OF THE HEAD.

§ **1539**. The *veins of the head* are distinguished into the *superficial* or *external* and the *deep* or *internal*. The latter convey the blood from the brain; the former return it from the other parts of the head. They terminate in two large trunks, the *internal* and the *external jugular* vein.

I. SUPERFICIAL VEINS OF THE HEAD.

§ **1540**. Almost all the superficial or external veins of the head open into the external jugular vein. A very few of them accompany the arteries; the largest of them however differ a little in their distribution from that of the large arterial branches to which they correspond. .

Those which resume the blood from the tongue, the pharynx, the skin, and the superficial muscles of the face, finally, from the sides and from the posterior part of the skull, unite in two large trunks, an anterior and a posterior, which correspond, the former to the facial artery (§ **1351**), the latter to that part of the external carotid artery which is above the facial artery, and to its outer termination, or to the temporal artery (§ **1358**). These two trunks unite to form one, which is short and corresponds to most of the external carotid artery, and is called the *common trunk of the superficial veins of the head* (*truncus communis venarum capitis superficialium*), or rather the *anterior cephalic* vein (*V. cephalica anterior*).

A. FACIAL VEIN, OR ANTERIOR BRANCH OF THE ANTERIOR VEIN OF THE HEAD.

§ **1541**. The *anterior trunk of the veins of the head, the facial vein, the anterior and internal facial vein* (*R. venæ cephalicæ anterioris anticus*, s. *V. facialis anterior*, Walter) is formed by the veins of the anterior and much the larger part of the face.

It follows the direction of the facial artery, but is situated more behind than this vessel, and as it is less tortuous, it is also some distance from it.

Regarded from above downward, according to the course of the blood, this vein arises gradually by the union of the following branches:

The upper branches are two in number, an *anterior* and *internal* and a *posterior* and *external*. The first is called the *supra-orbitar* and the second the *frontal* vein.

I. SUPRA-ORBITAR VEIN.

§ 1542. The *supra-orbitar* vein (*V. supra-orbitalis*) is situated below the frontalis muscle, proceeds transversely along the upper edge of the orbit, anastomoses externally with the frontal branch of the temporal vein, and arises from several venous twigs, which come from the orbicularis palpebrarum, the corrugator supercilii, and the frontalis muscles.

II. FRONTAL VEIN.

§ 1543. The *frontal* vein (*V. frontalis*) arises,

1st. From the branches which anastomose with the final anterior branches of the temporal vein and also with the synonymous branches of the opposite side, form thus a very complex vascular net-work on the frontal region, and come from the frontalis muscle, from the skin, and the frontal bone. The trunk formed by the union of these branches which often unites, at the lower part of the squamous portion of the frontal bone, with the synonymous trunk of the opposite side, by a large anastomosis, and frequently forms a median branch.

2d. From an inferior branch, the *superior dorsal vein of the nose* (*V. dorsi nasi superior*), which, after anastomosing very frequently with the inferior dorsal artery of the nose, ascends and unites with the superior branch, which we shall describe.

III. INFERIOR NASAL VEINS.

§ 1544. The supraorbital and frontal veins unite in a common trunk in the inner angle of the eye, which descends along the nose directly below the skin.

This trunk receives from before backward and from below upward, below the inner angle of the eye, first, the *inferior dorsal vein of the nose* (*V. dorsi nasi inferior*), then the *upper anterior vein of the nose* (*V. nasalis anterior superior*), afterward the *lower anterior vein of the nose* (*V. nasalis anterior inferior*), which frequently anastomose together, and with the upper dorsal vein of the nose.

IV. CORONARY VEIN OF THE UPPER LIP.

§ 1546. The trunk of the facial vein next receives, as high as the ala of the nose, the *coronary vein of the upper lip*, which often forms a common trunk with the anterior and inferior nasal artery, and which frequently anastomoses with it.

V. LOWER INTERNAL PALPEBRAL VEIN.

§ 1546. The facial vein receives at its upper part, opposite the anterior and inferior nasal artery, the *internal and inferior palpebral* vein (*V. palpebralis inferior interna*). This vein is situated in the lower eyelid, between the skin and the orbicularis muscle; it forms a very complex network which anastomoses externally with the upper palpebral vein, given off by the temporal vein (§ 1551), and with the external palpebral vein.

VI. LOWER INTERNAL PALPEARAL VEIN.

§ 1547. The *external inferior palpebral* vein (*V. palpebralis externa inferior*) descends directly under the skin, along the external edge of the orbicularis muscle, anastomoses within with the upper external palpebral vein furnished by the temporal vein, outward with the internal inferior palpebral vein, and, passing under the zygomaticus major muscle, before the malar bone, empties into the trunk of the facial vein much deeper than the preceding.

VII. UPPER AND ANTERIOR INTERNAL MAXILLARY VEIN.

§ 1548. Some distance below this external inferior palpebral vein the facial receives the *upper and anterior internal maxillary* vein (*V. maxillaris interna anterior superior*), which arises from the upper teeth and from the upper maxillary bone, from the posterior part of the nasal fossæ, and from the lower and anterior part of the orbit, by the following branches:

1st. The *upper alveolar* vein (*V. alveolaris superior*).

2d. The *posterior nasal* vein (*V. nasalis posterior*).

3d. The *anterior ophthalmic* vein (*V. ophthalmica superior*).

§ 1549. From this point to the lower maxillary bone the facial vein receives principally,

1st. The *lower* or *external vein of the upper lip* (*V. labii superioris inferior*, s. *externa*), which is much smaller than the internal.

2d. The *upper buccal* vein (*V. buccalis superior*).

3d. The *middle labial* vein (*V. labialis media*), which is transverse, and empties itself into the trunk opposite the angle of the lips.

4th. The *inferior labial* vein (*V. labialis inferior*).

5th. The *submental* vein (*V. submentalis*).

§ 1550. It receives upward and outward, in its course,

1st. The *inferior buccal* vein (*V. buccalis inferior*).

2d. Three or four *masseteric* veins (*V. massetericæ*), a *superior*, a *middle*, and an *inferior*, which arise from the substance of the masseter muscle, and form an extensive network on the surface of this muscle, which anastomoses with all the branches of the facial vein.

3d. The *vein of the submaxillary gland* (*V. glandulæ maxillaris inferioris*).

B. COMMON TEMPORAL VEIN OR THE POSTERIOR BRANCH OF THE ANTERIOR VEIN OF THE HEAD.

§ 1551. The *common temporal* vein, the *posterior branch of the anterior vein of the head* (*V. temporalis*, s. *R. primarius, venæ cephalicæ anticæ posticus*, s. *V. facialis posterior externa*, Walter), is formed partly of superficial and partly of deep branches. The former arise principally from the middle and lateral parts of the external face of the skull; the latter come from the deep regions of the face.

The following are the principal branches which unite below and backward to form the temporal vein:

I. EXTERNAL UPPER PALPEBRAL VEINS.

§ 1552. One or two *external upper palpebral* veins (*V. palbebralis superior externa*) receive the blood from the tunica conjunctiva, the orbicularis palpebrarum, the skin of the upper eyelid, and frequently anastomose together, and also with the upper and lower external palpebral arteries, and the following.

II. EXTERNAL SUPRAORBITAL VEIN.

§ 1553. The *external supraorbital* vein (*V. supraorbitaria externa*) proceeds transversely over the upper edge of the orbit, under the orbicularis palpebrarum and the ligaments of the eyelids, and anastomoses with the external upper palpebral veins (§ 1552).

III. EXTERNAL FRONTAL VEIN.

§ 1554. The *external frontal* vein (*V. frontalis externa*) arises from the skin of the forehead, from the frontalis muscle, from the periosteum of the frontal bone, and from this bone, anastomoses with the internal frontal vein (§ 1543) before, outward with the temporal vein, and communicates with the two or three preceding, at the outer extremity of the upper edge of the orbit.

IV. DEEP TEMPORAL VEINS.

§ 1555. These three branches are situated directly under the skin. The trunk which is formed by them, or the *deep temporal* vein (*V. temporalis profunda*), penetrates the aponeurotic envelop of the temporalis muscle, proceeds upward and backward under this aponeurosis, above the zygomatic arch, turns very frequently, receives in its course several branches which resume the blood from the temporalis muscle and the temporal bone, anastomoses frequently with those of the facial vein, and communicates, before the external ear and above the temporo-maxillary articulation, with the superficial temporal vein.

V. SUPERFICIAL TEMPORAL VEIN.

§ 1556. The *superficial temporal* vein (*V. temporalis superficialis*) is generally smaller than the preceding, and is formed by an anterior and a posterior branch, which are both situated directly under the skin. The first arises from the sinciput, the second from the upper part of the occipital region, from the upper part of the ear. They most frequently join at a right angle, and form a small common trunk, which is soon united with the deep temporal vein. These two branches frequently anastomose with each other. The anterior also communicates with the branches of the external frontal vein, and the posterior with the occipital vein.

VI. TRUNK OF THE TEMPORAL VEIN.

§ 1557. The common trunk formed by the union of the deep and superficial temporal veins, descends on the outer face of the malar bone, comes behind the ascending branch of the inferior maxillary bone, penetrates into the parotid gland, goes forward under the angle of the lower jaw, and anastomoses in this place with the facial vein or anterior branches of the veins of the head, and thus produces a short common trunk.

In this course it receives *anterior*, *posterior*, and *internal* branches.

VII. ANTERIOR BRANCHES.

a. Anterior articular vein.

§ 1558. The first anterior branch, counting from above downward, is the *anterior articular* vein (*V. articularis anterior*), which anastomoses very much with the deep temporal vein, and resumes the blood from the parts of the temporo-maxillary articulation.

b. Transverse facial vein.

§ 1559. The *transverse facial* vein (*V. facialis transversa*) empties into the trunk of the temporal vein, a little below the preceding: it is a considerable vessel, and generally arises by a *superior* and an *inferior* branch.

The *superior* branch arises from around the temporo-maxillary articulation, and anastomoses with the anterior articular vein (§ 1558), and with the external infraorbital vein.

The *inferior* branch arises from the superficial and the deep branches.

The *superficial* branches carry the blood from the parotid gland, from the outer face of the masseter muscle, from the skin of this region, and from the parotid canal, and anastomose with the maxillary veins.

The *deep* veins come from the pterygoideus externus muscle, and then go between the neck of the jaw and the posterior edge of the masseter muscle, where they communicate with the superficial branches.

c. Parotid veins.

§ 1560. The temporal trunk receives, much lower down and anteriorly, some small *parotid* veins (*V. parotideæ*).

VIII. POSTERIOR BRANCHES.

a. Anterior articular veins.

§ 1561. The posterior branches of the trunk of the temporal trunk, are, besides the following, the ***anterior auricular*** veins (***V. auriculares anteriores***), which arise from most of the concha of the ear.

b. Internal and posterior maxillary vein.

§ 1562. The *deep* branch (***R. venæ facialis posterioris profundus***, Walter) corresponds mostly to the internal maxillary artery, furnished by the external carotid artery. We may then term it the ***internal posterior maxillary*** vein, to distinguish it from the anterior and superior maxillary vein (§ 1548). It is formed by one or two inferior maxillary veins, and by four or five deep temporal veins, proceeds inward, before the common temporal trunk, backward and downward, and empties itself at some distance from the angle of the jaw, into the posterior part of the common temporal vein, after giving off a considerable branch, which descends and anastomoses with the external jugular and the occipital veins.

IX. LARYNGEAL VEIN.

§ 1563. The common trunk of the anterior and posterior veins of the face corresponds to the external carotid artery, and usually receives anteriorly a small branch, the *laryngeal* vein (*V. laryngea*) which arises from the mucous membrane, and from the muscles of the larynx and of the hyoid bone.

II. POSTERIOR CEPHALIC VEIN.

§ 1564. The *posterior cephalic* vein is formed principally by the veins of the brain, the tongue, and the pharynx.

I. VEINS OF THE BRAIN.

§ 1565. The *veins of the brain* may be divided into the *external* and the *internal*. The large branches produced by their union are all inserted in the pia mater of the brain, and carry the blood into trunks called *sinuses* (*sinus*) which are formed by the inner membrane of the veins and by the dura mater. These trunks are partly surrounded by the bones of the skull, have principally transverse and longitudinal directions, communicate by several smaller sinuses, which have no constant direction, carry the blood backward and downward, and finally open into the posterior cephalic vein.

It seems to us more proper to describe the sinuses before we mention the veins of the head.

a. Superior longitudinal sinus.

§ **1566.** The *superior longitudinal* sinus (*sinus longitudinalis s. falciformis superior*) is the longest sinus of the brain, and is situated on the median line. It occupies the convex edge of the falx of the cerebrum, directly under the frontal suture, the sagittal suture, and the upper half of the squamous portion of the occipital bone, from the *cresta galli* process of the ethmoid bone to the internal occipital protuberance. It has the form of a triangle, the base of which is turned upward, the apex downward; it gradually enlarges from before backward very much, and terminates in the internal occipital protuberance, where it generally anastomoses with the right transverse sinus, in an irregular depression called the *torcular herophili*. We usually remark within a greater or less number of transverse cords (*trabeculæ*): these extend from one side to the other, and are formed internally by the dura mater, externally by the internal membrane which is reflected upon the latter.

The longitudinal sinus receives on each side, in its inferior and lateral parts, ten or twelve veins, which arise from the upper and external face and from the internal face of the brain, and which proceed in the pia mater and principally above the grooves between the circumvolutions.

The veins of the outer and upper face are the largest and the most numerous. Before they empty into the upper longitudinal sinus, they receive those which ascend along its internal face. They always proceed from before backward, increasing considerably in volume.

Most of them, with the exception sometimes of the anterior, arrive at the longitudinal sinus at very acute angles and in a direction opposite to that of the blood which passes through it.

The posterior vein, also, before opening into the sinus, usually proceeds some distance, frequently an inch between the fibres of the dura mater, which separate to receive them, and in the intervals of which they frequently curve very much.

The curves of these posterior veins are also generally supplied with single more or less apparent valves, which the anterior do not possess, because as they open into the sinus more transversely, there is less danger of the regurgitation of the blood.

The superior longitudinal sinus also receives, above, a considerable number of little veins, some of which come from the bones, while others pass through the skull, and establish the communication between the internal venous system of the head, and the external branches of the temporal and facial veins. This results from the numerous ramuscules, and especially those of one or two larger veins, which passing through the parietal foramina (*F. parietalia*) carry the blood from within outward.

Finally, the dura mater also gives venous branches, which empty into the upper and lateral parts of the superior longitudinal sinus.

b. Inferior longitudinal sinus.

§ 1567. The *inferior longitudinal* sinus (*S. longitudinalis*, s. *falciformis inferior*, s. v. *falcis inferior*)(1) is much smaller than the superior. It extends from the beginning of the middle third of the falx of the cerebrum to its posterior extremity, where it anastomoses, generally dividing into two trunks, the inferior of which proceeds along the lower and unattached edge of the cerebral falx, and empties itself into the anterior extremity of the fourth sinus, while the superior reascends between the layers of the falx and penetrates downward into the centre of the same sinus.

This sinus receives the veins of the falx, and in some rare cases some inferior veins of the internal face of the brain and of the corpus callosum.

c. Right sinus.

§ 1568. The *fourth*, *right*, or more properly the *oblique* sinus, the *sinus of the tentorium* (*S. rectus*, s. *perpendicularis*, s. *quartus*, s. *obliquus*, s. *tentorii*), properly speaking, is only the posterior part of the preceding, but it is much larger than it. It descends obliquely from before backward, on the middle of the tentorium of the cerebellum, and occupies all the space between it and the union of the superior longitudinal sinus (§ 1566) with the transverse sinuses (§ 1571).

It gradually becomes broader from before backward and is triangular.

The transverse and oblique cords are more numerous in the anterior part than they are in the superior longitudinal sinus.

Forward and upward it receives the inferior longitudinal sinus (§ 1567). The two large internal cerebral veins, or those of Galen (*V. magnæ Galeni*), also open into its anterior extremity, below the anterior and inferior root of the inferior longitudinal sinus.

d. Large internal sinus.

§ 1569. The large internal sinus takes up the blood from the inner parts of the encephalon, and is formed principally on each side by the

(1) Bichat, *Anat. desc.*, vol. iv. p. 394.

union of two vessels, the choroid vein and the vein of the corpus striatum.

The first proceeds in the choroid plexus, along the pes hippocampi, goes forward with the choroid plexus between the corpus striatum and the posterior large cerebral ganglion, and receives in the latter part of its course numerous ramuscules of veins, which go from below upward, through the substance of the large cerebral ganglion, and extends to the anterior pillar of the fornix.

The second is formed by small veins, which arise from the substance of the large anterior cerebral ganglion or the corpus striatum. It goes from behind forward, in the channel grooved between the corpus striatum and the thalami optici, until it anastomoses by its anterior extremity with the corresponding extremity of the choroid vein.

It is sometimes double; the posterior then passes above the thalami optici, and usually opens into the vein of Galen.

The latter, arising from the point mentioned, proceeds directly from before backward, that is, in a direction contrary to that of the two branches which produce it, under the fornix, in the prolongation of the pia mater, which penetrates within the brain, and on that of the arachnoid membrane, which accompanies it. It generally receives, near its posterior extremity, the superior and anterior veins of the cerebellum. It opens into the anterior extremity of the right sinus, very near that of the opposite side, with which it sometimes unites to form a trunk of but slight extent, the direction of which it sometimes but not always crosses.

e. Superior veins of the cerebellum.

§ 1570. The fourth sinus also receives the superior veins of the cerebellum, that is, the posterior, for the anterior empty in the veins of Galen.

These veins, which, like the anterior, cross the transverse grooves of the cerebellum, go backward, and the anterior forward. Proceeding at first from before backward and then forward, they penetrate to the posterior part of the fourth sinus, and sometimes also into the commencement of the transverse sinus.

f. Transverse or lateral sinuses.

§ 1571. The *transverse* or *lateral* sinuses (*S. transversi*, s. *laterales*) are the largest, and descend on each side, in the transverse groove of the occipital bone, anastomose there with the fourth sinus and also with the upper longitudinal sinus, and terminate in the foramen lacerum, in the groove of the internal jugular vein.

That of the right side usually unites, but that of the left rarely, with the superior longitudinal sinus to form a short common trunk. Sometimes also the posterior extremity of the latter passes directly between the two lateral sinuses.

That of the right side is most generally larger than that of the left.

We not uncommonly observe that one or even both of them is divided in a greater or less part of its course, by a transverse layer, into a superior and an inferior portion.

When this layer exists through the whole extent of the lateral sinus, the latter is completely double.

One of these two lateral sinuses is sometimes deficient. The superior longitudinal sinus then descends to the large occipital foramen, around which it turns to go to the posterior foramen lacerum.

The lateral and inferior veins of the cerebrum and the inferior veins of the cerebellum open into the lateral sinus.

The *lateral and inferior veins of the cerebrum*, the inferior cerebral veins, arise at nearly the centre of the skull, on the outside of the hemispheres, and usually unite in three trunks; these are joined by a fourth, which comes from the lower face of the posterior lobe, separate from the cerebrum, go forward, and open separately from above downward at about the centre of each lateral sinus.

The *inferior veins of the cerebellum* arise from the lower face of this organ, unite in two or three trunks, go backward and outward, and open from from below upward into the transverse sinus.

g. Superior petrous sinus.

§ 1572. In the place where the transverse sinus touches the posterior extremity of the petrous portion of the temporal bone, and leaves its horizontal direction to go obliquely upward, we see detached, from its outside, a much narrower sinus, the *superior petrous* sinus (*S. petrosus superficialis*, s. *superior*), which proceeds downward, inward, and forward, along the upper edge of the petrous portion of the temporal bone, where it terminates in the cavernous sinus, consequently unites this and the transverse sinus by anastomosis.

h. Inferior petrous portion.

§ 1573. The *inferior petrous* sinus (*S. petrosus inferior*, s. *profundus*) arises at the lower extremity of the transverse sinus, directly above the posterior foramen lacerum, from the anterior side of this sinus; this is broader but shorter, and is situated between the anterior part of the petrous portion of the temporal bone, and the body of the occipital bone, and is almost wholly situated in a fossa hollowed from the latter bone, the posterior part of which is sometimes changed into a canal. This sinus proceeds from before backward and from without inward, which direction is preserved at its extremities better than in its centre; it opens into the back part of the cavernous sinus, and establishes another large anastomosis between it and the transverse sinus.

i. Cavernous sinus.

§ 1574. The *cavernous* sinus (*S. cavernosus*), a considerable dilatation and of a very irregular form, is situated, on each side, on the lateral part of the body of the sphenoid bone. It anastomoses posteriorly with the posterior extremities of the two petrous sinuses, forward with the coronary sinus, and backward with the anterior occipital sinus.

Its cavity has numerous soft reddish irregular filaments which intercross and are arranged in a reticular form, from whence it takes its name.

The internal carotid artery and the sixth pair of the cerebral nerves pass through it, covered by its inner membrane, which is reflected on them and unites them.

It receives superiorly the anterior and middle inferior cerebral veins, forward the ophthalmic veins, downward, on the sides, the venous branches from the dura mater.

k. Coronary sinus.

§ 1575. The *coronary* sinus (*S. circularis*, s. *coronoideus*) is generally much broader anteriorly than posteriorly, and surrounds the pituitary gland. Its anterior or posterior portion is often deficient. It is sometimes also partly double, which depends on the existence of a transverse branch which passes below the gland. It receives the vein from the pituitary gland, and sometimes also the ophthalmic veins.

l. Anterior occipital sinus.

§ 1576. The *anterior occipital* sinus (*S. occipitalis*, s. *basilaris anterior*) extends transversely on the posterior face of the basilar process, from the union of the two petrous sinuses on each side, and the posterior extremities of the cavernous and coronary sinuses to the corresponding point of the opposite side. It thus forms a considerable anastomosis between the sinuses of the two sides, and represents a second crown, situated below the preceding, which communicates below with the analagous sinuses of the vertebræ.

m. Posterior occipital sinus.

§ 1557. The *posterior occipital* sinus (*S. occipitalis*, s. *basilaris posterior*) is sometimes single, sometimes and more frequently double. In the latter case we find a right and a left. It extends from the inner extremity of the two transverse sinuses, and the external occipital protuberance, along the posterior edge of the circumference of the large occipital foramen, encircles the posterior and the lateral portions of this foramen, and anastomoses in front with the lower extremity of the transverse sinus; so that it forms a greater or less anastomosis between the lower and the upper part of this sinus.

It is sometimes double at its summit and single in the centre, but it always divides very high up, above the occipital foramen, into a right and a left portion. It is generally not very large; but it is frequently broad, and then the transverse sinus is smaller in a direct ratio.

It sometimes but not very often replaces this sinus either on one or both sides.

In other subjects, on the contrary, we cannot trace it in the least.

§ 1578. The transverse sinuses empty through the posterior foramen lacerum into a very short common trunk, which may be termed the *internal* and *posterior cephalic* vein, or the *encephalic* vein (*V. cephalica interna posterior*, s. *cephalica encephalica*, s. *cerebralis*), and thus contrast it, according to the analogy of the arteries, to the external and anterior cephalic vein, or to the facial vein.

This trunk is situated very deeply, and descends outside of the trunk of the internal carotid artery, on the inside of the posterior belly of the digastricus muscle. It extends from the posterior foramen lacerum to the upper edge of the larynx, where it anastomoses with the anterior cephalic vein.

It receives anteriorly the pharyngeal and the lingual veins, which generally empty separately, although they often unite with each other and with the superior thyroid vein.

II. PHARYNGEAL VEIN.

§ 1579. The *pharyngeal* vein (*V. pharyngea*) descends on the posterior and lateral part of the pharynx, and anastomoses very frequently with that of the opposite side. It is often double on one side; in this case, one of the two most generally arises from the thyroid vein.

III. LINGUAL VEIN.

§ 1580. The *lingual* vein (*V. lingualis*) arises from the end of the tongue, enters between the mylo-hyoideus muscle, the genio-glossus muscle, and the submaxillary gland, proceeds along the upper edge of the hyoid bone, before the hyo-glossus muscle; thus its direction is backward, and it opens into the internal cephalic vein, either by a common trunk with the preceding, or below it.

III. INTERNAL JUGULAR VEIN.

§ 1581. The anterior and posterior cephalic veins unite near the hyoid bone, to form the *internal jugular* vein (*V. jugularis interna*), which might be more properly termed by analogy with the arteries, the *common cephalic* vein (*V. cephalica communis*). This vessel descends almost perpendicularly on the anterior and lateral part of the neck, outside of the primitive carotid artery and the pneumo-gastric nerve, inside of the sterno-cleido-mastoideus and the omohyoideus muscles, comes to the anterior extremity of the clavicle under which it passes and unites with the subclavian vein, to form the trunk of the innominata.

I. SUPERIOR THYROID VEIN.

§ 1582. In this course the internal jugular vein receives some distance below the union of the external and internal cephalic veins, a vein sometimes single and sometimes double, which often forms a common trunk with the pharyngeal and lingual veins, this is called the *superior thyroid* vein (*V. thyroidea superior*): it corresponds exactly in its distribution to the artery of this name, but differs from it very constantly in its termination. It always empties into the common trunk of the external and internal cephalic veins. It not unfrequently divides, some distance from its insertion, into an upper and a lower branch, one of which ascends and the other descends. The superior thyroid artery, however, sometimes imitates the vein in this respect, and this anomaly frequently occurs, because it resembles the normal form of the vein.

II. INFERIOR THYROID VEIN.

§ 1583. The internal jugular vein also receives in its course, one or two *inferior* or *middle thyroid* veins (*V. thyroideæ mediæ*, s. *inferiores*, s. *descendentes*), which arise from the outside of the lower half of the thyroid vein and empty higher or lower into it.

This formation is remarkable also, as the superior or the inferior thyroid artery sometimes partially or wholly arises on one or both sides, from the common trunk of the carotid arteries, and consequently resembles the normal arrangement of the veins.

IV. EXTERNAL JUGULAR VEIN.

§ 1584. The *external jugular* vein (*V. jugularis externa*) is much smaller than the internal, and forms the superficial or cutaneous vein which corresponds to the latter. It arises as high as the angle of the lower jaw, from the back side of the internal, goes outward under the parotid gland, and receives first in this place the *posterior auricular* vein (*V. auricularis posterior*), and then descends vertically between the platysma myoides and the sterno-cleido-mastoideus muscles, crosses the direction of the latter, and is placed on the inside of the omohyoideus muscle. Its lower portion corresponds to the inside of the sterno-cleido-mastoideus muscle, and is much deeper than the superior. It opens into the subclavian vein outside of the internal jugular vein. In order to this, it generally passes on the inside of the clavicle, but it is also sometimes reflected on this bone, from without inward.

Its lower extremity is often divided into two branches which ascend more or less high.

Not unfrequently that part of its upper extremity which we have before mentioned as being that by which it arises from the internal jugular vein, is only a small anastomotic branch, and the external jugular vein is so large above this point, that it receives the common trunk of the temporal vein and of the posterior internal maxillary vein, which does not enter as usual into the anterior cephalic vein.

I. SUPERIOR SUPERFICIAL OCCIPITAL VEIN.

§ 1585. The external jugular vein receives a little way below the inferior posterior auricular vein (§ 1584) the *superior superficial occipital* vein (*V. occipitalis superficialis superior*), which descends between the skin and the occipitalis muscle.

Next come some deeper branches, which arise from the lateral and posterior muscles of the neck.

II. INFERIOR SUPERFICIAL OCCIPITAL VEIN.

§ 1586. The *inferior superficial occipital* vein (*V. occipitalis superficialis superior*) arises behind the superior, between the trapezius and the splenius muscle, some distance behind the external jugular vein, descends and empties into the latter at the lower part of the neck.

III. POSTERIOR AND SUPERIOR SCAPULAR VEINS.

§ 1587. Below, the external jugular vein receives posteriorly, the *superior* and the *posterior scapular* veins which accompany the arteries of the same name, and anastomose together and with the cephalic vein of the arm.

IV. ANTERIOR CUTANEOUS VEINS.

§ 1588. Before, it receives the *anterior cutaneous veins of the neck*, distinguished into the *upper*, the *middle*, and the *lower*. These veins arise from the skin and the anterior muscles of the neck, and frequently anastomose above with the inferior branches of the facial veins.

ARTICLE SECOND.

VEINS OF THE UPPER EXTREMITIES.

§ 1589. The blood of the upper extremities returns to the heart by the deep and the superficial veins.

I. DEEP VEINS.

§ 1590. The *deep* veins follow the arteries of the same name, each of which is usually attended by two veins which proceed at its sides.

II. SUPERFICIAL VEINS.

§ 1591. The superficial or the cutaneous veins are much larger than the preceding, and proceed under the skin, between it and the brachial aponeurosis.

Their roots, or the *digital* veins, arise principally from the back of the fingers, where we find from six to eight branches, situated at the side of one another, which frequently anastomose together. These branches also receive the largest veins which proceed along the palmar face of the fingers, which, at the height of the second or the first phalanx, leave this face to go to the dorsal.

We may refer these veins to two principal trunks, the *radial* vein, and the *ulnar vein.*

I. CATANEOUS RADIAL VEIN.

§ 1592. The *cataneous radial* vein, or the *brachial cephalic* vein (*V. brachialis radialis catanea* s. *cephalica*), arises from the thumb and the index finger, and is called the *cephalic vein of the thumb* (*V. cephalica pollicis*) proceeds on the back of the hand, in the space between the first two metacarpal bones, at first along the radial edge of the forearm, then along the anterior side of the arm, outside the biceps flexor muscle, passes between the pectoralis major and the deltoides muscle, and empties in the subclavian vein, below the clavicle.

II. CUTANEOUS ULNAR VEIN.

§ 1593. The *cutaneous ulnar* or *basilic* vein (*V. brachialis cutanea ulnaris*, s. *basilica*) arises from the dorsal face of the third finger, often also from all the space between the back of the index and that of the little finger, and forms, on the back of the hand, a considerable network, which anastomoses in front with the cephalic vein of the thumb. Sometimes, when it comes on the back of the carpus, it goes forward toward the radius, and anastomoses, from the lower extremity of the forearm, with the preceding, with which it always communicates on the anterior and posterior faces of the limb, by means of several large branches, which form a broad network. It almost always forms in the forearm the *anterior cutaneous ulnar* vein (*V. ulnaris cutanea anterior*), and the *posterior cutaneous ulnar* vein (*V. ulnaris cutanea posterior*), the latter being generally larger than the former.

After leaving the articulation of the elbow it ascends, under the brachial aponeurosis, on the inside of the arm, along the ulnar nerve which it covers, and empties into the lower extremity of the axillary vein.

III. MEDIAN VEIN.

§ 1594. The *median* vein (*V. mediana*) is a large branch which serves to anastomose the radial and ulnar veins and also the superficial and the deep veins of the arm. It is generally single, but is sometimes double; its length varies, and it extends obliquely upward and backward, from the ulnar to the radial vein, as high as the flexor carpi ulnaris muscle. It generally sends one or more considerable branches, which anastomose with the anterior part of the deep brachial vein, or of the deep radial or ulnar vein. These branches are sometimes replaced by others of the cutaneous radial vein. The lower part of this vein is called the *median cephalic*, and its upper part the *median basilic* vein.

Sometimes the median vein ascends on the anterior face of the forearm, between the cephalic and the basilic vein, with which it communicates by numerous anastomoses; it is generally termed the *common median* vein (*V. mediana communis*).

III. AXILLARY VEIN.

§ 1595. The *axillary* vein (*V. axillaris*) arises at the lower extremity of the axilla, from the union of the basilic with one of the brachial veins, most frequently the internal and posterior. It ascends directly before the axillary artery, receives in the centre of its course the second vein of the arm, the external thoracic and subscapular veins, finally comes under and behind the clavicle, and is called the subclavian vein when it reaches the upper extremity of the serratus magnus muscle.

IV. SUBCLAVIAN VEIN.

§ 1596. The term *subclavian* vein (*V. subclavia*) is usually applied to all that part of the system of the descending vena-cava which is included between the latter and the upper extremity of the axillary vein. Some anatomists, as Bichat, consider the upper part of the veins of the pectoral extremity, which extends to the scalenus anticus muscle, as also belonging to the axillary vein, and consider the subclavian vein as commencing only in this place, contrary to all analogy with the arrangement of the arteries. It would be more proper then to confine it to the external portion of this trunk, which extends from the upper extremity of the serratus posticus to the scalenus anticus muscle.

This proper subclavian vein receives the external jugular vein, which then empties into it (§ 1584) from below upward.

ARTICLE THIRD.

INNOMINATA VEIN.

§ 1597. The *innominata* vein (*V. anonyma*) is generally known as the subclavian vein; but it is more convenient to conform with the analogy of the arteries, and to apply to it the first term. It is formed on each side by the union of the internal and external jugular and the subclavian veins. The scalenus anticus muscle separates it from the corresponding artery; it passes before this muscle while the artery proceeds behind it.

The left innominata vein is nearly twice as long as the right. It goes almost transversely or at least very obliquely downward and to the right, directly before and above the arch of the aorta, and above the upper edge of the sternum, leaving the sternal extremity of the left clavicle.

The right leaves the sternal extremity of the right clavicle, goes more vertically downward and to the left,. unites at an acute angle with that of the left side, above the cartilages of the first rib, and thus gives rise to the descending vena-cava.

We may consider the inner third of the left subclavian vein as corresponding to the upper part of the arch of the aorta. The trunk of the descending vena-cava represents the beginning of this latter artery. The innominata vein of the right side corresponds perfectly to the innominata artery.

The innominata vein receives on each side the *vertebral*, the *superior intercostal*, *the internal mammary*, the *superior diaphragmatic*, the *thymic*, the *superior cardiac*, and the *lowest thyroid* veins.

I. VERTEBRAL VEIN.

§ 1598. The *vertebral* vein (*V. vertebralis*) accompanies the vertebral artery, before which it is placed. It anastomoses above with the occipital sinus, in its course from above downward and inward, by intermediate branches, with the vertebral sinuses of the neck, resumes the blood of the deep muscles of the neck by external branches, and often divides, at its lower extremity, into two roots, of which the upper emerges with the vertebral artery, through the vertebral foramen of the sixth cervical vertebra, while the lower emerges from that of the seventh either alone or at least attended only by a small arterial vessel.(1)

According to Bichat, that of the right side passes before, and that of the left side behind the pneumo-gastric nerve and the subclavian artery.

(1) Eustachius, *De ossibus*, in *Opp. omn.*, p. 191.

But this arrangement is by no means general. At most, the inferior root of the right vertebral vein, which passes through the vertebral foramen of the seventh cervical vertebra, usually goes behind these parts.

II. SINUSES OF THE VERTEBRAL COLUMN.

§ 1599. The *sinuses of the vertebral column* (*S. columnæ vertebralis*)(1) are situated on the posterior face of the bodies of the vertebræ, before the dura mater, are formed by two long lateral trunks and by numerous transverse anastomosing branches, which are not, like the sinuses of the skull, formed by the dura mater of the inner membrane of the veins, and which, instead of adhering intimately to the meningeal sinus, are retained between it and the bone by a loose cellular tissue.

The two trunks descend on the two sides of the posterior face of the bodies of the vertebræ, empty principally into the vertebral vein, with which they continue through the anterior condyloid foramen of the basilar bone, empty also the blood into the anterior occipital sinus, with which they communicate at least by considerable anastomoses, contract very much on the intervertebral ligaments, especially in the lumbar region, diminish singularly in caliber at the sacrum, approach each other in this place, and arise by several minute branches from the fat which surrounds the dura mater.

They anastomose together on each vertebra by several large *tortuous transverse* branches (*circelli venosi*). Hence each of these bones has a proper venous crown, similar to that at the base of the skull, and corresponds finally to the whole venous system of the interior of the skull, and opens externally into the adjacent veins, between each pair of vertebræ.

The two longitudinal trunks are also united at their inferior extremity by a large transverse posterior branch, which corresponds to the anterior transverse branch of the coronary sinus of the skull (§ 1575).

These trunks anastomose outwardly with the posterior branches of the vertebral, intercostal, lumbar, and sacral veins, through the intervertebral foramina. The transverse branches receive anteriorly numerous branches, which come from the substance of the bodies of the vertebræ, and posteriorly those which arise from the dura mater.

The branches which enter the external veins, which we have mentioned first, carry outward the blood which the sinuses of the vertebral column have received from the dura mater and from the vertebræ.

From this description it follows that each vertebra, consequently also each corresponding section of the spinal marrow, particularly in the early periods of life when the spinal cord occupies the whole vertebral column, has its proper venous system, and that all these systems anastomose together and form a chain of rings.

(1) G. Breschet, *Essai sur les veines du rachis*, Paris, 1819.

III. SUPERIOR INTERCOSTAL VEIN.

§ 1600. The *superior intercostal* vein (*V. imtercostalis suprema*) is almost as large as the azygos vein (§ 1605), is much larger on the left than on the right side, and is often only a branch of the vertebral vein. When it is distinct and separate from the latter, it empties from below upward into the trunk of the innominata. Its roots extend below the eighth rib. It arises from the intercostal spaces, the left lung, the left bronchial vein, the esophagus, the aorta, &c., and anastomoses by its lower branches with the right and left azygos veins, unites to the first, and always proceeds at the left side of the second. It is as much longer as the left azygos vein is shorter, and resembles the right azygos vein as the branches of anastomosis between it and the left are larger. It proceeds downward, along the vertebral column, behind the pleura.

§ 1601. The internal mammary vein, the superior diaphragmatic vein, &c., correspond precisely to the arteries of the same names. The lowest thyroid vein alone differs.

IV. LOWEST THYROID VEIN.

§ 1602. The innominata veins receive from above downward, usually on the right and left, or at least on one side, the *lowest thyroid* vein (*V. thyroidea ima*). The right is nearer the outer extremity of the right innominata vein than the left is to that of its own; and the latter almost corresponds to the median line, while the other is thrown still more to the right, although the latter arises from the left lobe of the thyroid gland.

Its constant existence deserves attention, because the lowest thyroid artery, which is not common, is a repetition of it.

CHAPTER III.

TRUNK OF THE SUPERIOR VENA-CAVA.

§ 1603. The *superior or descending vena-cava* (*V. cava superior*, s. *descendens*) is formed by the union of the two innominata veins, a little above the arch of the aorta, near the cartilage of the first rib on the right side. Thence it descends to the upper and right part of the right ventricle. Its direction is nearly vertical, a little oblique however from right to left and from behind forward. It proceeds on the right side of the aorta, and it is inclosed for the space of about two inches in the sac of the pericardium. Its upper part is loose and covered on the right by the summit of the right lung, on the left by the aorta, backward by the right superior pulmonary vein, forward by the cartilage of the upper eighth rib of the right side. It is situated entirely on the right.

§ 1604. This is its usual arrangement; but sometimes, although very rarely, we find two descending venæ-cavæ, and then the two trunks of the innominata vein are not united. We have before us two instances of this anomaly, which has been mentioned also by Bœhmer,(1) Murray,(2) and Niemeyer.(3) In this case the right descending vena-cava descends before the aorta, turns backward and outward around the left auricle, comes on the lower face of the heart, goes forward in the circular groove, reaches the right auricle, and opens into its lower and posterior part.

This anomaly is very curious, on account of its analogy with what is seen in several mammalia and in several reptiles.

CHAPTER IV.

AZYGOS VEIN.

§ 1605. The descending vena-cava receives no branch in the pericardium: at least it is extremely rare that the azygos vein empties into it within the pericardeal sac.(4)

But directly after leaving the pericardium, it receives at its posterior part, the *azygos* vein (*V. azygos*, s. *sine pari*), which opens still more rarely into the right auricle than into that portion of the vena-cava enveloped by the pericardium, and it more frequently opens into the vena-cava much higher than usual.

This vessel forms a large anastomosis between the descending and the ascending vena-cava, for it arises from the latter by numerous branches, and empties into the former.

It does not perfectly deserve its name, since we find on the left side also a vessel which corresponds to it, the *small semi-azygos* vein (*V. hemiazygos*): this latter does not however extend as high.

In the cases where this vein is thought to be doubled,(5) there is no new and unusual trunk, but generally, only a simple change in respect to capacity. This second azygos vein, which always exists on the left side, is only an extraordinary development of the left superior intercostal vein, which constantly anastomoses by considerable branches with the right and left azygos veins. In this case there is only a diminution, a contraction of the branches which anastomose between the common left and the right azygos vein, and likewise between the latter and left superior intercostal vein, with a considerable increase of the left azygos vein, whence a trunk is formed which occupies the left side, but which always empties into the corresponding subclavian vein at the usual place.

(1) *De confluxu triarum venarum cavarum*, Halle, 1763.
(2) *Neue Schwedische Abhandlungen*, vol. ii. p. 286.
(3) *De fœtu puellari difformi*, Halle, 1814.
(4) Cheselden, *Phil. Tr.*, No. 337.
(5) See our *Handbuch der pathologischen Anatomie*, vol. ii. p. ii, p. 127.

We have sometimes observed, in a similar case, a very curious formation, the insertion of the right azygos vein much higher than usual, and once even in the trunk of the vena-innominata of the right side.(1)

This greater development of the left azygos vein, and its union with the left upper intercostal vein in a common trunk are not rare, but the lateral insertion of this vessel is much less common; here the right azygos vein empties into the left, which is much larger, and its trunk does not terminate in the descending vena-cava, but in the left subclavian vein.(2)

The azygos vein arises below on the two sides, by considerable branches, either directly from the ascending vena-cava, or from the renal or the first lumbar veins, most generally by several of these vessels at once.

The trunks formed by the union of these branches, the right and the left, the former of which is the *proper*, or rather the *right azygos* vein, and the latter the *semi-azygos*, or more properly the *left azygos* vein, pass, sometimes with the aorta through its opening, sometimes more outwardly, through the diaphragm.

The trunk of the right side proceeds forward and to the right on the side of the esophagus, before the right intercostal arteries, on the anterior face of the vertebral column. It receives behind and on the right the ten or eleven inferior intercostal veins, of which the inferior ascend, the central are transverse, and the superior descend. Two or three of the latter generally unite in a single trunk. They all proceed below and before the intercostal arteries.

The right azygos vein receives anteriorly the esophageal and the right bronchial veins.

It receives on the left side, and nearly upon the seventh or the eighth dorsal vertebra, the semi-azygos or the left azygos vein, which passes behind the thoracic canal and on the vertebral column to come to it, after receiving the five or six inferior intercostal veins.

This left azygos vein is sometimes double; when this is the case, another, which is superior and smaller, anastomoses with it, and empties into the right azygos vein, when the superior left intercostal vein is smaller than usual.

The right azygos vein anastomoses, by transverse branches, on the anterior face of the bodies of the vertebræ, with the superior intercostal vein.

Similar anastomoses exist also between it and the left trunk, so that the formation of the venous system on the anterior face of the bodies of the vertebræ resembles that on their posterior face.

(1) Wrisberg has once observed the same thing (*loc. cit.*, vol. i. p. 136.) This arrangement of the right azygos vein does not necessarily exist whenever the left is unusually developed.

(2) We have seen this case once. Wrisberg is the only author (*loc. cit.*, obs. iii. p. 142–145) who mentions it.

CHAPTER V.

VEINS OF THE LOWER EXTREMITIES.

§ 1606. The veins of the lower extremities like those of the upper extremities, are divided into deep and superficial veins.

I. DEEP VEINS.

§ 1607. The deep veins which accompany the arteries, and with which they are closely connected on both sides, are double almost to the knee, but in such a manner that the two synynomous veins already unite with each other at some distance from their upper extremity. After leaving the ham they are single.

I. POPLITEAL VEIN.

§ 1608. The *popliteal* vein (*V. poplitea*) is single, and arises from the union of the anterior and posterior tibial and fibular veins; it is situated backward and a little on the outside of the popliteal artery. It is more superficial than this artery, and intimately adheres to its parietes.

II. CRURAL VEIN.

§ 1609. The *superficial crural* vein (*V. femoralis superficialis*), by which term the preceding vein is designated, after it passes through the tendon of the adductor magnus muscle, comes on the inside of the crural artery, which partly covers it; it is then situated more deeply than this artery.

III. DEEP CRURAL VEIN.

§ 1610. The *deep crural* vein (*V. femoralis profunda*) is generally more superficial than the artery of the same name.

IV. COMMON CRURAL VEIN.

§ 1611. The superficial and the deep crural veins unite and give origin to the *common crural* vein (*V. cruralis* s. *femoralis communis*), which is situated more inward and backward, and consequently more deeply than the corresponding artery. It is placed on the inside of this vessel, and is separated from it by the crural nerve. It passes under the crural arch to enter the abdomen.

II. SUPERFICIAL VEINS.

§ 1612. There are two superficial veins called the *saphenæ* (*V. saphenæ*), which carry back the blood from the skin of the lower extremities. They are distinguished into external and internal.

I. INTERNAL SAPHENA VEIN.

§ 1613. The *internal saphena* vein (*V. saphena*, s. *saphena interna*, s. *magna*, s. *cephalica pedis*) arises by a deep branch, situated below the layer of cellular substance, from most of the inside of the toes, like the superficial veins of the arm, and is composed on the back of the foot of several branches, which form a considerable network; it proceeds forward and backward along the internal and upper part of the tarsus, passes from the internal malleolus to the internal and anterior part of the leg, thus comes behind the inner condyle of the femur, then goes to the inside of the thigh, ascends along its inferior part before the gracilis or the adductor longus muscle, passes through the *fascia lata aponeurosis*, about one inch below the crural arch, and empties outward and backward into the common crural vein.

A second branch which is more superficial, and situated directly below the skin, arises from the inner and anterior part of the leg, sometimes also only from the inside of the tibio-tarsal articulation, often anastomoses with the preceding in this place, ascends on the anterior internal side of the thigh, and unites with the preceding, directly below its confluence with the crural vein. There it receives the superficial internal crural vein, and also most of the external pudic and subcutaneous abdominal veins, which descend outward to come to it.

II. EXTERNAL SAPHENA VEIN.

§ 1614. The *external saphena* vein (*V. saphena externa*) is much smaller than the internal with which it communicates at its origin. It arises on the outside of the back of the foot, goes backward and upward under the external malleolus, approaches the tendo Achillis, reaches the centre of the posterior part of the summit of the leg, is situated in the ham on the inside of the tibial nerve, and empties a little above into the popliteal vein.

III. EXTERNAL ILIAC VEIN.

§ 1615. The *external iliac* vein (*V. iliaca externa*, s. *anterior*) is the direct continuation of the common crural vein, (§ 1612) and ascends behind and on the inside of the external iliac artery and along the iliacus internus muscle. At its lower extremity it receives the epigastric and the circumflex iliac veins.

IV. HYPOGASTRIC VEIN.

§ 1616. The *hypogastric* vein (*V. hypogastrica*, s. *iliaca posterior*, s. *inferior*) arises by branches which correspond to those of the hypogastric artery, from the external and internal parts of the pelvis, consequently from the glutei muscles, the genital organs, the bladder, and the lower part of the rectum. The umbilical arteries which are the continuation of the hypogastric trunk in the fetus, alone have no corresponding vein, as the umbilical vein goes to the liver.

The twigs are here very considerable in proportion to the branches, so that these vessels form *plexuses*, which are termed according to the parts whence they arise, the *hemorrhoidal plexus* (*plexus hemorrhoidalis*), the *internal and external pudic plexus* (*P. pudendalis internus et externus*), the *vesical plexus* (*P. vesicalis*), the *sacral plexus* (*P. sacralis*), the *vaginal plexus* (*P. vaginalis*), and the *uterine plexus* (*P. uterinus*).

V. PRIMITIVE ILIAC VEIN.

§ 1617. The external iliac and hypogastric veins unite to form a short trunk called the *primitive iliac* vein (*V. iliaca primitiva*, s. *communis*). This trunk proceeds from below upward, and from without inward. It unites at an obtuse angle with that of the opposite side, on the anterior face of the fifth lumbar vertebra, and on the right to form the ascending vena-cava.

The right trunk is shorter than the left, exactly as the common trunk of the subclavian and jugular veins on the right side, a little less so however than the latter. It also ascends a little more vertically.

The right is placed behind and outside of the primitive iliac artery, the left behind and on the inside of this artery, before which its upper part passes.

These two trunks always unite below and on the right of the bifurcation of the primitive iliac artery, so that the upper part of the left primitive iliac vein is situated below the commencement of the right primitive iliac artery.

CHAPTER VI.

ASCENDING VENA-CAVA.

1618. The *inferior or ascending vena-cava* (*vena-cava inferior*, s. *ascendens*) extends from the fourth or the fifth lumbar vertebra, to the lower part of the right auricle. It is always much larger than the superior. In its whole course, it is situated on the right of the vertebral column, at the side of the aorta which is partly covered by it.

Below and in most of its extent, it proceeds perpendicularly upward, but its upper part inclines to the right, so that it there takes an oblique direction. This part is situated in a particular depression of the posterior edge of the liver, sometimes even it is surrounded entirely by the substance of this gland, from which it can be easily separated.

Directly below the liver, it passes through the square opening of th diaphragm, enters the chest, and opens there directly from below upwards, into the right auricle.

§ 1619. This is the common arrangement of the ascending vena-cava.

The anomalies it presents, relate to the *number*, the *situation*, and the *insertion* of the vessel.

1st. A rare anomaly is where the ascending vena-cava divides into two trunks; it presents several degrees.

The least anomaly seems to be that where the left side of the ascending vena-cava gives off, a little below the renal veins, a vessel which ascends behind the aorta to go to the left renal vein, with which it anastomoses, so that these two veins form around the trunk of the aorta a plexus, whence arise all the renal veins of the corresponding side.

We have seen this arrangement several times. In fact there seems then to be a double renal vein; but when we consider that this vessel passes behind the aorta to empty itself into the upper renal vein, and when we regard the following series of anomalies, we cannot but consider it as indicating the doubling of the trunk of the ascending vena-cava.

We sometimes see too, in the place where the ascending vena-cava arises from the confluence of the two primitive iliacs, an accessory vessel which varies in size, and ascends on the left of the aorta, and opens either into the vena-cava or into the left renal vein.(1)

When the division is more marked the two trunks which proceed on the right and the left of the aorta are still more similar. Zimmermann,(2) Wilde,(3) and Pætsche,(4) have described cases of this kind. The division always commenced as high as the renal veins, and the two trunks anastomose together, on the fifth lumbar vertebra, by a small transverse branch.

The division of the ascending vena-cava into two trunks more rarely depends on the fact that the hepatic veins do not unite with it. The first degree of this anomaly is where the hepatic veins open into the ascending vena-cava higher than usual, above, and not below, the diaphragm, as Huber(5) and Morgagni(6) have observed. It exists in the highest possible degree when the trunk of the hepatic veins empties the blood into the right auricle.(7)

(1) Morgagni, *De. sed. et. caus. morb.*, ep.47, a. 30.—Pohl, *De venar. var.*, 1773.—We have seen this anomaly several times.

(2) *De notandis circa naturæ humanæ machinæ lusis*, Duisburg, 1750, p. 54, 55.

(3) *Comm. Petrop.*, vol. xii. p. 312, vol. viii. fig. 1-2.

(4) *Sylloge, obs. an.*, in the *Hall. coll. dis.*, vol. vi.

(5) *Obs. anat.*, Cassel, 1760, p. 34.

(6) *De sed. et caus. morb.*, ep. 60, a. 6.

(7) Rothe, in the *Abh. der Joseph Akad.*, vol. i. p. 265.

All these anomalies are remarkable, as they establish an analogy between man and most reptiles and fishes, and also between the abdominal and the thoracic veins.

2d. The ascending vena-cava exists sometimes on the left, and not on the right side of the vertebral column, not only where the viscera generally are inverted, but even when the latter case does not exist.(1)

3d. The anomaly is greatest when the vein opens into the left auricle,(2) which depends on the development being arrested.

§ 1620. The ascending vena-cava receives the *lumbar*, the *spermatic*, the *splenic*, the *capsular*, the *inferior diaphragmatic*, and the *hepatic* veins.

I. LUMBAR VEINS.

§ 1621. There are three or four *lumbar veins* (*V. lumbares*) which correspond to the lumbar arteries and empty into the ascending vena-cava. The left, which pass behind the aorta, are longer than those of the right. All anastomose with each other, and with the vertebral sinuses, through the intervertebral foramina (§ 1599).

II. SPERMATIC VEINS.

§ 1622. The *spermatic* veins (*V. spermaticæ*) usually open the right into the anterior part of the ascending vena-cava, some distance below the right renal vein; the left opens more externally than the preceding into the left renal vein.

These veins, particularly the left, are divided at a greater or less distance from their union, an arrangement remarkable as being a greater development of the type of the left side. Hence results a plexus called the *corpus pampiniforme*.

III. RENAL VEINS.

§ 1623. The *renal* or *emulgent* veins (*V. renales emulgentes*) are usually single, and are numerous more rarely than the arteries, even where the latter vary. They are situated also farther forward than they.

The left is much longer than the right. It arises higher than it, opens into the vena-cava at more of a right angle, and usually passes before the aorta to go to it.

We not unfrequently find it behind the aorta,(3) an anomaly, to which that leads where the vein divides into an anterior and a posterior trunk, which pass, the latter behind, the former before the aorta, beyond which they are frequently again blended into one.

(1) Morgagni, *Ep. anat.*, m. 56, a. 31.

(2) Ring, in the *Med. and phys. journ.*, vol. xiii, p. 120.—Lemaire, in the *Bull. des sc. méd.*, vol. v. 1810.

(3) Albinus, *Annot. acad.*, b. vii. c. 2.—Sandifort, *Obs. an. path.*, b. i. c. 5; b. iv. c. 8. We have often seen this anomaly.

IV. CAPSULAR VEINS.

§ 1624. The *capsular* veins (*V. capsulares*) open, the right almost always into the ascending vena-cava, the left, on the contrary, into the left renal vein, nearly about its centre.

V. HEPATIC VEINS.

§ 1625. We may distinguish the *hepatic* veins (*V. hepaticæ*) into *large* and *small*.

The *small* are more numerous than the large. They empty into that portion of the ascending vena-cava, which ascends behind the liver, and are arranged irregularly in pairs one at the side of another. We number about twelve.

The *large* are much larger. They emerge from the posterior edge of the liver, much nearer its upper than its lower face, and empty into the anterior part of the vena-cava, directly below its passage through the square opening of the diaphragm.

There are usually two which open into the vena-cava near each other.

The *right* is smaller, and almost always a little deeper, and belongs entirely to the right lobe.

The *left* is much larger, especially in the fetus, and divides directly below its insertion into the ascending vena-cava, into two trunks, of which the right belongs to the inner part of the right lobe, and the left to the left lobe only.

VI. INFERIOR DIAPHRAGMATIC VEINS.

§ 1626. The *inferior diaphragmatic* veins (*V. phrenicæ inferiores*) accompany the arteries of the same name, and empty either into the large hepatic veins or enter into the vena-cava, directly before it passes through the diaphragm.

CHAPTER VII.

SYSTEM OF THE VENA PORTA.

§ 1627. The *vena porta* (*V. portarum*)(1), an extremely curious phenomena in the organism, is a small separate system, inclosed in the large, the roots of which arise from the intestinal canal, where it communicates with the system of the aorta by branches of the visceral and mesenteric veins, and which are distributed, like arteries, in the

(1) Walter, *De venâ port. exerc. anat.*, Leipsic, 1739, *Exerc. anat.*, vol. ii. 1740.—Hœnlein, *Descriptio venæ portarum*, Frankfort, 1809.

liver, where it unites by means of the hepatic veins (§ 1628) in the venous system of the body.

It is very unfrequently directly continuous with the venous system of the body, and then it does not ramify in the liver, but empties directly into the ascending vena-cava, of which it forms a ramification.(1) In this case the hepatic artery is larger than usual.

I. VENOUS PORTION.

§ 1628. The venous portion of the vena-porta is formed principally by three large trunks, the coronary vein of the stomach, the splenic and the mesenteric veins, which unite to produce the middle part or the trunk of the vena-porta.

I. CORONARY VEIN OF THE STOMACH.

§ 1629. The *coronary vein of the stomach* (*V. coronaria ventriculi superior*) corresponds to the artery of the same name. It is the smallest of the three branches. It empties from left to right, and from above downward into the trunk of the vena-porta, behind the piloric portion of the stomach. The constancy of its separation with the two other veins seems to be the cause why the cœliac artery divides so frequently into several trunks.

II. SPLENIC VEIN.

§ 1630. The *splenic* vein (*V. splenica*) not only takes up the blood from the spleen, the omentum, most of the stomach, the pancreas, and the duodenum, but receives also, shortly before it terminates, the last epiploic vein, and thus corresponds to the inferior mesenteric artery, so that consequently this latter is a subordinate trunk.

III. MESENTERIC VEIN.

§ 1631. The *mesenteric* vein (*V. mesenterica*, s. *mesaraica*) receives the veins of the small intestine, of the ascending and transverse colon. Consequently, it corresponds to the superior mesenteric artery. In the early periods of fetal existence, it receives the omphalo-mesenteric vein, which arises from the umbilical vesicle and commonly disappears at the third month of pregnancy.

(1) These cases are extremely rare. We know of but four instances, only two of which are authentic. Lieutaud mentions one of the first class from Bauhin, (*Hist. anat. med.*, vol. i. p. 190), and Huber mentions another (*obs. anat.*, p. 34); but perhaps he means the trunk of the hepatic veins, which is probable. The authentic instances have been mentioned by Abernethy (*Ph. Tr.*, 1793, vol. i. p. 59-63), and Lawrence (*Med. ch. tr.*, vol. v. p. 174). These anomalies are very important in the history of the secretion of bile, and likewise for the theory of the primitive part of the vena-porta, and because they establish an analogy with the invertebral animals.

II. TRUNK AND ARTERIAL PORTION OF THE VENA-PORTA.

§ 1632. These last two branches, in uniting at a right angle, form the trunk of the vena-porta, the walls of which are thicker than those of its venous portion. This trunk proceeds obliquely upward to the right, behind the second curve of the duodenum, having in front the hepatic artery, the biliary ducts, the lymphatic glands, and the hepatic plexus, with which parts it is united by a common envelop, which comes from the peritoneum, the *capsule of Glisson* (*capsula Glissonii*). It ascends before the vena-cava, and is much larger than it. Near the right extremity of the transverse fissure of the liver, it divides at an acute angle into from two to five branches, of which the right is larger and shorter, goes directly to the right lobe of this gland, while the left is smaller and longer, proceeds transversely in the fissure, and enters into the left lobe.

The latter, in the fetus, receives the umbilical vein, and gives off posteriorly the *venous canal*, which goes into the ascending vena-cava. These two vessels will be mentioned in the history of the fetus.

In describing the liver, we shall mention the distribution of the arterial portion of the vena-porta.

SECTION IV.

PULMONARY ARTERY.

§ 1633. The *pulmonary* artery (*A. pulmonalis*, s. *vena arteriosa*) is generally a little smaller than the aorta, and arises from the summit or apex of the right ventricle, ascends to the left and backward, and presents a convexity upward and forward on the right, while it is concave downward and backward to the left. At its lower part it covers the commencement of the aorta in front, and in the rest of its course it proceeds on the left side of this artery, below its arch and on the left of its trunk. After passing through about two inches, it divides into a right and a left branch. From its bifurcation arises a round solid cord, a line thick and about four lines long, called the *arterial ligament* (*L. arteriosum*). This is the remains of a duct, the *arterial canal*, or *canal of Botal* (*ductus arteriosus*, s. *Botallianus*), or the right root of the aorta, the changes of which we shall describe more minutely when giving the history of the fetus. This cord ascends a little obliquely to the left, toward the commencement of the ascending aorta, and is attached to its anterior part so firmly that it cannot be separated without tearing. A cylinder of bone, more or less apparent, generally forms within it, even in young people, shortly after the canal is completely effaced, in accordance with this general law, that ossification marks a diminution of the vital activity in the organs.

The two branches separate from the trunk at a right angle, to go each to its corresponding lung.

The right branch proceeds transversely to the right, directly behind the aorta and the descending vena-cava, before the right bronchia. It is not only larger than the left, which depends on the greater size of the right lung, but it is also longer than it by the whole breadth of the aorta. It also penetrates more deeply into the fissure of the lung, and divides from above downward, before coming to the substance of the organ, into two branches, an upper, which is smaller, and the inferior, which is much larger.

The upper branch goes upward, and at the moment it enters the lung, divides again into two ramuscules, of which the lower is also the larger, while the upper bifurcates in turn.

The lower branch descends behind the superior pulmonary vein, to arrive at the middle and inferior lobes of the lung. It divides, opposite the middle lobe, into two branches, an anterior and superior, which bifurcates also before it enters the most internal part of the middle lobe, the other is much larger and lower, and, covered at first before by the middle branch of the right bronchia, goes to the lower lobe, and divides into three branches before it penetrates into it.

The *left branch* of the pulmonary artery is shorter and narrower, ascends a little on the left, goes toward the left lung, passes before the origin of the descending aorta, goes outward in the fissure of this lung, between its upper and its lower lobe, and divides into upper and lower branches. Those of its branches which arise the first, the posterior, are generally smaller than the anterior, which arise afterward; and those which ascend into the superior lobe are smaller but more numerous than those which descend into the lower. All generally bifurcate when they enter this organ.

The two branches of the pulmonary artery and all their ramifications are situated above and before the bronchia and their subdivisions.

§ 1634. The congenital anomalies of the pulmonary artery are,

1st. The total absence.

2d. Its obliteration.

3d. A great narrowness.

4th. Its insertion in the aorta: then it sometimes forms only one trunk, and sometimes its two principal branches arise from two separate places.

5th. Its insertion in the left ventricle.

6th. Its insertion in the two ventricles by the perforation of the base of the interventricular septum.

7th. The existence of two or four valves, instead of three.

8th. The permanence of the arterial canal.

9th. The insertion of this canal in the subclavian vein.

10th. Finally, the insertion of this canal in the right ventricle.

SECTION V.

PULMONARY VEINS.

§ 1635. The *pulmonary* veins (*V. pulmonales*, s. *arteriæ venosæ*) are usually destitute of valves, with some very rare exceptions.(1) They generally form on each side an upper and a lower trunk, which open at the four angles of the right auricle (§ 1308), and which, considered together, are a little smaller than the trunk of the pulmonary artery. The upper veins are a little larger than the lower, and are somewhat more distant from each other when they arrive at the auricle. Those of the same side are much nearer each other than those of the two sides. They are looser anteriorly than posteriorly, and are placed in front of the branches of the pulmonary artery and of the trachea. After proceeding a short distance, from four to six lines, each trunk, the inferior generally sooner than the superior, divides anew into at least two principal branches, viz. the upper into an upper and a lower branch, the lower into an anterior and a posterior branch, which commonly directly subdivide into two or more branches, before even penetrating into the fissure of the lung.

The right pulmonary veins are a little larger, but most generally much shorter than the left. They are always covered anteriorly by the descending vena-cava and also by the right auricle. The upper vein of this side comes from the upper and middle lobes of the right lung, from the first by its upper branch and by its lower branch from the second. The upper branch however usually receives one or more ramifications from the middle lobe, while the lower receives them only from the inferior lobe. The distribution of the pulmonary veins is then the opposite of that of the artery.

§ 1636. We not unfrequently find a greater(2) or less(3) number of trunks of the pulmonary veins, either from their division or their union. The first anomaly seems to be more common than the second. It does not always occur exactly in the same manner, and differs in quantity and quality. Most generally the number of trunks is increased by one only, there being five. In two cases now before us, the anomaly exists on the right side: the three trunks are situated one above another: the central trunk is much smaller than the other two, and is placed directly below the superior, being nearer to it than to the lower. We then observe in this only a greater development of the normal type.

(1) Kelch (*Beytræge zur path. anat.*, Berlin, 1813, p. 81, No. 59) has found, before the orifice of one of the right pulmonary veins, a valve, which is very curious, as a repetition of what occurs normally in several reptiles.

(2) Meckel, *Mém. de Berlin*, 1750, p. 167.—Haller, *De part. corp. hum.*, f. i. f. ii. p. 123.—Portal, *Mém. de Paris*, 1771, *Hist.*, p. 74.—Sandifort, *Obs. anat. path.*, vol. iii. p. 41; vol. iv. p. 91.

(3) Loeseke, *Obs. anat.*, Berlin, 1754, p. 26.—Portal, *Mém. de Paris*, *loc. cit.*—Haller, *loc. cit.*—Pohl, *De venis*, Leipsic, p. 11.—Sandifort, *Obs. anat. path.*, book iii. p. 18.

Less commonly we find a third trunk, which we have observed also on the left side, and which, proportionally smaller than the usual supernumerary vessel, arises by branches coming from the posterior part of the upper and lower lobes, is separated from the right superior pulmonary vein by the right branch of the pulmonary artery, and empties from above downward and from behind forward, into the posterior part of the right portion of the pulmonary auricle, almost opposite its centre.

Still more rarely also the number of pulmonary veins is increased by two, and becomes six; there are then sometimes three on each side, and sometimes four on one side and two on the other.(1) We regret that Sandifort did not state on which side the anomaly existed in the latter case.

The pulmonary veins seem to be diminished on the left side more frequently than on the right; at least this diminution has been observed on this side by Loeseke, Sandifort, and ourselves, while the veins on the right side were normal.

Other anomalies of the pulmonary veins, such as the termination of all or of one only, in the descending vena-cava or in the right auricle, are much more rare.

SECTION VI.

LYMPHATIC SYSTEM.

§ 1637. We have already mentioned the general characters of the *lymphatic vessels*, in the first volume: they accompany the two sections of the vascular system already described, particularly the veins, which they resemble much more than the arteries in their arrangement, and correspond to them so exactly, that their history is already partially given in that of the sanguineous system. The topography of the lymphatic system is generally stated without any regard to the difference of the two principal parts which compose it, the *vessels* and the *glands*. But the method adopted by some anatomists, among others by Cruickshank and Bichat, and which is to describe first the glands and then the vessels, is preferable. We also have adopted it, because, by insulating the history of the glands, we can not only present a more general picture of the distribution of the lymphatic vessels, but can form more exact ideas of the most essential particulars presented by the glands, in respect to their existence, number, situation, and size, in different parts of the body.

Authors are not agreed as to the order of describing the lymphatics. Some, as Sœmmerring and Portal, examine first those of the head, next those of the limbs, finally those of the thoracic and abdominal cavities and of the parts they contain. Others again, as Hewson and Cruik-

(1) Sandifort, *Obs. anat. path.*, book iii. p. 41, book iv. p. 91.

shank, regard only the position, and begin with the lymphatics of the lower limbs, then pass to those of the abdomen and chest, and terminate by those of the upper extremities and of the head. Many, of whom we shall mention Mascagni and Bichat, whose method resembles the preceding very much, describe the lymphatics according to the relations between them and the principal trunk; so that they divide them first into two large sections, comprising, first, those which communicate with the thoracic canal within the abdomen and the chest, second, those which open in the neck, either in this canal or directly into the subclavian and jugular veins.

Although the method of describing the lymphatic vessels of the lower limbs is preferable, because we can then commence with the most considerable part of the system, and particularly because it allows us to state beforehand the origin of the principal trunk, whence it is generally followed in treatises, it seems to us more convenient, in a complete treatise on anatomy, to examine these vessels in the order in which we have described the other sections of the vascular system; and consequently, as we take the history of the arteries as the base of that of the other vessels, to treat, first of the lymphatic vessels of the head and neck, then those of the upper extremities, next those of the viscera of the chest and of the abdomen, and lastly those of the lower extremities. By this method we finally arrive at the principal trunk, and the description follows the same course as the lymph does in the system.

CHAPTER I.

LYMPHATIC GLANDS.

I. LYMPHATIC GLANDS OF THE HEAD AND NECK.

I. LYMPHATIC GLANDS OF THE HEAD.

§ 1638. The *lymphatic glands of the head* are, proportionally speaking, very small and very few. They have not as yet been demonstrated strictly to exist within the skull, either in the brain or in the parietes. At least we cannot consider certain tumors, as those of scrofula, which are not unfrequently found in greater or less quantity in the substance or on the surface of the brain, as proving that lymphatic glands exist in this viscus;(1) for we have no proof that these tumors arise from enlarged glands and are not new formations.

We cannot assent to the opinion that the pituitary and pineal glands are lymphatic glands.

Those formations called *glands of Pacchioni* and the other analogous corpuscles which appear in the choroid plexuses are very different.

(1) Reil, *Memor. clin.*, vol. ii. f. 1, p. 39.

Those small bodies found in the carotid canal, and which are lymphatic glands, according to some anatomists, as Winterbottom(1) particularly, seem to us to be the upper ganglions of the great sympathetic nerve. We have formed this opinion after frequent examinations of them.

§ 1639. On the contrary there are evidently lymphatic glands on the outside of the head. They are much more rare in the cranial than in the facial portion. In fact, in the skull they exist only at the lower part, behind the ear; even there they are not constant and very small.

They are more numerous in the face. They are found also at its lower part, under the zygomatic arch, and around the parotid gland in all its extent. The superficial glands cover the outer face of this gland; the deep glands are situated on the buccinator muscle and behind the parotid gland. We also find very constantly within this gland one or more, which are small and almost, either alone or with those near them, the primitive seat of those tumors which are generally considered, but very wrongly, as developed in the substance of this gland.(2)

The largest and most constant of these glands are situated along the lower edge of the lower maxillary bone, on the anterior part of the inferior belly of the digastricus muscle.

II. LYMPHATIC GLANDS OF THE NECK.

§ 1640. The lymphatic glands of the neck are distinguished into *superficial* and *deep*.

The *superficial* are smaller and less constant than the rest, and are found along the external jugular vein, between the platysma myoides and the sterno-cleido-mastoideus muscles.

The *deep* glands are much larger and more numerous; this region contains more than any other excepting the mesenteric.

There are none in the anterior part of the neck nor in the middle part of its lateral face, or we find at least only two or three of them which are small, which are not larger than a seed of hemp, and which are situated on the sides of the larynx, and between it and the hyoid bone. One or several of them are found on the mucous membrane of the trachea and of the esophagus imbedded in a great quantity of fat. They sometimes swell very much, and then may cause suffocation.(3)

The lymphatic glands are small and inconstant also on the posterior part of the neck.

The largest and most numerous are those in the upper and in the lower part of the lateral faces of this region of the neck.

The *upper* and *anterior* (*G. concatenatæ*, s. *jugulares*), which are the largest, extend under the sterno-cleido-mastoideus muscle, from the

(1) *De vasis absorbentibus*, Edinburgh, 1781.
(2) Burns, *Surgical anatomy of the head and neck.*
(3) Burns, *loc. cit.*, p. 85, tab. 5.

mastoid process, along the carotid artery and the internal jugular vein, to the upper extremity of the cavity of the thorax. Some are placed outward, before the carotid artery, others inward, between this artery and the vertebral column. The most and the largest of these glands are found at the upper part of the neck, where the large vascular trunks divide.

The nearness of the carotid artery renders it possible to confound the tumors produced by their enlargement with an aneurism.(1) These tumors derange respiration and digestion because they compress the great sympathetic and pneumo-gastric nerves.

When the glands behind the large vessels swell, they usually embrace these trunks, and also the nerves, and are blended with them in a single mass.

The *inferior* and *posterior* are usually smaller. They are surrounded with a very loose cellulai tissue; they occupy the triangular space between the sterno-cleido-mastoideus muscle, the clavicle, and the trapezius muscle, and frequently extend to the axillary glands, along the vessels of the shoulder.

II. LYMPHATIC GLANDS OF THE UPPER EXTREMITIES.

§ 1641. The lymphatic glands of the upper extremities are divided into the *brachial* and the *axillary*.

I. BRACHIAL GLANDS.

§ 1642. The *brachial* glands rarely exist below the humero-cubital articulation. We however sometimes find several on the course of the radial and ulnar vessels, but they are few and very small.

The glands of the elbow are situated on the anterior face of the arm, especially on that of the inner condyle of the humerus. They vary in number from one to four.

From the elbow to the axilla are from four to seven, placed successively on the inner and anterior side of the arm, along the superficial brachial artery.

II. AXILLARY GLANDS.

§ 1643. The axillary glands in number and size exceed the preceding: we number as many as twelve which surround the large trunks of the vessels. They exist principally between the serratus magnus and the pectoralis minor muscles and the internal part of the vascular trunks, to which they are sometimes very intimately united, but extend below the pectoralis major muscle and the clavicle.

(1) Burns, *loc. cit.*, p. 81.

The deepest are the largest, and are covered by the pectoralis minor muscle.

III. LYMPHATIC GLANDS OF THE TRUNK.

§ 1644. The lymphatic glands of the trunk are divided into those of the thorax and those of the abdomen.

I. LYMPHATIC GLANDS OF THE THORAX.

§ 1645. The lymphatic glands of the thorax comprise the glands of the parietes of the thorax, those of the mediastina, and those of the lungs.

I. OF THE GLANDS OF THE PARIETES OF THE THORAX.

§ 1646. They are very small, and their number varies exceedingly. They are found in no determinate order, principally between the external and the internal intercostal muscles, particularly along the heads of the ribs, on the side of the vertebral column. Opposite these latter there are from six to ten on the anterior face, along the course of the internal mammary artery.

II. GLANDS OF THE MEDIASTINA.

§ 1647. The glands of the mediastina are distinguished into those of the anterior and those of the posterior mediastinum.

The glands of the posterior mediastinum, descend along the esophagus and the aorta, and communicate outwardly with the posterior glands of the parietes of the chest. They are numerous but small. The largest are those which correspond to the central dorsal vertebræ. They not unfrequently swell and cause dysphagia, as Van Geuns has remarked.

Those of the anterior mediastinum are from eight to ten in number, and reascend along the anterior face of the pericardium from the diaphragm. They are rarely diseased, as Cruikshank has observed, and as we also have remarked.

III. BRONCHIAL GLANDS.

§ 1648. The *bronchial* glands (*G. bronchiales, pulmonicæ, Vesalianæ*) (1) are situated around the bronchi, but they penetrate, although gradually diminishing in size, in the substance of the lung along the ramifications of these channels. They are always numerous and large, and sometimes to an extraordinary degree. The largest usually exist

(1) Portal, *Sur la structure et sur les alterations des poumons, avec des remarques sur la nature de quelques symptomes de la phthisie; in the Mem. de Paris*, 1780.

before the bifurcation of the trachea between the two bronchi. In the adult they are more or less black. Sometimes this tint extends uniformly to every part; sometimes it exists in more or less broad and deep colored patches. In infancy, on the contrary, the bronchial glands are reddish, like those of all other parts of the body. We have observed, that before becoming entirely black, their surfaces are covered to a greater or less extent with black spots, which probably depends on the mode in which the lymphatic vessels are distributed. Generally they do not begin to be colored until the age of ten years, frequently not till twenty years. They do not all become dark at the same time, and their color gradually deepens.

The extent and the degree of coloring immediately relate not only to the age of the subject, but also to the state of the lungs, and perhaps even to the nature of the air which is breathed, particularly to the quantity of carbon it contains; at least the bronchial glands are always proportionally larger and blacker in subjects affected with chronic disease of the lungs. They were even blacker than usual in a person affected with this disease, and who was in the habit of smoking.(1)

The black coloring matter is situated not only in the substance of the gland, but also in the fluids they contain, as it may be obtained by expression. The coloring substance seems to be pure carbon,(2) which Pearson thinks is not derived wholly from without.

Although these bodies are generally considered as true lymphatic glands, they are not admitted as such by all authors. Some, as Portal, distinguish the lymphatic glands of the lungs from the bronchial glands, or admit in the lung only a single species of glands, to which they refer the bronchial glands also; but instead of regarding these bodies as lymphatic glands, consider them secretory organs. This is particularly the opinion of Senac.(3) This anatomist thinks, and in regard to the bronchial glands, Portal also, that they inclose a cavity communicating with the trachea by a canal, which may be easily demonstrated in a diseased state, by passing into it a bristle, and through which it is easy to cause the fluid they contain to pass into the trachea.

Not unfrequently, also, the most perfect similarity exists between the liquid contained in these glands, and that which lines the parietes of the trachea. Senac thinks that they do not act in the fetus: according to Portal, their action continues during life.

According to Portal, the bronchial glands differ from the lymphatic glands of the lungs admitted by this anatomist to exist independently of them, in their situation, volume, and form, since the lymphatic glands are not placed like them below the ramifications of the trachea, but are dispersed irregularly in the substance of the lung, and are collected

(1) Pearson, *on the coloring matter of the black bronchial glands and on the black spots of the lungs*; in the *Phil. trans.*, 1825, plate ii. p. 166.
(2) Pearson, *loc. cit.*, p. 164.
(3) Sonat, *Tr. du cœur*, vol. ii. p. 686.

particularly on the surface of this organ ; they are also smaller, rounder harder, and evidently receive lymphatic vessels. They are also distinguished from them by their changes produced by disease, as the two kinds of pulmonary glands may be affected independent of each other.

We are, however, inclined to agree with those who make no distinction between the bronchial and the lymphatic glands of the lungs. All the characters assigned to them are purely accidental ; the bronchial glands even frequently differ from each other in all these characters, as one may judge from the details we have previously mentioned.

In examining bronchial glands which are very much swelled and which manifestly contain a liquid, we have never discovered any canal going from these bodies to the trachea ; and when these two organs communicate, it may depend on the enlargement or the morbid alteration of the glands, and their pressure upon the trachea ; and farther, some persons have expectorated ossified portions of these glands.

In fact, our observations have shown that the bronchial glands are more subject to ossification than all others, within the substance of the lung, or around the bronchi.

II. GLANDS OF THE ABDOMEN.

§ 1649. The abdominal glands occupy principally the cavity of the abdomen. We find but seldom one or more of small size in the parietes of this cavity, for instance, above the umbilicus on the linea alba.(1)

The abdominal cavity of all the regions of the body, contains the most lymphatic glands, because there the form and functions of the lymphatic system are most completely developed.

They are principally situated in the folds of the peritoneum which unite the abdominal viscera with each other, and with the parietes of the abdomen, and they may be divided into *mesenteric*, *gastric*, *cœliac* and *lumbar*.

I. MESENTERIC GLANDS.

§ 1650. The mesenteric are the largest and most numerous of all the abdominal lymphatic glands.(2)

They are divided into the *proper mesenteric* glands (*G. mesentericæ*) and the *mesocolic* glands (*G. mesocolicæ*.)

The *proper mesenteric* glands are situated principally on the left and convex side of the superior mesenteric artery. They are incomparably more numerous and larger than the mesocolic glands. We usually number more than one hundred of them, sometimes even more than

(1) Mascagni, *loc. cit.*, p. 90.
(2) Werner and Feller (*Vasorum lacteorum atque lymphaticorum anatomico-physiologica descriptio*, Leipsic, tab. i), have figured some mesenteric glands and the lymphatic vessels of the small intestine. Barth, *De glandularum mesaraicarum inflammatione*, Halle, 1820.

twice that number, differences which depend only partially on the length of the intestinal canal. Those which correspond to the jejunum are more completely developed in every respect, than those which receive the lymphatics of the ileon. They are rarely less than two inches from the intestine. From this point to the base of the mesentery, they gradually enlarge and approach each other, so that sometimes many are blended in one mass, resembling what is seen in many mammalia, where they are termed the *panceas aselli*.

These are principally the glands which are swelled in scrofulous patients.

The *mesocolic* glands are much smaller and fewer than the preceding. There are seldom more than thirty; sometimes there are only twenty; in some rare cases there are fifty. They are situated nearer the intestine than the mesenteric glands, and sometimes rest directly upon it. There are still more in the transverse mesocolon, at the lower part of the ascending colon and in the sigmoid portion of the descending colon, than in the other regions.

These glands are rarely swelled even when the preceding are so.

II. GASTRO-EPIPLOIC GLANDS.

§ 1651. The *gastro-epiploic* glands (*G. stomacho-epiploœ*) are situated along the large (*G. ventriculi inferiores*) and the small (*G. ventriculi superiores*) curves of the stomach. They are small and few, and not more than four or five to each curve.

III. CELIAC GLANDS.

§ 1652. Under the term *celiac* glands we may include, as Bichat does, the *hepatic*, the *pancreatic*, and the *splenic* glands. They surround a greater or less portion of the trunk of the vena porta, the splenic vessels, and the trunk of the celiac and superior mesenteric arteries.

IV. LUMBAR GLANDS.

§ 1653. The *lumbar* glands (*G. lumbares*) are generally very numerous and very large, and surround, forward and on the two sides, the abdominal aorta and the ascending vena-cava, and also the renal vessels. The anterior are larger than the lateral, which are placed on the sides of the bodies of the vertebræ, and before their transverse processes.

IV. LYMPHATIC GLANDS OF THE LOWER EXTREMITIES.

§ 1654. The lymphatic glands of the lower extremities may be divided into the *crural* and *pelvic*.

I. CRURAL GLANDS.

§ 1655. Lymphatic glands are rarely found below the femoro-tibial articulation. Cruikshank(1) and Hunter have never seen them. Sometimes, although very rarely, there exists on the anterior face of the leg, between the tibia and the fibula, a little below the middle of the limb(2) or higher, near the upper extremity of the interosseous membrane, a small gland, which we have once seen double; this is called the *anterior tibial* gland (*G. tibialis antica*). The *popliteal* glands (*G. popliteæ*) are larger than the tibial, although they are very small. They are rarely more than three or four in number, and are situated deeply in the fat, and surround the popliteal vessels.

II. PELVIC GLANDS.

§ 1656. The *pelvic* glands (*G. pelvianæ*) are divided into the *inguinal*, the *external iliac* or *hypogastric*, and the *sacral* glands.

I. INGUINAL GLANDS.

§ 1657. The *inguinal* glands (*G. inguinales*), are the largest in the body except the mesenteric. They are divided into *superficial* and *deep*.

The *superficial* vary in number from six to thirteen, and are situated directly under the skin, between it and the fascia-lata aponeurosis. They sometimes commence on the internal face of the middle of the thigh. The upper, which are constant, are always closer to each other than the lower; they surround the upper part of the internal cutaneous vein of the thigh and extend to the symphysis pubis.

The *deep* are fewer in number, and vary from three to seven. They are placed below the crural aponeurosis, between the adductor, the sartorius, and the iliacus muscles, and surround the superficial crural arch.

The deep glands are not so constant as the superficial.

II. EXTERNAL ILIAC GLANDS.

§ 1658. The *external iliac* glands (*G. iliacæ externæ*) are six, eight, or ten in number, and extend along the external iliac vessels, from the crural arch to the beginning of the lumbar region, where they are continuous with the lumbar glands.

(1) *Loc. cit.*, p. 117.
(2) Hewson, *loc. cit.*, p. 27.

III. HYPOGASTRIC GLANDS.

§ 1659. The *hypogastric* or *internal iliac* glands (*G. hypogastricæ*, s. *iliacæ internæ*) also vary in number; but generally they are more numerous than the external. These glands accompany the internal iliac vessels.

IV. SACRAL GLANDS.

§ 1660. The *sacral* glands (*G. sacrales*) are situated between the rectum and the sacrum. They are united laterally with the preceding and above with the mesocolic glands.

CHAPTER II.

LYMPHATIC VESSELS.

§ 1661. We may divide the lymphatic vessels of all parts of the body into *superficial* and *deep*. We shall describe them in the same order as we have the glands.

ARTICLE FIRST.

LYMPHATIC VESSELS OF THE HEAD AND THE NECK.

I. SUPERFICIAL LYMPHATIC VESSELS.

§ 1662. The *superficial lymphatics of the head* proceed under the skin. They are divided into those of the skull and those of the face.

The *superficial lymphatics of the skull* unite in from four to eight trunks, which form two fasciculi, an anterior and a posterior. The anterior descend along the temporal arteries, the posterior along the occipital artery. The first pass through some of the superficial zygomatic glands, the latter those which exist behind the ear. Both unite with the superficial lymphatics of the neck.

The *superficial lymphatics of the face* are more numerous than those of the skull, because there is more of cellular tissue in the face. They descend along the vessels of the face, pass through, partly, the glands situated on the buccinator muscles, but principally and constantly across those which occupy the lower edge of the maxillary bone and the upper part of the neck.

In this place the superficial lymphatics of the skull and face anastomose frequently together, and with the deep lymphatic vessels of the head; descend, in three or four trunks, some on the sides of the trachea, others on the posterior part of the neck, along the internal and the external jugular veins, receive the lymphatic vessels of the thyroid gland and of the muscles of the neck, and pass over the inferior lateral glands.

II. DEEP LYMPHATIC VESSELS.

§ 1663. The *deep lymphatic vessels of the head* are also divided into those of the skull and those of the face.

The *deep lymphatics of the skull* have not been pursued with clearness and certainty into the substance of the brain, but only into its membranes. They are seen here and there, especially when serum is effused upon the surface of the brain, both in the outer face of this organ, in the pia-mater and the arachnoid membrane, and likewise in the dura-mater, where they follow the course of the blood-vessels. Their trunks descend from the skull, along the internal carotid and vertebral arteries and the internal jugular vein, and unite with the superficial lymphatics of the skull and head, some in the superior, others in the inferior cervical glands.(§ 1662)

The *deep lymphatics of the face*, arise from the muscles of this region, from the nasal fossæ, and from the buccal cavity, penetrate into the superior cervical glands and unite, both within these glands and after emerging from them, with those which arise from the trachea and pharynx.

§ 1664. The trunks of all the superficial and the deep lymphatics of the head and neck, pass through the inferior cervical glands which they unite, anastomose very frequently with each other and with some vessels which come from the upper extremities and from the cavity of the thorax, which arrive at the lowest of these glands, and unite in one or several trunks which open into the upper part of the thoracic canal, either directly into the angle of union of the jugular and subclavian veins, or finally into one of these last two, and then into the internal jugular, more frequently than into the subclavian vein.

ARTICLE SECOND.

LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1665. We must consider, at the same time with the lymphatic vessels of the upper extremities, particularly the superficial, the superficial lymphatics of the dorsal face of the trunk, and of the middle part of its anterior face: for all these vessels terminate in the axillary glands. This arrangement is demonstrated not only by dissection, but by the swelling of the axillary glands, when the vessels remote from these regions have been irritated; as when, for instance, a blister has been applied to the epigastric region.

I. SUPERFICIAL LYMPHATIC VESSELS.

I. SUPERFICIAL LYMPHATIC VESSELS OF THE DORSAL FACE OF THE TRUNK.

§ 1666. The superficial lymphatic vessels of all the dorsal face of the trunk, from the neck to the lumbar region, terminate in the axillary glands.

The superior, which arise from the neck, descend on the trapezius muscle, pierce the deltoides, and in this place, before arriving at the axillary glands, receive those which arise from the skin of the shoulder.

The middle and the inferior proceed transversely upward on the trapezius muscle, pass through this muscle, arrive outward, between it and the teres major muscles, and terminate in the axillary glands.

II. SUPERFICIAL LYMPHATIC VESSELS OF THE LATERAL AND ANTERIOR FACES OF THE CENTRAL REGION OF THE TRUNK.

§ 1667. These vessels arise from the chest, and from that portion of the abdomen above the umbilicus.

The *lateral*, which extend lower than the others, penetrate through the obliquus externus abdominis, and the serratus magnus muscles.

The *anterior* and *superior*, the highest of which arise from the lower part of the neck, proceed on the pectoralis major muscle, turn on the lower edge of this muscle, and go backward to the axillary glands.

Some of these vessels, the deepest, pass through the rectus abdominis muscle in some subjects, into the internal lymphatic vessels of the thorax. Others, which are situated above, proceed through the deep muscles of the parietes of the thorax, and anastomose with the intercostal lymphatics.

These lymphatic vessels frequently communicate with the inferior, which descend from the anterior face of the abdomen to the inguinal glands.

III. SUPERFICIAL LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1668. The superficial lymphatic vessels of the upper extremities, are distinguished into *external* and *internal*.

The *external* commence on the dorsal face of the fingers, proceed first on their sides, follow the course of the cutaneous vessels on the back of the hand, and ramify in this place and in the fore-arm, on the external and posterior faces of which they principally ascend, and where they are farther increased by the lymphatic vessels which arise from this region. They proceed gradually forward and inward, so that near the humero-cubital articulation, they are situated entirely on the inner face of the limb.

The *internal* arise from the internal face of the hand, also proceed along the lateral faces of the fingers, attended by the palmar vessels, anastomose in this place with the dorsal lymphatic vessels, and unite in the hollow of the hand in three or four trunks, two of which are formed by the lymphatic vessels of the thumb and little finger, and a third and sometimes a fourth is formed by those of the other three fingers. They then ascend on the inner face of the fore-arm, and there receive several of the lymphatic vessels from the integuments of this region. All, or at least most of them, pass through the glands of the elbow, and unite at this point and higher with the external. The largest trunks which result from this union, and which are the fewest, ascend along the inner face of the arm, and following the course of the large blood-vessels, terminate principally in the axillary glands.

Some of them, but very few, attend the cephalic vein between the deltoides and pectoralis major muscles, and go to the inferior cervical glands.

II. DEEP LYMPHATIC VESSELS OF THE UPPER EXTREMITIES.

§ 1669. The deep lymphatics of the upper extremities accompany the deep vessels so exactly, that it is useless to describe them, and they may be known well enough by the terms *radial*, *ulnar*, *and interosseous* (*vasa l. radialia*, *ulnaria et interossea*). They proceed principally on the inside of the hand, the fore-arm, and the arm, frequently anastomose with the superficial, and receive at the upper part of the arm the small trunks which come from the pectoral muscles.

These deep lymphatic vessels partly penetrate into the glands which are rarely formed in the fore-arm, and all terminate in those of the axilla.

III. TERMINATION OF THE LYMPHATICS OF THE UPPER EXTREMITIES AND TRUNK.

§ 1670. The lymphatic vessels hitherto described, and which pass through the axillary glands, unite in larger trunks within these glands and in the spaces between them, and are finally reduced to four or five in number, which surround the subclavian artery. They unite anew into two or three large trunks, in the place where this artery comes to the upper part of the chest; these ascend behind the subclavius muscle, above the subclavian vein, and open directly into it, either alone or united with the deep lymphatics of the trunk, the head, and even also those of the left side, with those of the lower extremity.

ARTICLE THIRD.

DEEP LYMPHATIC VESSELS OF THE THORAX.

§ 1671. It is most convenient to describe the lymphatic vessels of the abdomen separately from those of the chest, and to place the history of the former after that of the lymphatic vessels of the lower extremities.

We distinguish the deep lymphatics of the chest into those of the parietes and those of the organs it contains.

I. LYMPHATICS OF THE PARIETES OF THE THORAX.

§ 1672. The deep lymphatics of the parietes of the thorax are divided into *lateral*, *posterior*, and *anterior*.

I. LATERAL AND POSTERIOR LYMPHATIC VESSELS.

§ 1673. The *lateral* and *posterior* lymphatics (*Vasa l. intercostalia posteriora*) arise from all the muscles which surround the chest and contribute to form its parietes; also from the pleura, and reunite with the posterior intercostal trunks, which proceed along the intercostal vessels. They also receive on the side of the vertebral column the lymphatic vessels which come from the muscles of the back and from the vertebral canal, pass through the lateral glands of the vertebral column, frequently anastomose and communicate, particularly the upper, with the glands of the lung, principally follow a more or less descending direction, and gradually terminate in the thoracic canal.

II. ANTERIOR LYMPHATIC VESSELS.

§ 1674. The *anterior lymphatics of the parietes of the thorax*, or the *internal mammary lymphatic vessels* (*Vasa l. thoracica profunda antica*, s. *mammaria interna*), arise by their deepest branches from the upper and anterior part of the abdominal muscles and the diaphragm, penetrate into the chest, below the xiphoid cartilage, proceed on both sides of the sternum and along its posterior face, pass through the glands in this place, and receive, on each side, the *anterior intercostal lymphatic* vessels (*Vasa l. intercostalia antica*).

Those of the left side rarely reunite in two trunks, usually in one, which ascends obliquely before the left subclavian vein, passes through the inferior cervical glands, afterward descends on leaving this point, and opens into the thoracic canal, more rarely into the venous system.

Those of the right side commonly empty into the right subclavian and internal jugular veins; but they also sometimes unite previously with the lymphatics of the head and of the upper extremities.

II. LYMPHATIC VESSELS OF THE THORACIC VISCERA.

§ 1675. The lymphatic vessels of the thoracic viscera are divided into those of the lungs, the pericardium, the thymus gland, and the heart.

I. LYMPHATIC VESSELS OF THE LUNGS.

§ 1676. The *superficial* lymphatic vessels of the lungs arise on the surface of this organ from the pulmonary portion of the pleura, and form, on the lungs, a very complex network, with irregular meshes, which corresponds to the lobes of the viscus. Some of the trunks formed penetrate within the fissures of the lobes, and within the glands at the base of these spaces; others proceed along the internal face of the lungs and empty into the bronchial glands.

The *deep* lymphatics of the lung arise from the substance of the viscus, anastomose very frequently with the superficial, proceed along the ramifications of the trachea and the pulmonary vessels, also enter into the bronchial glands, anastomose with the superficial vessels within them, and then proceed along the air-passages.

After leaving the bifurcation of the trachea, the lymphatic vessels which come from the bronchial glands, soon unite in three or four trunks, of which only one exists on the right and the others belong to the left side.

Both pass through some inconstant glands situated before and on the sides of the trachea, go behind the internal jugular vein on their side, and empty immediately, or in connection with the lymphatic vessels of the neck and upper extremities, into this or into the subclavian vein.

The pulmonary lymphatic vessels receive, on the trachea, those of the pericardium and of the thymus gland, which ascend into the anterior mediastinum after passing through some glands placed before the aorta and the vena-cava.

II. LYMPHATIC VESSELS OF THE HEART.

§ 1677. The *lymphatic vessels of the heart* principally accompany the large vessels of this organ, leave the pericardium and ascend on the aorta and the pulmonary artery, pass through the glands on the former of these two vessels, and unite, on one side, with the lymphatic vessels of the lung, the thymus gland, and the pericardium, and on the other, usually empty, by several small trunks, either into the thoracic canal or directly into the left jugular and left subclavian veins.

ARTICLE FOURTH.

LYMPHATICS OF THE LOWER EXTREMITIES, AND SUPERFICIAL LYMPHATICS OF THE LOWER PORTION OF THE TRUNK AND OF THE EXTERNAL GENITAL ORGANS.

§ 1678. The most proper mode of describing the lymphatic vessels of the lower extremities is to pursue the order adopted for the upper extremities and for the superficial vessels of the neck and back, and connect their description with that of the superficial lymphatics of the lower portion of the trunk and of the external genital organs.

I. LYMPHATIC VESSELS OF THE LOWER PORTION OF THE TRUNK.

§ 1679. The superficial lymphatic vessels of the lower portion of the trunk arise from the skin and the cellular substance of that portion of the abdomen below the umbilicus, the lumbar region, the haunches, and the perineum frequently anastomose with each other or with the superficial vessels of the lower extremities, communicate also, at least the former, with the superficial lymphatics of the upper part of the trunk, and empty into the inguinal glands.

II. SUPERIOR LYMPHATIC VESSELS OF THE EXTERNAL GENITAL ORGANS.

§ 1680. The superficial lymphatic vessels of the external genital organs arise in the male from the scrotum and penis, in the female from the labia pudenda and clitoris. Those of the penis and clitoris proceed, in two or three trunks, along the sides and back of these parts. They anastomose frequently with the superficial lymphatics of the thigh, and empty into the inguinal glands.

III. LYMPHATIC VESSELS OF THE LOWER EXTREMITIES.

I. SUPERFICIAL LYMPHATIC VESSELS.

§ 1681. The *superficial* lymphatic vessels of the lower extremities are situated between the *fascia-lata* and the skin, and are divided into *anterior*, which correspond to those of the anterior face of the fore-arm, and *posterior*, which are repetitions of those in the hollow of the hand and of the inner side of the fore-arm. The *anterior* arise from the back and sides of the toes, and from the back of the foot, ascend on the anterior and lateral faces of the leg, are finally placed on the inside of this limb, and then ascend along the internal face of the thigh.

The *posterior* come from the sole of the foot, ascend along the posterior face of the leg, and anastomose frequently with the anterior.

The largest and fewest trunks which are formed by the union of both, ascend along the internal and anterior part of the thigh, and empty at the summit into the superficial inguinal glands.

The superficial lymphatic vessels of the thigh, proceed principally along its internal and its anterior face. Even those which arise from its posterior face take the same dirèction. They anastomose with those of the leg, and go to the inguinal glands.

II. DEEP LYMPHATIC VESSELS.

§ 1682. The deep lymphatics of the lower extremities, are fewer than the preceding, and also differ in their situation, being placed below the aponeurosis.

They form four fasciculi, each of which unites in one or two small trunks, which proceed along the three arteries of the thigh and the external saphena vein. They arise from the same parts as those to which these arteries proceed, and from whence this vein arises, and all unite in the ham, in the popliteal glands.

The anterior tibial lymphatic vessels sometimes pass through the anterior tibial glands (§ 1655), which are not constant.

From three to six trunks come from the popliteal glands which are united by these vessels: these trunks ascend along the superficial popliteal and crural vessels which they surround, and receive principally the deep crural lymphatic vessels, which accompany the deep blood-vessels of the thigh.

These deep crural lymphatic vessels, which anastomose frequently with the superficial, enter, some into the deep, others into the superficial inguinal glands. Some pass before these glands, to the inferior iliac glands.

§ 1683. The superior deep lymphatic vessels which arise from the adductor and extensor muscles, and those which rotate the thigh outward, and also from those of the perineum, accompany the obturator, ischiatic, and gluteal vessels, and terminate in the hypogastric and sacral glands.

ARTICLE FIFTH.

ABDOMINAL LYMPHATIC VESSELS.

§ 1684. The abdominal lymphatic vessels divide like the thoracic, into those of the abdominal parietes, and those of the organs contained in the cavity of the abdomen.

I. OF THE LYMPHATIC VESSELS OF THE ABDOMINAL PARIETES.

§ 1685. The lymphatic vessels of the abdominal parietes, are divided into the *anterior*, the *lateral*, the *posterior*, and the *inferior*.

The *anterior* arise from the skin, from the aponeurosis of the abdominal muscles and from the rectus muscle which they perforate, accompany the epigastric artery, and terminate in the external iliac glands.

The *lateral* come from the integuments, and from the lateral parts of the abdominal muscles, perforate the broad muscles in this region, proceed along the crest of the ilium, and arrive at the external iliac glands.

The *posterior* have their origin in the skin of the lumbar region, the quadratus lumborum muscle, the posterior part of the abdominal muscles, and the spinal canal, go inward with the lumbar arteries which they accompany, extend to the vertebral column, penetrate into its lateral glands, and anastomose frequently with those of the side opposite, on the anterior face of the vertebral column, thus giving rise to the *lumbar plexus*.

The *inferior* are distinguished into *lateral* and *posterior*. The *lateral* arise from the iliac bones, from the iliacus muscle, and from the levator ani muscle. They pass below the psoas magnus muscle, and go to the external and the internal iliac glands.

The *posterior* arise from the pyramidalis muscle, from the sciatic plexus, from the sacrum, and from the cavity of this bone. They terminate in the lumbar and the internal iliac glands.

All these lymphatics anastomose either at their origins, or within the glands which they enter.

II. LYMPHATIC VESSELS OF THE ABDOMINAL VISCERA.

§ 1686. The lymphatic vessels of the abdominal viscera, are distinguished into the deep lymphatic vessels of the genital and urinary organs, and into those of the digestive apparatus.

I. DEEP LYMPHATIC VESSELS OF THE GENITAL AND URINARY ORGANS.

§1687. The superficial lymphatic vessels of the genital organs, have already been described.

Among the deep, those of the penis and clitoris enter the pelvis along the deep blood vessels of those parts, go to the internal pelvic glands, and anastomose with the inferior lymphatic vessels of the parietes of the abdomen.

The lymphatics of the testicle, which are very numerous and proportionally very large, form two layers, of which the external arises from the tunica vaginalis, and the deep or internal from the substance of the gland. They unite in from eight to twelve trunks, ascend along the spermatic cord to the inguinal ring, and go to the lumbar glands, following the course of the spermatic artery.

The lymphatics of the prostate gland and vesiculæ seminales, anastomose with those of the bladder.

The lymphatics of the vagina and lower part of the uterus, penetrate into the internal pelvic glands; a part of those of the lower part of the vagina accompany the round ligament of the uterus, pass through the inguinal ring, and anastomose with those of the uterus. Those of the upper part of this latter organ which unite with those of the ovary, follow the course of the spermatic vessels, and terminate in the lumbar glands, like the corresponding vessels in the male.

§ 1688. Among the lymphatic vessels of the urinary passages, those of the bladder go to the internal pelvic glands.

Those of the ureters enter the external pelvic and lumbar glands, and anastomose with those of the bladder and kidneys.

Those of the kidneys arise from the outside and inside of these organs. The former, or the *superficial*, unite with the second or the *deep*, either directly or after forming several small trunks. The first is true of the internal, and the second of those which arise from the rest of the surface of the kidneys.

The trunks formed by the union of the deep lymphatic vessels, leave the renal fissure, accompany the renal vessels, anastomose frequently with those of the genital organs and of the capsulæ renales, and empty into the lumbar glands. Several of them open into the thoracic canal.

Those of the renal capsules unite, some with those of the kidneys, others with those of the liver, the spleen, and the intestinal canal.

II. LYMPHATIC VESSELS OF THE DIGESTIVE ORGANS.

§ 1689. The lymphatic vessels of the digestive organs are divided into those of the intestinal canal, those of the stomach and the omenta, the liver, the spleen, and of the pancreas. They are also called the *lacteal* or *chyliferous vessels*, on account of the fluid they carry at the time of digestion. If however, we except at most the final branches, we ought not to distinguish between the lymphatic vessels which take up the chyle from the intestinal cavity and those which receive the lymph in the substance of the organ, since both fluids follow precisely the same direction.

I. LYMPHATIC VESSELS OF THE INTESTINAL CANAL.

§ 1690. The lymphatic vessels of the intestinal canal (*V. l. intestinalia*), like the glands, are much more numerous in the small than in the large intestine: there are more also in the duodenum and the jejunum than in the ileon. They may be distinguished into *superficial* and *deep*.

The *superficial* arise from the peritoneum, between this membrane and the muscular tunic, and from the latter. They proceed along the intestine, and frequently anastomose together above and below.

The *deep* arise from the vascular and villous tunic, principally receive the radicles which absorb the chyle, follow a transverse direction, surround the intestinal canal like rings, and anastomose with the superficial, both on the intestine and between the folds of the mesentery. All unite in small trunks, which, two, three, or four in number, proceed between the folds of the mesentery, follow the course of the intestinal vessels, pass through the series of the mesenteric glands, gradually enlarge as they proceed, but become fewer in the same proportion, and anastomose near the pancreas with the lymphatic vessels of this organ, the spleen, and the liver, and concur with the latter to form one of the great roots of the thoracic canal. The lymphatic vessels of the descending colon however do not unite to produce the small trunks. They empty very low into the lumbar and sacral glands.

II. LYMPHATIC VESSELS OF THE STOMACH AND OF THE OMENTA.

§ 1691. The lymphatic vessels of the stomach and of the omenta, or the *gastro-epiploic* (*Vasa l. gastro-epiploica*), also form a superficial and a deep layer. We may divide them, in respect to their course, into three fasciculi, which follow the course of the principal blood-vessels of the stomach.

Those of the left side, which arise from the base of the stomach, accompany the short vessels and go to the left, where they anastomose with those of the spleen.

The middle superior arise from the upper part of the rest of the surface of the stomach, go upward and to the left, pass through the glands of the small curvature of the stomach, and reunite at the left orifice of this viscus. Thence they go to the right, pass through the other glands, and anastomose under the liver with the inferior lymphatic vessels of this gland.

The middle inferior, which come from the rest of the surface of the stomach and from the large epiploon, proceed, in company with the blood-vessels, along the large curvature of the stomach, pass through the glands in this place, go towards the right side, partially reunite with the middle superior, and go downward behind the pancreas to unite around the cœliac and superior mesenteric arteries, with the intestinal lymphatic vessels, with which they form one of the principal roots of the thoracic canal.

III. LYMPHATIC VESSELS OF THE SPLEEN AND THE PANCREAS.

§ 1692. Among the lymphatic vessels of the spleen and pancreas (*V. l. splenico-pancreatica*), the *superficial* vessels of the spleen arise from its peritoneal coat, and the *deep* vessels from its substance. The former are reflected around the edge of the spleen, and all, after reuniting in its fissure, leave this cavity, go to the right, accompany the splenic vessels, and anastomose there with the other lymphatics of the digestive organs.

Those of the pancreas soon join those of the spleen and the middle inferior lymphatics of the stomach.

IV. LYMPHATIC VESSELS OF THE LIVER.

§ 1693. The lymphatic vessels of the liver (*V. l. hepatica*)(1) are extremely numerous, and seem to differ from most of the others by the fewness and smallness of their valves. In fact we can generally succeed in injecting them from the trunks, and when injected their course is much more uniform than the others. They may be distinguished into *superficial* and *deep*.

a. Superficial lymphatic vessels.

§ 1694. The *superficial lymphatic vessels of the liver*(2) may in turn be divided into those of the upper and those of the lower face.

1. Lymphatic vessels of the upper face of the liver.

§ 1695. The superficial lymphatic vessels of the upper face of the liver form several fasciculi, which vary in number from four to ten.

Those of the middle fasciculus, which is the largest, arise from the middle region of the right lobe, partly also from the left lobe. They reunite in six or eight trunks, which enter into the suspensory ligament of the liver, and pass into the chest, between the diaphragm and the xyphoid cartilage of the sternum. There they reunite with the lymphatic vessels of the upper face of the diaphragm, form one or two trunks, enter into the mediastinum, through which they pass from below upward, receiving several lymphatics from the pericardium, the thymus gland, and from the anterior wall of the thorax, and usually open into the left thoracic canal, just before it terminates. They frequently also empty partially or wholly into that of the right side. Sometimes several trunks of this fasciculus do not unite with the rest, but go to the left, pass into the coronary ligament of the liver, between the diaphragm and the left lobe, join the other fasciculi of the hepatic lymphatic vessels, and empty into the lower part of the thoracic canal, within the abdominal cavity or in the chest.

The second fasciculus arises from most of the surface of the right lobe, sometimes in a greater and sometimes a less extent. The trunks reach the right ligament of the liver, pass through the diaphragm in

(1) Schmiedel, *De habitu naturali venarum lymphaticarum in hepate*, Erlangen, 1747.

(2) Werner and Feller, *De vasis hepatis superficialibus*, p. 34-44.—*Loc. cit.*, tables ii. iii. iv.

this place, proceed from below upward, and from behind forward on the convex face of this muscle, along its costal edge, and empty into the trunks of the first fasciculus. Others, which are smaller, go backward, and open into the lower part of the thoracic canal, anastomosing with the inferior diaphragmatic lymphatics.

The third fasciculus arises from most of the surface of the left lobe. Its trunks go to the left triangular ligament of the liver, separate in this place, unite with the upper lymphatic vessels of the stomach, and open into the lower part of the thoracic canal, which is still within the abdominal cavity.

2. Lymphatic vessels of the lower face of the liver.

§ 1696. The superficial lymphatic vessels of the lower face of the liver generally form fewer fasciculi than those of the upper face. Those too on the right side generally unite with those on the left. All anastomose with the superficial and the deep lymphatic vessels of the upper face, and give origin to small trunks. The latter approximate each other near the vena portæ, descend along the course of the hepatic blood-vessels, and reunite with those of the intestinal canal.

Other superficial lymphatic vessels of the liver enter into the substance of this gland but do not reunite to those described, and empty into the deep lymphatic vessels.

b. Deep lymphatic vessels.

§ 1697. The deep lymphatic vessels of the liver are much more numerous than the superficial, and accompany the hepatic blood-vessels and the biliary canals, emerge with the latter through the fissure of the vena portæ, and unite in the small epiploon, with the superior lymphatics of the stomach, emptying into the glands of this part, and reunite with the superficial lymphatics of the lower face of the liver, the lower lymphatic vessels of the stomach, those of the spleen and pancreas, descend along the hepatic vessels, anastomose at the base of the mesentery with the intestinal lymphatics, and form, in connection with them, one of the principal roots of the thoracic canal, the middle.

ARTICLE SIXTH.

OF THE THORACIC CANAL.(1)

§ 1698. All the lymphatic vessels open into the venous system of the body in two different places, at the union of the right and left inter-

(1) J. A. Leitersperger, *Præs.* Salzmann, *Encheiresis nova, qua ductus thoracicus una cum receptacula chyli in quovis subjecto humano demonstrari potest*, Strasburg, 1711.—J. S. Henninger, *De mesenterio*, Strasburg, 1714.—C. P. Wium, *De viis ali-*

nal jugular and subclavian veins. Most of them empty into the left side; this is the case with the lymphatic vessels of the left portions of the head and neck, those of the left upper extremity, the superficial vessels of the left portion of the trunk, all the deep lymphatic vessels of the chest, except those which arise from the right lung, those from the right portion of the heart and of the thyroid gland, generally also those of the right portion of the diaphragm, and of the right portion of the anterior wall of the chest, finally with those of the lower extremity and of the abdomen, except some which arise from the right half of the upper face of the liver.

On the contrary, the lymphatic vessels of the right portion of the head and neck, those of the right upper extremity, those of the right portion of the diaphragm, partially or wholly, and those of the right portion of the liver, go to the right side.

Those of the lower extremities, the intestinal canal, the stomach, and the spleen, most of those of the liver and the intercostal lymphatic vessels, do not empty directly into the venous system; but they always open(1) one after another, into the *left thoracic canal* (*ductus thoracicus sinister*), which is formed by their union. Those of the other organs, on the contrary, which we have described, do not empty except into the upper part of this canal, and in part also open directly into the internal jugular and subclavian veins.

I. LEFT THORACIC CANAL.

§ 1699. The lacteal vessels and the lymphatic vessels of the lower extremities, unite towards the first or the second lumbar vertebra, some-

mentorum et chyli., Copenhagen, 1717.—A. F. Walther, *Obs. de ductu hepatico bipartito, vena bronchiali sinistra et inferiore, arteria hepatica, superioris mesaraicæ sobole*, Leipsic, 1731.—J. C. Bohl, *De via lactea*, Konigsburg, 1741.—C. M. Bussmann, *Præs.* Haller, *De ductu thoracico*, Gottingen 1741.—F. J. Narcissus, *De generatione et receptaculis chyli*, Leyden, 1742.—C. H. Velse, *De mutuo intestinorum ingressu et aliis machinæ humanæ extraordinariis*, Leyden, 1742.—A. Portal, *Sur la struct, du canal thoracique et sur celle du reservoir du chyle ; in the Mem. de Paris*, 1770, p. 393-402.—Sabatier, *Remarques sur le canal thoracique de l'homme ; in the Mem. de Paris*, 1780, p. 693.

(1) Lippi, demonstrator at the hospital, Santa-Maria-Nuova at Florence, seeking some unknown channel by which nature conducted the white fluids into the sanguineous system, without carrying them by a long rout to the thoracic canal, has found a large lymphatic trunk, which emptied into the ascending vena cava, at about the third lumbar vertebra, after passing from above downward, between the trunks of this vein, into which it opened in a direction opposite to that of the course of the blood. The orifice had a kind of valve. Some days after, the same anatomist remarked four distinct trunks which opened, one into the primitive iliac vein, and others into the vena cava. Having injected an inflamed liver, he saw some lymphatics of its triangular ligament, entering into the ramifications of the vena portæ. As he first injected the right side, Lippi undertook to do the same on the left. Having pushed the mercury into the external iliac lymphatics, whence this metal arrived at those situated behind the vertebral column, in the lumbar region, he saw several lymphatics on the left side, entering into the vena cava, some passing above, others below the aorta he also saw some emptying into the splenic and mesenteric veins: Lippi believed that he could distinguish the lacteals which open into the thoracic canal, from those of the external face of the peritoneum, which empty in great part into the veins with those which arise from the lower extremity. F. T.

times also between the second and the third, or even upon the twelfth dorsal vertebra, between the internal pillars of the diaphragm, and not below, to form the *left* or the proper thoracic *canal*. The chyliferous vessels frequently do not form a trunk, but open into this canal very near each other, and nine or ten in number. Most generally, however, the thoracic canal is formed by three trunks, a right, a central, and a left trunk. The first arises by the union of the lacteal vessels; the other two are formed by the lymphatic vessels of the lower extremities. The right and the central are situated on the right side, and the left on the left side of the aorta. The first two unite before the third joins them. The latter sometimes unites to the principal trunk only by small branches.

§ 1700. The ancient anatomists admitted at the union of these vessels, and consequently at the commencement of the thoracic canal, a dilatation called the *reservoir* or *cistern of Pecquet* (*receptaculun*, s. *cysterna chyli*). This dilatation, however, is often very much contracted, and its apparent existence depends on the manner in which the lacteal vessels arrive at the thoracic canal. In fact they turn upon it, are enveloped by a common cellular sheath, and united by cellular tissue: when this sheath and this tissue are raised, the pretended reservoir almost always dissappears.

In some subjects, however, the thoracic canal presents in this place a considerable dilatation, a kind of reservoir.

§ 1701. The thoracic canal passes into the chest behind the aorta, and on the right of it, between the internal pillars of the diaphragm. It is at first placed in the centre of the dorsal vertebræ, rather more to the right than to the left, between the aorta and the azygos vein, a little however before the latter, and directly behind the right layer of the posterior mediastinum. In ascending it goes to the left, but does not always preserve the same situation, although it is placed from the third to the sixth dorsal vertebra behind the esophagus, and is covered by this canal in a greater or less extent. After leaving the third dorsal vertebra, it ascends at the side of the esophagus, and passing behind the arch of the aorta, leaves the chest to extend to the upper edge of the last cervical vertebra. Thence it goes downward and forward, which much favors the progress of the chyle, and in most subjects, it empties itself at the angle of union of the left subclavian and internal jugular vein, usually by one trunk, rarely by several. It rarely opens into one of these two veins.

§ 1702. It is always a little narrower at the middle dorsal vertebra, but below this point again dilates more or less, as it receives the superior and pulmonary intercostal lymphatic vessels. It presents in its course no projections, but describes greater or less curves, and it does not receive many lymphatic vessels, except towards its upper extremity, where the trunks of the left half of the head and of the left upper extremity, open into it directly before it joins the venous system.

It is rarely or never perfectly single; being always attended with a greater or less number of accessory branches, which open with it, and immediately arise again from its parietes.

It very frequently divides, especially a little above the centre of the chest, into two, and sometimes into three branches, which almost always reunite after proceeding a greater or less distance. Sometimes it divides in this manner in more than one place; the accessory vessels enlarge more or less, and assume the characters of real trunks. When this reticulated structure exists in the greatest degree, the whole of the thoracic canal is divided into two halves.(1)

§ 1703. The valves in this canal are not numerous, either near its origin, or near its termination. One pair exists above and opposite the upper dorsal vertebra. Higher up they are double or triple. The convex edge of these valves is turned downward, and their loose or concave edge upward. They are generally arranged in pairs, and rarely three and three, or singly.

We almost always observe, where the thoracic canal opens into the venous system, before its mouth, two very perfect valves, the loose edges of which are turned toward the cavity of the vein, and prevent the reflux of the blood into the canal. They are sometimes concealed by the valves of the internal jugular vein, so that some have pretended, but very unfortunately, that they were unconnected with the thoracic canal, because that they are farther from the heart than the orifice of the canal.(2)

II. RIGHT THORACIC CANAL.

§ 1704. The *right thoracic canal*, the formation of which we have already mentioned, is much smaller than the preceding (§ 1698), and is usually only an inch long. It descends to empty into the angle of union of the right internal jugular and subclavian veins, rarely into one of these two vessels. Sometimes it does not exist; this occurs when the vessels which give origin to it open separately into the venous system.

§ 1705. There are always considerable anastomoses, not only between the vessels which unite to form the two common trunks, but also between these trunks.

The insertion of the large thoracic canal in the right half of the venous system(3) is undoubtedly only a greater development of these anastomoses, in accordance with the same law by which analogous phenomena are seen also in other parts of the vascular system; for instance, the origin of the arteries of the fore-arm above the usual point, and that of the obturator artery by a trunk in common with the epigastric artery. This anomaly is indicated also by the division of the

(1) Sœmmerring, *loc. cit.* p. 487.
(2) Portal, *loc. cit.*, p. 398.
(3) Meckel, *Ep. ad Hallerum*, p. 30.—Cruikshank, in Ludwig, p. 152.

thoracic canal into two halves, which we have already mentioned (§ 1701).

When the great thoracic canal empties into the right side of the venous system, the lymphatics of the left half of the head, the neck, the arm, the lung, the heart, &c., do not join, but are arranged like the corresponding lymphatic vessels of the right side in the normal state.

Thus when we consider the gradual development of this anomaly, we see in it the first degree of lateral inversion.(1)

The insertion of the large thoracic canal, which takes place on the left side in the normal state, seems to depend on an effort to re-establish the symmetry which is deranged by the distribution of the venous trunks on the right side.

SECTION VII.

A COMPARISON OF THE DIFFERENT REGIONS OF THE VASCULAR SYSTEM.

§ 1706. According to a law established in our introduction, there is an analogy but not a perfect resemblance between the different parts of the vascular system, in respect to its three dimensions, that is, from right to left, from above downward, and from before backward.

§ 1707. In accordance with the same law, the most marked analogy is that between the right and the left half of the system, which differ but slightly. Except inconstant variations, the only one of consequence is that in the arrangement of the trunks given off to the head and the upper extremities by the arch of the aorta (§ 1335). This difference seems to be only a part of a general type, which exists in all the arterial system. At least, the right superior aortic intercostal artery and the bronchial artery of the same side usually arise by a common trunk (§ 1439), even as in anomalies, several vessels of the right side often unite in a single trunk, while on the left side one trunk divides into several. Thus, for instance, the left carotid artery not unfrequently arises from the innominata, although the left vertebral artery often comes from the aorta: so too the left renal artery divides into several trunks more frequently than the right. In the single instance we have seen of the high division of the brachial artery on one side only, this was the left. This side also is the only one where we once observed an uncommonly high division of the popliteal artery. The obturator artery arises from the crural artery on the left side more frequently than on the right. When the innominata is divided at the arch of the aorta into its two trunks, the right subclavian artery rarely remains on the right: it goes to the left, and arises more on the left of the aorta; so that in fact this anomaly seems to depend primitively on an extra-

(1) See our *Handbuch der path. Anatomie*, vol. ii. part 1, p. 183.

ordinary development of the left side and to the predominance of its type over that of the right side; this opinion is strongly favored by the fact that in cases of this nature the right subclavian artery no longer takes the shortest course to arrive at its limb, but turns aside, passing behind the esophagus.

The special characters of the two extremities are often unusually developed simultaneously. Thus, for instance, the left carotid artery is a branch of the innominata, at the same time that the left vertebral artery arises directly from the aorta; or the right and left carotid arteries are united in a single trunk, when the right subclavian artery arises below the left.

The contrary seems to be the case with the venous and lymphatic systems; for the left subclavian and common iliac veins are much longer than the synonymous trunks on the right side, and the superior and inferior thoracic canals of the left side unite, while the right superior proceeds alone.

Finally, the arrangement not unfrequently becomes unusually symmetrical, either by the union or the divisions of the trunks, or because a trunk which is generally placed on the right or the left proceeds on the median line.

§ 1708. Although the upper and the lower halves of the vascular system are less similar than the right and the left, the analogies between them much exceed their differences.

The diaphragm separates the upper from the lower half of the vascular system. If we compare these two halves with each other, after leaving this muscular septum, we obtain the following results:

1st. In the chest, as in the abdomen, the large circulatory system comprises two, which are smaller, viz. the pulmonary circulation in the thorax and that of the vena portæ in the abdomen. The trunk of the vena portæ is an imperfect repetition of the right half of the heart: its arterial portion represents the pulmonary arteries, and the hepatic veins correspond to the pulmonary veins. The system of the vena portæ is a very imperfect imitation of the pulmonary system, because no muscular heart is there developed, and because the veins open into the general venous system. These are however two conditions, which alone or united occur in the system of the pulmonary vessels of most animals which have blood-vessels, and which are below the class of birds.

2d. The upper and the lower halves of the arterial system are repetitions of each other in the following respects:

a. The superior and inferior diaphragmatic arteries correspond.

b. The esophageal arteries, the celiac, and the two mesenteric arteries correspond by large anastomoses.

c. The bronchial arteries are represented by a part of the renal and capsular arteries, and by the hepatic. In fact we may consider the liver, the renal capsules, and the kidneys, as analogous to the lungs, whence the vessels of these organs are repetitions of those of the lungs in different degrees of perfection. The vascular system of the liver resembles that of the lungs, as it includes the different arteries of the system of the vena porta ; but it is less perfect. The renal and capsular vessels are still lower in the scale, for there we cannot trace the separation between the vessels of nutrition and those of secretion ; this separation is indicated in the kidneys by some vessels different from the renal arteries, which are distributed on the surface of these organs and in the renal capsules, by numerous vascular ramifications, which come from very different regions.

d. The thymic arteries correspond to the spermatic arteries, as both generally arise from the trunk of the aorta, and the former frequently come from the bronchial arteries and the latter from the renal arteries.

e. The aortic intercostal arteries are represented by the lumbar arteries. In fact the latter are fewer ; but as the branches which arise from the middle sacral artery, a continuation of the trunk of the aorta, present the same arrangement as they, every difference in this respect disappears. The analogy remarked between the arteries which pass through the intervertebral foramina, above and below the diaphragm, is evidently strengthened by the fact that the superior intercostal artery is a branch of the subclavian (§ 1399), as the lateral sacral artery is one of the hypogastric artery.

f. The division of the upper and lower extremities of the aorta, and the arrangement of the vessels which arise from it on one side to go to the neck, the head, and the upper extremities, on the other to the organs of the pelvis and to the lower extremities, present a most striking analogy. The primitive iliac artery corresponds to the common trunk of the right subclavian and carotid arteries. It is true the analogy does not exist on the left side, but notwithstanding this difference is not essential, as it depends on a consecutive division, the analogy between the two regions is increased by the origin of the left vertebral artery directly from the arch of the aorta, between the left carotid and subclavian arteries, which is common, since this anomaly causes, in some measure, the union of the two vessels.

The carotid correspond to the hypogastric arteries, and the subclavian to the crural arteries, in respect to situation, origin, and distribution.

Of the trunks which arise from the carotid and the hypogastric arteries the superior thyroid and its branches correspond to the uterine and the vesical arteries, the facial and the ascending pharyngeal to the internal pudic and to its branches.

The differences in this respect are as follows :

The subclavian artery gives origin to the vertebral and the inferior thyroid artery ; the hypogastric to the gluteal and ischiatic artery. These latter are distributed like the branches of the subclavian and even of the axillary arteries. The former seem, at first view, to have none which correspond to them in the inferior vascular system, or to correspond to the vessels which arise from the hypogastric artery.

This difference almost disappears when the thing is examined attentively.

We cannot in fact deny that the vertebral and the inferior thyroid artery do not properly correspond to the hypogastric artery. The carotid arteries represent only a small part of the latter, which is much developed and reduced to a considerable trunk on account of the greater size of the parts it nourishes. The hypogastric artery is then divided in the upper part of the body into three trunks, the carotid, the vertebral, and the inferior thyroid artery. Hence why the inferior thyroid artery so often wholly or in great part arises from the carotid or the innominata artery, or is entirely deficient, or is replaced by the branches of the superior. The origin of most of the vessels of the neck and of the upper region of the shoulder from the inferior thyroid artery also favors this analogy very much, as these vessels are very similar to the gluteal, the ischiatic, and the obturator arteries.

The vertebral artery is ranked as a distinct trunk because of the size of the brain and the spinal marrow, organs to which it carries blood; but it evidently corresponds in its mode of distribution, to the lateral sacral arteries furnished by the hypogastric artery.

Many vessels which correspond in their distribution, arise above from the subclavian, and below from the hypogastric artery.

The branches which arise directly from the subclavian and from the crural artery are very analogous. The internal mammary artery exactly resembles the epigastric artery, as the first proceeds on the sides of the posterior face of the sternum, and the second backward and on the sides of the linea alba which corresponds to this bone. The anterior intercostal arteries, given off by the internal mammary artery, are represented by the analogous branches of the epigastric artery.

The circumflex iliac artery seems to us to correspond exactly to the long external thoracic artery (§ 1405).

The external pudic arteries manifestly represent several external thoracic arteries.

In both extremities the trunk of the artery divides a short distance above the first articulation into a superficial vessel, which descends to the extremity of the limb, and into a deep vessel, which does not extend beyond the first articulation, that is, beyond the arm or the thigh.

The two circumflex arteries arise very high, sometimes from the superficial and sometimes from the deep trunk. They evidently correspond in their relations with the bone and the first articulation of the extremity, although they slightly differ in their distribution, as those of the arm are expanded in the superficial, and the femoral in the deep muscles, and also as one of the circumflex arteries of the arm is generally much smaller than its corresponding one in the thigh. This latter circumstance depends upon the greater development of the muscles of the thigh. The first depends upon the fact that the highest branches, arising from the hypogastric artery, are distributed to the muscles corresponding to those of the arm, which receive the blood from the circumflex arteries.

The superficial brachial artery divides like the crural, at the second articulation, into two trunks, one of which soon bifurcates in a similar manner. The anterior tibial corresponds to the radial artery, the posterior to the ulnar, and the peroneal to the interosseous artery.

The division of these vessels however differs remarkably, as it frequently occurs unusually high in the upper extremity, while this anomaly is very rare in the lower extremity, as is proved by our numerous observations and those of other anatomists.

It is difficult to assign the cause of this difference. The most probable explanation is that it depends upon the fact that the upper limbs form and are developed sooner than the lower, and are nearer the hear . Perhaps it depends partly on the greater length of the fingers, the volume of which, compared to that of the posterior part of the hand, much exceeds that of the toes, compared with the posterior part of the foot, and hence they always appear long before the latter. This anomaly, which is almost peculiar to the arteries of the upper extremities, would consequently arise from the normal arrangement of these latter; to support which conjecture, we would mention the analogous difference in the arrangements of the muscles of the fingers and toes, since the hand presents no trace of the short flexor and extensor of these appendages of the foot. We even recognize with a little attention, that all the upper part of the vascular system differs thus from the lower; for the separation of the carotid with the vertebral and inferior thyroid arteries, the constant separation of the carotid with the subclavian artery on the left side, the frequent origin of the vertebral artery with the latter, and the not unfrequent existence of a second inferior thyroid artery, (§ 1395) are analogous phenomena, of which we find no trace in the lower extremities.

Thus the vascular system of the upper part of the body is characterized by a tendency to divide. But it is not the only part where this tendency is remarked, since it is observed in the development of the brain, the multiplication of the organs of the senses, and the perfection of the extremities, which are perhaps the cause and condition of it.

The arteries of the lower extremities have entirely opposite characters. The circumflex arteries of the thigh are given off by the deep crural artery, more frequently than those of the arm are by the deep brachial. The superficial crural artery seldom divides higher than usual, and the number of branches given off by the popliteal artery, is frequently less, because the peroneal or the anterior tibial, the first much more frequently and to a greater degree than the second, ceases to form a distinct trunk, and is replaced by the branches of the other vessels of the leg, precisely as the fibula is in some measure only an appendage of the tibia, while in the fore-arm the radius and ulna are also developed, and both articulate with the humerus, and exactly also as the toes are developed much more imperfectly, and much less movably than the fingers.

The articular arteries of the elbow and of the knee differ principally,

1st. Because the upper vessels of the thoracic extremity arise higher, and are always separated from the others, while those of the pelvic extremity are situated lower, and usually arise by a common trunk.

2d. Because the inferior arteries of the pectoral limbs arise from the arteries of the fore-arm, and those of the abdominal members from the lower part of the popliteal artery. The internal and superior popliteal artery not unfrequently arises very high; there are always two smaller inferior articular popliteal arteries which arise from the anterior and posterior tibial arteries, and not very unfrequently the recurrent radial artery is given off by the brachial artery. When the popliteal artery divides a little higher than usual, its two branches furnish also the two largest inferior articular arteries of the knee.

Many anatomists mention as a difference in the distribution of the arteries of the hand and foot, the want of a superficial arch in the latter. We have never found this assertion to be correct, and it certainly depends upon a want of care in searching into the analogies. In fact the internal plantar artery doubtless corresponds in its origin and course to the superficial palmar branch of the ulnar artery. Besides we have always known it to anastomose with the plantar branch of the anterior tibial artery, so as to form a superficial plantar arch.

But there is a real difference between the origin of the arteries of the fingers and toes, inasmuch as the former arise from the superficial, and the latter from the deep arch. This deviation of the vessels on the surface of the sole of the foot, is sometimes developed to such an extent, that the arteries of the toes come from the superior rather than from the inferior perforating arteries (§ 1530). This arrangement appears to be intended to prevent the compression of the arteries of the toes by the weight of the body. Perhaps also it depends on the difference between the back and the palm of the hand, as also between the back and the sole of the foot, in regard to muscularity; and perhaps the development, on the back of the foot, of the muscles which do not exist on that of the hand, is the reason that the arteries of the toes arise more deeply. Finally, this difference sometimes disappears, since in some subjects the arteries of the fingers are given off by the superficial palmar arch.

3d. The veins of the upper and lower portion are perhaps more similar than the arteries, at least the arteries present a difference which does not exist in the arrangement of the left jugular and subclavian veins, and that of the left primitive iliac vein.

4th. The upper and lower portions of the lymphatic system, also present the same analogies in respect to the existence, the number, and the situ ation of the vessels and of the glands.

§ **1709.** In the vascular system as in the rest of the organism, the analogy is not so great forward and backward, as from right to left, and from above downward. We may, however, in this direction, compare the internal mammary and the epigastric arteries to the aorta, and its branches to the posterior intercostal and the lumbar arteries. So, too, there is a correspondence between the anterior and the posterior branches of the anterior and posterior intercostal arteries and of the lumbar arteries: perhaps in the neck and in the head, between the superficial and the deep arteries, certainly in these two regions, and in the spinal marrow, between the anterior and the posterior spinal, and also between the occipital and the frontal arteries; finally in the limbs between the anterior and posterior circumflex arteries of the humerus, the external and internal circumflex arteries of the femur, the superficial and the deep brachial and the crural arteries, the radial and the ulnar, and the anterior and the posterior tibial arteries, the dorsal arches of the back of the hand and of the foot, and the superior interosseous arteries of the plantar and palmar arches.

The venous system presents the same analogies, which are rendered still more striking by the existence of an azygos and of a semi-azygos vein, which correspond very evidently to the internal mammary veins.

We may compare with the large thoracic canal, which proceeds before the vertebral column, a second lymphatic duct, which ascends behind the sternum.

BOOK V.

NERVOUS SYSTEM.

§ 1710. The nervous system(1) is generally divided into that of *animal* life and that of *vegetative* life, or into the *cerebral* system and the *ganglionic* system. Both are composed of an *internal* or *central* part, and of an *external* or *peripheric*. But we have already mentioned the reasons which prevent us from drawing the line between these two systems as distinctly as is usually established. We shall discuss the question more fully when speaking of the great sympathetic nerve. We shall then consider the nervous system as a whole, divided into a centre and a periphery.

SECTION I.

CENTRAL PART OF THE NERVOUS SYSTEM.

§ 1711. The central part of the nervous system is composed of the *spinal marrow* contained in the spinal canal, and of the *encephalon* contained in the skull. Bartels has proposed to designate it by the

(1) Besides the writers mentioned in the first volume who, in their general remarks on the nervous system, have given a complete description of the central part of this system, and who have even described in part its periphery, as Willis and Vieussens, we shall mention also the following, 1st, for the topography of the whole nervous system, A. Monro, *An. of the human bones, nerves, and lacteal sac and duct*, Edinburgh, 1732, 1750, 1777.—Id., *Nervorum an. contracta lat. reddita a Coopmans*, Franeker, 1754.—R. Martin, *Institutiones neurologicæ sive de nervis corporis humani tractatio*, Stockholm, 1781.—J. G. Haase, *Cerebri nervorumque corporis humani anatome repetita*, Leipsic, 1781.—D. E. Gunther, *Cerebri et nervorum distributionis expositio*, Duisburg, 1786.—G. Coopmans, *Neurologia c. obs. de calculo ex urethra extracto*, Franeker, 1795.—2d. Topography of the whole central portion or of some of its parts; N. Steno, *Discours sur l'anat. du cerveau*, Paris, 1679.—H. Ridley, *Anatomy of the brain*, London, 1695.—V. Malacarne, *Nuova esposizione della vera struttura del cerveletto umano*, Turin, 1776.—S. T. Sœmmerring, *De basi encephali et originibus nervorum e cranio egredientium*, Gottingen, 1788.—V. Malacarne, *Encefalotomia nuova universale*, Turin, 1780.—Sœmmerring, *Vom Hirn und Rückenmarck*, Mayence, 1788.—Malacarne, *Neuro-encefalotomia*, Pavia, 1791, 1798.—Sœmmerring, *Tabula baseos encephali*, Francfort, 1799.—Chaussier, *Expôsition sommaire de la struct et des diff. parities de l'encephale*, Paris, 1807.—Sœmmerring, *Academicæ annotationes de cerebri administrationibus anatomicis vasorumque ejus habitu*, in the *Denkschriften der acad. zu München*, 1809.—Rosenthal, *Beytrag zur encephalotomie*, Weimar, 1815.—C. L. Somme, *Recherches sur l'anatomie comparée du cerveau*, Antwerp, 1824.—Rolando, *Saggio sulla vera struttura del cervello*, in the *Dizionario periodico di medicina*, Turin, 1822, &c. Ludwig, *Scriptores neurologici minores selecti*, Leipsic, 1791, 1795.—In describing each part of the nervous system we shall mention the authors who have treated of them specially.

collective term *cerebrum;* but the term *cerebro spinal axis* is better. It bulges very much in its anterior or cephalic part, while, in its posterior or spinal, it terminates in a rounded, long, and thin cord. In a full-developed man it does not weigh quite four pounds apothecaries' weight.

CHAPTER I.

SPINAL MARROW.

§ 1712. Of the central parts of the nervous system we ought to mention first the *spinal marrow* (*medulla spinalis, s. dorsalis, corda spinalis*, Gordon, *Cerebrum oblongatum*, Collins,(1) *Corps et extremité inférieure du prolongement rachidien de l'encephale*, Chaussier), because it is formed first in the animal series and in the fetus.

§ 1713. Anatomists are not agreed as to the limits of the spinal marrow. Its lower extremity is well marked because the central portion of the nervous system there ceases; but all authors do not agree in respect to its upper extremity. Some confine the term *spinal marrow* to that part of the nervous system within the vertebral column, so that, in their opinion, it terminates at the first cervical vertebra and at the origin of the first cervical nerve. Others, on the contrary, include also under this term the lowest part of the mass within the skull, the medulla oblongata. Some also add the annular protuberance, the cerebral peduncles, the thalami optici, and the corpora striata.

The last two methods seem to us incorrect, because the medulla oblongata differs much from the cord contained in the spinal marrow, not only in its size but also in its structure and situation, the arrangement and the distribution of its nerves; and because in all these respects it resembles the rest of the mass lodged in the skull. As to the second, the only arguments in its favor are, that the spinal marrow continues uninterruptedly with the medulla oblongata, and that the annular protuberance seems to establish the boundary between this and the rest of the mass in the skull. But these two circumstances prove nothing, because the anterior cords of the spinal marrow are also uninterruptedly continuous with the cerebrum across the annular protuberance, and the posterior are also continuous with the cerebellum, on the outside of this protuberance, so that if we did not regard more essential differences there would be no separation between the cerebellum and the spinal marow, as the asserters of the third opinion mentioned above maintain.

(1) Rolando, *Ricerehe anatomiche sulla struttura del midolla spinale*, Turin, 1824. Ollivier, *Essai sur l'anatomie et les vices de conformation de la moelle epiniere chez l'homme*, Paris, 1823.—Racchetti, *Della struttura della midolla spinale*, Milan, 1816.

I. EXTERNAL FORM.

§ 1714. Generally considered, the spinal marrow is cylindrical; it is however a little broader from one side to another than from before backward, and thus in the first direction it appears slightly flattened. It may be divided into a *cervical* and a *thoracic* part, according to the regions of the vertebral column it occupies; in its extent from one extremity to the other it has several prominences.

The first is seen at the upper part of the neck, where the cord becomes a little broader. Its breadth is seven lines in this place, while above it is a little less than six lines. Its thickness from before backward, far from increasing, often sensibly diminishes, and is not quite half an inch.

The *upper* or *cervical* prominence extends from the lower extremity of the cervical portion to the upper extremity of the thoracic portion, where it suddenly stops. Its length is a little more than three inches, and occupies the space between the second cervical and the first dorsal nerve. It is broadest near the fifth cervical nerve. The middle region of the thoracic portion of the spinal marrow again contracts. It is a little thinner than the cervical portion above the upper prominence.

The spinal marrow forms, near its lower extremity, a second prominence, called the *inferior* or the *lumbar*, which is never as large as the upper, and which extends from the first lumbar to the third sacral nerve. This projection is two inches long and five lines broad. It gradually becomes thinner and terminates in a blunt point. This blunt extremity is generally single, sometimes it is evidently bifurcated, and presents a superficial transverse fissure from whence a tubercle arises.

After leaving this point, which corresponds to the first lumbar vertebra, the nervous substance diminishes; and at the extremity of the vertebral canal, the spinal marrow appears only as a rounded filament, a little larger above than below, not quite one line thick in its whole extent, and is formed by the pia-mater. This filament which may be divided into several longitudinal fibres, descends between the origins of the nerves of the lower extremities, concealed by them, and extends to the lower extremity of the spinal canal, where it is attached to the dura-mater.

Hence it follows that the nervous substance of the spinal marrow, or the proper spinal marrow, by no means fills the whole vertebral canal, and occupies only about two thirds of it, the cervical and the thoracic portions being to the lower portion of the vertebral column as 2 : 1. The spinal marrow is also smaller than the vertebral canal in its other two dimensions.

Its anterior and posterior faces present a longitudinal groove as far as the medullary substance extends; this corresponds to the median line, and is the *anterior* and the *posterior median groove* (*scissuræ medullæ spinalis medianæ anterior et posterior*), which divides this part into two symmetrical halves, a right and a left. These two grooves are extremely narrow, and anatomists differ in respect to their existence and proportional depth.

Some, particularly Haller, assert that the posterior is never or seldom found; Chaussier says expressly that the anterior groove is at least deeper and broader than the posterior; others, as Blasius, Petit, Vicq-d'Azyr, Gall, and Carus, say that the posterior is deeper than the anterior, which Vicq-d'Azyr and Carus think is the broader.

Others, Gordon for instance,(1) mention no difference between the two grooves. Bichat also expresses himself vaguely, for he only says that the two lateral halves are very distinct particularly anteriorly.

We have always observed an anterior and a posterior groove, the latter generally very narrow, and rarely deeper than the other, although neither penetrates to the centre of the spinal marrow and to its gray substance. When the posterior seems deeper than the anterior, we have several times found that it was enlarged during dissection, so that adopting the opinion of several correct anatomists, our predecessors, we believe the anterior groove to be larger in every direction than the posterior. The latter is much more perceptible in the prominences, particularly the lower, than in the rest of the spinal marrow.

Besides the median groove we observe also, on each side, but not exactly between the first two, and a little nearer the posterior than the anterior, a more superficial groove, which proceed obliquely inward and forward, and are called the *lateral grooves* (*fissuræ laterales*). These two grooves proceed then to meet each other and the posterior, whence each lateral portion of the spinal marrow is also divided into two other halves, an anterior and a posterior, the former being much the larger. But these grooves are generally only simple depressions, or are at least more superficial than the preceding We cannot trace them the whole length of the spinal marrow, and they are seen only in the upper region of its thoracic portion. They separate on each side, the most posterior part of the circumference of the spinal cord from the rest of this circumference, not far from the posterior median groove. They not only converge inward and forward, but also downward, in the longitudinal direction of the spinal marrow, until they finally unite at the summit of its thoracic portion.

These lateral grooves are much more distinct in the early periods of life, than at a later period, when they frequently disappear and leave not the least trace.

We must distinguish them from the other two lateral grooves, the *anterior* and the *posterior* (*sulci laterales anterior et posterior*) which exist on each side, the whole length of the spinal marrow, and which are much broader than the preceding. These grooves receive the roots of the spinal nerves; thus they include numerous small depressions, situated after each other, from above downward, and into which the branches of the nerves penetrate.

(1) *Mem. de Paris*, 1781, p. 599.

The posterior is larger than the anterior.(1) It seems to be a real fissure, more than a simple groove, since it penetrates internally as a very thin wrinkle, in the same direction as the lateral groove described above, and meets that of the corresponding side. This posterior groove not only receives the posterior roots of the spinal nerves, but also marks the limit between the anterior and the posterior medullary cords, into which each half of the spinal marrow is divided, and which slightly project upon the surface of the spinal cord, which is otherwise rounded.

II. STRUCTURE OF THE SPINAL MARROW.

§ 1715. We have already described (vol. 1) the intimate texture of the spinal marrow; we then have only to state in what manner the gray and the white substances are united, and the arrangement of the large division of these substances.

I. SUBSTANCES OF THE SPINAL MARROW.

§ 1716. The spinal marrow is composed of a gray and of a white substance, the first of which is every where surrounded by the second, and forms a nucleus which this latter envelops on all parts, or at least in most of its circumference.

These two substances differ in form. The gray is composed of a cen- t al transverse portion, and of two lateral parts, which send a penniform prolongation forward and backward. Each prolongation is arched, concave outward, convex inward, much thicker and blunter before than behind, where, except in the lumbar projection, which is almost as thick at its posterior part as in the anterior, it terminates in a point which is particularly evident in some subjects. It terminates loosely at the circumference of the spinal marrow, although it is not covered by the white substance, while the latter envelops its anterior extremity.

These penniform prolongations very probably, have intimate relations with the origin of the spinal nerves; for the posterior extends exactly in the groove whence the posterior series of their roots arise, and the anterior also goes towards the anterior groove.

The white substance is arranged in an opposite direction from the grey, is convex externally and internally, and the gray nucleus is lodged in it as in a cavity. It is much thicker on its sides than in its other parts. Its right and left portions are not united forward except by a thin layer, which, however, exists through all the spinal marrow, and separates the anterior groove from the gray nucleus. Vicq-d'Azyr(2) asserts that they are not united at all posteriorly; he thinks that the posterior groove penetrates to the gray nucleus; but they in fact appear to us to be connected by rather a thick medullary

(1) *Loc. cit.*, p. 177.
(2) *Loc. cit.*, p. 600.

layer, the existence of which is proved by dissection and by the analogy of the brain.

The proportional quantity of the gray substance is not the same in all parts of the spinal marrow. There is more of it at the lower than at the upper part of the cord. In the full grown fetus the lower part of the spinal marrow is frequently formed entirely of this gray substance, while in the rest of it a very distinct line of demarkation is already drawn between this and the medullary substance. Not unfrequently the gray substance in the adult is brighter, and the white browner than usual, and thus the texture of the medulla oblongata is more uniform than that of the rest of the central mass.

II. ARRANGEMENT OF THE GREAT DIVISIONS OF THE SPINAL MARROW.

§ 1717. The spinal marrow is composed in all parts of two lateral halves, or of two cords, which are fitted to each other, separated by two median grooves in most of their thickness, but united in the centre by the tranverse portion of the nucleus (§ 1716), backward and forward by the transverse layers of the white substance (§ 1718).

Each of these two lateral cords is formed of two halves ; an anterior which is much the larger, the form of which is that of a figure of 8 inverted (∞), and a posterior, which is much smaller and prismatic. The latter passes a little beyond the anterior posteriorly ; its base looks outward, and its summit inward.

Those two portions are separated by the posterior prolongation of the gray nucleus, and by the posterior lateral groove. The posterior cords are not only thinner and narrower than the anterior; they are also a little shorter, but not by any means in the same proportion. The lower extremity of the spinal marrow is formed entirely by the anterior, so that, seen from the side, it appears much lower in this place than in the rest of its extent.

Farther, each posterior cord is likewise composed of two portions, an external, which is larger, and an internal smaller, which are separated by a superficial but very distinct groove. Although this arrangement is also observed in the adult, it is much more evident in the early periods of life, and in animals, during their whole existence.

Most anatomists admit that the spinal marrow is composed of two lateral halves. Asch,(1) Monro,(2) and Sœmmerring,(3) have described the two cords which form it more or less minutely, the anterior which is larger, and the posterior which is smaller. Chaussier(4) even admits three on each side : he places the anterior and the posterior be-

(1) *De prima pare nervorum ;* in Ludwig, vol. i. p. 238.
(2) *Ueber das Nervensystem*, p. 22.
(3) *Nervenlehre*, p. 59.
(4) *Loc. cit.*, p. 148.

tween the two median grooves and the anterior and posterior lateral grooves and the middle cord between the latter.(1)

§ 1718. The large lateral cords of the spinal marrow, are fitted to each other in all their length, separated by the median grooves, but again united and blended in the centre. This central part may be termed the *anterior and posterior medullary commissures*, and the *median or cortical commissure*.

Gall thinks that the anterior and posterior medullary commissures differ, the first being composed only on the two sides of longitudinal fasciculi, placed side by side, while the second presents on both sides transverse slips, which exactly fit into each other. As yet we have not been able to satisfy ourselves of these two arrangements.

The posterior cords remain on the same side in all their extent. The anterior, on the contrary, *intercross* at the upper extremity of the spinal marrow, and those of the right side pass to the left, and those of the left side to the right, and all cross obliquely in this place. This decussation which is about five lines long, is indicated on the posterior face, where the anterior fissure does not exist in all its extent, and gives place to a broad but very superficial depression, to reappear immediately, and even deeper than before on the medulla oblongata. It becomes still more apparent on its anterior face, when we carefully separate the spinal marrow transversely in this place. The two cords do not intercross, but pass in a mass from one side to the other: they divide into from three to five fasciculi, which pass some above the others, like the fingers when the hands are clasped. The anterior cords however, do not wholly cross; their anterior and their posterior parts only present this arrangement. We may easily be convinced of this by a transverse section of the spinal marrow in this place: it is then very manifest, that a white medullary band is detached on each side from the posterior extremity of the anterior cord, which goes forward and inward, and intercrosses with that of the side opposite, while the lateral parts continue their progress from below upward uninterruptedly. By this decussation, the anterior part of the gray nucleus of the spinal marrow, is divided into two lateral portions, each comprised between the internal face of the decussation, and the external lateral portion of the anterior medullary cord.

But we have never found that the anterior internal part of the anterior cords of the spinal marrow which produce the pyramidal bodies of the medulla oblongata, remains on the same side, and that the intercrossing was confined to the fasciculi which proceed from the posterior

(1) Gall (*loc. cit.*, p. 115) and Chaussier (*loc. cit.*, p. 148) assert that Highmore mentions each half of the spinal marrow as composed of four cords, and consequently that the whole number of these last is eight. It would seem that Gall repeated the assertion after Chaussier, but we find nothing to justify it in the passage referred to by the Paris professor (*Anat.* b. iii. p. 1. chap. viii.) and Linden also quoted by Chaussier, says nothing like it. Although Chaussier rejects Highmore's opinion, it is not however contemptible, since by uniting Chaussier's description and our own, we arrive at the same conclusion.

part of this cord to the medulla oblongata.(1) If it was thus the decussation would not be visible externally: the anterior part would continue uninterruptedly to proceed externally along the same side of the body, and would receive the fibres from the posterior part of the cord on the other side only very deeply, but this is never seen.

This decussation is so evident, that we can hardly conceive of its being doubted by several anatomists, as Sabatier,(2) Vicq-D'Azyr,(3) Chaussier,(4) and Gordon(5). Gordon states that he does not speak of the two or three bands by which the anterior groove of the spinal marrow is interrupted at the union of the cervical with the cranial portion, except on account of the absurd theories with which physiologists have often connected it. But this decussation has been demonstrated since the time of Mistichelli,(6) by Petit,(7) who was the first to demonstrate it exactly: by Santorini,(8) by Vicq-D'Azyr,(9) with less of precision and clearness,(10) finally, it has been well described by Gall and Cuvier. It has been partly figured by Petit, Santorini, and Gall.

All the objections against its existence are refuted by a positive fact, that the particulars previously described in the whole spinal marrow, are observed only in the place mentioned, and are there constant.

But the cords of the spinal marrow intercross in no other place, and although the contrary has sometimes been maintained,(10) all other arrangements of the spinal cord which resemble these decussations, are only intended to unite the commissures.

The structure indicated by dissection, is demonstrated by the difference between the phenomena which occur when the central portion of the nervous system is injured either above or below the place we have mentioned.

§ 1719. The substance of the spinal marrow of man is solid, not only when it is perfectly devoloped, but even sometime after birth, although several writers have admitted a cavity within it. We may conclude this from the difference in the opinions of authors in regard to the situation and the size of this cavity. Stephanus mentions its existence only as a general fact, without telling where it is situated.(11) Morgagni asserts that it is placed in the centre of the spinal marrow, especially its upper part, where he has frequently found small longitudinal cavities entirely covered with gray substance, and where once even he found

(1) Rosenthal, *Beitrage zur Encephatotomie.*

(2) *Mém. sur la moelle de l'epine et ses enveloppes*; in the *Trait. d'anat.*, vol. iii. p. 452.

(3) *Mém. de Paris*, 1781, p. 598.

(4) *Loc. cit.*, p. 143.

(5) *Human anatomy*, vol. i. p. 177.

(6) *Dell' apoplessia*, Rome, 1709.

(7) *Lettre d'un medecin*, 1710, p. 11.

(8) *Septemdecim tabul.*, p. 28-29, vol. ii.

(9) *Loc. cit.*, p. 598.

(10) We instance Bartel's opinion, who considers respiration as a motion dependent on the brain.

(11) *De diss. part. corp. hum.*, b. iii. Paris, 1545, b. iii. c. xxxv. p. 341.

one which was very large, five fingers long.(1) Portal seems to have observed it in the same place: but once he found it comprised all the spinal marrow, and that it appeared to be covered with a very thin membrane: and another time it extended only to the fourth cervical vertebra. Gall, however, describes two canals existing all the length of the medulla, one on the right, the other on the left, which do not communicate with each other, or with the cerebral ventricles, but terminating in culs-de-sac, in the thalami optici, where they enlarge and produce a cavity the size of an almond, while the single and median cavity of the other writers is considered by them only as a prolongation of the fourth ventricle.

We have never found in man after birth, a median canal or two lateral canals. The circumstances under which they have been found by Gall and Portal, prove them to have been morbid. From Gall's observations, it cannot be doubted that the canals he saw were produced by art, since he remarks that they could be demonstrated only by dividing the spinal marrow in such a manner that air might be introduced for six or eight lines. The smoothness and distinctness of the surfaces do not prove the real existence of the canals in question, for the first circumstance depends on the softness of the nervous substance, and the second on th ecentral prolongation of the pia-mater. We shall add one observation which we have always made, viz. that the ease with which these canals may be demonstrated, is in a direct ratio with the softness of the medulla oblongata; and it is much more easy by continuing the inflation to make these communicate with the fourth ventricle, than to follow them into the thalami optici. We have succeeded, when the spinal marrow was soft, in pushing air into its whole length, without employing any cutting instrument, and without thinking that the existence of a normal cavity was proved by the space found in a soft and viscous mass, after having employed such a mode.

We discover only at the top of the spinal marrow, a rounded and extremely narrow canal, from six to nine lines long, terminating below by a cul-de-sac, and continuous above with the floor of the fourth ventricle.

III. WEIGHT OF THE SPINAL MARROW.

§ 1720. The absolute weight of the spinal marrrow, in the adult when deprived of its envelops, and entirely separated from its nerves, is more than an ounce. It is to the brain as 1 : 40.(2)

(1) *Adv. anat.*, vi. *anim.* 14.

(2) Chaussier establishes a ratio more favorable to the spinal marrow, as he gives the proportion as 1 : 19--25, but this is evidently wrong, doubtless because the origins of the nerves were not removed.

IV. CONSISTENCE OF THE SPINAL MARROW.

§ 1721. It is generally thought that the spinal marrow is softer than the cerebrum. When, however, it is observed in the recent state, we remark, that although it is less consistent than some parts of the encephalon, particularly the annular protuberance, it is at least harder than the cerebrum and cerebellum.(1)

CHAPTER II.

ENCEPHALON.

§ 1722. The *encephalon* (*encephalum*), or that part of the central portion of the nervous system contained in the skull, has a rounded and oblong form. It is composed of two parts, which differ in size and arrangement; an inferior which forms its base, and a superior which extends upwards and on the sides. These two parts are however directly continuous with each other, and with the spinal marrow.

The upper part very naturally divides into two portions, the *cerebrum* and the *cerebellum*, which differ in respect to situation size and structure. But it is more difficult to establish divisions in the lower part, since the different segments which form it, pass into each other by less evident shades. Hence, also, the difference which exists between authors in regard to the extent of the parts embraced by the same name.

Thus the term *medulla oblongata* has been used to designate a greater or less segment of the lower part of the encephalon: but some give this name to all the parts which form the lower region of this viscus, while others apply it only to some of them, and are not agreed in respect to the number of the parts which are thus collectively designated.

Many have limited the meaning of the word still more, and employ it only to designate the lower part of the nervous substance, which extends from the occipital foramen to the annular protuberance. Such is, for instance, the method of Haller, Sœmmerring, Cuvier, Chaussier and Bichat. Some of these anatomists, however, particularly Sœmmerring, Bichat, and Chaussier, have considered the medulla oblongata not as a particular portion of the central mass of the nervous system, but only as the upper extremity of the spinal marrow, as we have already remarked.

The middle region of the encephalon is situated in front of this part, and is considered by some writers, as Chaussier and Bichat, as a special segment of this mass, called the *cerebral protuberance* (*protuberantia cerebralis*) by Bichat, and the *mesocephalum* by Chaussier.

But these two authors do not give it the same limits, for Chaussier

(1) Chaussier, p. 116.—Gordon, p. 182.

states it to be composed only of the annular protuberance, the tubercula quadrigemina, and of the valvula cerebralis, while Bichat includes in it also under the term *prolongations*, those medullary fasciculi which extend from the annular protuberance forward to the cerebrum, and backward to the cerebellum. Others, as Gordon, consider the annular protuberance as belonging to the cerebellum.(1) Vicq-d'Azyr had already said with more justice, that it must be described separately, and that it belongs neither to the cerebrum nor to the cerebellum.

ARTICLE FIRST.

MEDULLA OBLONGATA.

§ 1723. The best mode, in our opinion, is to include under the term *medulla oblongata*, not only what Haller and his successors have so termed, but also the annular protuberance; to insulate this part from the rest of the encephalon, and then to divide the remainder into two other portions, the cerebrum and the cerebellum. We also maintain this position, as the portion we include under this term still belongs in common to the cerebrum and cerebellum, while that which is found in front of it, belongs only to the cerebrum, and that which is behind it makes a part of the cerebellum. We also ground ourselves on the fact, that what Haller and others term the *medulla oblongata*, differs so much from the rest of the spinal marrow in respect to structure, that we must consider it separately(§ 1713).

The *medulla oblongata*, in our opinion, occupies all the length of the base of the skull, from the large occipital foramen, to the posterior edge of the sella-turcica. Its form is irregularly quadrilateral as it gradually enlarges from behind forward. It is continuous below with the upper extremity of the spinal marrow, anteriorly with the cerebrum, laterally and superiorly with the cerebellum. We must therefore consider it the point of union, or the focus of these three segments of the central portion of the nervous system.

The posterior and inferior part, the proper medulla oblongata of several writers, may perhaps be termed the *rachidian bulb*, as Chaussier(2) and Bartels(3) call it; the anterior and upper will retain its usual name of *annular protuberance*.

I. RACHIDIAN BULB.

§ 1724. The *rachidian bulb* (*bulbus rachidicus*, *bulbus rachidicus superior*, s. *medulla oblongata*, Haller, *pars cephalica*, s. *extremum cephalicum*, s. *spinalis medullæ principium*) is the most posterior and the most

(1) *Loc. cit.*, p. 112.
(2) *Loc. cit.*, p. 120.
(3) *Vom. Athmen*, p. 108.

inferior part of the encephalon, the direct continuation of the spinal marrow. It extends from the first cervical vertebra to the centre of the body of the basilar bone, and exactly fills the posterior part of the upper and concave face of this body.

It has the form of an elongated triangle, and swells insensibly from behind forward, and from below upward. It generally does not exceed an inch in length, and its greatest breadth is about eight lines.

I. EXTERNAL FORM.

A. LOWER FACE.

§ 1725. The lower face of the rachidian bulb is slightly convex, and divided by a groove two or three lines deep, into two halves, a right and a left, which is continuous with the anterior groove of the medulla oblongata, from which, however, it is slightly separated by the decussation of the anterior cords.(§ 1718)

This inferior face presents two pairs of eminences, the *pyramids* and the *olivary bodies*.

a. Of the pyramids.

§ 1726. The *pyramids* (*eminentiæ*, s. *corpora pyramidalia*, s. *corpora pyramidalia antica*, s. *eminentiæ oblongæ*, Gordon, *medianæ internæ*) are visible with the intercrossing of the anterior cords of the spinal marrow (§ 1718), and are situated entirely inward, so that their internal faces touch. They occupy the whole length of the medulla oblongata. They are from about two and a half to three lines broad. They gradually become broader from below upward, and at the same time their upper projects more than their lower part. They terminate anteriorly by a contracted and rounded extremity, at the posterior edge of the annular protuberance, which projects downward and forward much beyond it. At the same time, they separate slightly from each other, so as to leave in the median line, between them and the posterior edge of the protuberance, a small triangular hollow, into which the pia-mater penetrates. The anterior groove of the spinal marrow extends between the two pyramids, and becomes deeper at their upper part. Although these eminences terminate as such at the annular protuberance, they however pass uninterruptedly through it, and go forward.

There is no decussation above the point we have already mentioned (§ 1718). The pyramids are also separated from each other by the anterior groove, in the rest of their length, always excepting the place directly below their upper extremity, where they are reunited by a small transverse medullary commissure, about a line and a half high. This reunion occurs at least frequently, just before they separate from each other, as if in this place their substance was pressed forward.

Prochaska asserts(1) that there is no gray substance within them: we have succeeded no better than Vicq-d'Azyr(2) in finding it.

In passing from below upward, they send off filaments which are entwined around the olivary bodies.(3)

b. Olivary bodies.

§ 1727. The *olivary bodies*, the *olivary eminences*, the *lateral eminences* (*olivæ*, s. *eminentiæ olivares*, Vieussens, s. *laterales*, Chaussier, s. *ovales*, Sœmmerring, Gordon), are situated on the outside of the pyramids. They go a little obliquely from below upward, and from behind forward, and form a rounded very elongated prominence, the largest diameter of which is from above downward. The prominence which disappears gradually above and below, passes from the lower face to the lateral face of the medulla oblongata, and is about seven lines long, two and a half broad, and one high. The olivary eminences do not extend so high as the pyramids: they cease about a line below the posterior edge of the annular protuberance.

The roots of the hypoglossal nerve arise from the groove between them and the pyramids.

These eminences are medullary externally, but the thin layer of white substance which covers them, is easily raised, and we then perceive a solid gray elongated nucleus, surrounded by an uneven and serrated edge, the centre of which is white, and the circumference of a deep gray. This nucleus is always loosely imbedded in medullary substance, and is called the *corpus fimbriatum* (*corpus olivæ fimbriatum*, s. *denticulatum*, s. *rhomboideum*). When cut longitudinally, tranversely, or horizontally, we see very evidently that the gray border of the olivary bodies is interrupted inward, and consequently that the white substance which they inclose, is continuous on this side with the pyramids. This gray edge, on the contrary, unites below with the gray substance of the spinal marrow. From the place of decussation, and even by this decussation, the gray nucleus of the spinal marrow is divided anteriorly into two halves (§ 1718). The olivary bodies seem to be only a development of this arrangement. In fact, new medullary substance develops itself in the gray substance as the spinal marrow enlarges in this place, and is continuous internally with the pyramids. It perhaps would be more correct to say that the latter enlarges outwardly, and that it penetrates into the gray substance in the same manner as the two halves of the spinal marrow separate from each other on the two sides, before it enters the skull, and are enveloped by the gray substance.

(1) *De struct. nerv.*, Vienna, 1779.—*Opp. min.* vol. i. p. 373.
(2) *Mem. de Paris*, 1781, p. 587.
(3) Santorini, *Septemd. tab.*, p. 26—27.

B. LATERAL FACES.

§ 1728. The two lateral faces of the medulla oblongata, are sloped and slightly convex outward. They are formed by a medullary projection situated outward and backward before the olivary bodies, which goes from below upward, and from within outward, and arrives at the cerebellum. This projection is called the *lateral pyramid*, the *restiform body*, the *crus of the cerebellum*, the *posterior eminence*, the *peduncle of the spinal marrow* (*eminentia pyramidalis lateralis*, Tarin; *corpus*, s. *processus restiformis*, Ridley; *crus cerebelli ad medullam oblongatam*, *eminentia posterior*, Chaussier; *pedunculus medullæ spinalis*, Gordon). Those of the two sides unite at their inferior internal extremity. Each of them is a prolongation of the posterior cord of the spinal marrow at its side. Where they unite, they project slightly inward. They separate from each other from below upward, from behind forward, and from within outward.

A thin medullary layer about three lines long, and less than three broad, leaves the back part of the upper edge of the restiform body on each side; this goes inward. These two layers are separated by the pia-mater, which passes from the restiform body of one side, to that of the other, but they never unite in a state of perfect development. They may be termed the *small bridges of the rhomboidal sinus* (§ 1729), and may be considered as indicating the union of the two posterior cords. A second and larger, and particularly thicker medullary prolongation, arises from the anterior part of the restiform body, and is covered by the root of the pneumo-gastric and hyoglossal nerves, and is attached to the choroid plexus of the fourth ventricle.

C. UPPER FACE OR CALAMUS SCRIPTORIUS.

§ 1729. The lateral face is imperceptibly continuous with the upper face, by means of the restiform body. This upper face is very much grooved at its anterior and larger part, and these present a triangular depression, which terminates in a point, and is called the *rhomboidal sinus*, the *sinus of the medulla oblongata*, the *ventricle of Arantius*, the *fossa of the fourth ventricle*, the *triangular fossa* the *calamus scriptorius*, (*sinus rhomboideus*, *sinus bulbi rachidici*, *ventriculus Arantii*, *foveola ventriculi quarti*, Chaussier; *fossa triangularis*, Gordon). This depression extends more or less into the upper extremity of the spinal marrow, where it gradually contracts to a considerable degree.

On the superior face of the medulla oblongata, directly at the side of the median depression, we observe two medullary cords, which gradually enlarge from behind forward, and are only the upper face of the anterior cords of the spinal marrow, which traverse the spinal marrow from below upward. Between them and the restiform bodies is a broader layer of gray substance.

a. Medullary striæ of the upper face.

§ **1730.** Near the anterior extremity of the upper face, we constantly observe white striæ,(1) which go from within outward, usually project a little, and generally extend from the median depression to the outer part of the face, but which vary in respect to their existence, number, volume, progress, and direction.

1st. *Existence.* They are, in fact, very constant: but they are sometimes deficient on one or even on both sides. We have never seen a case of the latter, but the former we have met with twice, and always on the left side. Prochaska(2) and Wenzel(3) have seen both.

2d. *Volume.* They vary in respect to the three dimensions. Sometimes they are extremely narrow from above downward, almost capillary, and at the same time single. In other cases they form considerable striæ, which are more than two lines broad. Sometimes, also, they are very thin, and do not pass beyond the inferior face of the rhomboidal sinus, and do not penetrate into it. They not unfrequently form a rounded projection above this same face, and penetrate more or less into the medulla oblongata, so as to arrive at its lower face. Finally their length varies much. Generally, but not always, some or all of them extend outward to the auditory nerve, and usually go inward to the median groove: but sometimes also they proceed beyond this groove, and blend with those of the opposite side. Not unfrequently they do not extend to it. We have generally remarked, that when they are large and numerous, they usually unite in part or entirely, on the median line.

3d. *Number.* Their number varies sometimes; it is independently of their size, and most generally is inversely as the latter, from one only to fourteen.

4th. *Arrangement.* The striæ of one side generally interlace differently together.(4) They are however sometimes entirely distinct.

5th. *Direction.* Their direction, most generally, is more or less transverse, although a little oblique from behind forward. Sometimes they proceed almost directly forward. All, or at least some of these striæ, most generally extend to the auditory nerve, as we have already stated, and very evidently form the most internal part of its origin.

Very commonly also, the anterior which compose the smallest part of the mass, go obliquely farther forward and outward towards the trifacial nerve, although we cannot clearly demonstrate any connection between them and this nerve. The posterior are sometimes attached to the filaments of the root of the pneumogastric nerve.

They frequently vary in a most striking manner, in every respect, on both sides of the body in the same subject.

(1) Prochaska *De struct. nerv.*, Vienna, 1779.—Wenzel, *De penit. struct. cerebri*, ch. xxiii.
(2) *Loc. cit.*, p. 388.
(3) *Loc. cit.* p. 171.
(4) Wenzel, *loc. cit.*, p. 173—We have seen this several times.

These striæ are very probably not only the roots of the auditory nerve, but are connected, although less evidently, both with the trifacial and with the pneumogastric nerve, of which we shall speak more fully, when endeavoring to establish a fewer number of cerebral nerves than generally admitted.

b. Gray bands of the upper face

§ 1731. Before the white striæ, we see on the upper face of the medulla oblongata, other larger and slightly elevated striæ,(1) which arise at some distance outside of the median line, so that their internal extremities are never blended. These striæ extend from within outward, gradually swell, are convex forward, and pass over the anterior part of the posterior pyramids. They always unite with the auditory nerve at their external extremity, and are very constant: for of ninety-seven cases they were deficient in only two.(2) They are called the ***gray bands*** (*fasciolæ cinereæ*). They are also generally much marked, and are similar on both sides: but sometimes, although very rarely, those of the two sides are dissimilar, or they are scarcely perceptible on either: this peculiarity depends neither on the age nor on the sex. They arise generally by one, and rarely by two roots, and are always single on each side. Their intimate connection with the auditory nerve, is proved by the fact that it disappears in deaf people.

II. TEXTURE.

§ 1732. The cords of the spinal marrow enlarge in the medulla oblongata, and divide there into fasciculi, more evidently than in the spinal marrow. At the same time, the posterior separate from below upward, and distinct bodies, the ***olivary bodies***, are developed in the substance of the anterior, which are unconnected with the organization of the spinal marrow.

The anterior cords of the spinal marrow, divide evidently into at least two halves, an anterior which is smaller, and a posterior which is larger. Of these two halves, the anterior cross and form the pyramids (§ 1726), the posterior ascend behind the olivary bodies, enlarge and form the floor of the ***calamus scriptorius***, and of the fourth ventricle. We also find another smaller fasciculus, which Gall asserts, is not constant, which Rosenthal has described more exactly,(3) and which our dissections have shown to be constant. This middle fasciculus, which touches the olivary bodies, surrounds them and passes through the annular protuberance to go forward into the tubercula quadrigenina.

(1) The merit of having made profound researches on these striæ belongs to Wenzel, but he neither discovered their existence nor constancy, nor their connection with the auditory nerve, since all these facts are already mentioned positively by Prochaska. (*loc. cit.* p. 387-391.)

(2) Wenzel, *loc. cit.* p. 184.

(3) *Beytræge*, p. 24—27.

The division of the posterior cords of the spinal marrow into two fasciculi (§ 1717) is still more evident in the restiform bodies, on account of their enlargement. The internal, which are smaller, swell at the lower extremity of the calamus scriptorius, but disappear in a point before the restiform bodies have terminated their course towards the cerebellum.

II. ANNULAR PROTUBERANCE.

I. EXTERNAL FORM.

§ 1733. The *annular protuberance*, called also *the bridge of Varolius* (*nodus cerebri*, *pons Varolii*, *eminentia*, s. *protuberantia annularis*, *protuberantia encephalica*, *commissura cerebri*), is a considerable and somewhat regularly quadrilateral eminence, extending however rather more from right to left than from before backward; it is observed on the lower face of the cerebrum, projects more than three lines above the lower face of the medulla oblongata and the cerebral peduncles, gradually becomes thicker on each side near its centre, and is separated from the medulla oblongata and the cerebral peduncles, by very distinct limits. Its greatest length is one inch, its greatest breadth is one inch and some lines, and its greatest height, at its anterior extremity, is nearly one inch. Its anterior and posterior edges are convex on the sides, and concave in the centre, the anterior more so than the posterior. A superficial, but very evident groove, extends all along its inferior face from before backward; this is continuous with the serrated portion of the anterior and of the posterior edge. On the sides, the annular protuberance imperfectly divides internally into two halves, one of which is turned toward the tubercula quadrigemina, the other up towards the cerebellum, and both turn around the posterior crura of the cerebellum.

II. TEXTURE.

§ 1734. The annular protuberance is formed externally of white fibres, transverse and convex forward, of which the central and the anterior particularly incline very much backward, towards the cerebellum. It is very firm, and the firmest part of the centre of the nervous system. On examining it internally, which must be done by horizontal, transverse, longitudinal, and even by perpendicular incisions, a little oblique from within outward, and from behind forward, we remark that its texture is very complex.

Immediately below the external medullary layer, we discover a grayish substance. This substance is not pure: it alternates the whole length of the protuberance with transverse and very numerous bands of medullary substance, which are thin and convex inward, and are attached to the external.

About two lines above the lower face of the protuberance, we observe on each side, almost in the centre of each lateral half, insulated longitudinal medullary fibres, which are directed from within outward, and from behind forward, and alternate with the transverse fibres. They are convex below, and concave above. They form a fasciculus, about four lines high, which contains in its centre only white substance, through which the cortical substance passes upward and downward.

This fasciculus is the direct continuation of the pyramids. It continues uninterruptedly forward with the lower face of the cerebral peduncles.

Next comes always from below upward, a very thick layer of gray substance, interrupted by perpendicular layers of medullary substance, situated some behind the others; then, on this layer is another which is thinner, of longitudinal medullary striæ, convex above, concave below, which arise behind the upper fasciculus of the anterior medullary cords of the medulla oblongata, pass above the central gray layer, blend forward with the lower and thickest layer of medullary substance, and thus arrive upon the upper face of the cerebral peduncles.

Consequently the upper and lower fasciculi which result from the division of the anterior cords of the medulla oblongata, again unite at their anterior part, in the annular protuberance.

The number of the longitudinal striæ, especially the inferior, diminishes much from without inward. They are separated from each other, upward and downward, by gray substance, and disappear entirely at about the centre of the annular protuberance.

The central part is formed of gray and of white substance; it is much higher in this place, and only some longitudinal medullary striæ pass above it.

Thus the anterior medullary cords not only increase in size and divide in their course across the annular protuberance, but they are still directed from within outward.

III. WEIGHT OF THE MEDULLA OBLONGATA.

§ 1735. The entire medulla oblongata generally weighs a little more than half an ounce. Its weight then is to that of the spinal marrow, as 1 : 2; to that of the cerebellum as 1 : 10; to that of the cerebrum as 1 : 74: finally to that of the whole central mass as 1 : 86.

The rachidian bulb weighs three drachms; the annular protuberance one.

ARTICLE SECOND.

CEREBELLUM.

I. EXTERNAL FORM.

§ 1736. The *cerebellum* (*cerebellum*, s. *parencephalis*)(1) is situated below the posterior part of the posterior lobe of the cerebrum, from which it is separated by the tentorium, and occupies the inferior fossæ of the squamous portion of the occipital bone. We may divide it into the *body* and *crura*, and the body comprises the *lateral* parts, and a *centre*.

§ 1737. The *body* of the cerebellum has a rounded and oblong form. Its greatest breadth, which is from side to side, is about four inches. It is about two and a half inches from before backward in its broadest portion : it is two and a half inches from above downward in its centre, and only half an inch at its edges ; in approaching which, it gradually becomes thinner, so that it seems a little flattened in the latter direction. Considered generally, it is circumscribed by two slightly convex faces, an upper and a lower, and by four obtuse edges, distinguished into anterior, lateral, and posterior. The upper face is sloped like a roof, that is, it projects most at its central part, whence it descends almost flat to the edges, backward, outward, and forward, although a little less in the latter direction. The inferior face, on the contrary, is concave from before backward, at its centre, so that the anterior and the posterior parts of this groove form the greatest hollow.

The two faces are separated by a groove an inch deep in most of its extent, which corresponds to the posterior edge, and thence goes inward. This is called the *large* or the *horizontal groove of the cerebellum* (*sulcus cerebralis magnus*, Vicq-d'Azyr ; *sulcus magnus horizontalis*, Reil). This groove divides the cerebellum into an upper and a lower half, besides the two lateral halves into which it is divided by the median longitudinal groove.

The anterior edge is the shortest, and is rendered very concave by a broad depression. The two lateral edges are straight, longer than the anterior, and oblique from before backward, and from within outward. They are continuous with the posterior, where the cerebellum is broader between their posterior extremities. The posterior edge is the longest, and is composed of two very convex lateral halves, which are separated by a median groove, about four lines deep and three broad. This groove is continuous with the median depression of the lower face. Thus the cerebellum is narrower in the centre than in the rest of its extent, and is divided by the anterior and posterior depressions of the edges, and by that of the lower face into two halves, called very im-

(1) Rolando, *Osservazioni sul cerveletto*, in the *Memoria della reale academia della scienza di Torino*, vol. xxix. p. 163.

properly, the *hemispheres* (*hemisphœræ cerebelli*). Each of these hemispheres has an irregularly quadrilateral form. The outer face of the cerebellum is not smooth. We observe in it numerous slight elevations, formed by the upper face of the layers (*laminæ*). These elevations are convex externally, concave internally, and go unevenly from before backward, being separated by grooves, into which the pia-mater descends. These layers are not single, but they frequently subdivide and interlace, and are adapted to each other very exactly, even externally. The depth of the grooves, and consequently the height of the layers, are not every where the same. In the place where the grooves are very deep and very long, and where also the adjacent layers are entirely separated from each other, the cerebellum is perfectly divided into several segments, which are called *lobes* (*lobi*).

The best mode of describing the form of the cerebellum, is to examine separately its lateral parts and its centre.

I. LATERAL PARTS.

§ 1738. The two faces of the cerebellum, the upper and the lower, are divided very constantly by deep grooves into several lobes, which are *superior* and *inferior*.

I. UPPER LOBES.

§ 1739. The two lobes of the upper half of the cerebellum, are the *upper anterior* and the *upper posterior*.

1st. The *upper anterior or square lobe* (*lobus anterior*, *superior*, s. *quadrangularis*) is irregularly quadrilateral, and narrower forward and outward than backward and inward. It is continuous with that of the opposite side by a central part which is not contracted, and is the highest point of the cerebellum. The two united lobes have a semicircular form. Their posterior edge is convex and sharp, and is turned backward with the posterior face, while the anterior, which is concave, and which forms at the same time the anterior edge of the cerebellum considered as a whole looks forward. The blunt extremity which forms the anterior half of the lateral edge of the cerebellum, looks forward and outward.

This lobe is separated from the upper posterior by a very deep groove, the *superior groove of the cerebellum* (*sulcus superior cerebelli*, Vicq-d'Azyr).

2d. The *upper posterior or semilunar lobe*, *lobe semi-lunaire* (*lobus superior posterior*, s. *semi-lunaris*), comes immediately next the preceding. It forms the posterior and external part of the upper half of each hemisphere. It is semilunar, thicker and broader forward than backward; separated backward from the lower posterior by the large lateral groove, and forward from the upper anterior by the upper groove: it is attached inward to the synonymous lobe of the other hemisphere by a thinner and more sloping part, formed of white substance, called the *commissure of the upper posterior lobes*. The considerable groove between the two upper posterior lobes, forms the commencement of the lower posterior median groove.

II. INFERIOR LOBES.

§ 1740. There are four inferior lobes.

1st. The *posterior or inferior semilunar* lobe (*posterior inferior*, s. *semi-lunaris*), forms the posterior superior and external part of the lower half of each hemisphere. It is separated from the superior and anterior by the large groove, (§ 1737) and from the next by the *inferior external groove* (*sulcus inferior externus*), which is very deep. It is divided by two considerable but more superficial grooves, into three concentric portions which follow one another from behind forward, and diminish in size in the same direction.

The two lateral halves are connected by a narrow and slanting commissure, with which the middle of these three lobes is directly continuous, while the anterior and the posterior only touch on its sides.

The most internal segment has been considered a special lobe, and termed the *small* or *thin* lobe ;(1) but this distinction seems to us inconvenient, because we might just as well consider the middle and anterior segments as so many distinct lobes.

2d. The *inferior anterior lobe*, the *cuneiform* or *internal inferior* or *digastric* lobe (*anterior inferior*, s. *cuneiformis*, s. *biventer*), is much smaller. It is composed of layers, which proceed almost directly from before backward. It is broader and thicker forward and outward than it is inward, where it at first contracts very much, and then terminates together with the third segment of the preceding lobe, in a very bulging central part.

3d. The third *inferior lobe*, the *lobe of the medulla oblongata*, the *spinal lobe*, the *monticule* (*lobus inferior internus*, *tonsilla*, Malacarne ; s. *lobulus medullæ oblongatæ*, s. *monticulus*, Vicq-d'Azyr; *lobus spinalis*, Gordon), is smaller than the preceding, and is composed of layers which proceed directly from before backward, and is convex both outward and inward. Its anterior extremity rests in the restiform body of the spinal marrow.(§ 1728) Posteriorly it gives origin to the uvula, which is inserted between the two amygdalæ.

4th. The fourth *inferior lobe*, the *lobe of the pneumogastric nerve* (*flocculus*, s. *lobus nervi pneumogastrici*, Vicq-d'Azyr, *lobus subpeduncularis*, Gordon), arises a little above and before the preceding, from the posterior edge of the peduncle which goes from the cerebellum to the tubercula quadrigemina, directly where this peduncle unites with that which extends from the cerebellum to the medulla oblongata. It arises in this place from a thin pedicle, descends between the auditory

(1) Malccarne, and Reil, *loc. cit.*, p. 13.

and pneumogastric nerves, and goes forward downward and outward. Almost all of its medullary nucleus is exposed forward and backward, fimbriated in its whole extent outward, and only in its lower part inward, and is covered both outward and inward with gray layers.

The direction of this segment of the cerebellum, is precisely the opposite of that of the others; it is also the loosest.

The two lobes become, upward and inward, a broad semicircular medullary layer, which rises above on the nodule, and is loose posteriorly, called the *posterior medulary vail* (*velum medullare posterius*). This layer swells on its internal edge, into a thick mass of medullary substance, folded crosswise, and covered with cortical substance, which assists to form the posterior part of the fourth ventricle.

II. CENTRAL PORTION.

§ **1741**. Although, strictly speaking, the central part of the cerebellum is no where separated from the two lateral parts, by a want of continuity in the substance; it however differs a little from them in form.

The distinctive character of the formation of this central part is, that it is formed by transverse layers and plates, and that except in its middle posterior region, it presents a rounded form bulging from behind forward.

On its anterior face is the most superior part of the cerebrum. The anterior part of its lower face is also very much elevated, but the posterior is lower. Its lateral faces and its anterior part are situated in a large depression, the direction of which is from before backward, which separates the two hemispheres.

The middle region is usually termed the *vermiform eminence* (*vermis cerebelli*), and it is divided into an upper and a lower part.

I. UPPER PART OF THE MIDDLE REGION.

§ **1742**. The upper part of the middle region extends from the middle of the posterior edge of the upper face, above the anterior edge to the tubercula quadrigemina.

It is composed of the upper or anterior vermiform process and the cerebral valve.

The upper vermiform process may also be divided into three portions:

1st. The commissure of the two upper posterior lobes.

2d. The larger upper part, or the *monticule* (*monticulus cerebelli*).

3d. The lower part which is much smaller, or the *anterior vermiform process*.

The *commissure of the upper posterior* lobes, is thin, narrow, and lower than the lobes it unites.

The monticule, which is the highest part of the cerebellum curves from behind forward, and from below upward, as high as the posterior edge of the tubercula quadrigemina. It is formed of five segments placed one after another from behind forwards, they become thicker from before backward, but the third is separated from the others by the deepest transverse grooves. These segments extend from the monticule into all the thickness of the hemispheres; but they gradually contract in approaching the anterior edge, so that the monticule, especially on account of the rounded prominence in its centre, is almost three times as long, as are the lateral edges of the upper face of the cerebellum.

The *lower smaller part*, or the *proper anterior vermiform process*, has a direction the inverse of that of the monticule, that is, it proceeds from above downward, and from before backward. It is reflected near its posterior extremity at an acute angle, and is continuous with the cerebral valve, on which it rests directly its entire length.

II. CEREBRAL VALVE.

§ 1743. The *cerebral valve*, the *large valve of the brain* (*valvula cerebri*, *valvula magna*, *velum medullare*, *velum medullare anticum*, *pars anterior veli medullaris*), arises from the posterior extremity of the anterior vermiform process, and is attached on the sides to the inner face of the prolongations sent by the cerebellum to the tubercula quadrigemina, and terminates by its anterior extremity in the depression between the posterior pair of the tubercula quadrigemina. It contracts from behind forward, becomes thin, and terminates in a convex edge.

Its lower face is smooth. The upper presents posteriorly in nearly all its extent, transverse grooves, which generally extend only to the lateral edges; it is frequently, but not always, divided by a slight longitudinal groove into two equal lateral parts. Its anterior part is much less extensive than the other, and smooth; it is formed in its greater and posterior part, of gray substance. It is also formed anteriorly, at least on its lower face by this substance; we however usually find at its anterior extremity, or directly behind it, on the median line, a white band from one to two lines broad, convex posteriorly and narrower on the sides: it is terminated forward by a small point, which is attached to the groove between the two posterior tubercula quadrigemina. This band generally gives rise to some filaments of the fourth cerebral nerve, but goes mostly only in the upper edge of the anterior peduncle of the cerebellum, and disappears on its outer face.

III. LOWER PART OF THE MIDDLE REGION.

§ 1744. The lower part of the middle region of the cerebellum, commonly called the *inferior vermiform process*, is a little lower posteriorly than the posterior part of the two lower posterior lobes which it unites, although it is not so low as the commissure of the upper posterior lobes situated above it. It is formed of two halves, separated by a superficial transverse groove, and situated one above the other. It presents a slight prominence in its centre, and is separated by a slightly perceptible contraction from the hemispheres which it unites.

The *central part* or the *pyramid* (*pyramis*, Malacarne) is next to this prominence, and is separated from it by a very deep fissure.

This central part projects in every direction much more than the posterior, and is attached, by much narrower and lower lateral parts, to the posterior half of the inferior external lobe, and to the inferior internal lobe.

Next to the pyramid, from which it is separated by a deep groove, comes a narrow part which is easily divided into several lobes situated one over another, and which generally is not perfectly symmetrical, being turned first to the right, and then to the left. This part also projects still more, in proportion to its breadth, and is continuous with the amygdalæ by a narrow and deeply situated medullary band.

Finally, we next observe the anterior and smallest part, called the *nodule* (*nodulus*, Malacarne), which is continuous on each side, with the posterior valve.

Thus, the central portion of the cerebellum, considered as a whole, is so curved, first from before backward, then from below upward, next from above downward and from behind forward, that the two extremities of the vermiform process, which proceed toward each other, almost touch, and are separated only by the narrow face of the summit of the fourth ventricle.

II. TEXTURE.

§ 1745. The gray substance surrounds all parts of the cerebellum, except its lower face which corresponds to the fourth ventricle; this is covered with medullary substance. The latter is continuous in the three prolongations of the cerebellum, anteriorly with the tubercula quadrigemina, posteriorly with the medulla oblongata, below, and on the sides, with the annular protuberance, and extends within this organ in ramifications, the collection of which is termed the *arbor vitæ*; of this we may be convinced by vertical incisions.

The medullary trunks follow a more or less curved direction, to near the circumference of the cerebellum, and give off, in this course, a greater or less number of branches, which arise from their convex edge.

A thin layer of yellow substance, covered by a thick layer of gray substance, exists on the surface of each medullary branch. This arrangement causes the lamellar structure of the cerebellum, since each layer incloses a layer of medullary substance, and each of the laminæ into which the principal layers divide always corresponds to a medullary branch.

The middle and lower part of the cerebellum presents this arrangement most distinctly. We find, in this place, seven medullary layers, three anterior, three superior, and one posterior; the upper of which are the longest, and ramify most simply.

All these layers become much larger from within outward, so that, with their covering of gray substance, they represent cones, the summits of which are turned inward, and the bases unite with the parietes of the fourth ventricle, and are separated from each other forward by deep grooves.

The medullary substance is proportionally much less in the central part, upon which circumstance alone depends its smallness; but externally it accumulates in a direct ratio with the enlargement of the hemispheres of the cerebellum.

§ 1746. A vertical section demonstrates that the medullary nucleus is thickest below, in the centre of the cerebellum, before the summit of the fourth ventricle, opposite the second and third segments, consequently in its anterior half. From this point to the circumference it grows thinner as it ramifies; but we constantly observe that the medullary layers of several lobes are much broader, toward the surface of the organ, than they are when they arise from the central nucleus.

This arrangement is not observed in the fourth lobe, the uvula, the pyramid, the cerebral valve, and the anterior vermiform process; but it is very perceptible in the other two segments. In the anterior lobes of the third segment the medullary layer, soon after leaving the nucleus, swells out considerably in passing through the lobes. The layer of the upper and the posterior lobes arises from a nucleus, almost as large as the central medullary nucleus, situated before the summit of the fourth ventricle. In the fourth segment we find a similar, but smaller, nucleus, more than six lines long, which is attached to the central nucleus by a thin filament.

§ 1747. In following this method, which is undoubtedly the strictest, we arrive at a new division of the medullary layers of the centre, and of the hemispheres of the cerebellum, very similar to the division mentioned above, but different from it in some respects.

The first of these seven layers belongs to the posterior part of the anterior valve. It is the smallest, and the folds of the posterior part of the valve rest upon it.

The second is formed by the anterior vermiform process, and the anterior part of the upper anterior lobe.

The third is much larger, and belongs to the anterior part of the monticule, and to the larger middle part of the upper anterior lobe.

The fourth, the most posterior, corresponds to the most posterior part of the monticule, to the commissure of the upper posterior lobes, to that of the lower posterior lobes, to the most posterior part of the upper anterior lobe, to the upper posterior lobe, and to the upper part of the lower posterior lobe.

The fifth is composed of the pyramid, of the lower smaller part of the lower posterior lobe, and of the digastric lobe.

The sixth corresponds to the uvula and to the amygdalæ. Finally,
The seventh, forms the nodules and fourth lobe; it is the smallest of all, except the first.

The last two are distinguished from the rest, as they are not cleft and covered with a gray substance, except in one part of their circumference, forward and backward. The first presents this arrangement in every part, and the latter at its upper posterior part. The others are divided several times on each side; they however present traces of the arrangement above mentioned, because the lower anterior half of the segments, which are turned the most forward, and the lower posterior half, which are turned backward, present the most simple and shortest grooves and ramifications, the former downwardand backward, the latter downward and forward.

CORPUS FIMBRIATUM.

§ 1748. In the centre of the medullary substance in each hemisphere of the cerebellum, little more internally than externally, we find a rounded, oblong, very vascular body, medullary internally, surrounded with a serrated edge, and intimately united to the medullary substance, called the *rhomboid* or *fimbriated body* (*corpus rhomboideum*, s. *fimbriatum*, s. *dentatum*). Its gray edge mostly surrounds it, except its lower anterior part, where the medullary substance within it is continuous with that of the walls of the fourth ventricle, so that the hemispheres of the cerebellum are consequently composed of a double layer of medullary substance, and of gray substance; the internal, formed by the corpus fimbriatum, and the external, comprising most of the external medullary substance and the external gray substance.

We here then find the repetition of what is observed in the medulla oblongata, in the olivary bodies, and the pyramids; (§ 1726–1727) only this form exists here in a greater degree, since the rhomboid body of the cerebellum is not only surrounded with a thin and smooth layer of white substance, as is seen in the medulla oblongata, but this layer is much thicker there, and not only forms several successive ramifications, but is covered a second time with grey substance.

§ 1749. The medullary substance of the cerebellum is extended in three fasciculi, which, however, are not distinctly separated; they are called the *prolongations of the cerebellum* (*crura cerebelli*). One is inferior and descending, another middle and anterior, the last is superior and ascending.

The *inferior descending prolongation* (*crus cerebelli descendens*, s. *ad medullam oblongatam*) blends with the posterior cord of the spinal marrow or the restiform body. The *superior ascending* (*crus cerebelli adscendens*, s. *ad eminentiam quadragesimam*) goes to the posterior tubercula quadrigemina. The middle *lateral* or *anterior* (*crus cerebelli ad portam*) goes forward and downward, and blends with the annular protuberance. Of these three prolongations, the third is the largest. The first two are situated farther inward, and surrounded by it, so that the rhomboid body exists between it and them. They blend forward and backward, and seem developed principally to form the middle region of the cerebellum, while the hemispheres of this organ rest on the lateral prolongations, so that the medullary layers which form them, are directed forward in the upper lobes, and backward in the inferior.

When we separate longitudinally a cerebellum hardened by immersion in alcohol, it is divided into an upper and lower half; we also see on one side a very broad but thin transverse medullary layer, which contracts and at the same time becomes thicker from before, backward and outward, and which is expanded to form the lateral prolongations: we have on the other side, particularly towards the centre, fasciculi which intercross from before backward, so that the ascending and descending prolongations, at least to some extent, are not directly blended with each other, but reciprocally interlace.

§ 1750. The cerebellum forms most of a ring, which is constituted below by the lower part of the annular protuberance, embraces the cerebral peduncles, and unites by its anterior and posterior prolongations, with the medulla oblongata, and with the cerebrum.

III. WEIGHT.

§ 1751. The cerebellum, if separated at the place where its prolongations enter the annular protuberance, the cerebrum and the medulla oblongata, generally weighs five ounces. Its weight consequently, is to that of the rest of the encephalon, as 1 : 8, or as 1 : 7, rarely as 1 : 10, or even as 1 : 11.(1) In the latter case, we must attribute its excess of weight to the suspended development of the encephalon.

IV. CONSISTENCE.

§ 1752. The cerebellum has about the same consistence of the cerebrum, and like this, it is softer than the medulla oblongata, and harder than the spinal marrow.

ARTICLE THIRD.

CEREBRUM.

I. EXTERNAL FORM.

§ 1753. The *cerebrum* forms most of the cephalic portion of the centre of the nervous system, and occupies its upper and anterior region.

Considered as a whole, its form is a rounded oblong, and it is for the most part convex. Its length exceeds its breadth, and particularly its height. Its greatest length is six inches, its greatest breadth is five, and its height is four. It is broadest and highest in its centre.

It is formed of two lateral and perfectly similar halves, called *hemis-*

(1) Chaussier, *loc. cit.*, p. 77.

pheres or *lobes* (*hemispheræ*, *lobi*, Chaussier). These two halves are separated at their upper part by a *longitudinal* fissure (*fissura longitudinalis*), much broader backward than forward; in the former direction its breadth is half an inch, but hardly a line in the latter. They are on the contrary, almost blended with each other at their middle and lower portion.

Each hemisphere is divided into two *lobes* (*lobi*, *lobuli*, Chaussier), an anterior and a posterior. The anterior is more than twice as large as the posterior. They are separated by a groove more than an inch deep, the direction of which is oblique from above downward, and from behind forward; this is called the *groove of Sylvius* (*fossa Sylvii*), Reil terms it the *valley*. This separation exists only below and on the side, for the groove does not extend to the upper face.

The posterior lobe is also frequently divided into two others, termed the middle and posterior lobe. The latter forms that part of the cerebrum which rests on the tentorium. It cannot be distinguished externally from the middle lobe, but is separated from it on its internal face by a fissure, the direction of which is obliquely from above downward, and from behind forward, and on the lower face by a slight depression.

In each hemisphere we distinguish an inferior, an external, a superior and an internal face.

I. INFERIOR FACE.

§ 1754. The inferior face should be examined first, for we there recognize most distinctly, that the cerebrum is directly continuous with the medulla oblongata.

Of the three faces, this is the most irregular, and its central portion is entirely separated from the two lateral parts.

I. MIDDLE REGION.

I. CEREBRAL PEDUNCLES.

§ 1755. We first observe from behind forward, directly before the anterior edge of the annular protuberance, (§ 1733) the *cerebral peduncles*, or the *crura of the medulla oblongata* (*crura cerebri magna*, *crura ad medullam oblongatam*). They are two large rounded bodies, about eight lines long, which become much larger from before backward, seven lines broad posteriorly, ten anteriorly, ten lines high, grooved longitudinally, and entirely formed of substance, white externally. They diverge from each other behind forward, and are separated at their lower part by a very broad and deep groove; this is only the anterior groove of the spinal marrow, which is deepened by the development of the peduncles. This part forms above the floor of the aqueduct of Sylvius; its lower face is gray, and numerous vessels pass through it, the direction of which is from below upward, and from without inward. Vicq-d'Azyr(1) terms it the *middle perforated substance* (*substantia perforata media*).

(1) *Loc. cit.*, p. 545.

Near the posterior extremity of these bodies there is generally a transverse and slightly projecting band which passes over all their lower face, and crosses the longitudinal groove. A second posterior transverse band is detached from where the anterior and middle prolongations of the cerebellum unite, and is directed from behind forward, and from above downward between the two peduncles, proceeding on their lower face. This band is situated directly before the annular protuberance, and is often united with it, representing to a certain extent a distinct edge. The cerebral peduncles are covered posteriorly by the anterior part of the annular protuberance, forward by the root of the optic nerve, which turns on them from above downward, from without inward, and from behind forward.

§ 1756. The cerebral peduncles are formed externally by a layer of white substance about two lines thick. Next comes a rounded and elongated layer of blackish substance, which has a semicircular form, as has the whole cerebral peduncle, being concave above and convex below. Next comes a third layer, the thickest; this extends upward to the surface, and is formed of a mixture of gray and of white substance.

§ 1757. Between the anterior extremities of the two cerebral peduncles, is a broad triangular surface, which enlarges very much from behind forward, and is continuous posteriorly with the middle portion, anteriorly with the anterior part of the perforated substance of the lower face. The direction of this surface is from behind forward, and from above downward at its posterior part, from below upward, and from behind forward at its anterior part, which is more perpendicular than the other; it forms the floor of the third ventricle. We remark from behind forward the mammillary eminences, the infundibulum with the pituitary gland, the anterior part of the root, and the decussation of the optic nerve; the rest of it is formed of gray substance.

II. MAMMILLARY EMINENCES.

§ 1758. The *mammillary eminences* or *pisiform tubercles*, (*eminentiæ medullares*, s. *candicantes*, s. *mammillares*, Chaussier) are situated side by side between the anterior extremities of the cerebral peduncles; they are two hemispherical prominences, formed externally of medullary substance, and internally of cortical substance, about half a line distant from each other in their whole height, but separated a little farther posteriorly. They are the inferior and anterior extremities of the fornix.

When attentively examined, we observe that these triangular eminences are each composed of a larger inner, and a much smaller outer half. The anterior and inner faces are straight, the posterior is convex; the latter is the longest, the inner is much the shortest. The two halves of each eminence are very distinctly separated; the internal projects very much; the outer terminates in a point on the outside of the gray substance, between the mammillary eminence and the optic nerve.

III. INFUNDIBULUM AND PITUITARY GLAND.

§ 1759. We find a rounded and conical prolongation between the mammillary eminences, called the *infundibulum*;(1) this descends obliquely forward, and terminates in the *pituitary gland* or *body* (*hypophysis cerebri*, s. *glandula pituitaria*, Chaussier).(2) This is situated in the sella-turcica of the sphenoid bone below the dura-mater, which covers its upper face, and is closely surrounded on all sides. The lower extremity of the infundibulum, is connected with it by a narrow opening in the dura-mater. The lower and the upper parts of the infundibulum are thicker than its centre. In its first two parts it is about a line thick. It is formed of gray substance.

The pituitary gland has an oblong rounded form. It is about six lines broad, three long, and less than three high; it generally weighs, including the infundibulum, eight grains. It is always formed of an anterior and a posterior lobe, which are intimately united. The anterior is very large, and generally twice the size of the other.

The anterior is bean-shaped; the posterior is more rounded, and is situated in the posterior and serrated edge of the anterior lobe.

The pituitary body is generally very hard, but its posterior lobe is softer than the anterior.

The anterior lobe is formed of two substances, an external reddish, and an internal which is white, which vary much in their degree of color and their proportional quantity. We rarely find one which is homogeneous. We observe on the right and left side, on the limit between the two substances, a depression in which those small ducts which arise from the external substance terminate. The posterior part of this depression forms a small canal, which, converging with that of the opposite side, goes towards the centre of the posterior edge of the lobes, and the place where the infundibulum is continuous with the pituitary body; the two canals unite in this place.

The posterior lobe has uniformly a more or less grayish tint.

Both lobes are directly attached to the infundibulum, which always descends on the upper face of the pituitary gland to the place where they unite, and are surrounded with it by a prolongation of the pia-mater.

The infundibulum is formed of gray substance, a continuation of that of the floor of the third ventricle, and it is considerably narrower in its centre than above and below, where it is several lines thick.

(1) A. Murray, *Observationes anatomicæ circa infundibulum cerebri, ossium capitis in fætu structuram alienam partemque nervi intercostalis cervicalem*, Upsal, 1772.

(2) Wenzel, *Observations sur le cervelet et sur les diverses parties du cerveau dans les epileptiques*, 1811.—Rayer, *Observations sur les maladies de l'appendice sus-sphenoidal du cerveau*; in the *Archiv. gen. de medecine*, t. iii. p. 320.—See also the extract from Guersent's case, same journal, v. iii. p. 312.—Ward, *Case of amaurosis produced by enlargement of the pituitary gland*; in the *Lond. med. repository*, 1823, t. xx. p. 217.

Opinions vary in regard to the nature of the infundibulum; some think it entirely hollow; others on the contrary that it is solid; and some assert that it is sometimes solid and sometimes hollow.

Although a canal is not always visible within it, as some writers have asserted, particularly the old anatomists, and Murray among the moderns; it is sometimes hollow in all its extent, and we can always introduce into it air or liquids, pushing them from the pituitary gland into the third ventricle; but this is more difficult, and even fails when attempted in the opposite direction from the ventricle towards the pituitary gland. The infundibulum may serve to transmit into the cerebral ventricles, a fluid which is secreted by the pituitary gland.

Sometimes, but rarely, we find within or on the surface of the pituitary gland, a solid and sandy substance (*acervulus cerebri.*)(1)

IV. ROOT AND DECUSSATION OF THE OPTIC NERVE.

§ 1760. The larger anterior and inferior part of the root of the optic nerve which is the largest, and the decussation of this pair of nerves, follow the two bodies described in the preceding paragraph; these parts are situated outwardly on the anterior extremity of the cerebral peduncles, inwards and in the centre before the grayish plate which forms the inferior wall of the third ventricle, from which the optic nerve receives in the angle formed by the union of its anterior with its posterior half, filaments which may be regarded as its anterior root.

When speaking of the optic nerve, we shall give a more detailed description of the course and union of its roots.

V. GRAY PLATE OF THE INFERIOR WALL OF THE THIRD VENTRICLE.

§ 1761. The *gray plate* (*tuber cinereum*) of the inferior wall of the third ventricle, is thicker in its posterior than in its anterior half, which is extremely thin, so that it tears very easily, merely from its weight, when the brain is turned over and all its sides are not well supported. It is continuous forward with the anterior extremity of the corpus callosum, where it forms on the surface of the anterior commissure a thin expansion, across which we perceive this cord.

II. LATERAL REGIONS.

§ 1762. The two lateral regions of the lower face of the cerebrum, are much more extensive than the central. Their internal edges touch anteriorly and posteriorly where they are separated only by the falx cerebri, while in the centre, there is a space filled by the parts we are about to describe.

(1) Bichat, *Anat. descript.*, vol. iii. p. 75.

This larger part of the lower face of the cerebrum, is formed by the lower face of the posterior and of the middle lobe. It presents a slight concavity posteriorly in all that part which corresponds to the posterior lobe, which is entirely covered by the cerebellum. Anteriorly it is slightly convex, loose, and terminated by a rounded extremity. Its anterior part projects considerably, and forms the lowest region of the cerebrum. It extends to the small wings of the sphenoid bone, and passes about an inch beyond the central part, which terminates by the decussation of the optic nerves.

This blunt anterior extremity of the middle lobe is loose, and covers the inferior extremity of the lateral part of the fissure of Sylvius. Behind it, the lower face of the middle lobe forms at first a large convex eminence, which rests outwardly on the base of the skull, and which covers within, the posterior part of the root of the optic nerve, with which it is united only by a short cellular tissue, and by the pia-mater.

This eminence is the commencement of a conical projection, which contracts from before backward, and marks in this place the transition from the external to the internal face of the cerebrum, and forms the posterior part of the inner edge of the middle lobe. The upper part of the eminence, the hook, has a direction from within outward, and from before backward, and terminates in a blunt extremity, which is continuous with the medullary semicircular band. The loose and concave edge of which is turned forward, while its attached and convex edge looks backward. This band called the *corpus fimbriatum* (*tænia*, s. *fimbria*), enlarges inward and upward. When the cerebellum is turned downward and forward, we see very clearly that it blends with that of the opposite side, and forms the posterior part of the fornix. Below, it is a longitudinal band, which has the same direction, but is less prominent; this is termed the *fascia dentata*. The latter extends forward a little farther than the preceding, and is covered by the external part of the base of the hook. It gradually enlarges from before backward, and presents numerous elevations and depressions situated longitudinally one after another.

The lower part of the internal edge of the lower face of the eminence which has the same direction, but which projects more, extends backward, upward, and inward, and is continuous with the posterior part of the corpus callosum. Its most internal part, which presents a convexity upward and downward, is white and smooth. The gray substance is seen where this internal part is continuous with the lower face of the cerebrum, and there also its circumvolutions commence, at least, unless we consider the *fascia dentata* as a rudiment, which seems more correct, inasmuch as a layer of gray substance, which communicates with the rest of the cortical substance of the brain, passes from each side to the posterior extremity of the corpus callosum on the origin of this inferior medullary layer, and is continuous with the fascia dentata. The circumvolutions arise imperceptibly in this place from the white band which we last described; and the most internal forms a considerable longitudinal prominence, which is not interrupted by transverse striæ, or at least by none which are very manifest.

The lower face of the anterior lobe, which is slightly concave and the internal edge of which descends much lower than the external, are situated before the anterior extremity of the middle lobe. The internal edges of the two lobes approach each other very much.

The middle lobe and the anterior lobe are separated by the internal part of the entrance of the fissure of Sylvius. This entrance corresponds entirely to the lower face. Its most internal part is loose, and is continuous with the thin plate situated before the decussation of the optic nerves; (§ 1761) it becomes broader from within outward, and is perforated with numerous considerable openings, which increase in diameter from within outward, and give passage to the vessels sent off by the origin of the middle cerebral artery into the cerebral substance. This is termed by Vicq-d'Azyr the *anterior perforated substance* (*substantia perforata antica*),(1) and by Reil, the *cribriform plate* (*lamina cribrosa*).(2)

This cribriform plate is formed almost entirely of gray substance. It is, however, white internally in its centre, whence arise the lateral longitudinal striæ of the corpus callosum, which go upward and inward. It is continuous outward and backward at the inner part of the summit of the middle lobe, and farther forward, with a small smooth elevation, about half an inch broad, where the white substance is exposed, and where the anterior and posterior lobes unite, without being separated by a deep fissure.

The olfactory nerve proceeds at a little distance in a deep groove, along the inner edge of the lower face of the anterior lobe; its direction is from before backward, from above downward, and from without inward, and it is united to the lobe by the pia-mater, which extends like a bridge on its upper face.

The extremity of this longitudinal groove, which is much deeper than the optic nerve is high, is bounded by a *triangular* tubercle, the *olfactory tubercle* (*processus*, s. *caruncculus mammillaris*), from whence the nerve partly arises. We also see a white band proceeding from it; this goes backward, upward, and outward, and terminates in the fissure of Sylvius, at the union of the anterior and posterior lobes, at the point where the white substance becomes visible externally.

II. EXTERNAL FACE.

§ 1763. The external face is convex, and is most prominent in its centre on each side upward and downward. It is imperceptibly continuous with the upper and lower faces, less however with the first than with the second. The *fissure* of *Sylvius* divides it into an anterior

(1) *Loc. cit.*, p. 545.
(2) *Archiv. für die Physiologie*, vol. ix. p. 199.

and a posterior half. At first view this fissure seems only an indentation, the direction of which is obliquely from below upward, and from before backward, and is situated at about the centre of the lateral face, a little nearer its anterior than its posterior extremity, the parietes of which are formed, the inferior by the upper face of the anterior part of the middle lobe; the superior, on the contrary, by the lower face of the middle part of the anterior lobes, and we may consider its posterior extremity as the upper limit of the external face. An attentive examination, however, soon shows that it has much more extent. In fact, at the outer extremity of the anterior cribriform plate, (§ 1762) the commencement of the fissure of Sylvius, hitherto single, divides into an anterior and a posterior groove. The posterior is that just described. The anterior is much shorter, goes directly upward, and communicates with the posterior extremity of the posterior, by a third groove, which proceeds directly from before backward. These three grooves consequently include a triangular space, the lower part of which is seen where we separate the two parietes of the posterior groove; but we cannot see its whole extent until we have opened the superior horizontal groove, by raising that part of the anterior lobe which forms it anteriorly. We then observe that the central part of the anterior lobe, at first convex, goes from below upward into this middle portion of the fissure of Sylvius, and thus forms a triangular space called the *island of the fissure of Sylvius*, then immediately descends again before its larger upper part, resting upon it, then describes a right angle to go directly outward for about an inch, and finally joins, also at a right angle, the external face of the hemisphere, and particularly of the anterior lobe. The lower and horizontal face of this reflected portion of the anterior lobe, which may be called the *roof of the fissure of Sylvius*, is situated at the upper face of the anterior and inferior part of the middle lobe, so that it entirely conceals the island.

The latter is about two inches long and an inch and a half high forward. It terminates backward in a blunt summit, and curves outward. We remark on its surface three or four flat circumvolutions, which diverge and enlarge from below upward; the anterior of these are shorter, but broader, perpendicular, and partly also go directly a little forward, while the posterior are longer, narrower, and proceed more obliquely backward. Both arise from the right portion, where the two lobes join and emanate as from a common centre of irradiation.

These circumvolutions are separated from those of the middle lobe by a smooth space about four lines broad; but they are so intimately united anteriorly with those of the anterior lobe, that they seem to be the continuation of it.

III. UPPER FACE.

§ 1764. The upper face is very convex from before backward, in which direction it curves uniformly. It is only slightly convex from without inward. It is the longest face of the brain.

IV. INTERNAL FACE.

§ 1765. The upper face forms a right angle with the internal, which is perpendicular and straight. This latter face is placed against that of the opposite side, from which it is separated by the falx cerebri. When the two internal faces are separated, we see at their base, the upper part of the corpus callosum, which unites them in most of their length.

Behind the posterior extremity of the corpus callosum, there is most generally, but not constantly,(1) a deep groove, almost perpendicular, which may more properly be regarded as the limit between the posterior and the middle lobe, inasmuch as it corresponds exactly to the commencement of the posterior horn of the large lateral ventricle, and lodges the posterior cerebral artery.

V. CIRCUMVOLUTIONS AND ANFRACTUOSITIES.

§ 1766. The upper, the internal, the external, and most of the inferior face of the outer surface of the cerebrum, is uneven from numerous elevations and depressions there seen.

The elevations called *circumvolutions* (*gyri*), from the curves they describe, are situated between the depressions termed *anfractuosities* (*sulci*), so that each is included between two grooves. They are covered in every part, outwardly by a layer of gray substance, which is at most but a line or a line and half thick. They are formed of medullary substance, and hence the latter alone determines the form of the surface of the brain. The external layer of gray substance is single in almost every part; and it is almost always divided, only in a slight extent in the posterior and inferior circumvolutions of the internal face of the hemispheres, by a band of white substance, into an external and an internal layer,(2) so that the structure of this part of the brain is more complex than the rest. The medullary band is infinitely thinner than the two gray layers, which together are not thicker than a single layer, and of which the internal is sometimes equal to that of the external, and sometimes also greater or less than it. However constant may be this arrangement in this place, we have never found it else where, except in the cornu Ammonis.

(1) Sœmmerring, *De basi encephali*, tab. iii.
(2) Vicq. d'Azyr, in the *Mém. de Paris*, 1781, p. 506.

The circumvolutions have a rounded surface, and are situated directly at the side of one another, so that the prominences of one correspond to the depressions of another, although where the angles are very re-entering, the prominent part of an adjacent circumvolution oe not perfectly fill them ; whence, in many places, particularly in those where large curves are observed, triangular spaces exist, which are included between two circumvolutions. But even in these places, the latter approach or touch at the bottom of the anfractuosities.

These circumvolutions vary much in the manner in which they are continuous with one another.

Their height and breadth are not uniform in every part ; the latter generally, being some lines greater. They are usually a little more than an inch high, and a little less than an inch broad.

We generally observe in the places where they are broadest, a greater or less depression, which has most commonlly, but not always, the direction of the length of the circumvolution, and the depth of which is usually proportioned to the breadth of the latter. This groove evidently marks the division of the circumvolution into two. It is more rare to see analogous depressions extending transversely from one edge to the other.

These circumvolutions are not perfectly similar either in different subjects, or in the two hemispheres of the same cerebrum : they differ, on the contrary, very much, which circumstance may be considered as a character peculiar to the cerebrum of man, since as Vicq-d'Azyr has already remarked,(1) the cerebrum of the other mammalia is much more symmetrical. Those on the lower face are much more symmetrical, and more constant than the lateral and the superior. The former are mostly longitudinal, the others have every direction. The anterior and the posterior are generally smaller than the middle.

§ 1767. After describing the parts of the surface of the cerebrum of the brain, which are observed without any derangement of this viscus, and which may consequently be called the *external*, we proceed to describe in the same order, those which are seen after partially or wholly raising the preceding, according to the situation which they occupy, without having any regard at present to their connections with each other, or with the whole cerebral mass.

I. TUBERCULA QUADRIGEMINA.

§ 1768. The *tubercula quadrigemina* (*eminentia quadrigemina*, s. *bigemina*, s. *nates et testes*), form a square mass, situated forward and laterally between the posterior extremities of the optic beds, below the pineal gland and the posterior commissure, before the cerebellum, and above the cerebralpeduncles. This massisobliquefrom abovedownward, and from before backward; it is about nine lines long, and ten or twelve

(1) *Mém. de Paris*, 1783, p. 512.—This subject has been more fully treated by Wenzel, *loc. cit.*, p. 23.

broad, and weighs half a drachm. It is composed of two pairs of rounded eminences, situated one after another from before backward. The anterior eminences are usually the largest, and about one line broad. They are called the *nates*, the posterior and the *testes cerebri*. The relation of the weight of the whole mass is to that of the whole cerebrum as 1 : 576. The four eminences are separated by a crucial depression. The anterior are usually more gray than the posterior; this difference of color is rarely as evident in the cerebrum of man, as in that of several animals, particularly the ruminantia.

The eminences are of a grayish red internally, and are surrounded with a very thin medullary layer, so that the reddish tint they present, depends upon the color of the gray substance appearing through the external envelop. The layer on which they are placed, is of a much deeper gray, and is continuous with the gray substance of the cerebral peduncles.

A considerable medullary band proceeds from the anterior extremity of the anterior eminences; this goes forward towards the tubercle, which terminates posteriorly the inner face of the optic bed: a second band also extends either directly to the optic nerve, or to the internal corpus geniculatum, or even in part to the external. Another, which is still larger and longer, is detached from the posterior eminences: this goes to the rounded prominence of the lower extremity of the posterior face, that is, to the external corpus geniculatum.

The tubercula quadrigemina, cover the upper part of the cerebral peduncles. They form an arch extended over a small space called the *aqueduct of Sylvius* (*aquæductus Sylvii*), which establishes a communication between the fourth and the third ventricle.

In the bottom and on the sides of this aqueduct, we remark longitudinal depressions, to which we shall return when describing the cerebral ventricles.

A narrow, prominent, medullary band, descends between the two posterior eminences from about their centre: this is situated exactly on the median line, and terminates in the large cerebral valve.

II. PINEAL GLAND.

§ 1769. The *pineal gland*, *conarium*, Ch. (*Gl. pinealis*, *conarium*), is an oblong rounded body, much broader from right to left than from before backward, solid, blunt at the extremity, of a very deep gray, sometimes of a reddish color, from three to four lines long, two to three broad, two thick, and weighing three grains, which always exists in the cerebrum, and which, probably, has not been found, owing to a superficial examination for it. This body is turned from before backward, and is attached anteriorly by its base by two thin medullary cords, which diverge from behind forward to the thalami optici, between which it is situated at their posterior part, but some lines distant from them on each side. It entirely covers the centre of the upper face of the anterior tubercula quadrigemina. Posteriorly, a medullary layer is detached from its base, which first goes forward, also blends with the upper face of the thalami optici, then immediately curves backward and goes to the point where the anterior pair of the tubercula quadrigemina unite. This is termed the *posterior small cerebral commissure*, which is thinner at its anterior than at its posterior part, the first of which sometimes sends to the pineal gland, filaments similar to nerves, while the second always presents transverse grooves, which soon disappear on each side. The pineal gland always incloses at its posterior part, a small cavity, which varies in size; its orifice is turned toward the middle cerebral ventricle, and the internal face of which is sometimes very manifestly lined by a medullary layer. This cavity is rarely closed in all parts, and its parietes are also proportionally very thick. The variations in its capacity depend neither on the age nor on any other constant condition. It is more consistent than the gray substance generally.

Before this gland, at its circumference, in its cavity, or finally in its substance, and sometimes in all these points at the same time, we find a yellowish substance, which is rarely abundant, but semitransparent, brilliant, hard, and formed of grains apparently irregular, but which are in fact rounded, and the diameter of which does not exceed half a line. (*acervulus cerebri*, s. *glandulæ pineales*).(1)

With some rare exceptions,(2) this hard substance is constantly found after the seventh year according to Wenzel,(3) and sometimes at least after the sixth, according to our observations. Before this period we find in its place a more viscous mass, which is not more unfrequently found at an advanced age, and which then sometimes even coexists with the concretions.

In young men the concretions of the pineal gland are usually found only around the organ and in its cavity, while in old men it also exists in its substance, or even only in the latter.

Their color is not always perfectly the same; generally they have a brighter tint in youth and in advanced age, than during the other periods of life. We however observe in this respect, differences which do not depend on the age. The larger calculi are usually darker than those which are small.

In regard to the proportional quantity of these concretions, it is least in youth and in advanced age. In this respect, however, we observe differences which cannot be referred to a determinate cause. The number of the concretions, also, has no direct ratio with the size of the pineal gland.

(1) Sommerring, *De acervulo cerebri*, Mayence, 1785, ed. ii., in Ludwig, *Opp. neurol.*, vol. ii. p. 322.

(2) We have never known it to be deficient. Wenzel has observed its absence only six times in one hundred cases, (p. 156).

(3) *Loc. cit.*, p. 135.

These concretions and the mass which they form, are united with each other, and with the adjacent parts, by a dense cellular tissue, and by an envelop like a sack. The mass is composed not only of a certain number of smaller masses, but each of these latter are formed of several calculi, which are all perfectly round.

Exposed to the air, these concretions become dry, opaque, and whitish. They seem entirely, or almost entirely, similar to the bones in their chemical composition.(1)

The calculi of the pineal gland, are not a pathological appearance and the cause or the effect of the diseases of the mind,(2) as Morgagni, (3) Gum,(4) and Greding(5) assert, because they are found in very small quantity in four individuals who were fools.(6) Although they are not unfrequently less abundant than usual, when there is no derangement in the mind; still the coincidence of their rarity with mental derangement, is curious, inasmuch as the fewness of these concretions in young and in old men, seems to lead to something analogous.

III. CORPUS CALLOSUM.

§ 1770. The *corpus callosum*, *mesolobe*, Ch. (*corpus callosum*, *trabs cerebri*, *commissura cerebri magna*),(7) is situated between the two hemispheres and unites them.

It is nearer their anterior than their posterior extremity, and occupies about the second and third anterior fifths of the length of the cerebrum, considering the length to be divided from before backward into five equal parts. It is, however, a little longer than two fifths.

It is about three inches long and eight lines broad. It gradually enlarges from before backward, but again contracts a little nearer its posterior extremity. In most of its length, excepting the middle, it is covered by the lower part of the internal wall of the hemispheres, which advances on it, whence a deep depression in form of cul-de-sac, is formed on each side, somewhat analogous to the lateral cavities of the larynx. Its mean thickness is about three lines.

It is uninterruptedly continuous on both sides, with the substance of the hemispheres, and there is no need of recurring to any artificial means to discover that it is formed of transverse medullary fibres, blended with grayish substance.

(1) Gordon, *loc. cit.*, p. 135.—Pfaff, who has analyzed these concretions, found them composed of animal matter, and of much phosphate of lime, and a little of the carbonate. See *Deutsches Archiv. für die Physiologie*, vol. iii. p. 170.

(2) J. F. Meckel, *Mém. de Berlin*, 1754, p. 92.—Rœderer, *De cerebro*, Gottingen, 1758.—Morgagni, *De caus. et sed.*, ep. lxi. a. 3, 4.—Sommerring, *loc. cit.*

(3) *De caus. et sed.*, ep. v. 12.

(4) *De lapillis glandulæ pinealis in quinque mente alien.*, Leipsic, 1753.

(5) *Advers. med.*, vol. ii. p. 522.

(6) Wenzel, *loc. cit.*, p. 165.

(7) Reil, *Sur le systeme et l'organisation du corps calleux*; in the *Archiv. für die Physiologie*, vol. x. p. 171-175.

The anterior extremity of its upper face is convex, and the posterior is concave, an arrangement which undoubtedly depends on the separation of the two hemispheres from each other from before backward.

The posterior edge is broader than the anterior.

On its upper face there is a superficial depression which extends through all its length, and corresponds exactly to the median line. Along this depression there is on each side a slight elevation, called the *raphe*, or the *external suture of the corpus callosum* (*raphe*, s. *sutura externa corporis callosi*). The raphe is not formed solely by the artery of the corpus callosum, but it is a sort of cicatrix, produced by the mutual adhesion of the two hemispheres.

Independent of this depression, we also remark on the upper face of the corpus callosum, two longitudinal striæ, generally broader, which proceed on each side parallel to each other, although not perfectly symmetrical; these are called the *lateral longitudinal striæ* (*striæ longitudinalis laterales*). Reil terms them the *covered bands*, because they are situated below the part of the hemispheres which projects inward, and which almost entirely covers the lateral part of the corpus callosum.

Transverse fibres exist also on each side, on this upper face: they leave the median line, and are continuous with those of the hemispheres.

We also observe transverse elevations on the lower face; but the latter resemble still more the fasciculi, separated from each other by superficial depressions. They arise from the inferior face of the corpus callosum, being concave and less extensive than the superior. In fact, the transverse fibres extend through all the thickness of the corpus callosum.

These fibres are not transverse at the anterior and posterior extremities of the corpus callosum: they there have a direction from before backward, and from without inward in the first, from behind forward and from without inward in the second, so that they converge.

The corpus callosum is curved at each of its extremities. It is inflected from before backward, and from above downward at its anterior extremity, from behind forward, and also from above downward at its posterior extremity. Reil termed the anterior curve the *knee*, and its extremity the *beak*, the posterior the *glove*. These two curves connect the upper and lower faces of the corpus callosum.

The latter is much more complex than the other. After leaving the knee, it descends from before backward, extends to the anterior commissure, reascends from behind forward, is parallel to the upper face, again proceeds forward, then a third time backward, and is finally continuous with the upper face, after giving origin to the glove.

This lower face is loose only at its anterior and its posterior part, forward from the knee to the anterior commissure, backward to its union with the arch; every where else it is uninterruptedly continuous with the septum lucidum.

The commencement of the lower face from the knee to the anterior commissure, gradually becomes more and more narrow. From the knee to its centre, the upper raphe and the longitudinal lateral striæ are very distinct. But the raphes disappear in this place, the striæ approach each other still nearer from before backward, but do not touch; and at the same time the lower face is grooved from the extremity of the superior raphe to the commissure, where it terminates by a small depression in form of cul-de-sac; consequently the two lateral halves of the corpus callosum are, in this place, less broad, and less flat, and have the form of a straight layer; but their internal faces are inclined one towards another, whence comes the longitudinal groove which we have mentioned.

Hence, also, the part of the corpus callosum, covered by the hemispheres, becomes narrower from before backward, after leaving the knee, so that the most posterior part is entirely disengaged, and it is directly continuous with the ascending internal face of the anterior lobes of the cerebrum. Hence, also, the lateral longitudinal striæ are entirely loose in this place. They are directed backward, downward, and outward, and proceed below and before the anterior commissure, between it and the decussation of the optic nerves. At the posterior extremity of the lower face of the posterior lobe, they unite to the cribriform plate or anterior perforated substance of the lower face of the cerebrum, so that in this place the corpus callosum is continuous, through them, with the lower face of the anterior and the middle lobes; although we cannot term the lateral longitudinal striæ the *peduncles of the corpus callosum*, as has been done by Vicq-d'Azyr.

Posteriorly the corpus callosum is also reflected on itself from above downward, and from behind forward. As the superior face of this reflected portion is adapted to the lower face of the straight portion, it forms what Reil has termed the *glove*.

The septum lucidum is attached to all the rest of the lower face of the corpus callosum, which may be called its *internal* portion, in opposition to the upper and loose part of the inferior, considering the latter as *external*.

The corpus callosum is continuous at its posterior extremity in the posterior and descending horn of the lateral ventricles, partly with the roof of these cavities, partly with the medullary covering of the eminences they enclose, the pes hippocampi minor and the cornu ammonis, which will be described hereafter.

IV. SEPTUM LUCIDUM.

§ 1771. The middle and anterior region of the part of the cerebrum which extends from before backward on the median line, forms the *septum lucidum*,(1) *septum median*, Ch. (*Septum pellucidum*, s. *lucidum*). (2) This septum, which is extended vertically between the corpus

(1) A very improper term, for the septum is but slightly, or even not at all transparent.

(2) Meckel, *Obs. sur la glande pineale, sur la cloison transparente, etc.*, in the *Mém. de Berlin*, 1765, p. 91-102.

callosum and the fornix is triangular. Its height and thickness are much greater anteriorly than posteriorly. It is continuous upward and forward with the anterior, horizontal, and reflected portion of the corpus callosum; posteriorly, but only to a slight extent, with the anterior portion of the fornix, and forms the larger anterior part of the common internal wall of the lateral ventricles.

It is composed of two layers, directly adapted one to the other, but they are not fused together. Each of these layers is formed in turn of an external thin and medullary stratum, and an internal thicker and gray stratum, the former of which is continuous with the medullary substance of the corpus callosum, and of the fornix. The medullary layer is lined by a very delicate membrane, which is demonstrated with peculiar facility, when there is an accumulation of serum in the space between the two layers.(1)

The space between the two layers is the *ventricle of the septum*, called also the *fossa of Sylvius*, the *sinus* of the *median septum*, Ch. (*ventriculus septi*), which is usually termed the *fifth ventricle*, and which Wenzel has called the *first ventricle*. This space does not every where present the same form or the same volume; but generally it is more spacious, and particularly broader in proportion, in the early periods of life, than afterward. Its breadth anteriorly is three or four twelfths of a line in the full grown fetus. It is usually about an inch and half long in the adult. It is always narrower in its centre, while at the anterior and the posterior extremity, it terminates in a triangular fossa, the angles of which are turned one towards the other.

Opinions are divided on the question, whether this ventricle is entirely separated from the others, or if it communicates with them, whether the communication be constant or simply accidental. Opinions differ also in regard to the position of this opening.

The ventricle of the septum is generally considered as a perfectly closed cavity. Our dissections have demonstrated that in the normal state it is always closed in subjects who are perfectly developed: it however much exceeds the limits generally assigned to it anteriorly; for a canal which is at first rather broad, but which gradually contracts, and finally becomes very narrow, extends from its anterior part downward and backward, towards the third ventricle, to near the space between the anterior pillars of the fornix and the anterior commissure. We, however, cannot generally observe the orifice of this duct, although a communication between the third ventricle and that of the septum sometimes exists exactly in this place.(2)

(1) Sabatier, *loc. cit.*, p. 433.—Meckel, *loc. cit.*, p. 96.—Wenzel, *Prodr.*, p. 7.—Vingtrinier, *Cas remarquable d'hydropisie de la cavite du septum lucidum, ou cavite de Sylvius, chez une jeuné fille idiote*; in the *Revue medicale*, vol. viii. p. 299

(2) Tarin, *Anthropotomie*, Paris, 1750, vol. i. p. 232. This septum sometimes opens by the small fissure which separates the two cords of the anterior pillar into the lateral ventricles.

V. FORNIX.

§ 1772. The *fornix, trigone cerebral*, Ch. (*fornix*) forms the lower part of the upper and anterior wall of the third ventricle. It is uninterruptedly continuous upward and backward with the corpus callosum, forward in most of its length with the septum. The upper and attached edge is convex; the lower is concave, and rests on the internal part of the upper face of the thalami optici, which it almost entirely covers, and is directed from behind forward, and from above downward. Posteriorly, the fornix is continuous by its posterior extremity with the corpus callosum. Externally, but first becoming broader, it joins uninterruptedly, the manifestly fibrous envelop of the cornu ammonis, then unites directly forward with the corpus fimbriatum. The posterior part of the fornix presents oblique and transverse striæ in its centre, and has been termed, very improperly, the *lyre* (*lyra*, s. *psalterium*), since, as Sabatier has already remarked, the Greek word ψαλλις does not mean a lyre but an arch; hence too the term καμαριων also applied to this part. The origin of the corpus fimbriatum, and the white envelop of the pes hippocampi, are called also the posterior *pillars of the fornix*. We may consider the centre of this latter as its *body*. Anteriorly, the fornix descends directly behind the anterior commissure, then turns backward, and penetrates before and below the optic thalamus of its side, in the floor of the fourth ventricle, where it seems to disappear.

The portion of the fornix between its posterior extremity, and some lines beyond the anterior commissure, is flattened from above downward, and is single. After leaving this point, the fornix becomes cylindrical, and gradually divides into two lateral cords, which diverge from above downward, and are called its *anterior pillars* (*crura fornicis anteriora*), so that the anterior commissure which passes before them, is very evident in the interval between them. Each of these cords then glides below the optic bed of its side, in the floor of the fourth ventricle, directly above the decussation of the optic nerves. There, surrounded entirely by gray substance, it goes first outward, then again inward, so that it describes an arch very convex outwardly, whence opposite the union of the optic nerves, striæ descend into the decussation, where they may be easily followed, and it finally terminates in the gray substance of the mammillary eminences. We may then consider these latter as making part of the fornix, and Santorini is perfectly right(1) in terming them the *bulbs of the fornix* (*bulbi fornicis*). The fornix, however, does not terminate in this place; for a considerable medullary cord detaches itself from the mammillary eminences; this proceeds within the optic bed, directly behind its internal face, covered in all parts by gray substance, enlarges above and expands in a fan. The mammillary eminences also give off a third medullary cord, which proceeds, at least in great part, nearer the surface, on

(1) *Obs. anat.*, vol. iii. c. 2.

the inner face of the optic bed, goes farther forward and divides into an anterior and a posterior fasciculus: the posterior follows from before backward the upper edge of the inner face of the optic bed, and is continuous with the peduncle of the pineal gland: the anterior goes outward, and is continuous with the semi-circular band, between the corpus striatum and the optic bed. Finally, the mammillary eminences also send backward and outward a third medullary cord, which is covered by the roof of the optic nerve, and goes to the optic bed.

Thus the fornix represents a very complex chain, which unites the two hemispheres in several parts, and which also establishes a communication between the anterior and the posterior parts of each hemisphere.

VI. THALAMI OPTICI.

§ 1773. The *thalami optici*, or the *posterior cerebral ganglions*, the *optic beds* (*ganglia postica*, Gall, *corpora striata posteriora et superna*, Vieussens; *thalami*, s. *colliculi nervorum opticorum*), are two grayish, elongated, rounded bodies, which converge from behind forward, and from without inward, and are situated before the tubercula quadrigemina, envelop the anterior ends of the cerebral peduncles in most of their extent, especially upward and inward, so as to leave loose only a small part of them outward and downward, if we except the root of the optic nerve: but if we include this root, the cerebral peduncle is surrounded in this place by a complete ring, of which the optic bed is the commencement, and the union of the roots of the optic nerves the termination. These bodies are about an inch and a half long, nine or ten lines high, and from eight to ten broad. They weigh nearly four drachms, so that their weight is to that of the rest of the cerebrum, about as 1 : 36.

Their upper face is convex. We there remark a longitudinal projection, the direction of which is from before backward, and which is most prominent at its anterior part, and which imperceptibly disappears posteriorly. The most prominent part of this projection is the extremity of a large medullary fasciculus, which comes from the mammillary eminences, and expands superiorly like a fan.

The internal face is slightly convex, and almost straight at its anterior part, which is the most extensive.

It is continuous with the upper at an almost right angle. At the anterior part of its union with this latter, we observe a white medullary band about one line and a half broad. The bands of the two sides which are inflected to go to meet each other, unite on the median line, where they become the peduncles of the pineal gland, then go backward towards the mammillary eminences, slightly concealed forward and downward by the inner face of the optic bed.

Behind the posterior extremity of this medullary band, the internal wall is slightly convex, and terminates finally in a rounded prominence.

The optic beds are not united by the nervous substance at their upper part, nor in those subjects which are perfectly developed, nor even at the early periods of life,(1) although Vieussens,(2) Santorini,(3) Morgagni,(4) Winslow,(5) and Gunz,(6) have asserted the contrary. They are connected in this place only by the pia-mater, which passes from one to the other. But their internal faces adhere anteriorly for the extent of three or four lines, by a small rounded cord, about a line broad, and formed of gray substance, called the *commissura mollis*. Very rarely the commissura mollis,(7) does not exist;(8) hitherto we have known it to be deficient only three times, nor is it common to find two situated one above the other.(9)

Below there is no continuity of substance between the thalami optici. These two bodies are not united, except by the medium of the floor of the middle cerebral ventricle.

The external face is convex, and intimately united to the corpus striatum, but in such a manner, however, that we every where observe between the two eminences, medullary substance, which is the continuation of the cerebral peduncles. The posterior face is also convex, and always evidently divided into three rounded tubercles arranged in a triangle, and situated, one, the *posterior* (*tuberculum ganglii postici posterius*, s. *posterius superius*), upward and backward; the second, the *internal corpus geniculatum* (*corpus geniculatum internum*, s. *tuberculum posticum medium*), downward and inward: finally the third, the *external corpus geniculatum* (*corpus geniculatum externum*, s. *tuberculum posticum inferius*, s. *externus*), still lower and externally.

The posterior tubercle is always larger than the two corpora geniculata, but more connected than they with the substance of the posterior cerebral ganglion.

The two corpora geniculata are sometimes equal in size, but usually the internal is larger. Their form is rounded.

Both are directly connected with the tubercula quadrigemina by medullary bands, which are sometimes blended, but are usually distinct and seperate from each other. The medullary band of the posterior tubercula quadrigemina, goes to the external corpus geniculatum, and that of the anterior to the internal corpus geniculatum. The first is much more constant and stronger than the second.

(1) At least we have always observed this. Sabatier has made the same remark, (*Anat.*, vol. iii. p. 437.)
(2) *Neurogr.*, l. i. c. ii.
(3) *Obs. anat.*, c. iii. § 7.
(4) *Advers. anat.*, l. vi. c. x.
(5) *Exp. anat.*, l. iv. p. 163.
(6) *Prolusio de cerebro*, ii. Leipsic, 1750, p. xi.
(7) Morgagni and Gunz, claim the honor of its discovery.
(8) Wenzel has known it to be deficient five times out of sixty-six, (*De cereb.* p. 129). Gordon (p. 98) has always found it, and Sabatier almost always (p. 437.)
(9) Vicq. d'Azyr, p. 527.—Wenzel, *Prodr.* p. 15.—We also have observed this anomaly.

The two corpora geniculata are composed only of medullary substance externally. Internally they are formed by a mixture of white and of gray substance.

They are continuous downward with the root of the optic nerve.

The upper and posterior face of the optic bed, is covered with with a thin layer of white substance ; the internal of gray. Internally they present a mixture of white and of gray substance. Beside the medullary fasciculi from the tubercula quadrigemina, and which partly remain in the substance of the ganglion, partly also blend in its surface with the pineal gland, this body is formed of several superimposed layers, the rays of which are directed from within outward, unite in the substance of the cerebral peduncle, and intimately interlace with it.

VII. CORPORA STRIATA.

§ **1774**. The *striated bodies, beds of the ethmoidal nerves*, Ch., *anterior cerebral ganglions*, Gall, (*corpora striata, corpora striata antica inferiora, ganglia cerebri magna antica*),(1) are two elongated, rounded, and flat bodies, formed almost entirely of a substance very gray externally, which occupy most of the lateral ventricles and the lower part of the anterior lobes. They are usually about two inches and a half long, and their greatest height is about one half of it. They are from eight to nine lines thick, and are highest and thickest anteriorly ; they gradually become thinner and lower posteriorly. The mean weight of each is about five drachms, and is to that of the optic bed as **5 : 4**. The weight and proportional size of these two eminences are, however, not always the same, as has been determined by Vicq-d'Azyr and Gordon, with whose observations our own agree. Their weight is to that of the whole cerebrum as **1 : 29**. Their greatest diameter is from before backward, and from within outward. They are nearly four lines distant from each other forward, and about two inches posteriorly ; because posteriorly the thalami optici and the tubercula quadrigemina exist between them, while anteriorly they are separated only by the septum, and the anterior part of the fornix.

Their upper and their internal portions are loose and unattached to a considerable extent ; this forms the floor, and the outer wall of the anterior horn of the large cerebral ventricle, has a conical form, is gradually elongated from before backward, where it is pointed, and describes in its centre a considerable curve, the direction of which is from before backward. After leaving the external edge of this loose part, the medullary substance is reflected from below upward at an acute angle, and forms the lateral and upper walls of the large cerebral ventricle. When cut from within outward, proceeding from this edge, we arrive only into the medullary substance of the hemispheres, but if the incision is made downward and a little outward, we come to the

(1) Magendie, *Note sur les fonctions des corps striés et dés tubercules quâdrijameaux* ; in the *Journ. de phys.*, vol. iii. p. 376.

outer face of the corpus striatum, which makes an obtuse angle with the superior. This external face extends to near the entrance and the island of the fissure of Sylvius, from which it is only a few lines distant. Its upper part is straight, and formed from behind forward by a layer of medullary substance about four lines broad. The lower is convex in almost all its extent, composed of gray substance, and but loosely connected with the medullary substance of the posterior part of the anterior lobe, in the midst of which it is imbedded, so that the corpus striatum can easily be detached from this latter. Only the posterior part of the lower half of the external face is also straight and medullary, because the white band we have mentioned is reflected downward and forward: but at its most posterior part it again becomes gray, and here the gray substance, which is visible externally above, forms a tail which is inflected downward and forward in the same direction as the medullary substance, but does not however extend to the anterior large half of the external gray face.

The gray substance of the corpus striatum, seems then to be divided externally by a considerable layer of medullary substance, into an internal and upper half, and an external and lower.

The inferior face of this body is narrow and rounded. It is imperceptibly continuous with the internal and the external. Below it is blended with the medullary substance of the hemispheres, which gives it a whitish gray tint.

The lower part of the internal face is convex, and closely envelops the external face of the optic bed.

Horizontal, vertical, and oblique incisions, make us acquainted with the essential characters of the structure of the corpora striata. They demonstrate that these bodies are composed of three substances, one a deep gray, the second a light gray, and a third medullary, which form several alternate layers.

All these layers describe arches, the convex edges of which are turned upward, and the concave edges downward.

The medullary substance proceeds from behind forward, and from below upward, from the cerebral peduncle and the optic bed to the middle of the gray substance. At its entrance, which corresponds to the posterior extremity of the lower face of the corpus striatum, it extends its whole height; but it soon divides into several fissures and superimposed layers, which are generally three in number, which go forward; the lower two of these are much narrower and shorter than the upper. The latter, which also extends farther forward than the other two, does not proceed except to the upper and posterior part of the loose face of the corpus striatum, while forward and downward it is entirely enveloped by the gray substance which forms its anterior extremity. At the same time its breadth diminishes forward and downward, and it is interrupted by some gray substance both from before backward and from above downward, so that it is divided below into several layers of small white rays, some of which occur also between the third and second layer. This white substance, however, penetrates from behind forward, and from below upward, through the gray, and is continuous in every direction with the medullary substance of the hemispheres.

The light gray substance forms the middle and lower part of the corpus striatum: it is situated between the inferior and the first medullary layers, and likewise between this and the second, which it much exceeds in thickness. It occupies the smallest part of the corpus striatum.

Most of this body is formed of a deep gray substance, which is abundant particularly above, where it occupies the space between the second and third medullary layer, and forms the loose part of the corpus striatum, situated above and before this space.

The corpus striatum is then formed by alternate layers of white and gray substance; all these layers are conical. Those of gray substance bulge forward, and those of white substance backward. All terminate in a point at the opposite extremity, and interlace with each other.

The light gray substance which forms the middle and lower part seems to be formed by an imperfect separation of white and gray substance; for the two lower layers of white substance are not so pure a white as the upper, which are contrasted with a deep gray substance.

The best method of becoming acquainted with the structure of the corpus striatum, is to cut and scrape its posterior and inferior part, and follow the medullary substance of the cerebral peduncle within it. The cerebral peduncle enters it from below upward, and from behind forward, and the medullary substance with which it is continuous is enveloped directly downward, inward, and outward, by the gray substance; the corpus striatum is interrupted by this only in a small portion of its posterior extremity.

The medullary substance of the cerebral peduncle disappears at the posterior extremity of the corpus striatum, like the branches of a fan, in the form of fasciculi, which penetrate the gray substance in all parts, enlarge from before backward, and become thin from within outward. It sends outward and inward numerous radiating and pointed prolongations which expand in the gray substance, but do not extend to the circumference.

The gray substance of the corpus striatum is then divided in its whole extent by the white, which is continuous with the cerebral peduncle, into two parts, an external and an internal, which are blended together below, but not above. The white band of its upper face is the anterior edge of the medullary expansion which passes through it; and the commencement of the medullary substance of the hemisphere formed by the white substance which passes through the middle of the corpus striatum.

As the medullary substance gives off in its course expansions which radiate in every direction, the corpus striatum ought necessarily to present internally the appearance described above, when cut transversely and longitudinally; so that it much resembles the cerebellum, from which also the medullary substance disappears in thin layers, only there the gray substance which covers the latter, instead of having the same form, merely appears as a layer which is expanded uniformly over its surface.

VIII. TŒNIA SEMICIRCULARIS.

§ 1775. In the groove between the upper faces of the corpus striatum and the optic bed, is a narrow and prominent band, called the *tœnia semicircularis* (*stria cornea*, s. *terminalis*, s. *tœnia striata*, s. *geminum centrum semicirculare*). This band is a little more than a line broad and is slightly prominent; it commences before the foramen of Monro, near the anterior pillar of the fornix, with which it is always connected. It rarely terminates at the posterior extremity of the corpus striatum: it generally curves downward and outward, and disappears near the end of the roof of the descending horn of the lateral ventricle, where it communicates with the summit of the corpus fimbriatum in the descending horn of the great ventricle, and the most external fibres of the corpus fimbriatum and of the anterior commissure.

This band projects but slightly in the early periods of life: is whitish, and formed of longitudinal fibres, which raise in this place the inner membrane of the ventricle. It afterwards becomes, particularly on its inside, more prominent and brownish, and there is deposited on the surface of the medullary fibres primarily existing and which alone form it at the commencement, a more or less brownish layer, which is hard and solid, whence it is called the *lamina cornea*. This change ensues as the subject grows older, or cephalic affections exist; so that it is not essential to the organization of the band. Tarin considers this substance as of a peculiar nature.(1) Vicq-d'Azyr regards it as the common gray substance.(2) Wenzel has attended particularly to its formation, and considers it as formed by an effusion of fibrin, and as it is developed, the adjacent membrane of the ventricles also thickens, and the number of the glands of Pacchioni increase.(3)

IX. ANTERIOR COMMISSURE.

§ 1776. The *anterior commissure* (*commissura anterior*, s. *magna*,)(4) is a transvere, rounded, medullary fasciculus, which is slightly flattened from above downward, and is a little thicker than the optic nerve: it is inclosed in a sheathe formed from the pia-mater, and is situated directly in front of the anterior peduncles of the fornix. Its anterior part is loose and exposed, but on the right and left the cord

(1) *Advers. anat.*, 1750, p. 2.
(2) *Loc. cit.*, p. 430.
(3) *Loc. cit.*, p. 82.
(4) Reil, *Archiv. für die Physiologie*, vol. xi., p. 69.

penetrates into the lower and anterior part of the corpus striatum; is a little broader, becoming also gradually thinner; goes outward, then backward, and a little downward, and thus describes an arch which is convex forward. This arch passes through the substance of the corpus striatum, but does not blend with it, and is situated in a special canal from which it is grooved. After leaving this transverse canal, it vanishes in rays, and terminates in the lower region of the fissure of Sylvius, and of the descending horn of the lateral ventricle, where it blends with the most external fibres of the corpus fimbriatum and tœnia semicircularis.

Only the middle part of the anterior commissure is then perceptible, and even this to a very slight extent without, if none of the cerebral substance be removed.

This cord unites the anterior and inferior parts of the posterior lobe of the two hemispheres, and forms the anterior part of a ring which is closed posteriorly by the fornix, its appendages, and the tœnia semicircularis.

It is, however, very probably connected with the origin of the olfactory nerve, since it passes above the anterior cribriform plate, at a little distance from its roots, especially the external, and an undoubted relation between the development of these roots and that of the commissure, may be demonstrated in animals. Hence the origin of the optic and olfactory nerves very much resemble each other.

The structure of the anterior commissure is extremely curious, since it resembles a nerve, not only being surrounded externally by a thin neurilemmatic envelop, but is also formed internally by fasciculi of a very minute cellular tissue. The external and internal envelops do not disappear, except at the place where the commissure vanishes on leaving the corpus striatum.

X. CEREBRAL VENTRICLES.

§ **1777.** The substance of the cerebrum is not perfectly solid. It incloses a considerable space, which corresponds generally in form to that of the external face, because it proceeds into all parts of this viscus, but its extent is much less. We may term this space generally the *cerebral ventricle* (*ventriculus cerebri*), or the *central fissure* (*fissura centralis*).

The floor of this cavity is formed by that part of the cerebrum which corresponds to the anterior cords of the spinal marrow, and of which it is properly only a development. Its sides and roof are formed by the parts superadded to these cords.

It begins at the posterior extremity of the upper face of the medulla elongata in the place where the posterior cords of the spinal marrow separate, and is here called the *rhomboidal sinus*, or the *calamus scriptorius*; it continues then under the cerebellum, where it gives rise to the *fourth ventricle*, dilating in every direction: thence it contracts and passes under the tubercula quadrigemina, and forms the *aqueduct of Sylvius;* it then again enlarges in every direction, principally, however, from above downward, between the thalami optici, where it forms the *third ventricle*, terminates anteriorly in this place in a cul-de-sac, but extends much to the right and left, and thus forms on each side the *lateral ventricle.*

The cerebral ventricle considered as a whole has the form of a cross, the anterior longitudinal arm of which is considerably shortened, while each of the lateral ones is divided into three arms.

All the different compartments communicate uninterruptedly with each other.

This cavity is not entirely closed. Its internal face, and consequently that of the cerebrum, communicates with the external in many parts, viz. backward, between the cerebellum and the medulla oblongata by the *small transverse fissure* (*fissura cerebri transversa parva*); and forward, between the corpus callosum, the corpus fimbriatum, the tubercula quadrigemina, and the thalami optici, by the *large transverse fissure* (*fissura cerebri transversa magna*). These spaces, however, which are caused by the interruption of the cerebral substance, are filled by the arachnoid membrane and the pia-mater.

The parietes of these different cavities are smooth, and moistened with serum. Many anatomists(1) admit here only the choroid plexus, and no special membrane. Bichat(2) and Wenzel,(3) on the contrary, whose opinion is more correct, have there found a special membrane, which is, according to the former, a continuation of the arachnoid membrane, while the latter regards it as a membrane of a particular character. The internal membrane of the first, second, third, and fourth ventricles is evidently continuous with the arachnoid; but that which lines the fifth forms a closed sac. This circumstance, however, proves nothing against Bichat's opinion, since the ventricle of the septum probably communicates with the others at first.

The inner membrane of the cerebral fissure is demonstrated with peculiar facility in youth, when the medullary substance above the lateral ventricles is carefully removed. It may be easily demonstrated also(4) in the ventricle of the septum or the corpora striata, in the posterior horn of the large ventricles, and on the floor of the fourth. It usually becomes thicker in hydrocephalus internus. Sometimes also it is very evident when serum accumulates between it and the cerebral substance. It can rarely, however, be separated completely, and some cerebral substance almost always adheres to its external face. Hence why many anatomists have termed it the *medullary layer* (*lamina medullaris*). Very recently, also, Reil has applied the term *epithelium*

(1) As Sœmmerring, *loc. cit.*, p. 48, § 59.
(2) *Tr. des membranes*, p. 216.
(3) *Prodromus*, § 8, *p.* 8. *De cerebro*, cap. viii. *Integumentum ventriculorum cerebri et partium in iis sitarum*, p. 80.
(4) Wenzel, *loc. cit.*, p. 81.

to the union of this membrane with the shapeless substance which covers the parts of the cerebrum below it.(1)

Its thickness also varies in the normal state in the different regions where it is considered.

Of the divisions comprised by the cerebral ventricle, we have already described the rhomboidal sinus (§ 1729): we have then only to examine the others.

a. Ventricle of the cerebellum.

§ 1778. The *ventricle of the cerebellum*, the *fourth ventricle*, the *fifth ventricle* (*ventriculus cerebelli*, *ven. quartus*, s. *quintus*, Wenzel),(2) is triangular: its base looks downward and backward, and its summit upward and forward. It is continuous downward and backward with the rhomboidal sinus of the medulla oblongata. It penetrates backward and upward between the anterior and posterior extremities of the vermiform process in the substance of the cerebellum, and terminates there in a point. Anteriorly it passes under the posterior edge of the tubercula quadrigemina, and is continnous with the aqueduct of Sylvius. Its floor, which in the natural position of the cerebrum, constitutes the anterior wall, is formed by the upper face of the annular protuberance. Along the median line is a longitudinal groove about one line deep; on each side of this rises a prominence which turns over from within outward.

From the anterior to the posterior extremity of this floor a narrow and elongated *blue place* extends, which probably exists only in man; this is formed of numerous minute blood-vessels, and is apparently connected with the origin of the auditory nerve(3).

The posterior and inferior wall is formed by the anterior and internal face of the posterior half of the vermiform process, and laterally by the posterior valve. The lateral walls are composed of the anterior and middle prolongations of the cerebellum. Finally, the superior is formed posteriorly by the posterior face of the anterior half of the vermiform process, and anteriorly by the anterior cerebral valve.

The fourth ventricle is open posteriorly, so that in this place the inner face of the cerebellum is continuous with the external by the *small cerebral fissure*.

(1) *Archiv. für die Physiologie*, vol. ix. p. 143.

(2) Desmoulins, *Mémoire sur le rapport qui unit le développement du nerf pneumogastrique à celui des parois du quatrième ventricule;* in the *Journ. de phys. exp.*, vol. iii. p. 362.

(3) *Loculi cærulei in basi ventriculi quinti;* in Wenzel, *loc. cit.* vol. xvii. p. 168–169.—This blue place has already been described by Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 585.

b. Aqueduct of Sylvius.

§ 1779. The *aqueduct of Sylvius* (*aqœductus Sylvii*, s. *canalis eminentiœ quadrigeminœ*), is a very narrow channel which establishes a communication between the ventricles of the cerebrum and cerebellum. It is formed below by the upper and convex face of the cerebral peduncles, on the sides and above by the tubercula quadrigemina, and anteriorly by the posterior commissure and the pineal gland. It is continuous posteriorly with the fourth ventricle, anteriorly with the third, and also communicates in the latter place with the external face of the cerebrum.

The parietes of this canal present four longitudinal depressions, an inferior, two lateral, and a superior.(1)

The inferior is the most posterior, and is situated in the median line: it terminates the longitudinal groove in the floor of the fourth ventricle. The lateral are situated farther forward, become deeper towards the centre, and converge from behind forward. The superior, which corresponds exactly to the inferior, and which passes through the centre of the upper face, is the deepest: it is broader anteriorly and still deeper posteriorly.

We do not consider these depressions as particularly important, as Wenzel thinks them. We regard them only as the remains of the large ventricle covered in the fetus by the tubercula quadrigemina.

c. Third ventricle.

§ 1780. The *third ventricle* (*vent. tertius*, s. *processus fissurœ medianœ perpendicularis*, Gordon), commences at the anterior extremity of the aqueduct of Sylvius, and descends obliquely from behind forward. It is much larger than the fourth ventricle in man, while in animals the reverse is true.(2) Its form is very irregular, resembling an oblong square. Its length is much greater than its height, and it is only a few lines broad.

Its floor is formed by the gray substance situated before the cerebral peduncles by the mammillary eminences, finally between and before the latter, by the decussation of the optic nerves. Its anterior face is covered by the thin layer of gray substance situated before the decussation of the optic nerves, by the anterior peduncles of the fornix, and by the anterior commissure. Its upper wall or roof is covered by the body and the posterior peduncles of the fornix, and also by the posterior fold of the corpus callosum. Finally, its lateral walls are formed below by the internal, and above by the external faces of the thalami optici. Its lower face is the most irregular: considered generally, it descends from behind forward; but we remark in it two culs-de-sac, the posterior of

(1) Wenzel, *Scrobiculi in canali corporum quadrigeminorum*. *Loc. cit.*, vol. xvi. p. 166–167.

(1) Wenzel, *loc. cit.*, cap. 21–22.

which is the commencement of the infundibulum, and the anterior is situated before the decussation of the optic nerves. Both of these depressions terminate in a point.

The fourth ventricle is imperfectly divided near its centre, posteriorly into an upper and a lower half by the commissura mollis of the thalamic optici.

The anterior, superior, and inferior walls are perfect, but the lateral presents a space, or rather the anterior and the superior lateral walls are not united by cerebral substance. The middle and lateral ventricles of the cerebrum communicate by this space between the optic beds and the fornix. When the pia-mater and arachnoid membrane to which it gives passage are removed, it is quite large, but when these two membranes continue in place it is very small, and forms a very narrow opening between the lower anterior extremity of the thalamic optici and the anterior pillars of the fornix.

This opening is called the *foramen of Monro* (*foramen Monroi*).

It is constant, except in certain pathological states. The impossibility of passing air from one of the lateral ventricles into the other, the permanent fullness of one of these cavities after the other has been opened and the fluid removed from it, and finally the difference sometimes remarked between the liquids accumulated in the two lateral ventricles,(1) have been adduced as arguments against its existence. But most of these phenomena may be explained by the falling of the vascular plexus across the opening, and also by the morbid adhesion with the edges of this latter, or of the edges themselves.(2) This latter cause is more probable, as most of the observations on which the above mentioned arguments rest have been made in circumstances favorable to a morbid adhesion.(3)

We must not confound with the foramen of Monro an opening admitted by incorrect anatomists in the septum lucidum, which does not exist; when this is seen, it depends on the awkwardness of the anatomist, the bad condition of the cerebrum, or a morbid laceration.

In fact the third ventricle is continuous upward and backward with the aqueduct of Sylvius; but it also communicates with the external under the posterior extremity of the corpus callosum, above and before the pineal gland, through a broad opening of which the pia-mater and the arachnoid membrane which penetrate into the cerebrum, contract the diameter, and which forms the central part of the large cerebral ventricle.

There is consequently in this place, about the centre of the encephalon between the cerebrum and cerebellum, a point where the external face of the cerebrum is continuous anteriorly and posteriorly

(1) Portal, *Sur une hydropsie particulière des ventricules latéraux du cerveau et sur la cloison qui les sépare;* in the *Mém. de Paris*, 1770, p. 240.
(2) Monro, *On the brain*, Edinburgh, 1793, ch. 1.
(3) *Vicq-d'Azyr*, in the *Mém. de Paris*, p. 539.

with the internal by means of the third ventricle, and from before backward by the aqueduct of Sylvius.

d. Lateral ventricles.

§ 1781. The *lateral*, *anterior*, or *large ventricles* (*ven. cerebri laterales*, s. *anteriores*, s. *magni*, s. *tricornes*),(1) are situated in each hemisphere, on the sides of the corpus callosum, the fornix and the septum. They have an irregular are generally oblong form, being arranged so that their greatest length extends from before backward. Above they do not pass beyond the corpus callosum, and that part of the hemispheres into which the body extends. They form their roof, which must not be described as a separate and distinct part from the rest of the cerebral substance.

We may distinguish in it a *middle part*, and *horns* or *curves* (*cornua*).

The middle part proceeds directly from behind forward, and from above downward. It is continued inward by the septum lucidum and the corpus callosum, outward by the corpus striatum. Its floor forms most of the fornix.

1. Anterior horn.

§ 1782. The *anterior horn* is the smallest. It goes outward and downward. It is convex forward, and concave backward. It is situated between the anterior wall of the ventricle, and the anterior extremity of the corpus striatum.

2. Posterior horn.

§ 1783. The *posterior horn*, and the *inferior* or *descending horn*, are detached from the posterior extremity of the central part.

The *posterior horn*, the *digital depression* (*fovea digitata*), terminates imperceptibly in a blunt point, goes rather directly backward, although it inclines also a little outward, and extends almost to about an inch from the posterior extremity of the hemisphere: its length, however, varies much.

The internal wall, and always that alone, presents in its inside a considerable eminence, called the *digital eminence*, the *spur*, the *nail*, the *pes hippocampi minor* (*eminentia digitalis*, *calcar*, *unguis*).(2) This eminence is very constant. We have always found it in the numerous brains we have dissected. Wenzel, out of fifty-one subjects

(1) Haase, *De ventriculis cerebri tricornibus*, Leipsic, 1789.—Rudolphi, *De ventriculis cerebri*, Gripswald, 1796.

(2) Morand, *Obs. anât. sur quelques parties du cerveau; in the Mém. de Paris*, 1744, p. 430.

dissected for this purpose, found only three in whom it was deficient on both sides, and two where it appeared on one side only.(1)

This part bulges a little at its centre, and terminates posteriorly in a rounded extremity, which gradually becomes thinner. It is very constant in respect to its existence and situation: but its form and volume differ considerably, even in the two hemispheres of the same cerebrum.

Its form is sometimes narrow and elongated, and sometimes broader. It is generally smooth; but it sometimes presents several transverse grooves, especially posteriorly, or is divided by a longitudinal groove into two halves, the upper of which is generally the larger.

Its size is usually in direct ratio with the development of the posterior horn. But there are exceptions to this rule, for a very small horn often incloses a very large eminence, while another which is very large may contain one which is hardly perceptible.

The structure of this eminence is generally homogeneous. It is composed of one circumvolution and a half: a small triangular groove arises from the bottom of one of the cavities between two adjacent hemispheres, on the inner face of the posterior cerebral lobe; its summit is turned upwards, and its medullary substance is continuous with that of the inner face of the posterior horn. Its gray substance is blended with a layer of cortical substance, situated directly below the white substance which covers the internal face of the posterior horn, and forms with this latter the inner layer of the pes hippocampi minor. The medullary layer of this eminence is continuous upward with the white substance of the circumvolution above, as the gray substance also is continuous with the gray substance of the circumvolution which follows it.

This arrangement is easily recognized when we cut the pes hippocampi minor transversely.

There is then a resemblance in regard to form between the external circumvolutions and the pes hippocampi minor: this disappears or at least becomes smaller when the pia-mater is removed.(2)

3. Descending horn.

§ 1784. The *descending* or *lateral horn*, the largest of the three horns of the lateral ventricle, is convex outward and concave inward. It goes downward and forward in the external face of the cerebral peduncle, and occupies the lower, inner and anterior part of the middle lobe; but it does not extend to its extremity, for it terminates half an inch behind it.

On its lower face are two large eminences, the *cornu Ammonis* and the *corpus fimbriatum*.

(1) *Loc. cit.*, p. 144–145.
(2) Wenzel, *loc. cit.*, p. 146.

The *cornu Ammonis* or *pes hippocampi* (*cornu Ammonis*, s. *arietis*, s. *pes hippocampi*, *protuberantia cylindrica*, Ch.) is convex externally and concave internally, and rests on the lower face of the descending horn. It gradually becomes broader and higher backward than forward. Its anterior extremity, which is also that of the descending horn of the lateral ventricle and is considerably broad, curves inward and usually but not always presents from two to five longitudinal notches. The loose face of the cornu Ammonis is medullary, and longitudinal fibres are often very distinct in this layer of white substance, which is otherwise so thin that the gray substance which forms most of the protuberance is easily distinguished.

Sometimes, but rarely, we find a second eminence, which varies in length, at the side of and behind the cornu Ammonis so that it seems divided into two parts situated one above the other. This eminence is termed the *collateral eminence* of Meckel (*eminentia collateralis Meckelii*), and seems to arise from suspended development.

On the inner and concave side of the cornu Ammonis is a narrow falciform medullary projection, which is perfectly parallel to this side, but less broad than it, and terminates in an inner loose and sharp edge on which the large choroid plexus rests. This is termed the *corpus fimbriatum* (*tænia*, s. *fimbria*). This body ceases about an inch before the large cornu Ammonis, and terminates imperceptibly in a circumvolution of the cerebrum.

At the side of the corpus fimbriatum, but farther inward and backward, consequently a little covered by it, but situated out of the descending horn, is another analogous and shorter body of gray substance which exists in the depression between it and the inner descending edge of the large lateral horn: this is the *fascia dentata*.

The loose edge of this small eminence is divided from above downward by numerous transverse incisions or folds into about twelve or fourteen small segments, which give it a waved appearance; these disappear on removing the pia-mater.

A transverse incision across the parts within the descending horn shows that the cornu Ammonis is covered on its upper and lower faces by a medullary layer, which terminates above in the corpus fimbriatum, and which penetrates farther inward below and is reflected in the medullary substance of the lower face of the horn.

Next to this medullary layer comes another of gray substance which is much thicker, being as thick as that on the surface of the cerebrum; this exactly covers the preceding, and is continuous with the cortical envelop of the encephalon. The upper face, which is farther from the median line, and consequently forms the outer part of this gray layer, is the fascia dentata. The internal is continuous with the gray substance of the inner face of the lower part of the posterior lobe of the cerebrum.

Between this internal and this external part a thinner medullary layer is interwoven; this enlarges above where it is loose and unattached.

These parts are then evidently similar to the corresponding halves of two adjacent circumvolutions, between which a medullary layer penetrates instead of the pia-mater alone, and which is covered internally only by a very thin medullary layer.

The thin medullary layer which covers the gray substance is continuous in all parts with the rest of the white substance, but that which exists before the lower face of the cornu Ammonis is always separated in every part from that opposite, which covers the upper face of the eminence and is inflected only at the upper part to go and meet it. If these adhered, this lower layer and this inner layer of gray substance of the cornu Ammonis united to the floor of the descending horn of the lateral ventricle and to the substance below, would form a complete circumvolution.

The medullary envelop of the cornu Ammonis is continuous with the posterior part of the corpus callosum, and partly also with the posterior pillar of the fornix. The whole corpus fimbriatum passes into the latter.

The lateral ventricles are inclosed and enveloped by cerebral substance in most of their extent, which is uninterrupted.

This is true particularly of the anterior horn and the posterior horn. On the contrary, the middle region and the lower horn are interrupted in a considerable part of their extent, since the fornix and the corpus fimbriatum are not united to the adjacent parts. From this arrangement it follows that the middle region communicates from above downward and from without inward with the third ventricle: that the descending horn is in relation with the external face of the posterior cerebral lobe, and consequently that there is between the corpus fimbriatum and the posterior part of the optic beds, a space which forms the two sides of the large cerebral fissure, with the central part of which it is blended internally. If we then separate the edges of this space which is filled by the arachnoid membrane, and also by the pia-mater and the cellular tissue, we arrive at the descending horn of the lateral ventricle and the third ventricle without cutting the cerebral substance; thus by slitting the roof of the descending horn from within outward, we can reflect from behind forward all the posterior part of the hemispheres with the corpus callosum and the fornix.

II. TEXTURE.

§ 1785. The cerebrum is the developed and expanded anterior part of the spinal marrow.

The two lateral cords of this anterior part intercross and form above the decussation, the pyramids, which project very distinctly on the lower face of the medulla oblongata.

At their sides is a narrower fasciculus, the fibres of which divide below the olivary bodies into an anterior and a posterior layer, which surround these eminences, above which they again unite to enter the annular protuberance.

The third fasciculus is the largest. It is situated inward and backward at the side of the preceding. It forms the floor of the calamus scriptorius and of the fourth ventricle, where it is covered by the gray substance.

These three fasciculi, situated one above another, and separated by the gray substance and also by the transverse fibrous layers which arise from the lateral prolongations of the cerebellum, pass through the annular protuberance.

They unite in front of this protuberance, and form the cerebral peduncle, of which the pyramids form the outer and lower side, and the two other cords the inner and upper side.

The formation of the cerebral peduncle by longitudinal layers, the edges of which converge from without inward, is more evident in the lower face than in the upper, the lower and convex face of which rests on the upper and concave face of the former. We may then oppose the upper and the lower parts to each other, and call the former the *base* and the latter the *cap* (*Haube*), of the cerebral peduncle.(1)

The three fasciculi produced by the division of each lateral anterior cord in the medulla oblongata, still continue separate in the cerebral peduncle and the cerebrum.

It is most convenient to describe the middle fasciculus first, because it terminates the soonest.

This fasciculus proceeds from within outward, and divides in the posterior part of the pons Varolii into two fasciculi: one proceeds below the black substance of the cerebral peduncle; the other, termed the *knot*,(2) goes upward, is seen externally between the anterior and middle prolongations of the cerebellum, and proceeding along the outer face of the former, goes obliquely to the posterior tubercula quadrigemina. It divides at the outside of the latter into two arms; one goes forward upon the external corpus geniculatum, and into the optic bed: the other proceeds transversely inward, disappears below the tubercula quadrigemina, forms the roof of the aqueduct of Sylvius, and blends forward with the posterior commissure, backward with the middle cord which goes from the posterior tubercula quadrigemina to the large cerebral valve.

The lower anterior fasciculi of the anterior cord of the spinal marrow, which correspond to the pyramids in the medulla oblongata, and

(1) Reil, *Archiv. für die Physiologie*, vol. ix. p. 150.
(2) Reil, *Archiv. für die Physiologie*, vol. ix. p. 505.

which are the direct continuation of them, form the lower part of the cerebral peduncle, and go from below upward and from within outward below the optici thalami.

The upper and posterior, which are larger, proceed directly towards the posterior part of the optic beds.

Both unite, leave the optic bed outward and the fibres of the layer forward, which proceed from within outward, and pass above them; at the anterior and external side of the protuberance, these cords and fibres interlace and give rise to a kind of suture, expanding in every direction. The external layers are reflected backward, and do not pass through the optic bed.

Hence it follows, that in each of the cerebral hemispheres there is a semicircle, the concavity of which is turned toward that of the opposite side, while it is convex externally, and which like the cerebral peduncle is composed of layers or rings which are directed from above downward. These rings expand in every direction like the sticks of a fan. Reil terms this the *corona radiata*. The posterior and middle rings, which are fewer, soon go outward and backward, and form most of the posterior and middle cerebral lobes. The anterior are more numerous, first pass through the corpus striatum, and then form the larger anterior lobe of the cerebrum.

The circumvolutions are formed of two strata of layers which are fitted to each other; they are united by serum effused in the ventricles, and may be more or less easily detached in the cadaver by compression, or by hardening the brain in different modes.

III. WEIGHT.

§ 1786. The cerebrum generally weighs three pounds, apothecaries' weight. Its proportion then to the cerebellum is as 8 : 1, and to the medulla oblongata as 72 : 2.

IV. CONSISTENCE.

§ 1787. In regard to consistence, it differs only from the annular protuberance, which is much harder.

CHAPTER III.

ENVELOPS OF THE CENTRAL PART OF THE NERVOUS SYSTEM.

§ 1788. The central part of the nervous system is, as we have already stated, (§ 176) surrounded by several superimposed membranes. For a long time three have been admitted, an internal, the *pia-mater*, a middle, the *arachnoid*, and an external, the *dura-mater*. But the ancient anatomists, and Lieutaud, Sabatier, and Chaussier among the moderns, considered the internal and middle as forming but one, called the *meningeal* (*meningina*), which is composed of two layers distinct in the vertebral column, on the cerebellum and lower face of the cerebrum, but intimately blended in all other parts.

We must admit as correct, that the two inner membranes are very intimately connected in several parts, that they must be considered as forming only one: for we cannot demonstrate in the upper and lateral parts of the surface of the cerebrum, the two layers mentioned by Chaussier, and which he says are united by a very short cellular tissue. The pia-mater is alone visible in these parts.

In fact it is asserted that the arachnoid membrane extends like a bridge on the circumvolutions, while the pia-mater penetrates into these cavities, and that the former membrane may be easily separated by inflation: but we have always observed in repeating this and similar experiments, that the pia-mater was raised, and not a membrane distinct and separate from it.

It does not follow, however, that we must admit that the two inner meningeal membranes are the same. On the contrary, the following arguments exist against this opinion:

1st. *Difference of structure.* The arachnoid membrane is whitish, semitransparent, and destitute of vessels; the pia-mater is transparent and formed entirely of blood-vessels united by cellular tissue.

2d. *Difference in the arrangemement.* The two membranes are entirely distinct in several parts, and the arachnoid membrane is never found except on the surface, while the pia-mater penetrates deeply, and every where attends the surface of the cerebrum and spinal marrow.

3d. *The structure of the fetus.* In the cerebrum we can easily separate the arachnoid membrane from all the encephalon.

4th. *Difference of pathalogical changes.* The arachnoid membrane becomes harder and thicker: false membranes are formed by exudation from it. The pia-mater generally only receives more blood, and consequently assumes a redder tint. We must admit, however, that the pia-mater in several parts, particularly internally, sometimes experiences those changes regarded as belonging exclusively to the arachnoid membrane.

As the latter blends in a single membrane with the pia-mater within the skull, so too it unites with the dura-mater in the skull and vertebral canal so intimately, that it is very difficult and almost impossible to separate them.

ARTICLE FIRST.

OF THE PIA-MATER.

§ 1789. The *pia-mater* (*tunica cerebri vasculosa*, s. *propria*, s. *pia-mater*) is a thin membrane formed of mucous tissue, in which the large vessels which go to or return from the central part of the nervous system expand. Its unattached upper face is smooth and moistened with serum. The internal, on the contrary, presents inequalities which arise from numerous villosities, greater or less branches of vessels, which attach it to the surface of the brain and spinal marrow. It not only lines the external face of the central portion of the nervous system, but also penetrates in several parts within it, where it conducts those vessels which carry the blood, and receives those which take it up again. We may then divide it into *external* and *internal*. These two sections of the membrane present considerable and constant differences in different regions of the central portion of the nervous system.

I. PIA-MATER OF THE SPINAL MARROW.

§ 1790. The *pia-mater of the spinal marrow* increases very much from above downward in thickness, hardness, and solidity. It exactly envelops the spinal cord in all its extent, so that when cut across, the medullary substance rises above the surface of the incision. Its color is yellowish white. Its external face is smooth and entirely loose: it is in contact with the arachnoid membrane, from which it may be easily separated by blowing air between the two membranes.

At the lower extremity of the spinal marrow, the pia-mater becomes a simple filament, which descends between the nerves of the cauda equina to the lower extremity of the spinal dura-mater, with which it is blended at its termination.

Its internal part is formed by an anterior and a posterior prolongation, of which the former is larger and more apparent. These two prolongations extend from before backward and from behind forward, into the two middle fissures, and are arranged like the neurilemma as we have already remarked (§ 160).

II. PIA-MATER OF THE ENCEPHALON.

§ 1791. The *pia-mater of the encephalon* should necessarily be distinguished into *internal* and *external*, from the manifest differences in its form, presented within or on the outside of the organ.

a. EXTERNAL PIA-MATER.

§ 1792 .The external pia-mater of the cerebrum, the cerebellum, and spinal marrow, is intimately adapted to the surface of these three sections of the central part of the nervous system, and penetrates into the greatest as well as into the smallest cavities to their bases, so that it represents exactly the external form of the parts. It does not leave the surface of the brain except in a few points. Thus in the *calamus scriptorius*, it passes from side to side, forming a transverse bridge sustained by a small medullary prominence, which is continuous forward at an acute angle with the pia-mater which covers the posterior face of the cerebellum. So too the thin layer which closes the third ventricle forward and downward before the decussation of the optic nerves, is often replaced by the pia-mater only, which extends like a bridge from one hemisphere to the other. These prolongations which penetrate into the superficial cavities, particularly into the grooves of the cerebellum and the anfractuosities of the cerebrum, are real folds,(1) since each is composed of two layers, which are united more intimately at the entrance of the anfractuosities than in their course and at their base, which must be attributed partly to the large vessels which pass in this place to the surface of the encephalon, so that they are easily insulated from each other when these vessels are destroyed.

The external pia-mater is continuous with the internal, wherever the external face of the encephalon is itself continuous with the internal, that is with that which forms the parietes of the ventricles. Thus these two membranes unite in the fourth ventricle, through the posterior cerebral fissure, and in the aqueduct of Sylvius, and also in the lateral ventricles by the anterior cerebral fissure.

We frequently observe on the external pia-mater, rounded and generally soft corpuscles, which are yellowish white, and collected in several masses; these are generally termed the *glands of Pacchioni* (*Gl. Pacchionianæ*)(2) but Bichat terms them the *cerebral granulations* (*granulationes cerebrales*). These corpuscles are situated principally along the centre of the superior longitudinal groove, especially at the orifice of the veins which enter into it. Placed on the external face of the pia-mater, they pass through the dura-mater, and even enter into the cavity of the sinus, where they are covered by the inner membrane of the venous system. They are generally arranged in several groups, but so that the different corpuscles of one must rest on a common base. They vary much in number and size ; their structure is entirely homogeneous. As they are found particularly in the latter periods of life, as they never exist before, as they are not numerous except in per-

(1) Soemmerring, *De cerebri administrationibus anatomicis, vasorumque ejus habitu*; in *Munchner Denkschriften* for 1808, p. 66, 67.

(2) Pacchioni, *Epist. phys. anat.*; in *Opp. omn.*, Rome, 1741, p. 125.

sons often afflicted with diseases of the head, and as they are not observed particularly in any animal, we have reason to think them mere morbid formations resulting from the frequent rush of blood towards the brain.(1)

Still in no case do they deserve to be called glands. They have no excretory canals which carry a fluid secreted by them between the dura-mater and the pia-mater, or between this latter and the encephalon, or even within the cerebral ventricles, as Pacchioni asserts.

B. INTERNAL PIA-MATER.

§ 1793. The internal pia-mater differs from the external in its texture and form. In fact it is thinner and of a more delicate tissue. It adheres more intimately to the parts which it lines, and is, in fact, blended with them, as are the serous membranes with the articular cartilages upon which they pass. The portion which does not cover the surface of the ventricles, gives rise to the *choroid plexuses* (*plexus choroidei*). These latter are composed essentially only of that portion of the internal pia-mater which is loose and entirely unattached in the ventricle. They form an immense number of folds which intercross, and are arranged in several parallel longitudinal series. They are situated on the internal pia-mater, very near its union with the external, and on the edges of the fissures by which the external and the internal faces of the brain communicate. We find them in every section of the cerebral fissure, or of the cavity of the ventricle generally. Are not the folds there observed so many marks of the prolongations of the external pia-mater, which enter into the grooves of the external face, or rather do they not result from the collapse of the choroid plexuses after the early periods of life, when they are larger and are situated in the cavities of the encephalon, which are much more extensive ?(2)

The branches of the veins from the inner face of the cerebral substance, unite in the choroid plexuses, and the arteries which penetrate into this same substance ramify in them.

(1) Wenzel, *loc. cit.*, cap. i. *Corpuscula in exteriori meninge et infra eam abs utroque falcis latere.*—Portal (*Cours d'anat. med.*, vol. ii.) has already doubted the glandular nature of these corpuscles, and maintained they were only cellular tissue filled with adipose substance (p. 10). In regard to similar bodies found in the choroid plexuses, he says, "(p. 44) as these glandular bodies appear only in disease, are they not concretions which are formed in the cellular tissue of the pia-mater, varying in size and hardness?"

(2) Desmoulins thinks (*Journâl de physique*, Feb. 1821) the choroid plexuses and telæ arise, from the fact that the internal pia-mater, after deposing concentric layers of white fibres, finally contracts. From this contraction or obliteration, result the concave internal surfaces of the folded membrane of the hemispheres, and the formation of the white and solid nucleus known as the oval centre. Tiedemann has already expressed, with slight modifications, the same opinion as Meckel. Desmoulins thinks that the membrane of the hemispheres gradually folds to produce the circumvolutions, and that the pia-mater contracts proportionally in the cavity of the ventricles. He admits, consequently, the correctness of Gall's process for unfolding

We also find there some corpuscles corresponding to the glands of Pacchioni of the external pia-mater, in the same cases as the latter, and most generally at the same time as they.

Another very common pathological change of the choroid plexuses, is the occurrence of serous cysts, which are there accidentally developed.

I. CHOROID PLEXUS OF THE FOURTH VENTRICLE.

§ 1794. The *choroid plexus of the fourth ventricle* (*plexus choroideus ventriculi quarti*) begins on each side at the side and on the lower face of the root of the fourth lobe of the cerebellum, and is situated between it, the anterior edge of the monticule, the facial, the auditory, the glosso-pharyngeal, the pneumo-gastric, and the accessory nerves. Thence it goes transversely on the anterior part of the *calamus scriptorius* directly below the monticule, between it and the restiform body, and approaches that of the opposite side. The two plexuses united by a narrow band of the pia-mater then divide each into an anterior and a posterior branch. The posterior branches ascend in the posterior groove of the cerebellum, along the anterior part of the internal face of the monticule, become pointed, blend together, and terminate at the upper extremity of the uvula. The anterior, which are shorter, approach each other from before backward, and are blended together on the nodule of Malacarne.

This plexus receives from below upward the ramifications of the basilar and vertebral arteries and from above downward, and also on the sides those of the veins which arise from the inner face of the cerebellum.

The glands of Pacchioni are perhaps more common in this part than in the choroid plexuses of the cerebrum.

II. CHOROID PLEXUSES OF THE CEREBRUM.

§ 1795. The internal pia-mater of the cerebrum begins at the large cerebral fissure. It forms a layer which is much broader in the centre than on the sides, but more folded, on the contrary, on the sides than in the centre.

the brain, and thus explains the nature of what the latter terms the mucous neurilemma of agglutination of the internal surfaces, saying that it is the residuum of the pia-mater, which sometimes becoming permeable to the blood, can re-establish in greater or less portions, the primitive liberty of the internal surfaces. We only mention this assertion, without disputing it, as it seems easy to do with advantage. It is connected with another opinion of Desmoulins, that the development of the intellectual faculties is in direct ratio with that presented by the surface of the folded membrane of the hemispheres, consequently in a ratio with the number and depth of the circumvolutions. (*Sur le rapport le plus probable entre l'organization du cerveau et ses fonctions*, in the *Journ. compl, des de méd.* vol. xiii. p. 206). F. T.

It goes inward and forward from the posterior edge of the corpus callosum, the internal face of the posterior lobes, the cerebral peduncles, the tubercula quadrigemina, and from the middle anterior portion of the cerebellum, is continuous on one side with the external pia-mater which covers these parts, and envelops on the other the pineal gland, and proceeds forward and inward under the posterior edge of the corpus callosum and of the fornix. It thus forms a triangular layer, the base of which looks backward and the summit forward. The internal face of this layer is united by its lower part with the upper face of the optic bed, and by its upper with the lower face of the fornix. Hence these faces are connected so intimately, except at the lower part, for the space of about two lines deep and one high, that the third ventricle is perfectly closed at its upper part, and is separated outward from the two lateral ventricles.

This portion of the internal pia-mater may be termed the *choroid web* (*tela choroidea*, Vicq-d'Azyr.)

It is continuous outward and backward with the choroid plexuses of the lateral ventricles.

These plexuses which arise from the opening through which the two lateral ventricles communicate, proceed from behind forward and from within outward on the lower face of the centre of each ventricle, and afterward descend from behind forward in the lateral horn, on the corpus fimbriatum and the cornu Ammonis. A slight fold attaches them in all their course to the lateral edges and the anterior edge of the fornix and the corpus fimbriatum which is detached from it. Their form then exactly represents that of the descending horn, into which they penetrate to its anterior extremity, and the lower face of which they cover in great part. At their anterior extremity, that is, at their origin, in the communication open between the two lateral ventricles they are very narrow, but they gradually enlarge from before backward, and finally become considerably broad.

Their breadth, however, does not increase from their origin to the lower extremity of the lateral horn. Their broadest and thickest part corresponds to about their centre, that is, where instead of internal they become external. There, in fact, they form a kind of button, which has been remarked by Vicq-d'Azyr,(1) and has been admitted by Wenzel.(2) The vessels, particularly the veins, are there much larger and also more tortuous than in the rest of the plexus: the internal pia-mater which unites them also forms there more numerous folds.

(1) *Loc. cit.* p. 541. "The region in which the plexus is thickest, is that where it curves backward, at the level of the posterior prolongations of the lateral ventricles." Vicq. d'Azyr has also described the structure of the choroid plexus, and this figure of it resembles that given by Wenzel.

(2) *Loc. cit.* n. ix. *Animadv. peculiarem quand. proprietatem plexus choroidei, etc. Proprietas quædam ratione morborum, ut nobis videtur, notatu digna ab auctoribus prætervisa.*

The choroid plexus also, when otherwise perfectly healthy, is rather more disposed in this place to morbid changes, such as thickening, opacity, and more or less abundant granulations which vary in form and size, and which probably arise, at least in part, in the folds of the plexus, but which are also developed on the surface of these folds.(1)

The greater development of the choroid plexus in this place depends particularly, and even solely, on the origin at that part of the posterior horn, which receives no special choroid plexus.

Besides this common choroid plexus, we sometimes find in the lateral ventricles a smaller and anterior plexus, which is situated on the corpora striata. This communicates with the veins which proceed between the anterior and posterior cerebral ganglions, and with those which arise from these eminences.(2)

On the contrary, we constantly find two small choroid plexuses, those of the third ventricle, which extend from before backward, from the anterior extremity of the lateral choroid flexus to the circumference of the pineal gland, separate from each other in this course, are attached to the lower face of the tela choroidea, gradually increase in size and receive the vessels of the third and fourth ventricle.

All the sections of the general ventricle of the encephalon include then the choroid plexuses which communicate by the internal pia-mater and the cerebral vessels, and which are most generally found more or less precisely in the same state in the same subject.

ARTICLE SECOND.

OF THE ARACHNOID MEMBRANE.

§ 1796. The *arachnoid membrane* (*mem. arachnoidea*, s. *mucosa*), the second envelop of the spinal marrow and encephalon, is delicate, thin, semitransparent, whitish, and perfectly homogenous in structure. We have not as yet been able to discover in it either vessels or nerves.

It is very distant from the preceding in the vertebral column and in the lower part of the skull.

It surrounds the spinal marrow, like a sac which is much larger than this cord, which is attached to it only by some distinct filaments of cellular tissue. It begins at the lower extremity of the vertebral column, and gives a general envelop which covers the origin of all the nerves in the spinal canal until they leave this cavity. We may then separate it very much from the spinal marrow by blowing in air, or by any analogous process.

(1) Vicq-d'Azyr has also made this remark: he expresses himself very strongly against the glandular nature of this body.

(2) Vicq. d'Azyr, p. 540.

It is also intimately united with the dura-mater in the place where this membrane forms narrow canals which receive the nerves before they leave the vertebral canal, and where the slips of the ligamentum dentatum are attached to its surface.

It proceeds from the spinal marrow to the encephalon, enlarging very much. It adheres to the lower and middle portions of the cerebrum, and also to the posterior part of the cerebellum and to the lower face of the medulla oblongata very loosely and by long distinct bands of cellular substance, passes like a bridge from the spinal marrow to the posterior part of the cerebellum, and from one lobe of the latter organ to another, consequently fills the space between them, closes the common cerebral fissure posteriorly, below and on the sides, is reflected from the annular protuberance on the floor of the third ventricle towards the decussation of the optic nerves, with which it is intimately united, as also with the nerve itself; then arrives at the lower face of the anterior lobes, and connects both these two lobes and also the central part of the posterior, on which it extends on each side on leaving the annular protuberance. It also forms a bridge which proceeds on the fissure of Sylvius, between the posterior and anterior lobes.

All the veins and nerves which come from the encephalon, and also the arteries which go to it, are covered by prolongations of the arachnoid membrane until they emerge from, or enter the cranium.

But the places we have mentioned are the only ones where it is so slightly attached to the subjacent pia-mater that it may be considered a separate and distinct membrane. In every other part, even where it passes from one circumvolution to another, proceeding over the anfractuosities, it is so intimately united with the pia-mater that, however carefully we may attempt to raise it, particularly by the common mode, that of insufflation, this membrane is always detached with it from the surface of the cerebrum.

§ **1797**. From the idea generally formed of it, the arachnoid membrane forms only a single layer, which covers the outer face of the spinal marrow and encephalon; but it rarely extends farther, and has a more complex course. In fact, it is reflected from all the places through which the nerves and vessels pass upon the dura-mater, the internal face of which it covers, and also penetrates within the encephalon through the large cerebral fissure.

The first proposition is perfectly demonstrated either by dissecting the arachnoid membrane and the dura-mater in the normal and abnormal state, or by analogy. The brilliant and smooth appearance of the inner face of the dura-mater favors it, since the parietes of the pectoral cavity, the abdominal cavity, and the pericardium, depend for this character on the presence of serous membranes, which after directly covering the surfaces of the organs, leave them to be reflected externally. This external layer of the arachnoid membrane is fitted to the inner face of a fibrous membrane like the serous tunic of the pericardium, the peritoneum and the two pleuræ in many places, the synovial membranes, &c. That the shining appearance of the inner face of the dura-mater does not depend on this membrane is proved by the fact that the interior of the canals it furnishes to the nerves out of the arachnoid sac is very uneven.

When we examine the dura-mater either from without inward or from within outward, although all the external layers seem formed of fibres and of a very complex texture, we may always detach to a greater or less extent an internal layer, which is thinner than the others, and has not a fibrous appearance: this may be easily proved in the early periods of life. This internal layer is sometimes separated from the others by a congestion of pus between it and the dura-mater it lines.(1)

The arachnoid membrane not only covers the surface of the cerebrum, but also penetrates within this organ. The place where it enters is between the anterior extremity of the upper face of the cerebellum and the corpus callosum, in the place where the portion of this membrane which covers the cerebrum unites to that of the cerebellum, without forming however a simple sac. The connection seems on the contrary to be interrupted by a rounded opening in this place, in the circumference of which the glands of Pacchioni are generally situated in old persons, and which give passage to the veins which arise from the ventricles of the cerebrum: but this opening is the commencement of the inner part of the arachnoid membrane, for it leads to a canal which passes on the pineal gland and extends from behind forward on and between the anterior edges of the optic beds, and below the fornix to the anterior extremity of the third ventricle. This canal surrounds the venous trunks which return from the middle and lateral ventricles. It is every where perforated for the branches which go to it. Its external face is connected with the adjacent parts of the cerebrum only by slight adhesions, and is also attached to the veins by distinct filaments. It terminates at the foramen of Monro. Thence it continues, uniting intimately to the pia-mater, with the internal membrane of the ventricles, which in the normal state is much thinner than it, but which in the pathological state, in inflammation and hydrocephalus, thickens, becomes opaque, whitish, so that then it is still nearer to it and to the outer part of the arachnoid membrane.

The arachnoid membrane most resembles the serous membranes in its form, texture, secretions, its anatomical relations with the encephalon and spinal marrow and with the dura-mater, and in its diseases, as thickening, increase of its secretory power, whence result congestions of serum, adhesions between contiguous surfaces or the formation of accidental membranes. It is almost exactly like them. Gordon then is wrong in supposing that the analogy between its texture and that of the serous membranes is not proved, and that we must consider it as a separate organic tissue different from all others.

(1) Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 497.

All the facts we have adduced authorize us to arrange the arachnoid membrane and the dura-mater in the class of sero-fibrous membranes. It however is important to remark, that these two membranes are very intimately united with each other, and that the difference observed between them in the adult does not exist in the fetus, where we find, instead of the dura-mater, only a single thin transparent membrane destitute of fibres, and having all the characters of a serous membrane. But there we evidently have a new fact in support of our opinion in regard to the nature of the arachnoid membrane. At first only the inner layer of the dura-mater is formed; afterward it is changed externally into a fibrous tissue, or this tissue is developed between it and the bones.

ARTICLE THIRD.

OF THE DURA-MATER.

§ 1798. The *dura-mater* (*dura meninx*), a fibrous membrane, is the most external envelop of the spinal marrow and encephalon. It forms a sac closed in every part, which has the form of these two organs. Its external face looks to the inner face of the spinal canal and the skull; the internal is turned towards the outer face of the arachnoid membrane. This latter is smooth in every part.

The vessels of the spinal portion of the dura-mater arise from the vertebral, the intercostal, the lumbar, and the sacral arteries: those of the cranial portion from the internal maxillary artery.

I. SPINAL DURA-MATER.

§ 1799. The spinal portion of the dura-mater differs in several respects from the cephalic. It forms a very long canal, terminated at its lower part in a cul-de-sac, which occupies the whole spinal canal, gradually enlarges from above downward, but terminates in a blunt summit at the lower extremity of the sacrum. This sac is narrower than the spinal canal, to which it adheres, principally on the sides and posteriorly, only by a very loose cellular tissue, which contains, especially at its lower part, an abundance of substance similar to fat, of a reddish yellow color. It is united anteriorly to the posterior ligamentous envelop of the vertebral column much more intimately.

The two faces of the spinal dura-mater are smooth. It is not only longer, but much broader than the spinal marrow. Outwardly it gives to each spinal nerve a sheath which accompanies it to beyond the intervertebral foramen, enlarges a little in this place on account of the ganglion of the posterior root, and gradually terminates in the external cellular tunic of the nerve.

It is very evidently formed of longitudinal fibres which are more regular but less distinct than those of the cranial portion, and it is thinner than the cerebral dura-mater.

II. CEREBRAL DURA-MATER.

§ 1800. The portion of the dura-mater which corresponds to the encephalon, is attached to the internal face of the skull by numerous small ramifications of vessels which extend from it to the bones: its external face is corrugated. It adheres very strongly to the skull at its lower part: its lateral and upper faces are connected with the sutures more intimately than with the other parts of the cranium.

The arteries and veins proceed on its external face in the slight depressions which they exactly fill, and also project above its surface.

There are but few fibres visible on its external face. The centre of its upper part presents some which are irregular, flat, have a transverse direction, and intercross.

We distinguish through the dura-mater the vessels of the pia-mater, and also the elevations and depressions of the external face of the encephalon.

The inner part of its upper face presents at intervals along the large longitudinal sinus, and some lines from this venous canal, some broad and some narrow openings which are seen principally in the region of the sinciput.

Internally it presents in all its extent a fibrous texture much more distinct than that of the spinal portion. We may divide the fibres seen there into two layers. The external follow a longitudinal direction for all the extent of the membrane, and are arranged very compactly; the internal are placed on the preceding, to which they generally adhere but slightly, and are much more separated from each other; they are particularly apparent and very numerous at the upper part, while they gradually disappear at the lower.

Although the dura-mater is usually considered as divided into several layers, between which the venous sinuses proceed, and is composed of two folds, and although we can in fact divide it into two layers, still this separation is purely artificial, always excepting the serous layer; we can never form them except by destroying the tissue, and we may at pleasure diminish or increase the number of the layers.

The cerebral dura-mater principally differs in its arrangement from the spinal by the following characters:

1st. It does not form a single sac but a cavity which is divided into several partitions by different prolongations which it sends inward. These prolongations are in direct ratio with the development of the encephalon, as they divide the cavity of the skull into compartments destined to receive the principal portions of this organ. We number three of them, a transverse and two longitudinal. They have this in common, that at their external edge, which is connected with the internal face of the skull, they divide into three layers, the external of which continues to follow the direction of the common sac of the dura-mater, while the two internal converge inward and are soon blended in a single layer which terminates in a loose internal edge. Besides the external edges, the internal edges, and the faces of these prolongations, are continuous with each other, and they may be described under the common name of the *crucial prolongation of the dura-mater* (*processus duræ matris cruciatus*), the branches of which extend to the right and left, upward and downward, and forward and backward.

The transverse prolongation is the *tentorium of the cerebellum*, the *transverse septum* (*tentorium cerebelli*). Its form is nearly semicircular. Its posterior, convex, and internal edge, which is the longest, arises from the transverse branches of the cruciform ridge of the occipital bone, and from the upper edge of the petrous portion of the temporal bone. The anterior which is much smaller and concave, is loose: it forms the posterior and lateral parts of an opening which is closed anteriorly by the basilar portion of the spheno-occipital bone, and is attached on each side by two separate points to the anterior and posterior clinoid processes, between which it covers on both sides the sella turcica.

The cerebellum and the medulla oblongata are situated under this tentorium, which completely separates from the rest of the skull, excepting only from the anterior opening, the posterior and inferior part destined to receive it.

The central portion of the tentorium is continuous upward and downward with the two longitudinal prolongations, the falx of the cerebrum, and the falx of the cerebellum, both of which are situated on the median line, and the external edge of which is convex and broader than the other, and is attached from before backward to the external edge of the dura-mater, while the internal is concave, sharp, and loose. These prolongations separate the right and left portions of the cerebrum and cerebellum.

The *falx of the cerebellum*, the *median septum of the cerebellum* (*falx cerebelli*), is situated posteriorly between the two hemispheres of the cerebellum, extends from the centre of the posterior edge of the tentorium of which it makes a part, and from the inner occipital protuberance to the centre of the posterior edge of the large occipital foramen. It descends along the internal occipital crest, gradually contracts and divides at its lower extremity into two small lateral folds which extend forward.

The *falx of the cerebrum*, or the *large falx*, the *longitudinal fold of the meninx*, (*falx cerebri*, s. *processus falciformis cerebri*, s. *major*) arises from the centre of the upper face of the dura-mater, under the form of a prolongation which descends vertically between the two hemispheres of the cerebrum in all their length. It gradually increases in height from before backward. Posteriorly it rests by its lower edge on the tentorium, of which it forms a part, and its anterior portion which is much more extensive, terminates in a loose and concave edge. It advances above the centre of the corpus callosum, but does not touch it except at its posterior extremity, for the arteries of the corpus callosum are at least one line distant from it.

The large falx is attached by its external edge forward to the internal frontal crest, and in the rest of its extent to the inside of the sagittal suture. The upper longitudinal sinus is situated between the two layers which form its external edge superiorly. It is also divided at its concave edge into two layers which receive between them the inferior longitudinal sinus and the right sinus. The posterior part of its inferior edge is continuous on each side with the tentorium.

This prolongation is smooth on its two faces. It has manifestly a fibrous structure.

Most of the fibres which form it are oblique from behind forward and from below upward. They are more horizontal the more anterior they become. Others, which are much fewer, and which cross the preceding, are observed particularly at the anterior part and at the upper edge of the falx, so that we cannot there mistake the analogy between the dorsal and ventral faces any more than the distinctive character of these two faces, which is that the first is stronger than the second.

The falx presents not very unfrequently, especially near its lower edge, considerable spaces, openings through which the internal walls of the two cerebral hemispheres touch and sometimes even adhere together.

2d. The cerebral dura-mater has not the same relation as the spinal in regard to the nerves which emerge from the skull; it generally accompanies them farther than this latter and follows the spinal nerves so that, for instance, the commencement of the three branches of the trifacial nerve is inclosed in special canals. The envelop it gives unites them still more closely, and when they emerge from the skull it is continuous with the periosteum of the bones, while the spinal dura-mater terminates only in the cellular sheath of the nerves.

III. LIGAMENTUM DENTICULATUM.

§ 1801. The spinal marrow has one mode of attachment which the cerebrum has not, and which very probably serves to compensate for the liberty which it enjoys in the vertebral canal, on account of the disproportion between its volume and the caliber of this canal. We mean the *ligamentum denticulatum*, or *serratum*.

This ligament descends on both sides between the anterior and the posterior series of the roots of the spinal nerves, commences directly above the occipital foramen and terminates some distance above the extremity of the spinal marrow, at the summit of its inferior expansion. It is situated above the vertebral artery when it enters the skull, and before the accessory nerve: in the rest of its course it is nearer the anterior than the posterior roots. It is smooth, thin, narrow, whitish, and composed of a series of triangular slips united at their base by a very thin band. The base of these slips is thin and flat, and rests directly on the pia-mater. Their summits are rounded, harder, thicker, and turned downward, and are attached to the arachnoid membrane and still more firmly to the dura-mater. There is generally one between each pair of cervical and dorsal nerves, and they are usually nearer the lower than the upper nerve. Hence, in most subjects, there are twenty of them. Their number, however, is by no means constant: they are frequently fewer than the nerves, because one slip between one or several pairs of nerves is generally deficient, although there is nothing determinate in this respect. More rarely two are found between two pairs of nerves. Their whole number then varies from twelve or fourteen(1) to twenty-two or twenty-three.(2)

The ligamentum denticulatum enlarges from above downward, and the slips separate still more from each other the lower they are. Below these latter we observe a fold about an inch in length which proceeds along the sides of the spinal marrow, but rarely or even never descends to the real termination of this cord. Not unfrequently also the ligamentum denticulatum is perforated, especially at its upper part, whence it has a reticulated appearance.(3)

Judging from its texture, this ligament seems to belong to the class of fibrous organs, since not only the slips but also the external part of the membrane extended between them have a silvery lustre, and longitudinal fibres are very evident internally. It also adheres very intimately to the spinal dura-mater, while it is attached to the pia-mater only by a cellular tissue which is in fact solid, but is easily torn. We cannot then consider it as a prolongation of the pia-mater as do many anatomists, whose opinion Bichat has justly opposed,(4) and it is more proper to regard it as an internal prolongation of the dura-mater, since the cerebral portion of this membrane sends those prolongations which are so remarkable between the different regions of the mass of the encephalon.

(1) Sabatier, *loc. cit.* p. 460.
(2) Gordon, *loc. cit.*, p. 190.
(3) Vicq-d'Azyr, *loc. cit.*, p. 603.
(4) *Anat. génér.* vol. iii. p. 122.

CHAPTER IV.

PERIODICAL DIFFERENCES OF THE CENTRAL PORTION OF THE NERVOUS SYSTEM DURING ITS DEVELOPMENT.

§ 1802. The development of the central part of the nervous system(1) has been studied but a few years: hitherto only the general traits of this history, its most prominent features, have attracted attention.

I. SUBSTANCE.

§ 1803. The principal differences in the substance of the central part of the nervous system relate to the extent, form, situation, texture, color, and relations with the envelops.

1st. *Extent.* The central part of the nervous system is generally much larger in proportion to the body the younger the organism is. The spinal marrow occupies all the length of the vertebral canal until the end of the third month of pregnancy. It is true that from this period it begins to shorten, but it is not confined to its normal limits till the eighth month of pregnancy. It is also thicker during the early periods of life.

The encephalon, with the exception of the cerebellum, is also proportionally much more extensive. It must not however be thought, especially in regard to this viscus, that a greater extent is perfectly synonymous with a greater mass, for the parietes are proportionally much thinner than at a more advanced age.

The encephalon until perfectly developed, continues to be larger in proportion to the body than it is finally: for between six and seven years, according to Wenzel,(2) and Sœmmerring(3) states even from the third year, it has acquired the size and weight which it will retain through life.

2d. *Situation.* The very imperfect development of the posterior part of the vertebral column causes the spinal marrow and the encephalon to be much looser and less attached during the early periods of existence.

(1) Tiedemann, *Anatomie du cerveau, contenant l'histoire de son dérveloppement dans le fœtus*, trans. by Jourdan, Paris, 1823.—Schoenlein, *Von der Hirnmetamorphose*, Wurzburg, 1816.—Serres, *Anatomie comparée du cerveau dans les quatre classes de vertébrés*, Paris, 1824.—Desmoulins, *Exposition succincte du développement et des fonctions du systême cérébro-spinal;* in the *Archives généralés de médecine*, juin 1823.—Rolando, in several articles of the *Dizzionario periodico di medicina*, Turin, 1822 et suiv.

(2) *De penitiori struct. cereb.*, p. 266.

(3) *Tab. baseos encephali*, p. 13.

3d. *Form.* The differences in respect to the form are very remarkable.

I. SPINAL MARROW.

a. The caliber of the spinal marrow is much more uniform the younger the fetus is. The prominences which correspond to the nerves of the extremities develop themselves only in proportion as the extremities appear.

b. The spinal marrow which is entirely full and solid, not only in full grown subjects but already even during the early months of existence, incloses at first in all its length a canal which is uninterruptedly continuous with the cerebral fissure, and which is larger in those parts where the spinal canal is prominent.

This canal is at first not rounded, but oblong from before backward; and if we except a small plate which bounds it anteriorly, it extends through the whole thickness of the spinal marrow. Hence the internal face of the latter is at first continuous with the external, as the whole canal is much larger during the early periods of life than at a more advanced epoch, and then it does not resemble a proper canal so much as a fissure, which separates almost entirely the two lateral portions of the spinal cord. This canal also gradually closes and contracts from without inward at the posterior part: the spinal marrow then folds longitudinally forward and backward: hence arise anterior and posterior longitudinal grooves, which never communicate with the central canal, even as the cerebrum and the summit of the spinal cord, present, during life, not only two longitudinal grooves, an upper and a lower, but also two central cavities separated from these same grooves by medullary substance in at least most of their extent, and by the pia-mater in all their course. The longitudinal grooves of the pia-mater, however, are broader during the early periods of existence, and the posterior not unfrequently entirely disappear as the subject grows older.

c. Although the spinal prolongation is at first much larger in proportion to the whole body than it is in the adult, we soon see an opposite relation between it and the encephalon, both from the development of the latter, and from the diminution of the spinal cord.

Thus we have found that the proportion between the spinal marrow and the cerebrum was still as **1 : 107**, and even as **1 : 112**, in the full grown fetus and the child of five months: for the cerebrum of the fetus weighs nine ounces and four drachms, and that of the child five months old, twenty-one ounces, the spinal marrow of the former two scruples and five grains, and that of the second a drachm and a half. In a fetus of five months, on the contrary, the proportion was as **1 : 63**, since the cerebrum weighed six drachms, one scruple, and eight grains, and the spinal marrow six grains. It was as **1 : 18** in a fetus of three months, where the brain weighed thirty-six grains and the spinal marrow two. In the adult it is as 1 : 40. These estimates will serve to rectify the calculations given by some anatomists, of the differences observed at different periods of life, in the respective proportion of the encephalon and the spinal cord.(1)

The younger the fetus, the larger the spinal marrow in proportion to the encephalon. It is evidently larger and heavier in proportion to this latter, even in the human fetus of three months, than in the adult, either on account of its greater size, or of the smallness of the encephalon; but the latter soon exceeds it more than in the adult, both because it increases much, and because the spinal cord itself diminishes.

II. MEDULLA OBLONGATA.

a. The medulla oblongata, except perhaps in the earliest periods of its formation, is much more distinct from the spinal marrow, and the angle between the two organs is much nearer a right angle, the younger the fetus is.

b. It is also proportionally much more developed during the early periods of life than at a more advanced age. This proposition is applicable particularly to its lower and anterior part, which concurs to form the cerebrum. Hence, why the medulla oblongata is still more distinct from the spinal marrow in the full grown fetus and the young child than in the adult, and why, also, all its parts, particularly the eminences of its lower face, the pyramids and olivary bodies, are then more permanent, and separated by more distinct limits. This circumstance seems to be in direct ratio with the greater development of the cerebrum.

c. The *calamus scriptorius* is much larger in the early periods of existence, because its parietes are then thinner, and the distance between them from behind forward is greater. The transverse cord

(1) Carus (*Anatomie und Physiologie der Nervensystems*, p. 262) expresses himself upon this subject very vaguely, for he merely states that the proportional volume of the spinal marrow and cerebrum, is that which varies the least in the human fetus and the adult, both because the disproportion between the encephalon and the spinal marrow seems less from the great volume of this latter, and because the type of the human species always predominates even here. He, however, admits farther on (p. 266), that the spinal marrow is always larger, compared with the encephalon in the human fetus than in the adult, although it is not much larger than when the subject is fully developed. Tiedemann (*loc. cit.*, p. 141, 142, 143) makes a more exact statement: he says that the volume of the spinal marrow is much larger compared to that of the brain the younger the fetus is; that the human fetus perfectly corresponds to animals in this respect, and that the cerebrum becomes much larger in proportion to the spinal marrow the nearer it is to its period of perfect development. From what we have said above, it follows that this proposition is true, at most only for the early periods of fetal life; that an inverse proportion soon supervenes, and that consequently, we observe, before that which marks the perfect state, another, where the encephalon presents, in proportion to the spinal marrow, a much greater volume than it has in the adult, so that regarding only the mass and weight, we find at this period a relation more favorable to the cerebrum than that observed in full grown subjects.

which closes it superiorly, does not exist at first, but it is greater during the early periods of fetal existence than in the adult.

The white striæ upon the floor of the *calamus scriptorius*, do not appear till some months after birth, while the gray eminences before them are visible in the fetus of three months.(1)

d. The olivary bodies appear in the third month of fetal existence,(2) but when the fetus is full grown, they are formed externally only of gray substance. In the third, and even in the fifth month of pregnancy, we discover within them a small cavity, which disappears entirely at the sixth.(3) When they have become completely solid, the gray substance ramifies there at first more simply than it does afterward.(4)

e. The pyramids appear much sooner than the olivary bodies, and are also, proportionally speaking, much larger at first than in the adult.

f. The corpus callosum does not appear till late and till the third month. It is at first thinner and shorter. Its size in proportion to that of the medulla oblongata is still less. The longitudinal groove of the lower face is deeper in the full grown fetus than in the adult.

III. CEREBELLUM.

The cerebellum is one of the parts of the central mass of the nervous system which are developed the latest.

It appears during the sixth week of fetal existence as a very small layer, at first hardly visible, thin, horizontal, situated transversely on and before the *calamus scriptorius*, divided by a deep median fissure into two halves, which is only a slight appendage of the tubercula quadrigemina, with which it is continuous upward and forward at an obtuse angle. The transition is made afterward less insensibly, because the anterior valve is developed between the two organs. Very probably, the part of the cerebellum which exists first, is only the valvule of Vieussens, which opinion is supported by this thinness, and the fact that the cerebrum, generally considered, is formed from below upward. This primitive layer gradually becomes thicker from above downward, and finally gives rise to the cerebellum: but it is very low in regard to its other two dimensions, and is very small in proportion to the other parts of the encephalon.

In the full grown fetus, the relation of the cerebellum to the cerebrum, is still generally as 1 : 23, since the cerebrum weighs between nine and ten ounces, and the cerebellum about three and a half drachms. The cerebellum, however, rapidly attains its normal proportional size.

(1) Wenzel, *De pen. struct. cereb.*, p. 320, 321.
(2) Carus, *loc. cit.*, p. 289.—Tiedemann asserts that they are not developed till the end of the fifth or the beginning of the seventh month.
(3) Carus, *loc. cit.*, p. 289.
(4) Carus, *loc. cit.*, p. 290.

We have determined that the relation one month after birth is as 1 : 17, and five or six months later is as 1 : 8, at which period the cerebrum weighs about sixteen ounces, and the cerebellum two.

The component parts of the cerebellum, however, are developed earlier than those of the cerebrum. We observe grooves on its surface about the end of the fourth month of pregnancy: they appear first at its central part. The largest also, those which divide the organs into lobes, appear before the small, and the latter are at first much more superficial and more simple than at subsequent periods.

The rhomboid body of the cerebellum includes at first a cavity, which still appears at the third month.(1)

IV. CEREBRUM.

If we except the early periods when the spinal marrow and medulla oblongata predominate so manifestly, the cerebrum is at first much larger and heavier in proportion to all the other parts of the centre of the nervous system than in the adult.

The great differences in its structure, oblige us to consider its parts in the same order as when we described them.

a. Cerebral prolongations. The most remarkable thing in regard to the cerebral peduncles, is the direction they assume at first: their posterior part rises perpendicularly, and is continuous at an acute angle with the anterior, which also descends as vertically as the other, and directly before it.

They are besides much larger in the fetus than in the adult, in proportion to the other parts of the cerebrum.

b. Tubercula quadrigemina. These tubercles, with the cerebral peduncles, are at first the largest part of the cerebrum. They are then much larger in proportion to the volume they have afterward, than one of the central portions, and form the highest part of the cerebrum, so that they have sometimes been mistaken for the cerebellum.(2)

They do not at first deserve the name which is generally given to them, for they are separated neither lengthwise nor breadthwise, but form a very elongated homogeneous mass. Their lateral halves are probably not united at first on the median line by nervous substance, and the communication between them is established only by the pia-mater.

Their longitudinal groove appears a little before the transverse. It is developed from before backward, so that it separates the two anterior eminences sooner than the two posterior. The transverse groove is situated at first, proportionally speaking, farther back, whence the anterior pair of eminences is always much larger proportionally at first than in the adult.

(1) Carus, *loc. cit.*, p. 285.
(2) Harvey, *De generat.* Amsterdam, 1662, p. 301.—Autenrieth, *Suppl. ad hist. emb.*, p. 21.

The tubercula quadrigemina are still larger in proportion to their breadth, in the fetus than in the adult. Although in the latter they are more long than broad, they however possess their normal length at the period of birth, and after this time they only increase more or less in breadth.

Their parietes are much thinner if examined at a period still nearer conception. They also inclose a considerable cavity which gradually becomes smaller as their parietes thicken, and which is united by the small grooves within them.

c. Pineal gland. It would seem as if this body did not begin to appear till the third or fourth month of pregnancy.(1) It is at first more rounded and flat. We find no trace of concretions until the period of birth, but sooner or later, sometimes not till the seventh year, a soft and viscous substance forms before it, which is situated on the posterior commissure, and gradually hardens after the age of seven years, and begins by surrounding it. Sometimes, however, we find no trace of pineal concretions in much older subjects, a rare peculiarity which is established by the observations of Wenzel and ourselves. The number of these concretions generally increases in age. In youth, the viscous substance and the concretions are situated before the pineal gland: in the adult we find them also in the anterior depression and in the substance of the gland: in old subjects they exist in all these places at once. These concretions are paler in infancy and in old age, than in the intermediate periods.(2)

d. Optic beds. These eminences are larger in the fetus than in the adult, in proportion to the corpora striata and the hemispheres.

At first they are entirely separated from each other. Afterward, but always at an early period of conception, they adhere on the limits of their upper and internal faces, by a thin but very distinct medullary layer, which extends between them like a bridge. Much later, and about the fourth month, the commissura mollis is formed, but it is at first much larger than in the adult, which character it still preserves in the full grown fetus, and even in infancy. The upper bridge has long disappeared at birth.

e. Corpora striata. These bodies appear later than the optic beds. They are at first smaller in proportion to the latter and the hemispheres, and are developed in the form of prominences of the inferior wall of these latter; they are never hollow internally, and are much more distinct from the hemispheres and the optic beds as the fetus is younger.

f. Hemispheres. We have always found the hemispheres of the cerebrum before the corpora striata. They are much larger and more extensive in proportion to these latter, the younger the fetus is. At first, however, they are extremely small in proportion to the other parts before which they are situated, but do not extend beyond them

(1) Tiedemann, *loc. cit.*, p. 216.
(2) Wenzel, *loc. cit.*, p. 315.

on the side. At first they are very rounded, and then become more oblong than they are when fully developed. We are not yet certain whether they are separated from each other at the period of their formation, or if they form only one rounded transverse prominence. Observations upon the fetuses of sheep, analogy with the development of other parts, the tubercula quadrigemina for instance, and the manner in which they are developed in the animal series, render the second hypothesis probable.(1) This period, however, if it occurs, (of which we have not the least doubt, from researches made recently upon very young fetuses of sheep,) passes very quickly, and is replaced by another which presents an arrangement opposite to that we have mentioned. The two hemispheres separate from each other completely; their internal parietes are perfect except a small space at their posterior part, and their internal faces are, it is true, placed one against the other; but we can separate them entirely without the least laceration, as in the cerebral hemispheres of birds.

The hemispheres continue to increase and gradually extend outward, backward, and upward, so that they cover first the optic beds, then also the tubercula quadrigemina, and finally the cerebellum.

Their surface continues smooth for a long time, and we observe there no trace either of the division into lobes, or of circumvolutions and anfractuosities. Their parietes are at first exceedingly thin in proportion to the space they circumscribe.

The fissure of Sylvius is developed at the third month, under the form of an oblique fissure, between the anterior lobe and the middle lobe; but it continues for a long time more superficial than in the adult, and forms at first only a slight depression, which depends particularly on the fact that the middle lobe is then proportionally much shorter, and only increases gradually from above downward. Hence, why the isle of the fissure of Sylvius is at first entirely loose and unattached. The circumvolutions and the anfractuosities appear afterward, not until the fourth and fifth month, and the internal of the upper face appear before all the others. The prominences of the isle of the fissure of Sylvius form last, and we have found no trace of them in the fetus of eight months.

g. Those parts of the cerebrum which serve to unite the others, the corpus callosum and the fornix, are developed the last. At first we find in their place only a fold of the internal wall of the hemispheres, which is entirely hollowed outward, and which projects within the cerebral cavity. This fold gradually disappears in its anterior part, and as it vanishes, the corpus callosum forms from before backward, so that this latter seems to depend on the circumstance that the cerebral substance turned at first outward, is reflected inward, and the internal walls of the two hemispheres then unite in this latter direction.

(1) Meckel, *Deutsches Archiv fur die Physiologie*, vol. i. p. 385.

But below this point the internal parietes separate still more, and thus form the ventricle of the septum, which finally contracts considerably.

The *fornix* and the *corpus fimbriatum* arise from the enlargement of a small cavity in the hemisphere through which the pia-mater penetrates from before backward to produce the large cerebral fissure which increases its distance from the optic bed.

The *mammillary eminences* form until the seventh month a single eminence, which perhaps develops itself in the same proportion as the internal wall of the lateral ventricles is separated by the pia-mater which penetrates within it.

The *anterior commissure* appears at three months.

The *ventricles of the cerebrum* present several remarkable differences at different periods of development.

It is a general law, that they are larger in proportion to their parietes, the younger the organism is. This circumstance depends principally on the thinness of their parietes, as we have already stated when speaking of the tubercula quadrigemina, the optic beds, the cerebral hemispheres, and the medulla oblongata. The fossa of the medulla oblongata is also much larger in the early periods from the great development of this part.

The form of the hemispheres also varies at different periods of life.

In the early stages of pregnancy, the hemispheres form in fact only one large cavity, since there is then no ventricle of the septum nor corpus callosum, the space between the internal walls of the hemispheres is in no manner closed.

At a later period the ventricle of the septum, which when the subject is perfectly developed is generally entirely separate from the others, communicates with the third ventricle below the anterior commissure.

The third ventricle is not at first divided into an upper and a lower canal by the commissura mollis; but in the latter periods of fetal existence this separation is more marked than in the adult.

The lateral ventricles are not divided at first into three horns, but are entirely single. The anterior and middle horns are developed the first when the corpus striatum forms. The posterior horn is the last to appear. The formation of the latter and this complete separation of the first two, depend on the thickening of the parietes of the hemispheres, and the increase in the size of the corpora striata.

4th. *Texture, consistence*, and *color*. The nervous system in general and particularly its central mass, are extremely soft in the early periods of life. It is curious however, that notwithstanding this softness, its fibrous texture(1) is easily distinguished, and is even more evident than in the adult, even as in fishes we observe it in several parts of the cerebrum without recurring to any artificial means to render it more evident. The fibres seem to be arranged in elongated and

(1) Petsche, *Syllog. obs. anat. select.* Halle, 1736, p. 33, § 76.

pyramidal fasciculi, the summits of which are turned inward, and the bases of which look towards the surface of the cerebrum; at least we have observed this phenomenon several times in the brains of fetuses macerated for a short time before or after their immersion in alcohol.

The difference between the gray and the white substance is visible at a later period. It appears earlier in the spinal marrow than in the cerebrum, where it is evidently formed from behind forward, and from below upward. It is already very evident at seven months in the spinal marrow, and perhaps even it is observed there sooner. The gray substance has then even a deeper tint than that which marks it afterward. But the medulla oblongata is still entirely gray towards the period when the embryo is fully grown. After this period we first see the pyramids whiten, then the olivary bodies are covered with white substance. The annular protuberance is still entirely gray externally in the first weeks after birth, although the longitudinal fibres, extended into the pyramids, which pass through it, are entirely white. The transverse fibres soon afterward also become white: the inferior and external before the superior and internal, which at two months are but few in number, and scarcely perceptible. The difference between the gray substance and the white substance is observed in the cerebellum during the later periods of fetal existence. The gray substance however is much greater there in proportion than in the adult. The yellow substance, situated between the gray and the white, rarely forms before the end of the first year, and it never appears in the course of the first six months.

The cerebral peduncles are still gray externally in the first periods of life, although the prolongations of the pyramids within them have already a whitish color at this time. Some months after they are often entirely white on the surface. Sometimes however we have found them entirely gray in children five months old, while the white substance was completely developed in the medulla oblongata and the cerebrum. It is true they had then a brighter tint than the rest of the white substance. The black substance which is met with internally in the adult, is simply gray in the first year. The mammillary eminences are usually entirely gray at five or six months.

The difference between the gray and the white substance already begins to show itself in the other parts of the cerebrum at the period of birth, or at least in the first few weeks of life. Their arrangement, however, then differs much from what it is afterward. The optic beds and the corpora striata are entirely gray, although having very manifestly a fibrous texture, or at least it is very difficult to distinguish the two substances, because the gray is but slightly colored, and the white is grayish. On the surface of the corpora striata is a very vascular layer, giving them a redder and a deeper tint than belongs to them, and under this is a homogenous mass of a brighter color and still entirely gray. There are developed in this layer yellowish white rays which perfectly fit with it, are still less abundant than it, and are not attached to those of the cerebral peduncle: but we have not yet determined with certainty at what period they appear, although they are evidently formed in the first weeks after birth and not in the latter of fetal existence. These yellow rays disappear in the course of the first month. At the same time the red and vascular substance is discolored, and a medullary band scarcely about a line broad, forms between it and the external gray substance, and gradually extends particularly inward.

This layer formed alternately of red substance and of a yellowish white substance about six lines broad, presents a very marked analogy with the fimbriated nucleus of the olivary bodies and of the cerebellum. But the cerebrum differs from the cerebellum and the medulla oblongata, inasmuch as its corpus dentatum is only a temporary formation, while in the other two it is permanent.

The gray cortical substance is much thicker in the cerebrum in the early periods of life than subsequently. At five months its average measure of thickness is about two lines.

As the intermediate yellow substance is not developed in the cerebellum at this period, so too the envelop of the posterior circumvolutions of the cerebrum is not yet divided by an intermediate medullary band into an external and an internal layer; we must then attribute the absence of this arrangement to a suspension of development which is sometimes observed in adults.

V. ENVELOPS.

§ 1804. The pia-mater is generally much more vascular and much better developed, but also united much less intimately with the nervous substance the younger the fetus is. The internal pia-mater seems to form gradually. The choroid plexuses seem to participate remarkably in this difference dependent on age; but they do not exist at all during the early periods, although the cavities which include them are already formed, so that the differences in their development depend according to all appearances less on the increase of the mass of the cerebrum than on the extent of its cavities, and they are in direct ratio with the activity of the secretion even as in the mammalia, where the ventricles are larger than those of man in proportion to the medullary mass, the choroid plexuses are also much more developed than in the human species.

The *arachnoid membrane*, if we except perhaps the first periods, is at first much more evidently distinct from the pia-mater and from the dura-mater in all its extent. It is also proportionally softer, thicker, and less transparent. We find between it and the other two membranes, and also in the cavities of the encephalon and the spinal marrow, during the early periods of life, much more fluid than exists afterwards. Its differences at different periods of its development are then most probably in direct ratio with its power of secretion, since when the latter is increased by a morbid state the membrane is changed exactly in the same manner. It generally becomes less pellucid, thicker, and harder, as the subject grows older.

The *glands of Pacchioni* are not generally observed till at an advanced period of life.

The *dura-mater* is proportionally more vascular, but thinner and less distinctly fibrous in the early stages of life than at a more advanced period. Its prolongations, particularly the perpendicular, are very thin, much less extensive, and easy to divide into two lateral layers in all their extent, so that considered generally they are but slightly developed. The connections between the skull and the cerebral dura-mater which is still imperfect, are much more intimate in the fetus than in the adult. The substance between the spinal dura-mater and the vertebral column is at first much more abundant, but also thinner and gelatinous: it does not become changed into fat until after the first year of birth.

§ 1805. Notwithstanding all the researches hitherto made, the mode of the formation of the centre of the nervous system is not yet ascertained. Two of the characters presented by it at all periods of life are very much developed in the early states, viz. the ventricles and the two lateral corresponding halves. We may then conjectnre that the central portion of the nervous system forms in the centre of a fluid and down it, that it there assumes the form of a hollow canal, or that it is developed there in layers or cords more or less separated on the median line, which gradually unite to form a cavity. In this latter hypothesis, the number of degrees of development through which the cerebrum and spinal marrow pass would be greater than in the first, which does not admit of the primitive simple form of layers. But there are facts which favor the latter opinion, and although it renders the formation of the central mass of the nervous system more complex, we must not discard it to admire wrongly the simplicity of nature in her operations. The facts we allude to are the almost entire division of the spinal marrow into two lateral portions, which is seen from the first, the possibility of entirely separating also the anterior cords from each other, and thus of changing the spinal cord into two lateral cords: the great breadth and the slight thickness of the medulla oblongata; finally the total separation of the two lateral halves of the cerebellum, probably also of the tubercula quadrigemina, and very certainly of the optic beds. Thus the central mass of the nervous system is developed from below upward, although we are as yet unable to determine if it is by one or two layers: these layers cross from before backward, curve inward to meet each other and blend on the median line, giving rise in this manner, first to a semi-canal and then to a perfect canal. This theory is supported not only by the facts supplied by the history of the fetus, but also by the development of the nervous system in the animal kingdom. The dorsal medulla and the cerebrum of worms and insects evidently correspond to the inferior or anterior cords of these same parts in the upper classes of animals, and we may without much trouble extend a higher degree of organization to these organs partly by supposing the superior cords to be added, and partly by supposing them united posteriorly, by which the layers or cords which first existed assume the form of a canal.

The final development of the central part of the nervous system is by the increase of the mass, which augments the thickness of the parietes of the ventricles, and contracts the latter. Next supervenes a period when the mass settles, so that the surface which was at first smooth and united becomes very uneven, and at the same time much more extensive. Differences then occur in the nervous substance which divides into gray and white, by which phenomenon the development of its intimate structure terminates. These different characters generally appear in the parts in the same order as they are formed. The spinal marrow is first perfected in every respect. The tubercula quadrigemina change but slightly after birth. The cerebellum seems to be an exception to the rule, for although it is formed late, it becomes perfect in respect to form and texture long before the cerebrum, and even before the annular protuberance.

CHAPTER V.

OF THE MOTIONS OF THE CENTRAL MASS OF THE NERVOUS SYSTEM.

§ 1806. The central mass of the nervous system has certainly two motions(1) which are very evident in the brain. One depends on the pulsation of the arteries, the other on respiration; of these, the latter is much less frequent than the former. Both consist in an alternate rising and falling of the encephalon, which in the second is undoubtedly enlarged and contracted alternately. Respiration determines the second kind of motion, because when the air is expelled from the lungs it is more difficult for the blood to return to the brain, while on the contrary, its return is more easy during inspiration. The encephalon enlarges then in the first of these two cases, and collapses in the second.

(1) Schlichting, *De motu cerebri;* in the *Mém. prés.*, vol. i. p. 113.—Lorry, *Sur les mouvemens de cerveau et de la dure-mère*, same journal, vol. iii. mem. i, p. 277, mem. ii. p. 344.—Haller, *Experim. ad motum cerebri a refluxu sanguinis natum;* in the *Opusc. phys.*, vol. i. p. 231.—Lamure, *Sur la cause des mouvemens du cerveau;* in the *Mém. de Paris*, 1753.—Richard, in the *Journ. de méd.*, vol. xxix. 1768, p. 140.—Ravina, *De motu cerebri;* in the *Mem. de Turin*, 1811.—Portal, *Mém. sur un mouvement qu'on peut observer dans la moelle épinière;* in the *Mem. sur plus. malad.*, vol. ii. p. 81.—Magendie, *Sur un mouvement de la moelle épinière isochrone à la respiration;* in the *Journ. de phys. expér.*, vol. i. p. 200.

CHAPTER VI.

OF THE CENTRAL PORTION OF THE NERVOUS SYSTEM IN THE ABNORMAL STATE.(1)

§ 1807. Most of the deviations in the formation of the central part of the nervous system are congenital. They all relate to the *existence*, the *number*, the *situation*, the *size*, and the *form* of this mass.

§ 1808. *Existence* and *number*.(2) Not unfrequently a greater or less portion of the central mass of the nervous system is deficient by a primitive deviation of formation. In *acephalia vera*(3) the spinal marrow is usually developed as far as the vertebral column extends, and in this place terminates in a point, where it divides like the cerebrum into two rounded eminences. The cerebrum is then entirely deficient, or at least exists but very imperfectly, except when there is a rudiment of a head in *spina bifida* and in *acephalia falsa*, which is similar to *spina bifida* and which frequently coexists with it. The cerebrum

(1) J. Baader, *Obs. med. incisionibus cadaverum anatomicis illustratæ*, Friburg, 1762.—J. F. Meckel, *Rech. anat. physiol. sur les causes de la folie*; in the *Mém. de Berlin*, 1764.—J. E. Greding, *Melancholico-maniacorum et epilepticorum quorumdam in ptochotropheo Waldhemiensi defunctorum sectiones*; in Ludwig, *Advers. med. pr.*, Leipsic, 1771, vol. ii.-iii.—Burdach, *Beytrage zur nähern Kenntniss des Gehirns in Hinsicht auf Physiologie, Med. und Chirurgie*, Leipsic, 1806.—Home, *Observations on the functions of the brain*; in the *Phil. trans.*, 1814, vol. ii.—Lallemand, *Observations pathologiques propres à éclairer quelques points de physiologie*, Paris, 1818.—J. Abercrombie, *Ueber die Krankheiten des Gehirns und des Rückenmarks*; with additions, Nasse, Bonn, 1820.—Id., *Observations sur l'inflammation chronique du cerveau*; in the *Journ. compl. des sc. méd.*, vol. i. p. 346.—Lallemand, *Recherches anatomico-pathologiques sur l'encéphale et ses dépendances*, Paris, 1820 et suiv.—Georget, *De la folie, considerations sur cette maladie, suivies de recherches cadaveriques*, Paris, 1820.—Geoffroy-Saint-Hilaire, *Philos. anat., monstruosités humaines*, Paris, 1823.—Serres, *Recherch. sur les malad. organiques du cervelet*; in the *Journ. de phys. exp.*, vol. ii. p. 172, 249, vol. iii. p. 114.—C. Oppert, *Diss. de vitiis nervorum organicis*, Berlin, 1815.—Magendie, *Hist. d'une maladie singulière du système nerveux*; in the *Journ. de phys. exper.*, vol. ii. p. 99.—A. L. J. Bayle, *Mémoire sur quelques points de la physiologie et de la pathologie du système nerveux*; in the *Revue médicale*, vol. i. p. 46.—L. Martinet, *Observations tendantes à éclairer la doctrine des phénomènes spasmodiques dans les cas de ramollissement du cerveau*; same journal, vol. i. p. 56.—A. L. J. Bayle, *Mémoire sur l'existence de la paralysie du même côté que la lèsion cerebrale qui la determine*; same journal, vol. i. p. 33.

(2) The following terms have been proposed for the deviations in the formation of the central mass of the nervous system which may appertain to this class: *aneuria*, the deficiency of the whole nervous system: *amyelencephalia*, simultaneous absence of the encephalon and spinal marrow: *amyelia*, entire absence of the spinal marrow; *atelomyelia*, imperfection of the spinal marrow; *anencephalia*, absence of the encephalon. F. T.

(3) The most complete treatise on acephalia, is that of Tiedemann, *Anatomie der kopflosen Missgeburten*, Heidelberg, 1813.—See also Tiedemann, *Beobachtungen über Missbildungen des Gehirns und seiner Nerven*; in the *Zeitschrift fur Physiologie*, part i. 1824, p. 55.

and the spinal marrow are frequently partly or wholly deficient, although no mark leads us to suspect that they have existed anteriorly.

When the facial portion of the skull is imperfectly developed, the anterior part of the encephalon is also deficient, or at least is very imperfectly formed. The anomaly generally extends only to the cerebrum: the medulla oblongata is rounded before, especially when there is no trace of the cerebrum, or when the latter is replaced by a thin vesicle, although we cannot trace the hemispheres, the corpora striata or the optic beds.

More rarely only some parts of the spinal marrow and encephalon are deficient, while these two organs and the whole body are otherwise perfectly developed.(1) The commissures are most frequently deficient, a very curious phenomenon as these parts are formed latest in the animal series and in the fetus. The commissura mollis of the optic beds is most often absent;(2) but this is developed latest in the embryo, and birds are destitute of it. The corpus callosum is more rarely wanting,(3) and the annular protuberance still more rarely in subjects where the cerebrum and the cerebellum are regularly developed in all other parts. We know of no instance of the want of an anterior and posterior commissure, which is completely formed in the fetus and in the animal series before the parts of union above mentioned.

Authors frequently mention the absence of the pineal gland and its concretions; but the pretended deficiency of this gland depends doubtless upon a careless or too hurried dissection.

The imperfect development of inequalities on the external and internal surface of the cerebrum, is connected with the total absence of parts which possess a great character of individuality. Malacarne states that the intellectual faculties are developed directly in proportion to the number of the layers of the cerebellum, which vary from six hundred to eight hundred.(4) So too the external surface of the cerebrum is sometimes more or less smooth, a circumstance which perhaps is also connected with the degree of intelligence, for of all parts of the encephalon the circumvolutions vary the most.(5) In regard to the internal eminences, the prominence of the posterior horn of the lateral ventricle is deficient more frequently than that of the middle horn. The imperfect development of the external circumvolutions is not un-

(1) Breschet has observed in an idiot three years and a half old, an imperfect development of the outer part of the left hemisphere, the corpus striatum, and the optic bed of the same side, (*Note sur des enfans nouveau nés, chez lesquels l'encephale offrait un developpement imparfait*; in the *Journ. de phys. exp.*, vol. iii. p. 232.)

(2) We have reported previously several instances. Greding (*loc. cit.*, vol. iii. p. 650) observed, that of the great number of brains he has dissected, the commissura mollis of the optic beds was deficient in seven only.

(3) Reil, *Archiv. fur die Physiologie*, vol. xi. p 341.—Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 301.—Wenzel, *De penit. structurâ cereb.*, p. 302.

(4) *Neuro-Encefalotomia*, Pavia, 1791.

(5) Wenzel, chap. iii.

frequently attended with an analogous arrangement of the internal eminences: but perhaps it is not so correct to admit the relation of cause and effect between these two states, for instance to attribute the second to the first,(1) as to ascribe the origin of both to the same cause.

The deviations in formation by excess are much less common than those by defect, particularly when the body is single, and they at most affect only insignificant parts. Here we may mention among others the existence of a small prolongation of the decussation of the optic nerves which goes forward,(2) and is perhaps only a repetition of the hypophysis, the increase of the number of the internal and external prominences which is little less frequent, the doubling of the commissura mollis of the optic beds, finally the existence of a double pineal gland,(3) although this anomaly depends perhaps on the division of the pineal gland, which is generally single.

2d. *Situation.* The anomalies in respect to situation generally depend on the imperfect manner in which the organs which surround the spinal marrow and the encephalon are developed in *spina bifida* and in *acephalia falsa*, whence they are left more or less exposed.

In *encephalocele* (*hernia cerebri*) a greater or less portion of the encephalon projects outward, and is or is not covered by the common integuments.(4) This hernia which generally supervenes after a congestion of serum within the encephalon or the skull, usually occurs either through one of the points of the osseous envelop which always continue open, as the occipital foramen, or through one of those spaces which are gradually filled up, as the fontanelles.

We have as yet no well authenticated instance of anomalies in the respective situation of the parts of the encephalon.

3d. *Volume.* Excess and deficiency in volume are not rare phenomena in the central part of the nervous system. Both may be primitive and congenital, or consecutive and accidental.

a. Smallness. The spinal marrow is rarely too small from a primitive deviation of formation; and it sometimes diminishes in *tabes dorsalis*.(5)

(1) Greding, *loc. cit.*, vol. iii. p. 613.
(2) Wenzel, p. 147.
(3) Sœmmerring, in Noethig, *De decussatione nervorum opticorum*, Mayence, 1786.
(4) Meckel, *Handbuch der pathologischen An.*, vol. i.—Neagele, *Sur l'encephalocele;* in the *Journ. compl. des sc. med.*, vol. xiii. p. 207.
(5) The wasting of the spinal marrow has been observed by Bonet (*Sepulchretum*, vol. i. p. 305, 370). Morgagni has often remarked that the spinal marrow in persons affected for a long time with hemiplegia, was considerably diminished in all the lateral portion corresponding to the side affected. (*De sed. et caus.*, ep. xi. sect. 60). This wasting has been observed also by Salzmann, Chaussier, Olivier. It seems to be generally attendant on old age, and may supervene whenever there is a slow and long continued compression of the spinal prolongation, as in the disease of Pott. We have even known in some cases of this kind, the medulla to disappear entirely at the part compressed. Olivier mentions a remarkable instance of it (*loc. cit.*, p. 143). F. T.

The encephalon presents instances of this deviation of formation much more frequently at birth. In *acephalia falsa*, *hemicephalia*, and in *microcephalia*, the cerebrum is exposed and is frequently developed perfectly, except in its volume. We can then hardly suppose that it has been affected by external compression, or admit that when it is partially or entirely deficient it has always pre-existed, and has been destroyed; but we have every reason to think, that in many such cases, any obstacle whatever, for instance, an accumulation of serum either within this viscus or between it and the skull, has prevented its normal development, and has destroyed it. This conjecture is strengthened by the analogy presented by the heads of monsters of this species with those of children affected with hydrocephalus, by the traces of an old or actually existing congestions of serum often found in membranous sacs hanging on the outside of the head: finally by a phenomenon which frequently occurs under the eye of the observer, the change of hydrorachitis into the denudation and destruction of the spinal marrow. As the cause of suspended development of the cerebrum, the abnormal accumulation of serum, is only the continuance at one of the temporary degrees through which the organ successively passes in its formation, it is easy to refute all objections made against this theory by alledging that similar anomalies occur simultaneously in other organs, that monsters which present instances of it are all similar to one another, and that they are more common in the female sex.(1) We however do not think that a mechanical obstacle of this nature is always necessary, since the cerebrum is formed later than the spinal marrow, and even when there is no external obstacle, it is at first very small in proportion to the spinal marrow and the body, and particularly its hemispheres appear last, and are at first proportionally very small.

(1) The observations of the ancients on this doctrinal point, are collected in Morgagni, *De caus. et sed. morb.*, ep. xii. 6.—Sandifort, *Anat. infantis cerebro destituti.* Leyden, 1784.—Sœmmerring, *Abbild. und Beschreib. einiger Missgeburten*, 1791.—Meckel, *Handbuch der pathol. Anatomie*, vol. i. p. 193.—Tiedemann, *Beobachtungen über Missbildungen des Gehirns und seiner Nerven*; in the *Zeitschrift für Physiologie*, vol. i. p. 56. Among those collected by the moderns, we shall mention the following,

1st. Females. Pullin, in the *Med. and. phys. journ.*, vol. i. 1799, no. 3, p. 224.—*Id.*, *ibid*, vol. iii. 1800, no. 12, p. 138.—Pole, *Case of extraordinary malformation in a fetus*; same journal, vol. iii. no. 15, 1800, p. 397.—Beclard, in the *Bullet. de la fac. de med.*, 1812.—Burrows, *A case of malformation of the head*; in the *Med. chir. trans.*, vol. iv. p. 52.—Lawrence, *Account of a child born without a brain*; same journal, vol. v. p. 165.

2d. Males. Cam, *A case of monstrosity*; in the *London med. and phys. journ.*, vol. vii. no. 39, 1802, p. 385.—Osiander, in the *Gœtting. Anzeig.*, 1812, p. 1377, 1388.—Kelch, *Beytrage zur patholog. Anatomie*, Berlin, 1813, p. 83.—*Account of four male children born without a brain*; in the *London med. and phys. journ.*, vol. xxxiv. no. 198, 1815, p. 104.

3d. Undetermined. Two cases by Simmons, in the *Lond. med. and phys. journ.*, vol. iv. no. 19, 1800, p. 189.—Two others by Beclard, in the *Bullet. de la soc. de med.*, 1813, no. 1.

From the extreme smallness and the denudation of the encephalon, life is generally very short, continuing only for a few hours; sometimes however, it remains several weeks.(1) When the wasting of the organ is not so extensive, the individual can live, but his intellectual faculties are imperfect. Instances of this anomaly are seen in idiots(2) and cretins;(3) in them the cerebrum is characterized principally by the smallness of its anterior and upper parts, or by its slight extent from one side to the other, by which its height or its breadth(4) are diminished.

It is still less probable that a diminution, a *wasting* of the encephalon, is attended with a diminution of the activity of the mind, since not only the nerves but the parts of the cerebrum to which they correspond, diminish and waste when their action has long been suspended.

Thus many anatomists, particularly Wenzel,(5) have noticed the wasting of the optic beds, and Gall of that of the anterior tubercula quadrigemina in blind people. Wenzel has determined by very minute researches, that in blindness the optic beds first flatten and then become narrower and shorter.

b. Sometimes the whole central mass of the nervous system or some one of its parts, are larger than when normal. Here, as in similar anomalies of the vascular system, we must distinguish simple dilatation from real enlargement.

Simple dilatation occurs in dropsy of the ventricles where the cerebrum is enormously distended, but is only a few lines thick; and when the congestion of serum is very abundant, its mass is even smaller than in the normal state.(6)

But the cerebrum in children affected with rachitis presents on the contrary an abnormal enlargement in mass.(7)

(1) We have collected the cases of this kind in our *Handbuch der pathol. Anatomie*. To those already mentioned, we may add the following: Harder (*Pæon et Pythag*., p. 125, c. 22.) mentions a child with this affection which lived ten days. Osiander (*Gœtting. Anzeig*, 1812, p. 1387, 1388) has seen a boy in whom the medulla oblongata and the cerebellum were regular, and the cerebrum was but a slight rudiment, although possessing small cavities and the cortical and medullary substance, which lived fifteen days: it enjoyed good health during twelve, and died from the consequences of a disease of the mother. Lawrence (*Med. chir. trans*., vol. v.) mentions a female child who lived four days, and Burrows (*Ibid*., vol. ii.) another who existed six days.

(2) Rœderer, *De cerebro observ*., Gœttingen, 1758, p. 5.—Greding, *loc. cit*., vol. iii. p. 594.—Siebold, *Journal für Geburtshülfe*, vol. i. part ii. 259-265, 272-278.

(3) Wenzel, *Ueber Cretinismus*, Vienna, 1812.—Ackermann, *Ueber die Cretinen*, Gotha, 1790.

(4) We find the skulls of idiots and cretins which possess an analogous formation of the cerebrum figured in Prochaska, *Disq. org. corp. hum*., Vienna, 1812, tab. 8-10.—Blumenbach, *De nisus format. aberr*., Gœttingen, 1813, tab. 2.

(5) *De penit. struct. cereb*., p. 125.

(6) Home, *Observat. on the functions of the brain*; in the *Phil. trans*., 1814.

(7) Ludwig, *Adv. méd. pr*., vol. ii. p. 221.

The spinal marrow is sometimes larger than usual in *spina bifida*, as it is then found entirely filling the vertebral canal.(1)

The increase of some parts of the central mass of the nervous system is rather a rare phenomenon. Sometimes however we find the fourth lobe of the cerebellum,(2) the pineal gland,(3) the pituitary gland,(4) the optic beds, and the corpora striata,(5) larger than usual.

This anomaly is not always essentially the same. Hydrocephalus, the enlargement from rachitis, the abnormal length of the spinal marrow, the largeness of the prolongations, and of the pituitary gland, should undoubtedly be considered as a continuation of development after a type which is regular only in the early periods of life, since it is easy to demonstrate that these phenomena are normal in the early periods of existence.

The abnormal enlargement of the optic beds seems intended to compensate for the wasting of one of these two eminences, as these two states are usually seen simultaneously.

4th. The cerebrum and the spinal marrow rarely present primitive deviations of formation not included in one or another of the preceding classes.

In *spina bifida* the spinal marrow is sometimes flatter and broader than usual, or even divided into two halves, which manifestly indicates a suspension of development.

Among the deviations in the formation of the cerebrum, we may arrange the following :

a. The mutual and perfect adhesion of the two hemispheres which is observed without any injury of the intellectual functions, and which sometimes occurs in all the inner faces of the hemispheres,(6) sometimes is confined to some points of these same surfaces,(7) which remarkably increases the number of the commissures when, as in the cases cited in the note, the two halves of the cerebrum are continuous. An arrangement similar to this is where there is an intimate adhesion of the inner faces of the hemispheres by a close cellular tissue.(8) In both cases the large cerebral falx is more or less imperfect. The deficiency of this prolongation of the dura-mater,(9) the first degree of which, the existence of one or more openings which pass through it in different parts, and which is quite common, is curious as an analogy with the formation of most animals.

(1) This has been observed several times by Laennec.
(2) Kelch, *loc. cit.*, p. 90.
(3) Blane, in *Trans. of a soc. for the improv. of med. and surg. knowl.*, London, vol. ii. p. 16.
(4) Greding, *loc. cit.*, vol. ii. p. 515.
(5) Wenzel, *loc. cit.*, p. 125, 126.
(6) Carlisle, in the *Trans. of a soc. for the improv. of med. and surg. knowl.*, vol. ii. p. 212.
(7) Wenzel, *loc. cit.*, p. 288.
(8) Greding, *loc. cit.*, vol. iii. p. 630.
(9) Gunz, *De lapillis gland. pinealis*, p. xi.

b. Defect in symmetry, the obliquity of the cerebrum, which involves a corresponding obliquity of the head and often also mental alienation, (1) although this latter does not attend it necessarily. This defect sometimes exists to such a degree that, at least if we may judge from appearances, one half of the cerebellum is twice or three times as large as the other.(2)

Wounds of the central part of the nervous system endanger the life of the person wounded, and the more the nearer they are to the medulla oblongata.(3)

1809. *Alterations of texture.* We may arrange under this head the following alterations:

1st. *Differences in consistence.* The spinal marrow has been studied but slightly in this respect.

The degree of consistence of the cerebrum is not always perfectly the same, nor are the anomalies presented by it always attended with the same derangements of the intellectual faculties.

a. Induration.(4) Of this there are several degrees. If very extensive, the tissue of the cerebrum is at the same time more or less altered, and earthy particles(5) are even mixed with it. When this occurs, it is sometimes hard to cut the cerebral substance at those places where the induration exists. The cerebrum not unfrequently becomes more consistent in mental alienation,(6) and the intellectual faculties are more affected the greater the hardness of the cerebrum.(7)

b. Softening.(8) The induration of the cerebrum, notwithstanding the facts we have mentioned, is in general so slightly a necessary condition of mental alienation, that we much more frequently find the contrary state, the softening of the organ; excellent observers who have had opportunities of seeing, have determined this fact.

(1) Greding, *loc. cit.*, vol. ii. p. 525, 595, vol. iii. p. 453.

(2) Greding, *loc. cit.*, vol. ii. p. 525.

(3) See the excellent memoir of Casper, *Sur les lesions de la moelle épinière, par rapport à leur degre de lethalité*; in the *Journ. compl. du Dict. des sc. med*, vol. xvi. p. 309, vol. xviii. p. 107.

(4) S. Pinel, *Recherches d'unatomie pathologique sur l'endurcissement du système nerveux*; in the *Journ. de phys. exp.*, vol. ii. p. 191.

(5) Morgagni, *De sed. et caus. morb.*, ep. an. i. 10, 17, viii. 14.—Marshal, *Morbid anatomy of the brain in mania and hydrophobia*, London, 1815. Sixteen times in twenty-four cases.

(6) We find two cases in Home, *loc. cit.*—Portal, *Anat. med.*, vol. iv. p. 110.

(7) Greding, *loc. cit.*, vol. ii. p. 533, vol. iii. p. 662.

(8) The softening of the cerebrum is a subject of important research to the French pathologists, a very general picture of which would be too extensive for a place here. We refer to the article *cephalite* in the *Dictionnaire des sciences medicales*, and to the good remarks of Lallemand. See also Rostan, *Recherches sur le ramollissement du cerveau*, Paris, 1828. We will only remark that Lallemand considers this morbid organic alteration as the result of inflammation of the cerebrum. His opinion is that which is most followed in France, where it is almost universally adopted. No one now denies, that in most cases of *ataxic* diseases, that is, with complicated symptoms of excitement and of diminution of the action of the encephalon, where the encephalon is found perfectly regular, more or less extensive softening of the cerebral substance appears. F. T.

The consistence of the cerebrum also is very commonly increased in some parts, and diminished proportionally in others, but in subjects affected with mental derangement,(1) and with dropsy.(2) This state of the cerebrum is even common in fools.(3)

But none of these states are necessarily connected with idiocy in general, or with its different species in particular, for the cerebrum has been found of the normal consistence in every species of mental derangement.(4)

The cerebrum has been found much harder or softer than usual in subjects whose intellectual faculties were unimpaired.(5)

The cerebrum in idiocy has been found not only more or less consistent than usual,(6) but often of a normal consistence, or uncommonly soft, or finally too soft in some parts and too hard in others.(7) So too in madness it has been found too soft(8) and too hard.(9)

2d. *Dropsy*. Dropsy of the centre of the nervous system (*hydrorachitis* and *hydrocephalus*) is very common, especially in the early periods of life, and is often congenital. We have every reason to think that in this case it arises from suspended development.

In *hydrorachis* the serum is generally accumulated around the spinal marrow, most generally between it and the arachnoid membrane, more rarely between this membrane and the dura-mater, very rarely or even never between this membrane and the bones. When the congestion exists in the greatest degree, it opposes the development of the arches of the vertebræ to a greater or less extent, either in one or in several points, where the serum accumulated in the vertebral canal distends the membranes and the skin so as to form a tumor which is more or less prominent, and which finally breaks.(10)

Most generally hydrorachis is attended with *hydrocephalus*, which is generally distinguished into *acute* and *chronic*.(11) The congestion

(1) Home, *loc. cit.*—Portal, *loc cit.*, p. 110.
(2) Portal, *loc. cit.*, p. 75.
(3) Greding, *loc. cit.*, vol. iii. p. 664, 665.
(4) Greding, *loc. cit.*, vol. ii. p. 532, 533, vol. iii. p. 662.
(5) Morgagni, *De caus, et. sed. morb.*, ep. viii. 18, lxi. 8.
(6) Meckel, *Recherches anat. phys. sur les causes de la folie;* in the *Mem. de Berlin*, 1764, obs. 1-6.
(7) Greding, vol. ii. p. 557, vol. iii. p. 662, 665.
(8) Meckel, *loc. cit.*, p. 71.
(9) Greding, *loc. cit.*, vol. ii. p. 537, vol. iii. p. 664, 665.—Home, *loc. cit.*—Portal, *loc. cit.*

(10) This tumor is most frequently situated in the loins, more rarely in the back, often in both of these places at once, rarely in the neck, rarely also in the sacrum, where it has been seen among others by Vrolik (*Memoires sur quelques sujets interressans d'anatomie et de physiologie*, trans. by Fullot, Amsterdam, 1822, p. 761.) F. T.

(11) Breschet, *Recherches anatomiques et chimiques sur une hydrocéphale chronique;* in the *Journ. de physiol. experimentale*, vol. i. p 93 —Id.. *Note sur deux enfans nouveau nés hydrocéphales et manquant de cerveau*, same journal, vol. ii. p. 269.—J. L. Brachet, *Essai sur l'hydrocéphalite, ou hydropise aiguë des ventricules du cerveau.* Paris, 1818.—Coindet, *Mém. sur l'hydrocéphale*, Geneva, 1817.—Bricheteau, *Mémoire sur l'hydrocéphale interne;* in the *Journ. compl. des sc. méd.*, vol. v. p. 193.

of serum is situated sometimes in the cerebral ventricles (*hydrops cerebri, hydrencephalus*), sometimes on the surface of the brain between the arachnoid membrane and the dura-mater ; finally sometimes and most commonly in both these parts ; in all these cases the arachnoid membrane is that which is primitively diseased. The cerebrum itself is always more or less softened. When the serum is accumulated principally or solely in the ventricles, these cavities are dilated in proportion to its quantity, the substance of the cerebrum becomes thinner, and the circumvolutions are flatter. The latter are finally entirely defaced, when the cerebrum is distended and is considerably thin. When on the contrary the serum is collected on the surface of the brain, the latter collapses in proportion to its quantity.

The mass of the cerebrum is less than in the normal state, at least when there is a considerable congestion of serum, and when it takes place slowly.

Notwithstanding the normal communication between the cerebral ventricles, the serum is accumulated sometimes in only one of these cavities,(1) which proves that the openings have been obliterated by an inflammatory effusion, and not as is pretended(2) that they do not exist.

Chronic hydrocephalus is most generally congenital, and probably even original. It depends then on the cerebrum continuing to grow after a type of first formation.(3) This is perhaps, at least in part, the reason why it often continues so long without necessarily deranging the intellectual faculties, even as the rupture of the septum of the heart is fatal, while its original perforation seems not to endanger life, which continues sometimes to an advanced age notwithstanding this anomaly.

3d. *Inflammation*. The substance and the envelops of the encephalon and spinal marrow may be inflamed. They then receive more blood than usual.

Wenzel has asserted that the pituitary gland always presents traces of inflammation and its consequences in idiopathic epilepsy.(4) Presented in this general manner the assertion is false, as is proved by the facts collected by several observers,(5) and by ourselves.

vol. vi. p. 302, vol. vii. p. 97.—John, *Recherches chimiques sur la liqueur que les ventricules du cerveau renferment dans l'hydrocéphale* ; same journal, vol. vi. p. 270.—Consult also Coutanceau, *Des épanchemens dans le crâne pendant le cours des fièvres essentielles*, Paris, 1802, the excellent article *Hydrocéphale* by Itard, in the *Dictionnaire des sciences médicales*, the article *Hydrocéphale* by Boisseau, in the *Dictionnaire abrégé des sciences médicales*, and Ducrot, *Essai sur la céphalite*, Paris 1812.

(1) Tulp, *Obs. méd.*. I. c. 25.—Wepfer, *Obs. anat .de apoplexie*, Schaffousne, 1675, p. 68.—Portal, *Mém.*, vol. ii. p. 58.—Monro, *On the brain*, p. 18.

(2) By Portal among others.

(3) See our *Handbuch der pathologischen Anatomie*, vol. i.

(4) *Observations sur la glande pituitaire dans l'épilepsie*, Paris, 1811.

(5) For instance Kelch, *loc. cit.*, p. 103.—Otto, *Seltne Beobachtungen*, 1816, p. 106.

Among the membranes the arachnoid is particularly liable to inflame. Hence the results of inflammation are observed most frequently in it.(1) Here we include,

a. The thickening of its substance, the result of exsudation.

b. The formation of yellowish white corpuscles, the *glands of Pacchioni* which are developed in several regions, particularly in the sinciput, and which are seen more particularly in maniacs and persons who have been subject during life to congestions of the brain.(2)

c. The effusion of pus between the parts of the arachnoid membrane which line the dura-mater and the pia-mater.

d. Very probably the abnormal new formations, ossification, &c.

The inflammation of the cerebral substance(3) is very remarkable, particularly in respect to its consequences, inasmuch as not unfrequently this substance is destroyed even to a very considerable extent, although for a long time such a disorder has caused no marked derangement in the functions of the cerebrum, and has not manifestly endangered the life of the patient.(4)

Sometimes the pus found in the cerebrum is contained in special cysts,(5) which phenomenon cannot be explained better than in saying that it is not the cerebral substance which separated, but an accidental tissue developed within it, for,

a. The cysts adhere but slightly to the cerebral substance which surrounds them.

b. The latter is not hardened but softened around them.(6)

(1) Parent-Duchateletand Martinet, *Recherches sur l'inflammation de l'arachnoide cérébrale et spinale*, Paris, 1821.—Deslandes, *Examen des diverses formes que peut prendre la phlegmasie des méninges*, Paris, 1817.

(2) Meckel, *loc. cit.*, p. 77.—Greding, *loc. cit*, vol. ii. p. 471.—Wenzel, *Prod.*, cap. i.

(3) Inflammation of the substance of the cerebrum has been termed *encephalitis*, or *cerebritis* and *cerebellitis*, when confined to the cerebrum or cerebellum (Lallemand, *loc. cit.*); that of the spinal marrow is termed *myelitis*, which is a better term than *rachialgia* and *spinitis* (Klohs, *Diss. de myelitide*, Halle, 1820—Harles, *Ueber die Entzündung des Rückenmarks.*—Clot, *Recherches et observations sur le spinitis*, Montpellier, 1820.—Brera, *Della rachialgite;* in the *Atti dell' accademia di Livorno*, 1810.—Bergamaschi, *Osservazioni sull' inflammazione della midolla spinale*, Pavia, 1810). In the encephalon and even in the spinal marrow, inflammation seems usually to cause the softening and sometimes the induration of the medullary substance with the formation of abnormal tissues, or at least a tendency to this formation. It would seem as if this last effect, that is, induration, is more particularly the result of a slow, or as is generally termed, a chronic inflammation. F. T.

(4) Since inflammation of the cerebrum has been more studied, we know better what to think of these cases. A softening of a few lines in diameter seems to cause death. If the same is not true, at least promptly, of a schirrous or even a cancerous change, it is because they take place slowly, and we may consider as a law of the organism, in the state of disease, that an alteration even extensive but slow, destroys life less surely and less rapidly than another less extensive but acute. F. T.

(5) Bateman, *Case of an encysted tumor, occupying the greater part of the right hemisphere of the brain;* in the *Edinb. med. and surg. journ.*, vol. i. p. 150.

(6) Brodie, *Case of abscess in the brain;* in the *Trans. of a soc. for the improv. of med. and chir. knowl.*, vol. iii. p. 106.

4th. *New formations.* Beside these alterations in the consistence of the cerebrum, which are mentioned above and which supervene, although none is observed in the texture, the composition, and the color of this viscus, the centre of the nervous system is frequently also the seat of entirely new formations. These formations constitute a series of pathological changes which commence by manifest alterations of texture, which however unite with the rest of the mass, and which terminates by more or less distinct bodies which adhere but slightly to this mass.

The *cysts* filled with a fluid analogous to serum or thicker should probably be considered as the first degree of these new formations, since the concrete fluid they contain has no determinate character. These cysts appear both in the substance of the cerebrum, cerebellum, and medulla oblongata,(1) and on their surface between the meninges and in the ventricles.(2) Those in the cavities of the ventricles are very common in the choroid plexuses, which are, generally speaking, the most usual seat of their development. They generally have thin parietes ; but sometimes also, the membranes which form them are several lines thick. They are generally attached but feebly to the adjacent parts.

They vary much in size, from a head of a pin to a hen's egg. The largest particularly, and those situated in the cerebral substance, are almost always isolated, but the small, those developed externally and in the cerebral ventricles, are united in a greater or less number.

The abnormal repetitions, of normal tissues, other than that of the serous tissue on the surface or in the substance of the cerebrum, are rare. They perhaps occur only in the cartilaginous and osseous tissues.

The abnormal ossifications are most frequently situated in the arachnoid membrane, and occur like all the formations of this kind in advanced age. They seem to be rarer in the spinal than in the cranial portion of this membrane.(3) We have every reason, however, to believe that this difference depends in great part on the fact, that the spinal marrow is examined less frequently than the cerebrum, for Morgagni has seen them once, and we have observed them twice in this region. They assume the form of thin and irregular layers, which project more or less above the surface of the arachnoid membrane, and are found principally on its posterior side and its lower part, to which they often adhere but very slightly.

They are developed on the surface of the cerebrum, between the dura-mater and the arachnoid membrane ; at least they almost always

(1) Portal, *loc. cit.*, p. 72.—Morrah, *A case of hydatids in thebrain;* in the *Med. chir. trans.*, vol. ii. p. 262.—Home, *loc. cit.*, p. 54.

(2) Buchanan, *Case of encysted tumor of the brain;* in the *Edinb. med. journ.*, vol. viii. p. 276.

(3) Morgagni, *De sed. et caus. morb.*, ep. 25, a. 9.—Sabatier, *Sur quelques particularités de la moelle épinière et de ses enveloppes;* in the *Mém. de Paris*, 1783, p. 75.—Hertel, *De cerebri et meningum tumoribus*, Berlin, 1814.

form on the inner surface of the first, that is to say, in fact, on the external arachnoid membrane which lines it. Those which are considered as belonging to the pia-mater,(1) are always formed not from this membrane, but from the layer of the arachnoid membrane which covers it, since they are found on the external face of the pia-mater, and often adhere very strongly to the inner face of the dura-mater.(2) They vary much in their number, extent, figure, and degree of adhesion. Sometimes they are insulated, sometimes expanded in several parts, sometimes scarcely perceptible, and again several inches broad, smooth or rough, with even or serrated edges, sometimes adhering by a broad base, and sometimes only fitted to the membrane, to which they are attached only by a few filaments. Their situation is the only thing in regard to which certain generalities can be established with precision. They are most generally found on the large falx, or at least very near this fold, along the superior longitudinal sinus. Their influence on the cerebrum depends on the circumstances mentioned above, on the age of the subject, or on his greater or less susceptibility.

Besides these accidental ossifications, the tissue of the arachnoid membrane is sometimes, but more rarely, changed in an analogous manner. It becomes thicker, harder, and cartilaginous.(3)

The ossification of the cerebral substance itself, or the development of osseous substance within the cerebrum, is on the contrary a very rare phenomenon. Very probably, in most of the cases where it has been admitted, there were only exostoses of the bones of the skull, which projected within this cavity, and caused the crowding or destruction of the encephalon. Sometimes, however, earthy substance has really been found accumulated in the cerebrum in so great quantity, that it was difficult to divide it with a cutting instrument:(4) osseous concretions entirely distinct from the cerebral substance, have also been found, which were formed within it;(5) finally, bone and car-

(1) Greding, *loc. cit.*, vol. ii. p. 483, 485, vol. iii. p. 626, 628.

(2) Greding, *loc. cit.*, vol. ii.

(3) Greding, *loc. cit.*, vol. ii. p. 484.—Esquirol, in the *Bull. dé la fac. de méd.*, vol. v. p. 426.

(4) Home (*loc. cit.*) has observed this peculiarity in the annular protuberance of a boy, an idiot from birth, and who at sixteen years, when he died, was only about the height of a child three years old. Andral has found in an individual who died of phthisis, on the upper surface of the left hemisphere, not far from its anterior extremity, and near a large fissure, a granulation of the volume of a large pea, having the consistence of calcareous concretions of the lung, and penetrate into the cerebral substance which they crowded; but perhaps it was only the ossification of the arachnoid membrane. (*Journal de physiologie experimentale*, vol. ii. p. 110.) The same observer has found a kind of fibro-cartilaginous change of several circumvolutions of the two hemispheres of the cerebrum; the latter resisted like the fibro-cartilages when pressed between the fingers. In pulling them they are elongated, and then contract, and are very elastic; they had the color of ivory, but no trace of the gray tint. Such indurations existed in the thickness of the hemispheres, and at their base (*loc. cit.*). The cartilaginous induration of the spinal marrow has been observed also by Bergamaschi and Portal.

(5) Greding, *loc. cit.*, vol. iii. p. 658, in the cerebellum.

tilage have been met with in a cyst developed in the midst of the cerebral mass.(1)

It is not unfrequent to find, particularly in the cerebrum, entirely new formations, assuming the form of rounded tumors; but they are rarely or never developed in this viscus alone, and they are generally only portions of a mass of the same morbid formation existing in most of the other organs.(2) They differ from each other so much in respect to consistence, volume, number, and connections, that they must necessarily be referred to different species, between which, however, numerous intermediate degrees exist, as between all new and abnormal formations generally.(3)

In respect to *color*, these masses are whitish, of a yellowish white,(4) reddish,(5) of a tint similar to that of cortical substance,(6) of a deep red,(7) or red and streaked with white.(8)

They are generally extremely solid,(9) whence they are often termed *schirrous*. Sometimes, however, they are spongy and soft, of a tissue which is soft and similar to that of the spleen.(10)

Sometimes they are homogeneous,(11) sometimes more or less evidently fibrous,(12) and composed of several rounded bodies.(13)

They sometimes become quite large, and have a diameter of from two to three inches.(14) Sometimes they are single,(15) sometimes more or less numerous.(16)

(1) Hutchinson, *Case of disease in the brain;* in the *Med. chir. trans.*, vol. iv. p. 202.

(2) Reil, *Memorab. clin.*, vol. ii. f. I. p. 39.—Portal, *loc. cit*, p. 92.—Earle, *A case of diseased testicles, accompanied with diseases of the lungs and brain;* in the *Med. chir. trans.*, vol. iii. p. 57—Merat, in the *Journ. de méd.*, vol. x. p. 3.

(3) Among these tumors there are some which must be referred to the schirrous and encephaloid tissues, which Andral has observed once, both crude and softened from the level of the optic beds to near the base of the cerebrum (*Note sur le cancer du cerveau*, in the *Journal de phys. exp.*, vol. ii. p. 106). Hitherto Bayle is the only one who has well described the cancer of the cerebrum. We know as yet of no well authenticated case of cancer of the spinal marrow. Guersent, Pinel-Grandchamp, however, mentions a case of cancer of the medulla oblongata, which had principally destroyed the pyramids and olivary bodies (Ollivier, *De la moelle epiniere et de ses maladies*), and Andral (*loc. cit.*) has also found numerous tubercles in the cerebrum of a man who died of pleurtic effusion. Some were already suppurated and surrounded with softened cerebral substance. F. T.

(4) Portal.—Reil.—Hutchinson.—Morgagni, *loc. cit.*, vol. xii. p. 15.—Bateman.—Baillie,—Ozanam, *Observations sur une affection tuberculeuse du cerveau*; in the *Journ. comp. du Dict. des sc. méd.*, vol. xix. p. 189.

(5) Merat,—Salter, *Case of disease in the brain;* in the *Edinb. med. journ.*, vol. ii. p. 469.—Morgagni.

(6) Steinbach.

(7) Earle, p. 67.—Buchanan, *Case of encysted tumor in the brain:* in the *Edinb. med. journ.*, vol. viii. p. 276.

(8) Earle.

(9) Earle.—Portal.—Merat.—Reil.—Baillie.

(10) Buchanan, p. 279.

(11) Hutchinson.

(12) Salter.

(13) Morgagni.

(14) Merat.—Earle.

(15) Buchanan.—Merat.—Hutchinson.

(16) Merat, twice.—Salter, once.—Earle, seven times.

In certain cases they are imperceptibly continuous with the substance of the cerebrum, or at least adhere to it very intimately, but are not surrounded by a cyst.(1) In other cases they are slightly attached to the cerebral substance,(2) or are inclosed in a special cyst, usually with very thin parietes.(3)

These abnormal formations do not always continue in the same state during all their existence. It is infinitely probable that they all tend sooner or later to suppurate, although death often occurs before this period, snd the greater or less facility with which they suppurate, has no relation with their size. When suppuration attacks them, they resemble sacs which vary in thickness and are closed or open.(4)

New formations of a similar character are developed also in the envelops of the centre of the nervous system.

Among the meninges, they are situated principally in the dura-mater. They are termed generally the *fungi of the dura-mater*,(5) although all certainly do not belong to the same class, as they differ much in texture and form. They do not generally attack only the cranial portion of the dura-mater;(6) observers entitled to credit, have also proved their existence in that portion of this membrane which lines the vertebral canal,(7) although there they seem to be less frequent in proportion.

Finally, we must place last the *foreign bodies* which are found principally within or on the surface of the central mass of the nervous system. Some arise from the greatest degree of the formative action, and these are the entozoaries. Others are liquids which are not always effused within or on the surface of the nervous system, from a change in its mode of action.

a. Entozoaries. The only intestinal worm which has certainly been known to exist in the encephalon is the *cysticercus cellulosæ*,(8) which

(1) Reil.—Hutchinson.—Salter.—Morgagni.

(2) Earle.—Steinbach.—Bateman.—Brodie.—Merat.

(3) Home, *loc. cit.*, p. 51.—Merat.—Buchanan.

(4) Brodie.—Bateman.

(5) Louis, *Sur les tumeurs fongueuses de la dure-mère*; in the *Mém. de l'ac. de chir.*, vol. v. p. 1.—Wenzel, *Ueber die schwammigen Auswüchse der harten Hirnhaut*, 1811.—Walther, *Essai sur les fongus de la dure-mère;* in the *Journ. compl. des sc. méd.*, vol. vii. p. 118.—Esquirol, *Tumeur considérable developpée dans l'intérieur du crâne;* in the *Archiv. génér. de méd.*, vol. iii. p. 594.—C. B. Tilanus, *De fongosâ duræ meningis exerescente dissertatio*, Utrecht, 1819.—Heusinger compares these tumors to those described by the Germans, as *cephalomatoma*, which have been mentioned in Michælis, *Ueber eine eigene Art von Blutgescywülsten;* in Loder, *Journ. für die Chirurgie*, vol. ii. cab. iv. p. 657.—Nægele, *Erfahrungen und Abhandlungen aus dem Gebiethe der Krankheiten des weiblichen Geschlechts*, Manheim, 1812, p. 245.—C. Zeller, *De cephalæmatomate, seu sanguineo cranii tumore recens natorum commentatio*, Heidelberg, 1822.

(6) Wenzel, *loc. cit.*, xxiii.

(7) Knox, in the *Med. obs. and inq.* vol. iii. p. 160.—Philipps, *New med. journ.*, vol. i. p. 144.

(8) Steinbuch, *Cogitata quædam dé vermium visceralium physiologia*, Erlangen, 1801.

occurs principally in the internal and external pia-mater, particularly in the choroid plexuses of the cerebral ventricles. The serous cysts often found in these bodies are very probably connected with its formation.(1)

b. The second class of foreign bodies is composed particularly of sanguineous effusions.

Not unfrequently there is an effusion either of pure blood or of a more or less bloody serum, either between the meninges or in the ventricles, or in the substance of the cerebrum and spinal marrow,(2) or finally between the dura-mater and the skull. This latter case is rather rare in the skull, and most generally results from an external wound. Such an effusion results sometimes in the more or less perfect and transitory or permanent and fatal suspension of the action of the cerebrum, *apoplexy*, sometimes the *paralysis* of the voluntary organs, according to its quantity and the place where it occurs.(3) It does not necessarily suppose the laceration of the vessels; but it often and

(1) Of all the entozoaries, the *cysticercus cellulosa* is found most frequently in the encephalon, where it sometimes lives in the cerebral substance (*Zeitschrift fur die Anthopologie*, 1823, part iii. p. 197); but Romberg has also found there *acephalocysts*, and Arnott the *echinoooccus hominis* (*V.* Romberg, *Sur les entozoaires du cerveau*, in the *Journ. comp. du Dict. des sc. med.* vol. xix. p. 276). Esquirol mentions the existence of acephalocysts in the cavity of the arachnoid membrane of the spinal marrow (*Bullet. de la Fac. de med.*, vol. v. p. 426). F. T.

(2) But little attention has been paid to effusions of blood in the spinal marrow, where they are in fact rare. Home has found a clot of blood about two inches long in the centre of the organ, after a dislocation of the sixth cervical vertebra on the seventh (*Phil. trans.*, 1814). This internal hemorrhage sometimes occurs spontaneously, and forms a circumscribed effusion similar to those in the cerebral substance in apoplexy, but it would seem not to have been observed until at present, except in the upper part of the spinal marrow, or rather in the medulla oblongata, and even only beyond it in the annular protuberance. Serres mentions several cases of it (*Annuaire des hôpitaux*, 1819). When these effusions are but of slight extent, they may be resolved like those in the substance of the encephalon. Pinel Grandchamp has found in the left half of the annular protuberance of a cadaver, evident traces of an absorbed effusion, that is, a circumscribed cavity filled with a filamentous tissue, infiltrated with yellowish serum: the cavity would contain a common sized bean. Ollivier has described and figured this case (*loc. cit.*, p. 263. p. ii. fig. 3. a). Gautier-Claubry, however, has stated a case where there was an effusion of blood in a very great extent of the spinal marrow, which had become a semifluid reddish ball, similar to the deposit from red wine, and presented no trace of organization (*Journ. gèn de méd.*, 1801). F. T.

(3) Deep wounds, compression by a portion of bone, by a foreign body, by an effusion of blood, serum or pus, the softening of the nervous substance may cause apoplexy or paralysis. Rochoux assigns as the character of apoplexy, caused by an effusion of blood, its manifestation by sudden paralysis. Lallemand thinks that the paralysis supervening after the combined phenomena of excitement and collapse, is caused by softening which arises from inflammation. If paralysis supervenes after symptoms of arachnoiditis, it is probably caused by a serous, sero-sanguineous or sanguineous effusion, which, however, is situated in the ventricles or on the surface of the viscus. Serres, Flourens, Foville, Pinel-Grandchamp, and Lachampe-Lousteau, have attempted after Willis, Morgagni, and many others, to determine the exact relations between the phenomena of paralysis and of lesion of the encephalon or of the spinal marrow. Their researches are contradictory. It only remains proved, as it had been before they attended to it, that the lesion is always on the side opposite to that paralyzed, and that the sanguineous effusions, the softening of the fornix, of the corpus çallosum and of the septum lucidum, do not cause paralysis. F. T.

apparently most generally arises from a sanguineous exsudation from the capillary vessels.(1)

The cerebral arteries, however, are more exposed to laceration than the others from their feebleness, and this lesion generally seems to attack the middle large cerebral artery, at the lower extremity of the fissure of Sylvius.(2)

We can easily conceive that an effusion of blood in the substance of the cerebrum and spinal marrow cannot occur without a rupture of the vessels.

These effusions seem to be more common in the corpora striata than in all the other parts of the cerebrum, on account of their softness: perhaps, however, it is more correct to say that those which occur in these eminences endanger life more than those in the other regions of the encephalon, especially in the hemispheres of the cerebrum where traces of old effusions are frequently seen.(3)

When effusion does not cause death, we find traces of it long afterward. Such are the simple or multilocular spaces filled with a deposit of blood or of liquid serum, coagulated or mingled with cellular tissue, and often covered with a serous cyst, which are found in the cerebrum of those who have survived long after an attack of apoplexy, or who have been deprived for a greater or less length of time of the use of their intellectual faculties.(4)

This is, in fact, the course most generally employed by nature to heal the ruptures of the cerebral substance caused by the effusions of blood. In the rarest cases the effused fluid is entirely absorbed, and the rupture of the cerebral substance is entirely closed by a solid cicatrix.(5)

(1) Wepfer, *Hist. apoplect.*, p. 5.—Cheyne, *On Apoplexy*, London, 1812.

(2) Portal, *loc. cit.*, vol. iv. p. 80.—Wepfer, *loc. cit.*, p. 8.

(3) Rochoux has found in bloody effusions eighteen on the left, eleven of which were within the corpora striata, seven on the right, eight of which were in the same part, finally six on the two sides, three of which were in the same place. F. T.

(4) Brunner, in the *Eph. nat. cur.*, dec. iii. a. i. p. 374.—Santorini, *Obs. anat.*, iii. § 6.—Morgagni, *De sed. et caus.*, ep. iii. 6. ix. 20, 23.—Cruveilhier, *Anat. pathol.*, Paris, 1816, vol. i. p. 205.—Rochoux, *Recherches sur l'apoplexie*, Paris, 1814. This author was the first who treated well of the alterations of the cerebrum which attend or follow the effusion of blood in this viscus. Bnt the cysts which are developed around, and are termed apoplectic, have been described well only by Riobe (*Observations propres á résoudre cette question: L'apoplexie dans laquelle il se fait un épanchement de sang dans le cerveau est-elle susceptible de guérison?* Paris, 1814).—See also Bricheteau, *Considérations et observations sur l'apoplexie:* in the *Journ. compl. dei sc. méd.*, vol. i. p. 129, 289.—Consult also the treatise of Lallemand.

(5) We have lately received a new work of Gmelin, who on analyzing the brain of man and the ox, concludes from his researches that the pulpy substance contains, besides a fluid fat body, two other kinds of fat bodies, viz: 1st. a lamellar substance, similar in every respect to cholesterine, except that it contains a mixture of phosphorus, the quantity of which has not yet been determined: 2d. a small quantity of a substance similar to wax: this latter is the most fusible of all the fatty bodies, and does not saponify; it also contains a small quantity of phosphorus. (Tiedemann, G. R. Treviranus, and L. C. Treviranus, *Zeitschrift für die Physiologie*, part i. 1824, p. 119). F. T.

Sometimes the cerebral ventricles are so filled with blood that the substance of the encephalon is finally torn, and the liquid is effused through this opening on its surface between the meninges.

An effusion of blood (*apoplexia sanguinea*) is not, however, necessary to produce apoplexy, since the latter frequently supervenes, from an accumulation of serum either in the cavities or on the surface of the cerebrum, as in *apoplexia serosa*,(1) or even without any manifest change, as in *apoplexia sine materia*.(2)

(1) We have every reason to think that this apoplexy is an effect of arachnoiditis. F. T.

(2) This *apoplexia sine materia*, is exactly that which presents so frequent instances of softening of the brain. We may add to the three varieties mentioned by the author, the *aploplexia convulsiva* of some pathologists, which seems to be an inflammation of the encephalon, attended more or less promptly with a comatose state and with paralysis. F. T.

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