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PRACTICAL ANATOMY

A

MANUAL OF DISSECTIONS

BY

CHRISTOPHER HEATH, F.R.C.S.

HOLME PROFESSOR OF CLINICAL SURGERY IN UNIVERSITY COLLEGE, LONDON, AND SURGEON TO UNIVERSITY COLLEGE HOSPITAL; MEMBER OF THE COUNCIL AND COURT OF EXAMINERS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND; FELLOW OF KING'S COLLEGE

SEVENTH EDITION

REVISED BY

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WITH 24 COLOURED PLATES AND 278 ENGRAVINGS ON WOOD

LONDON

J. & A. CHURCHILL

11, NEW BURLINGTON STREET

1888

PREFACE TO THE SEVENTH EDITION.

In preparing a new edition of my Practical Anatomy, I have again had the advantage of submitting its pages to my friend and colleague, Mr. Rickman Godlee, who has carefully revised it throughout, making some important additions to the sections on the Thorax and Brain. The number of coloured plates from Maclise's "Surgical Anatomy" has not been increased, but a few new woodcuts have been added, and some old and worn illustrations have been recut.

CHRISTOPHER HEATH.

36, Cavendish Square,
March, 1888.

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COLOURED PLATES.

PLATE I.

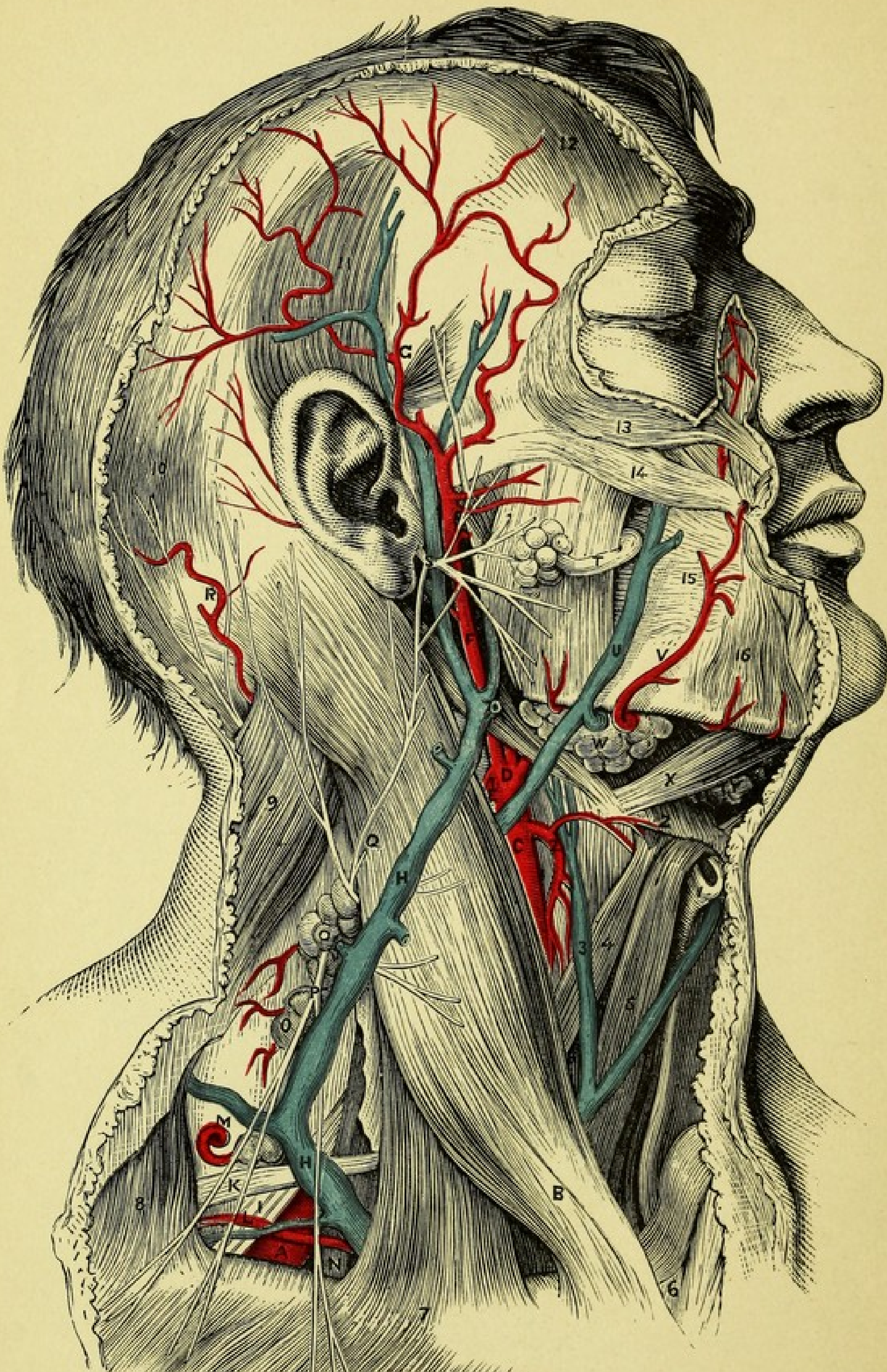

PLATE I.

SUPERFICIAL DISSECTION OF THE HEAD AND NECK.

(From Maclise's Surgical Anatomy.)

A. Third portion of the Subclavian artery.
B. Sterno-mastoid muscle.
C. Common Carotid artery.
D. External Carotid artery.
E. Internal Carotid artery.
F. Continuation of the External Carotid, through the parotid gland.
G. Temporal artery.
H. External Jugular vein.
I. Brachial plexus.
K. Posterior belly of Omo-hyoid.
L. Suprascapular artery.
M. Transverse cervical artery.
N. Scalenus anticus.
O. Glandulæ concatenatæ.
P. Superficial descending cervical nerves.
Q. Great auricular nerve.
R. Occipital artery and nerve.
S. Facial nerve.
T. Duct of Stenson.
U. Facial vein.
V. Facial artery.
W. Submaxillary gland.
X. Digastric muscle.
Y. Lymphatic gland.
Z. Hyoid bone.
1. Thyroid cartilage.
2. Superior thyroid artery.
3. Anterior Jugular vein.
4. Anterior belly of Omo-hyoid.
5. Sterno-hyoid (right)
6. Inter-clavicular notch.
7. Clavicle.
8. Trapezius muscle.
9. Splenius capitis.
10. Posterior belly of Occipito-frontalis.
11. Attollens aurem.
12. Anterior belly of Occipito-frontalis.
13. Orbicularis palpebrarum.
14. Zygomaticus major.
15. Buccinator.
16. Depressor anguli oris.

PLATE II.

DEEP DISSECTION OF THE TRIANGLES OF THE NECK.

(From Maclise's Surgical Anatomy.)

A. Innominate artery.
B. Right Subclavian artery.
C. Right Common Carotid.
D. External Carotid.
E. Internal Carotid.
F. Lingual artery.
G. Facial artery.
H. Temporo-maxillary artery.
I. Occipital artery.
K. Internal Jugular vein.
L. Spinal-accessory nerve.
M. Cervical plexus (cut).
N. Pneumo-gastric nerve.
O. Hypoglossal nerve on hyo-glossus.
P.P. Brachial plexus.
Q. Subclavian artery (3rd part).
R. Posterior Scapular artery (arising from subclavian).
S. Suprascapular artery.
T. Superficial Cervical artery.
U. Suprascapular vein.
V. Posterior belly of Omo-hyoid.
W. Subclavian vein.
X. Scalenus anticus, with Phrenic nerve.
Y. Clavicle.
Z. Trapezius.
1. Left Sterno-mastoid.
2. Right Sterno-mastoid (cut).
3. Scalenus posticus.
4. Levator anguli scapulæ.
5. Upper part of Sterno-mastoid.
6. Internal Maxillary artery.
7. Duct of parotid gland.
8. Genio-hyoideus.
9. Mylo-hyoid (turned down).
10. Superior Thyroid artery.
11. Anterior belly of Omo-hyoid.
12. Sterno-hyoid.
13. Sterno-thyroid.

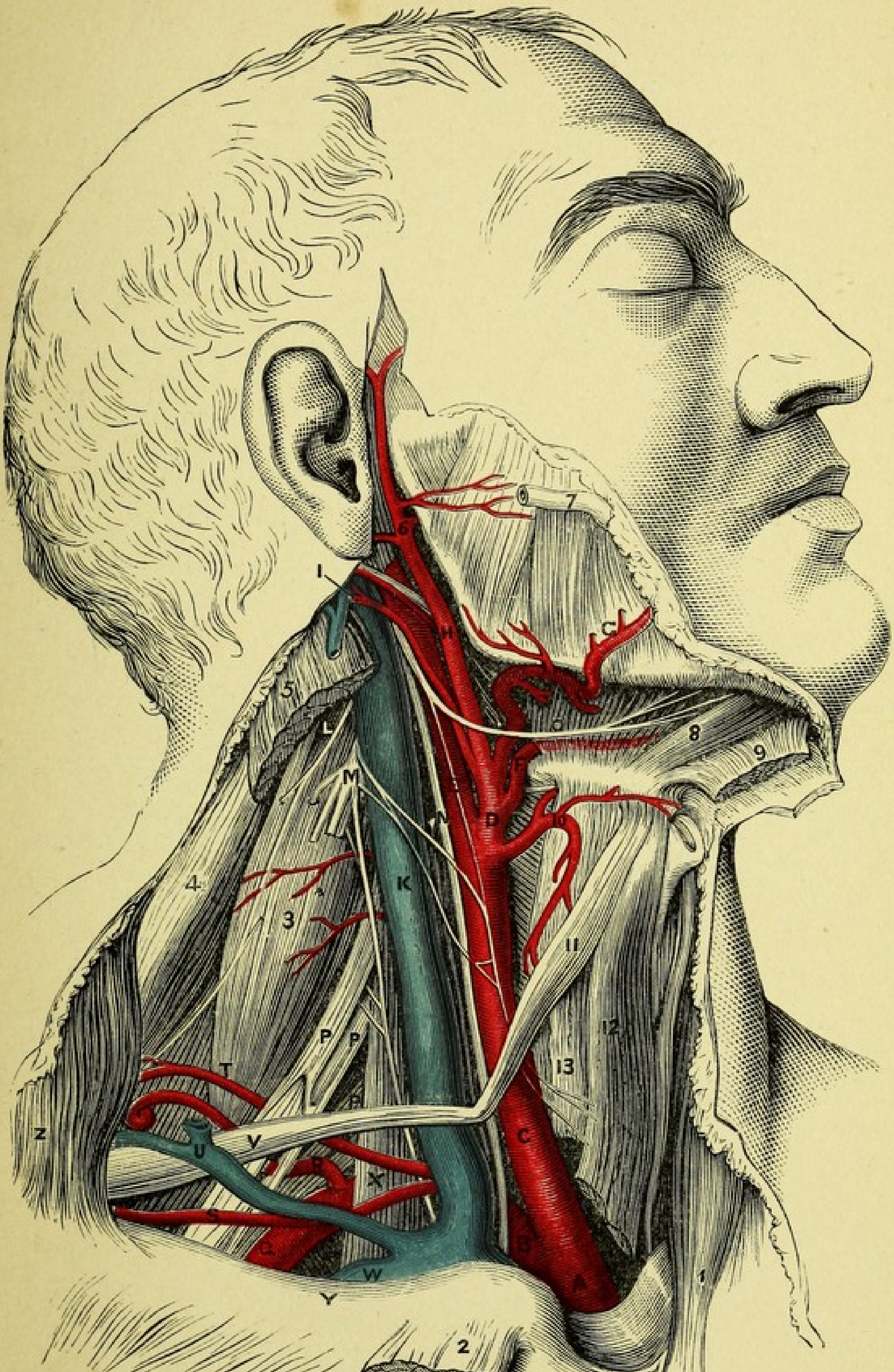
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PLATE III.

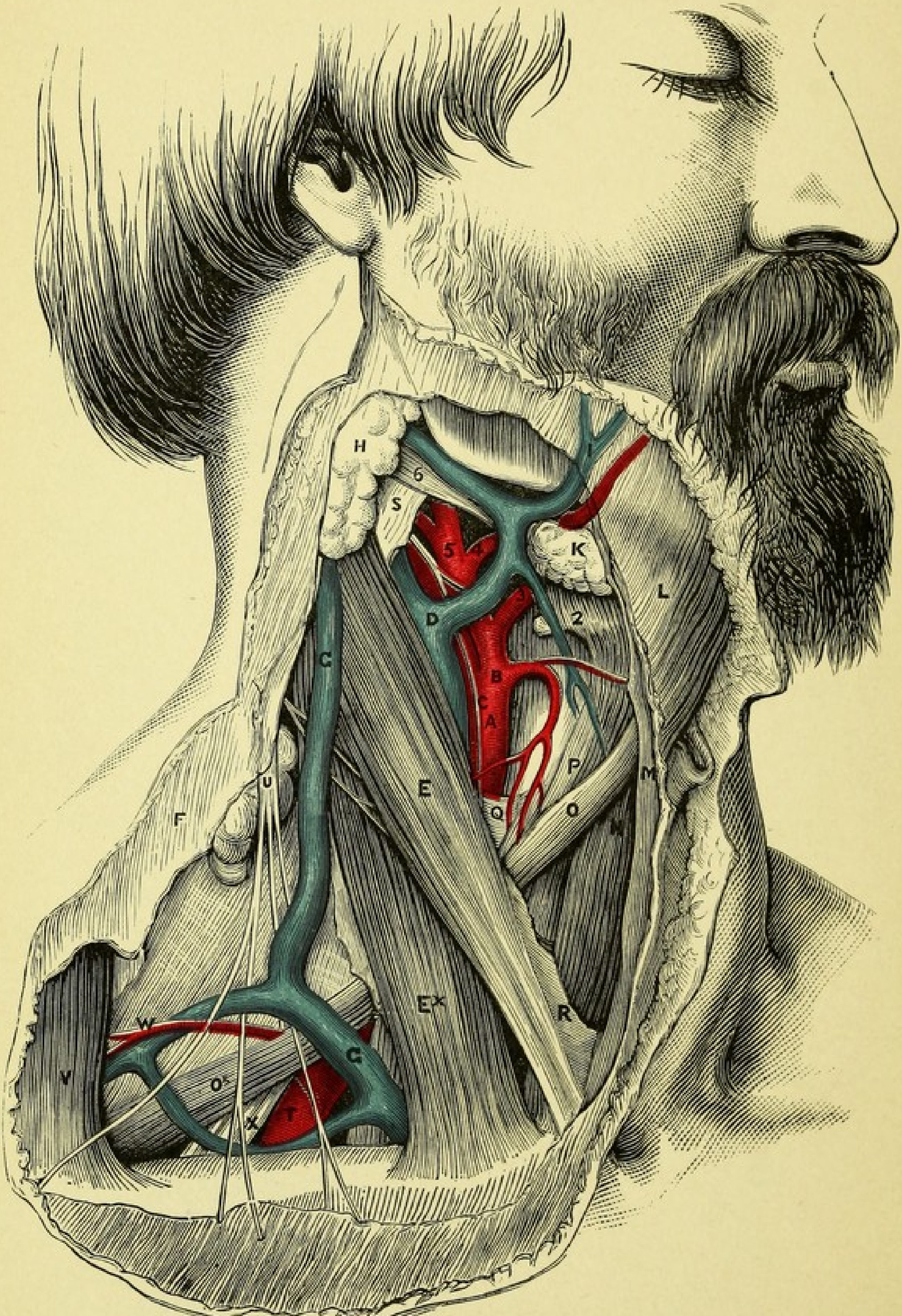

PLATE III.

THE TRIANGLES OF THE NECK.

(From Maclise's Surgical Anatomy.)

A. Common Carotid.
B. External Carotid.
C. Descendens noni nerve lying on the Internal Carotid.
D. Internal Jugular vein.
E. Sternal portion of Sterno-mastoid.
*E. Clavicular portion of Sterno-mastoid.
F. Platysma (cut).
G. External Jugular vein
H. Parotid gland.
I. Facial vein.
K. Submaxillary gland.
L. Upper part of platysma.
M. Cervical fascia.
N. Sterno-hyoid muscle.
O. Omo-hyoid muscle.
P. Sterno-thyroid muscle.
Q. Sheath of Carotid artery.
R. Cervical fascia enclosing sterno-mastoid.
S. Upper part of same fascia.
T. Third part of Subclavian artery.
U. Descending superficial branches of cervical plexus.
V. Trapezius.
W. Transverse cervical artery.
X. Brachial plexus.
2. Hyoid bone.
3. Lingual artery.
4. Facial artery.
5. Occipital artery.
6. Posterior belly of digastric.

PLATE IV.

DEEP DISSECTION OF THE HEAD AND NECK.

(From Maclise's Surgical Anatomy).

A. Right Common Carotid (cut).
B. Right Subclavian artery.
C. Trachea.
D. Thyroid axis.
E. Vagus nerve crossing subclavian.
F. Subclavian artery (3rd part).
G. Posterior scapular artery arising from subclavian.
H. Suprascapular artery.
I. Transverse cervical artery.
K. Posterior belly of Omo-hyoid.
L.M. Brachial plexus.
N. Scalenus anticus.
O. Cervical plexus.
P. Upper part of Internal Jugular vein.
Q. Upper part of Internal Carotid artery.
R. Superior cervical ganglion of Sympathetic.
S. Upper part of Pneumo-gastric nerve.
T. Superior thyroid artery.
V. Hyo-glossus muscle covering Lingual artery.
W. Sublingual gland.
X. Genio-hyoid muscle.
Y. Mylo-hyoid muscle (turned down).
Z. Thyroid cartilage.
1. Sterno-hyoid muscle.
2. Omo-hyoid muscle.
3. Inferior constrictor of pharynx.
4. Cricoid cartilage.
5. Crico-thyroid muscles.
6. Thyroid body.
7. Inferior thyroid artery.
8. Sternal origin of sterno-mastoid.
9. Clavicular origin of sterno-mastoid.
10. Clavicle.
11. Trapezius.
12. Scalenus posticus.
13. Rectus capitis anticus major.
14. Stylo-hyoid (turned back).
15. Temporal artery.
16. Internal maxillary artery.
17. Inferior dental nerve.
18. Lingual nerve (5th).
19. External pterygoid.
20. Internal pterygoid.
21. Temporal muscle (cut).
22. Zygoma.
23. Buccinator.
24. Masseter.
25. Middle constrictor of pharynx.

PLATE IV.

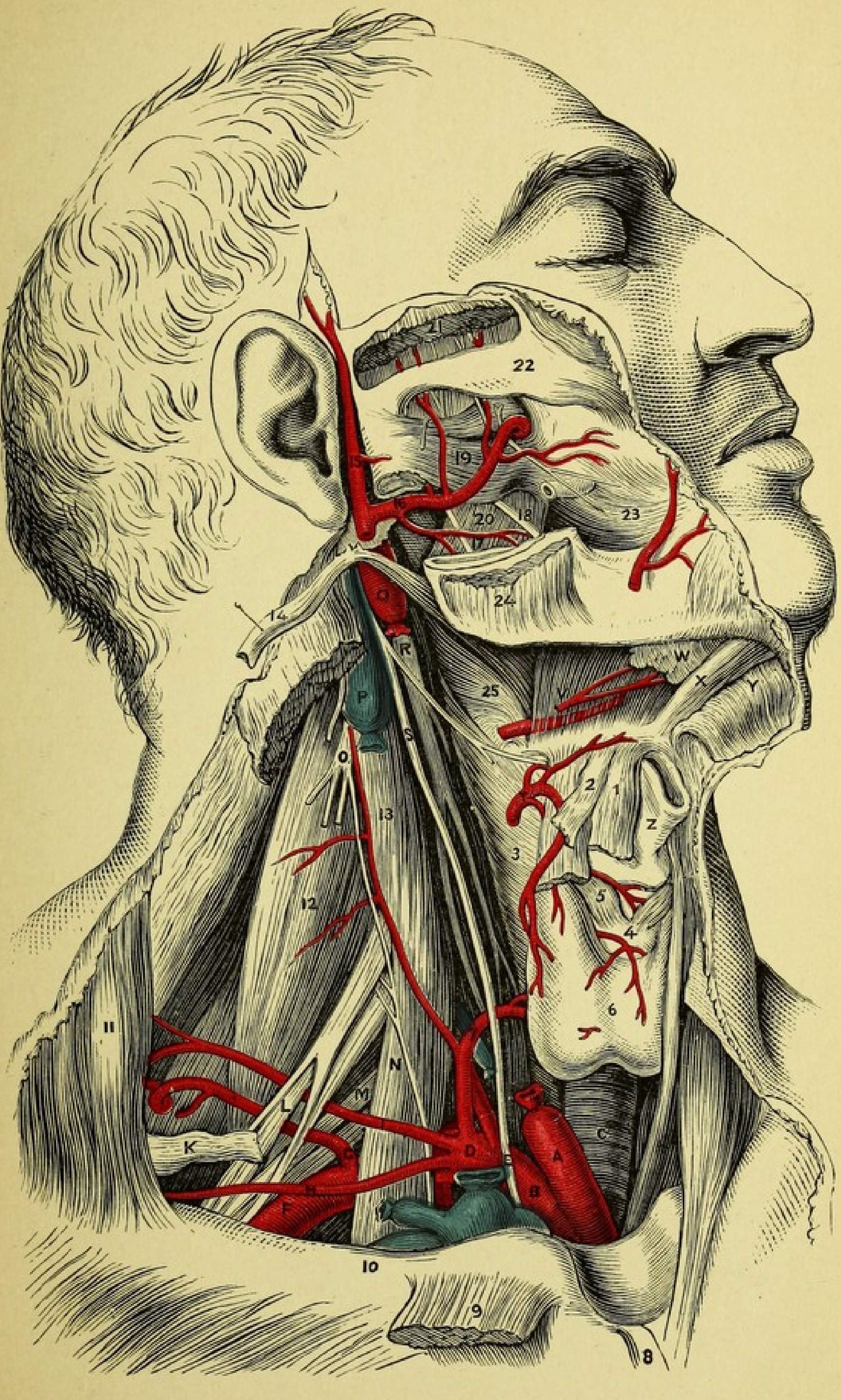

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PLATE V.

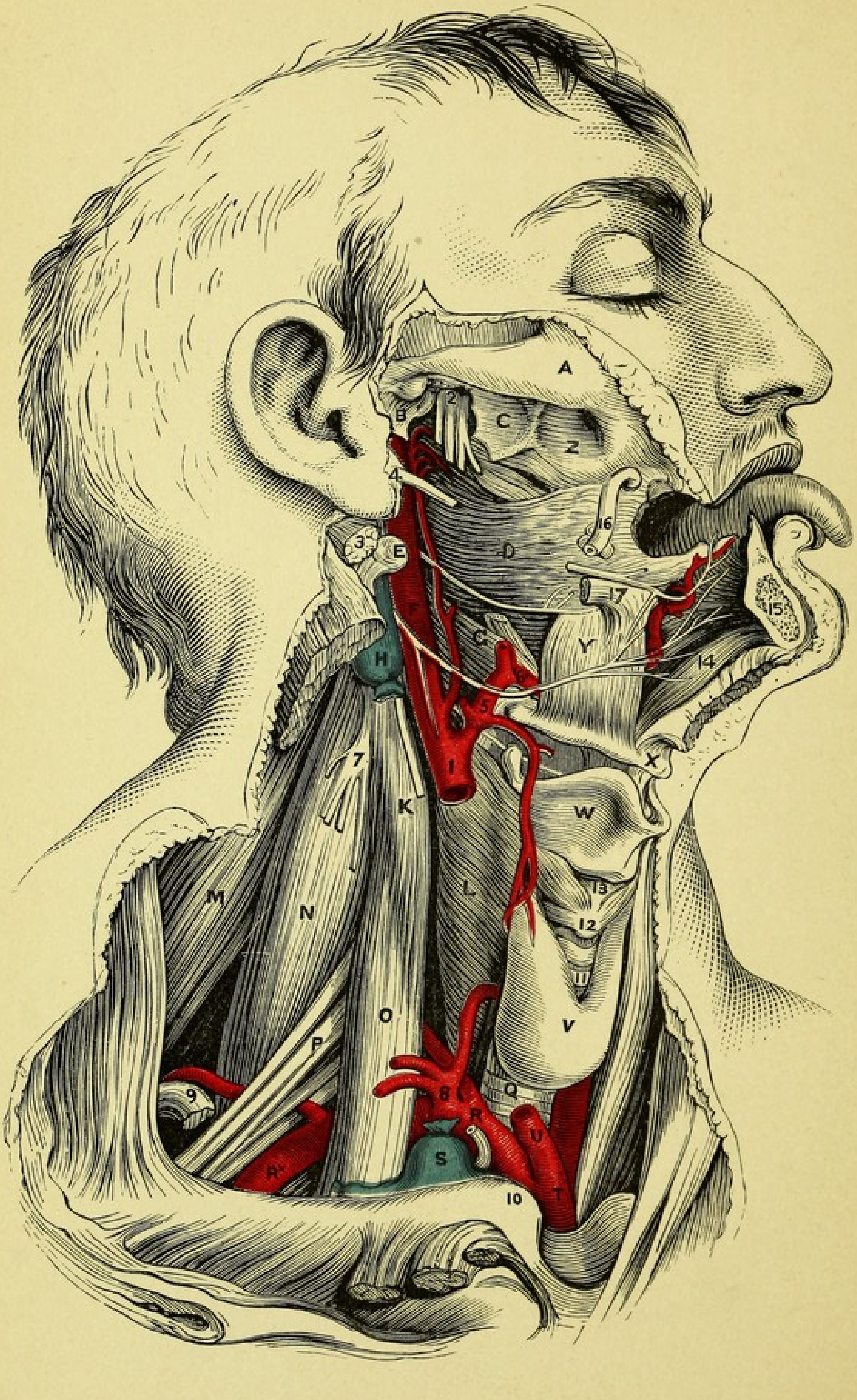


PLATE V.

DISSECTION OF MOUTH AND PHARYNX.

(From Maclise's Surgical Anatomy.)

A. Zygoma.
B. Glenoid cavity.
C. Pterygoid process.
D. Superior constrictor.
E. Transverse process of atlas.
F. Internal carotid, with glosso-pharyngeal nerve crossing behind, and hypoglossal nerve in front.
G. Middle constrictor.
H. Internal Jugular vein (tied).
I. Common Carotid (cut).
K. Rectus capitis anticus major.
L. Inferior constrictor.
M. Levator anguli scapulæ.
N. Posterior scalenus.
O. Anterior scalenus.
P. Brachial plexus.
Q. Trachea.
R. Subclavian artery (1st part).
*R. Subclavian artery (3rd part).
S. Lower end of internal jugular vein (tied).
T. Innominate artery.
U. Root of Common Carotid.
W. Thyroid cartilage.
X. Hyoid bone.
Y. Hyo-glossus muscle.
Z. Superior maxilla.
2. Inferior maxillary division of 5th nerve.
3. Digastric (cut).
4. Styloid process.
5. External Carotid artery.
6. Lingual artery.
7. Cervical plexus.
8. Thyroid axis.
9. Omo-hyoid (cut).
10. Clavicle.
11. Upper rings of trachea.
12. Cricoid cartilage.
13. Crico-thyroid membrane.
14. Genio-hyoid.
15. Symphysis menti.
16. Duct of parotid.
17. Stylo-glossus.

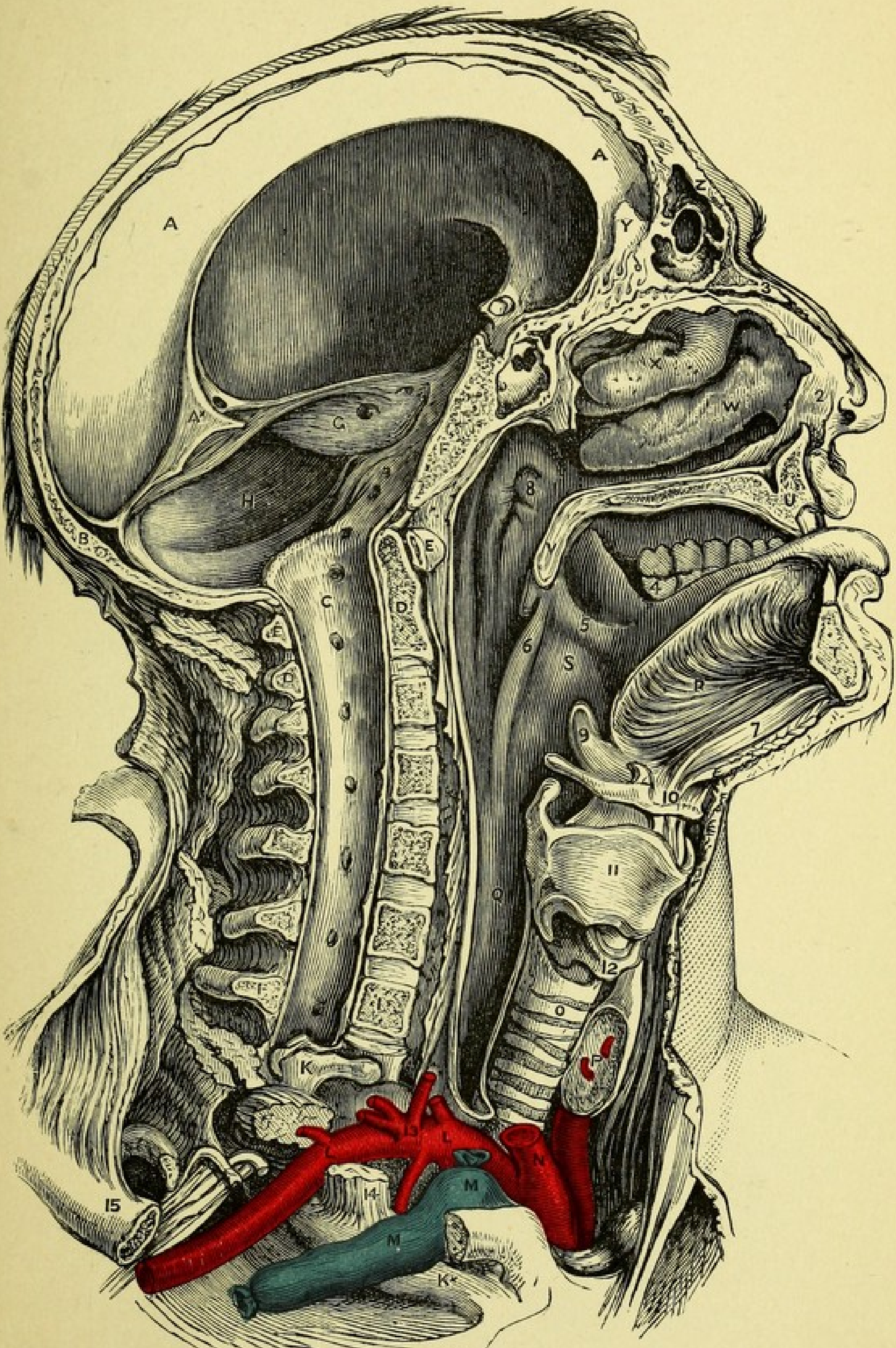
PLATE VI.

SECTION OF SKULL AND PHARYNX.

(From Maclise's Surgical Anatomy.)

A. Falx cerebri.
*A. Tentorium cerebelli (cut).
B. Falx cerebelli.
C. Spinal dura mater.
D. Axis.
E. Atlas.
F. Basi-sphenoid bone.
G. Petrous bone.
H. Cerebellar fossa.
I. Seventh cervical vertebra.
K. First rib.
L. Right Subclavian artery.
M. Right Subclavian vein.
N. Right Common Carotid.
O. Trachea.
P. Thyroid body (cut).
Q. Œsophagus (opened).
R. Genio-hyo-glossus.
S. Left tonsil.
T. Symphysis menti.
U. Section of upper jaw.
V. Velum palati.
W. Inferior turbinate bone.
X. Middle turbinate bone.
Y. Crista galli of ethmoid.
Z. Frontal sinus.
2. Part of septal nasal cartilage.
3. Nasal bone.
4. Last molar tooth.
5. Anterior pillar of fauces.
6. Posterior pillar of fauces.
7. Genio-hyoid.
8. Opening of Eustachian tube.
9. Epiglottis.
10. Hyoid bone (entire).
11. Thyroid cartilage.
12. Cricoid cartilage.
13. Thyroid axis.
14. Scalenus anticus.
15. Clavicle (cut).

PLATE VI.



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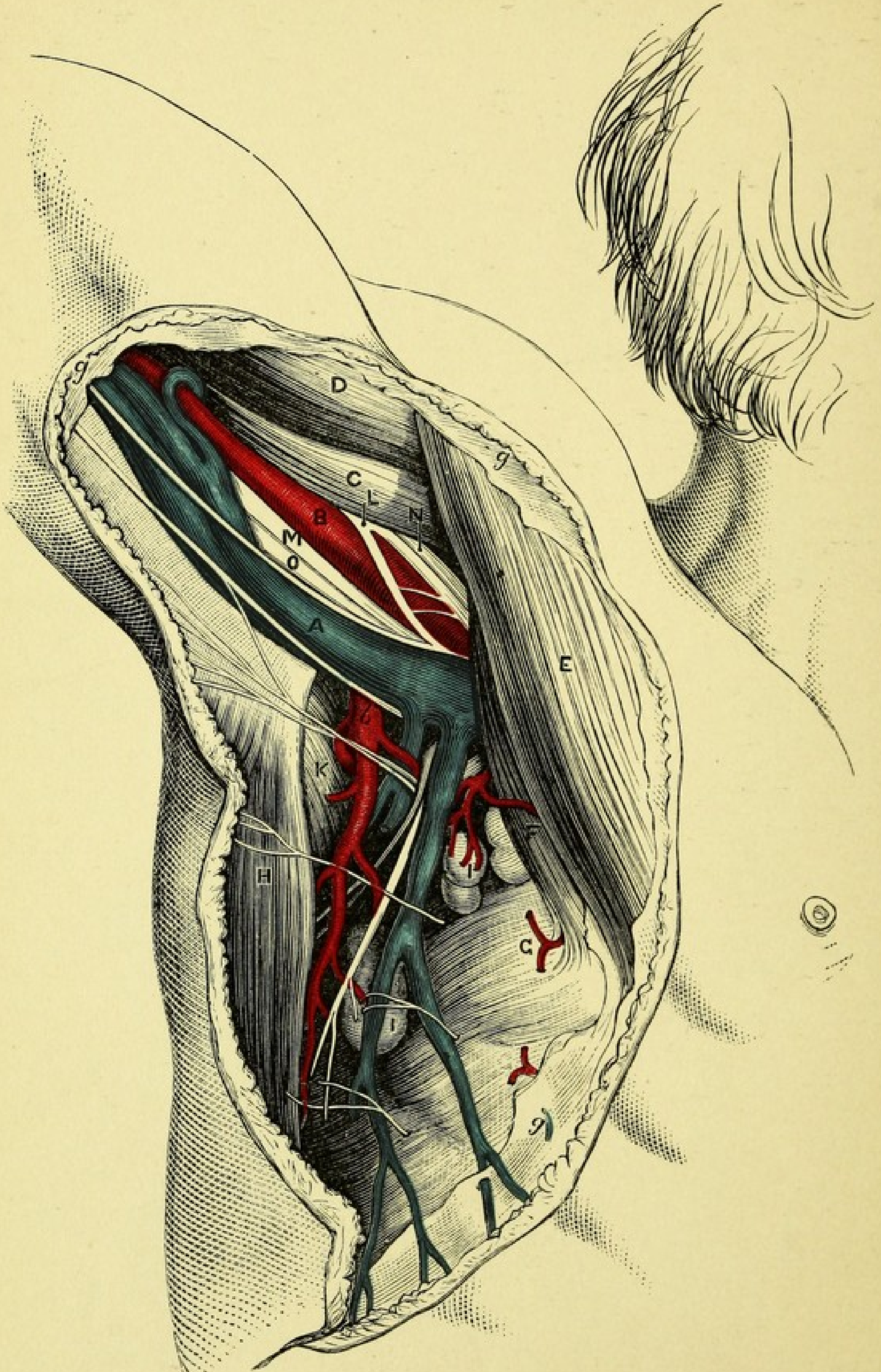


PLATE VII.

THE AXILLA.

(From Maclise's Surgical Anatomy.)

A. Axillary vein.
B. Axillary artery.
b. Subscapular artery.
C. Coraco-brachialis.
D. Biceps.
E. Pectoralis major.
F. Pectoralis minor.
G. Serratus magnus.
g.g. Axillary fascia.
H. Latissimus dorsi.
I. Lymphatic glands.
K. Subscapularis.
L. Median nerve.
M. Ulnar nerve.
N. Musculo-cutaneous nerve.
O. Musculo-spiral nerve.

PLATE VIII.

THE AXILLA AND UPPER ARM.

(From Maclise's Surgical Anatomy.)

1\. Median nerve.
2.2. Ulnar nerve.
3\. Musculo-spiral nerve.
A. Sterno-mastoid (cut).
B. Scalenus anticus.
C. Sterno-hyoid (cut).
D. Clavicle.
E. Sterno-thyroid (cut).
F. Subclavius muscle.
G. Innominate artery.
H. Common Carotid artery.
K. Upper cord of Brachial Plexus.
L. Junction of Internal Jugular and Subclavian veins.

M. Basilic vein and junction with Axillary vein.
m.m. Cephalic vein.
N.N. Pectoralis major.
O.O. Pectoralis minor.
P. Latissimus dorsi.
Q. Teres major.
S. Axillary artery.
T. Brachial artery.
U. Coraco-brachialis.
W. Internal condyle.
X.X. Triceps.
Y. Fascia of arm.
Z. Biceps.

PLATE VIII.

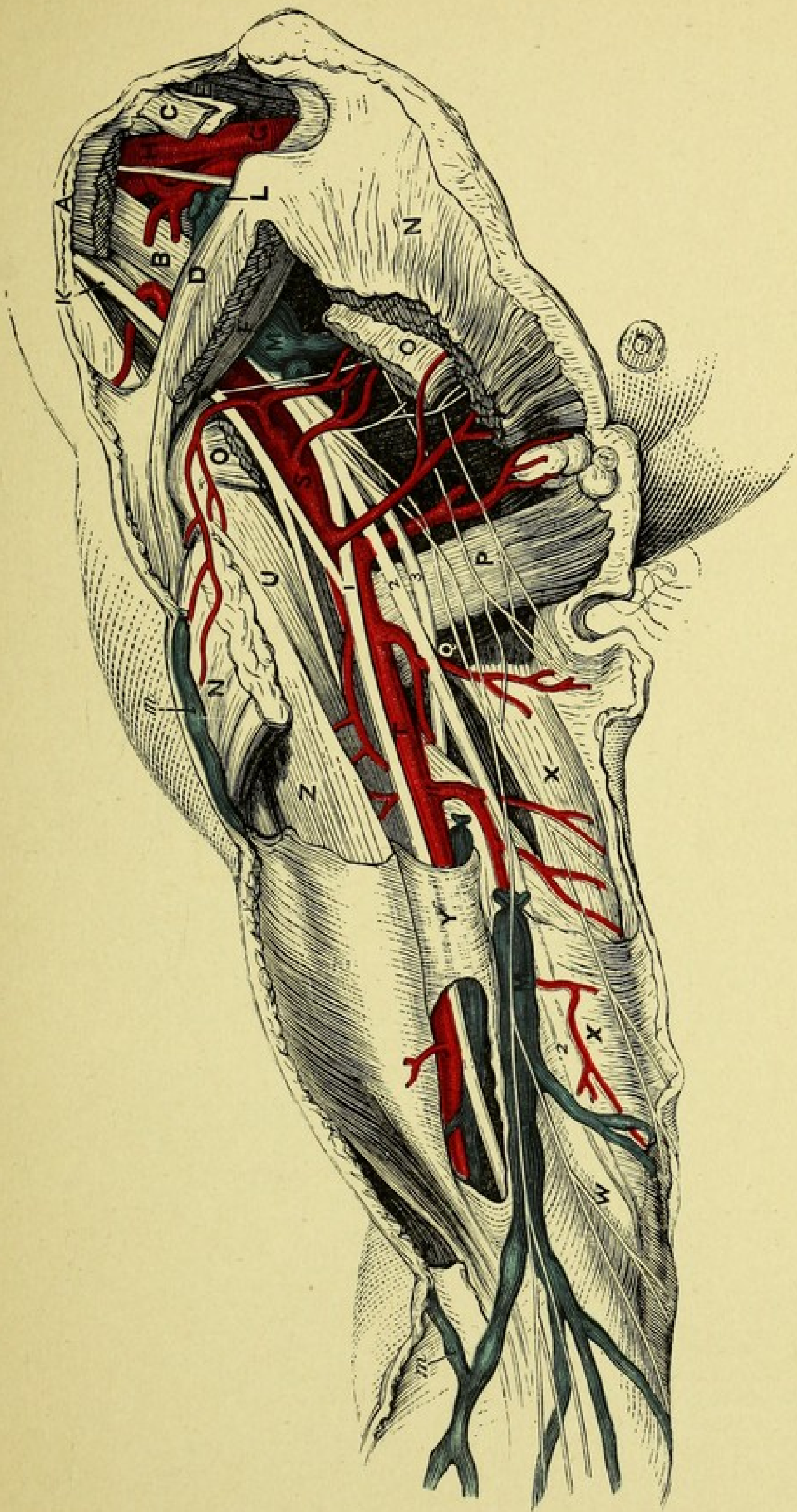


PLATE IX.

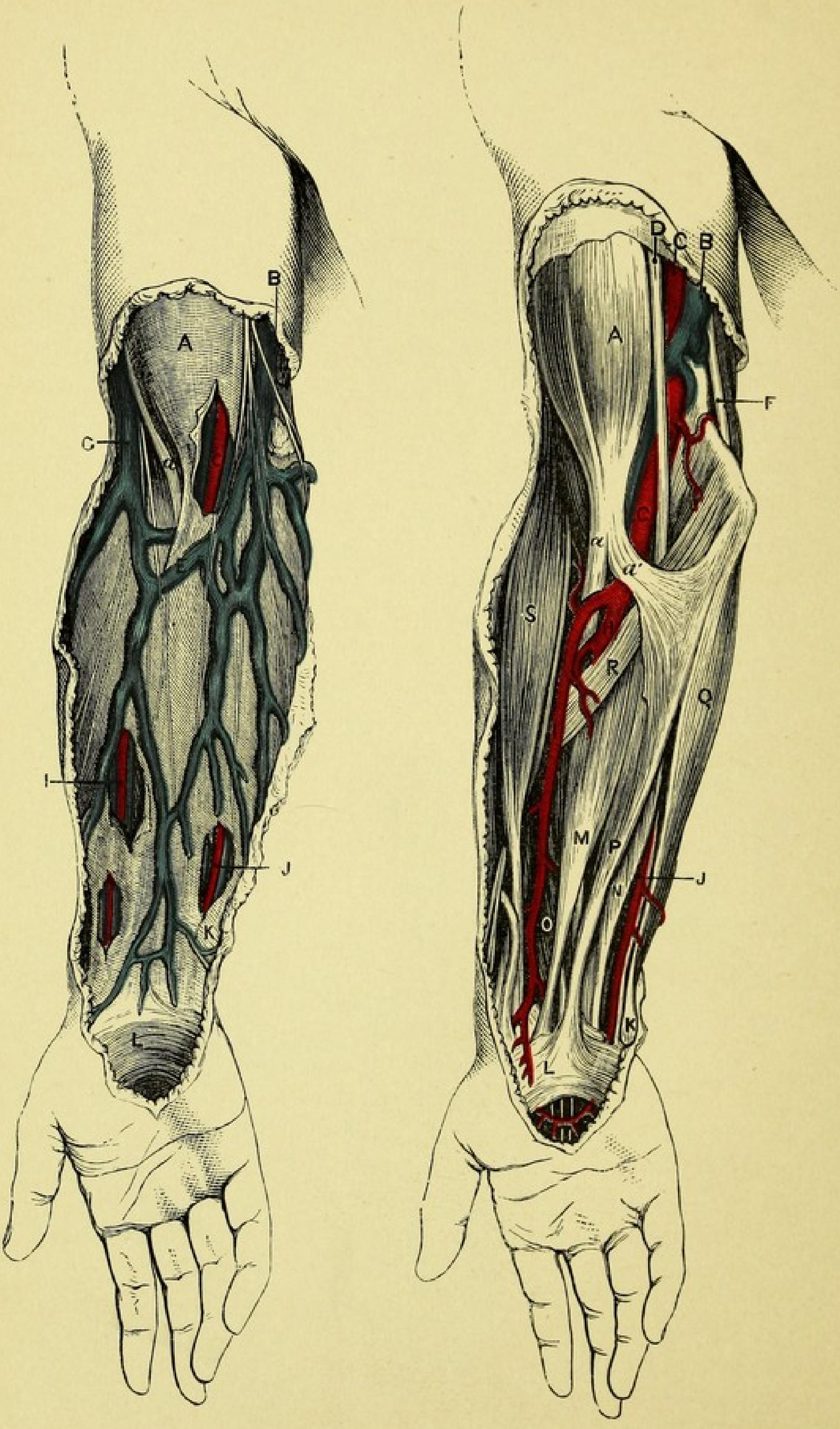


PLATE IX.

SUPERFICIAL AND DEEP DISSECTION OF THE FRONT OF THE FORE-ARM.

(From Maclise's Surgical Anatomy.)

A. Biceps.
a. Tendon of biceps.
à. Bicipital fascia.
B. Basilic vein.
C. Brachial artery.
D. Median nerve.
E. Median-basilic vein.
F. Ulnar nerve.
G. Cephalic vein.
H. Ulnar artery.
I. Radial artery.
J. Ulnar artery.
K. Fascia of fore-arm.
L. Annular ligament.
M. Flexor carpi radialis.
N. Flexor sublimis digitorum.
O. Flexor longus pollicis.
P. Palmaris longus.
Q. Flexor carpi ulnaris.
R. Pronator radii teres.
S. Supinator longus.

PLATE X.

PALM AND BACK OF THE HAND.

(From Maclise's Surgical Anatomy.)

Figs. 1 and 2.

A. Radial artery.
B. Median nerve.
C. Ulnar artery.
D. Annular ligament.
E. Ulnar nerve.
F.G. Pisiform bone.
H. Abductor minimi digiti.
I. Tendon of flexor carpi radialis.
K. Abductor pollicis.
L. Flexor brevis minimi digiti.
M. Flexor brevis pollicis.
O. Lumbricales.
P. Flexor tendons.
Q. Tendon of flexor longus pollicis.
R. Supinator longus.
S. Flexor sublimis digitorum.
T. Flexor carpi ulnaris.

Fig. 3.

A. Extensor communis digitorum.
B. Posterior annular ligament.
C. Radial nerve.
D. Ulnar nerve.
E. Radial artery.
F. Extensor carpi radialis brevior.
G. Extensor carpi radialis longior.
H. Extensor secundi internodii pollicis.
I. Extensor primi internodii pollicis.
K. Extensor minimi digiti.

Fig. 3

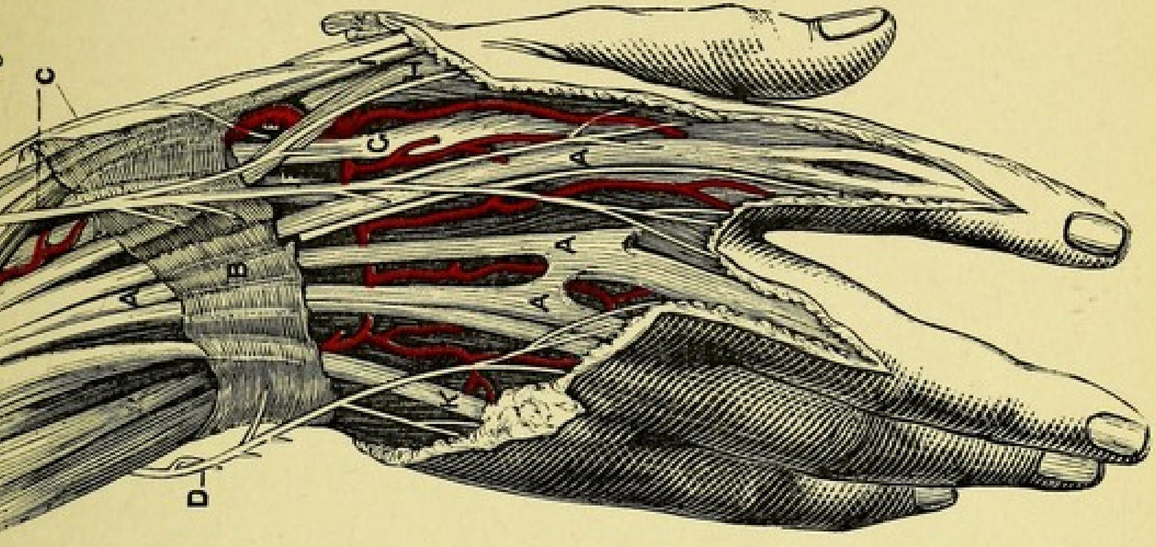


Fig. 2

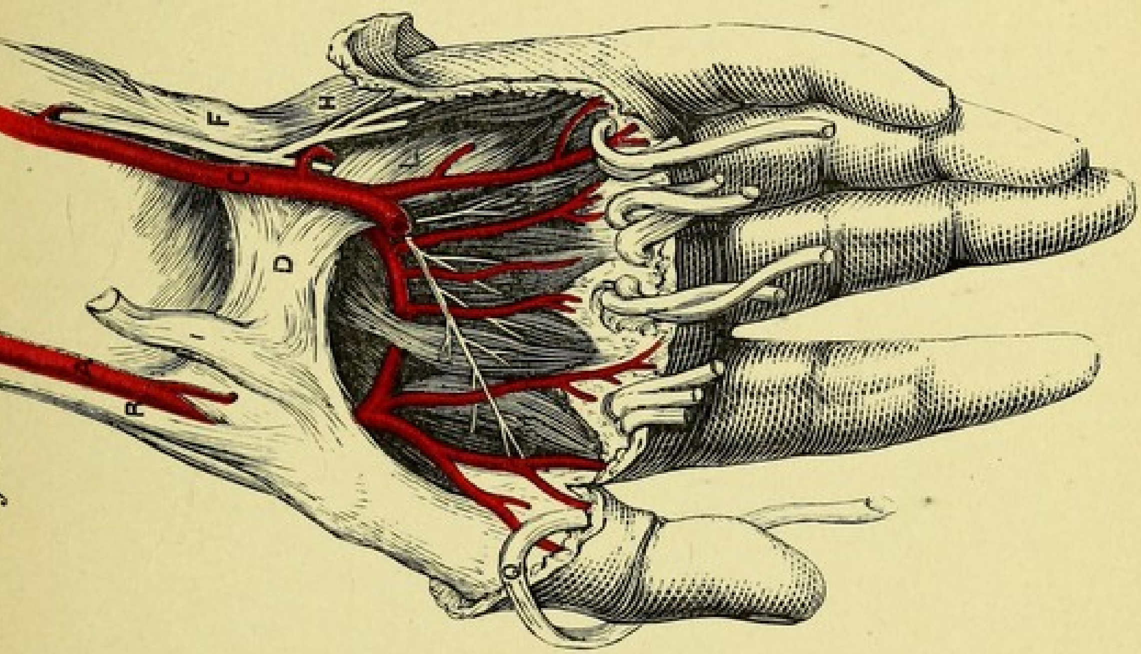
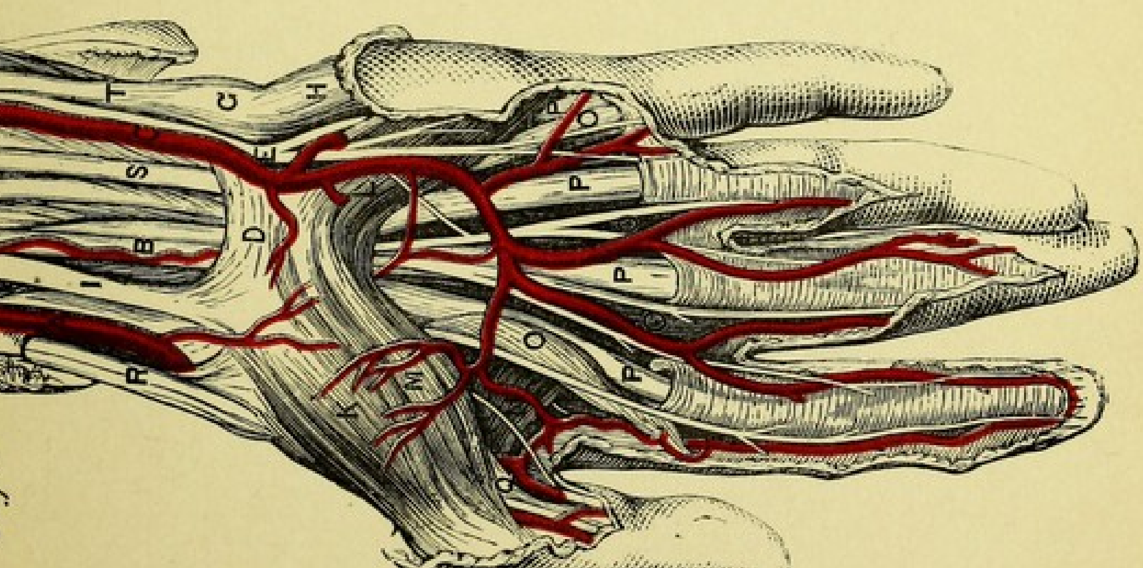


Fig. 1



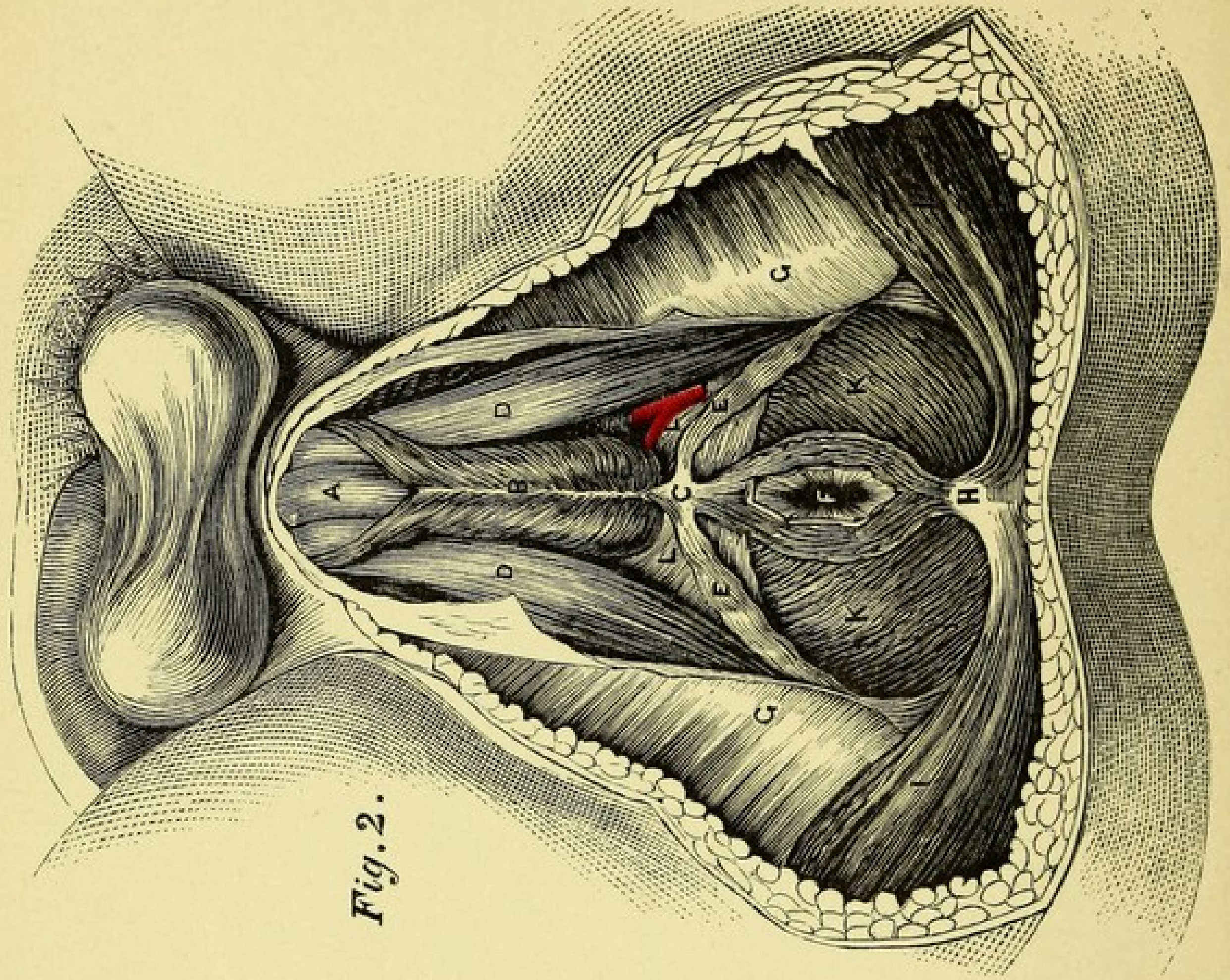


Fig. 2.

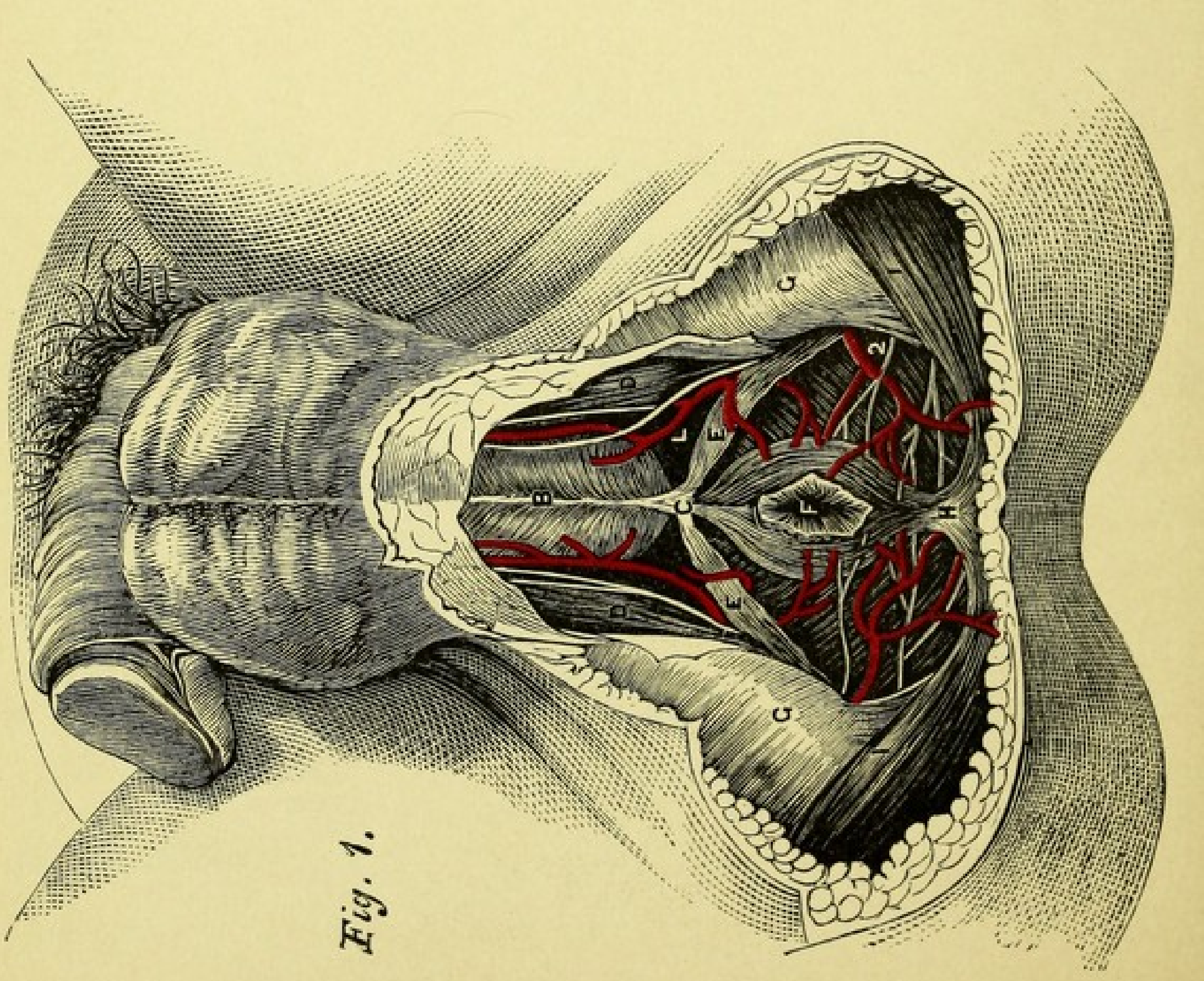


Fig. 1.

PLATE XI.

THE MALE PERINÆUM.

(FROM MACLISE'S SURGICAL ANATOMY.)

Fig. 1.—A superficial dissection showing the vessels and nerves.

Fig. 2.—A dissection of the muscles.

A. Urethra.
B. Accelerator urinæ.
C. Central point of perinæum.
D. Erector penis.
E. Transversus perinæi.
F. Anus.
G. Tuber ischii.
H. Coccyx.
I. Gluteus maximus.
K. Levator ani.
L. Triangular ligament.
1. Superficial perinæal vessels and nerves.
2. Inferior hæmorrhoidal vessels and nerve.

PLATE XII.

THE MALE PERINÆUM.

(From Maclise's Surgical Anatomy.)

Fig. 1.—The accelerator urinæ removed to show the bulb of the urethra, and the triangular ligament partially removed to show Cowper's glands.

Fig. 2.—The levator ani removed and the rectum turned down, to show the prostate and neck of bladder.

A. Urethra.
B. Bulb.
C. Prostate.
D. Crus penis with erector.
E. Triangular ligament (cut to show Cowper's glands).
F. Anus.
G. Tuber ischii.
H. Coccyx.
I. Gluteus maximus.
K. Levator ani.
L. Pudic artery.
M. Membranous urethra.
N. Vesicula seminalis.
O. Sacro-sciatic ligament.
P. Base of bladder.
Q. Vas deferens.

PLATE XII.

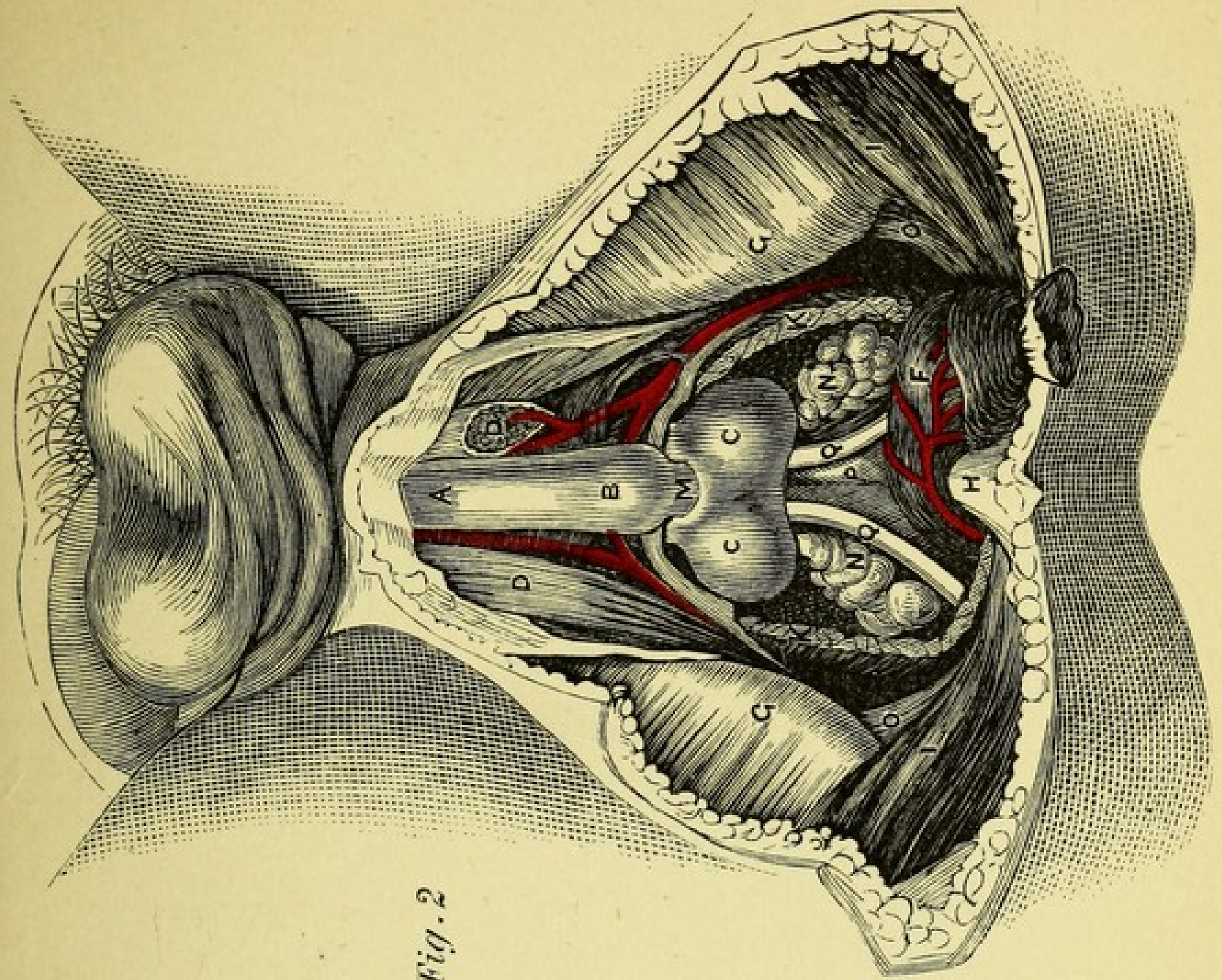


Fig. 2

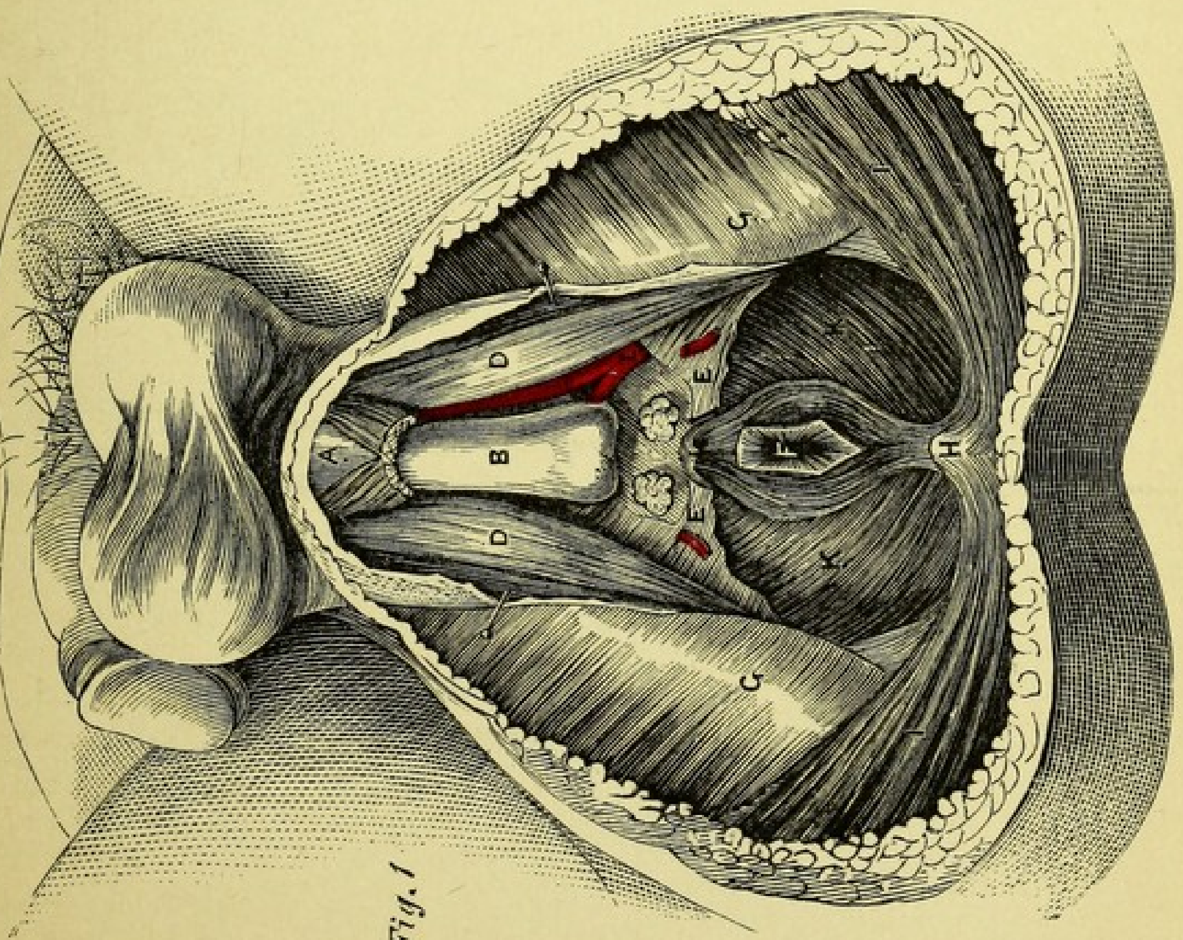


Fig. 1

PLATE XIII.

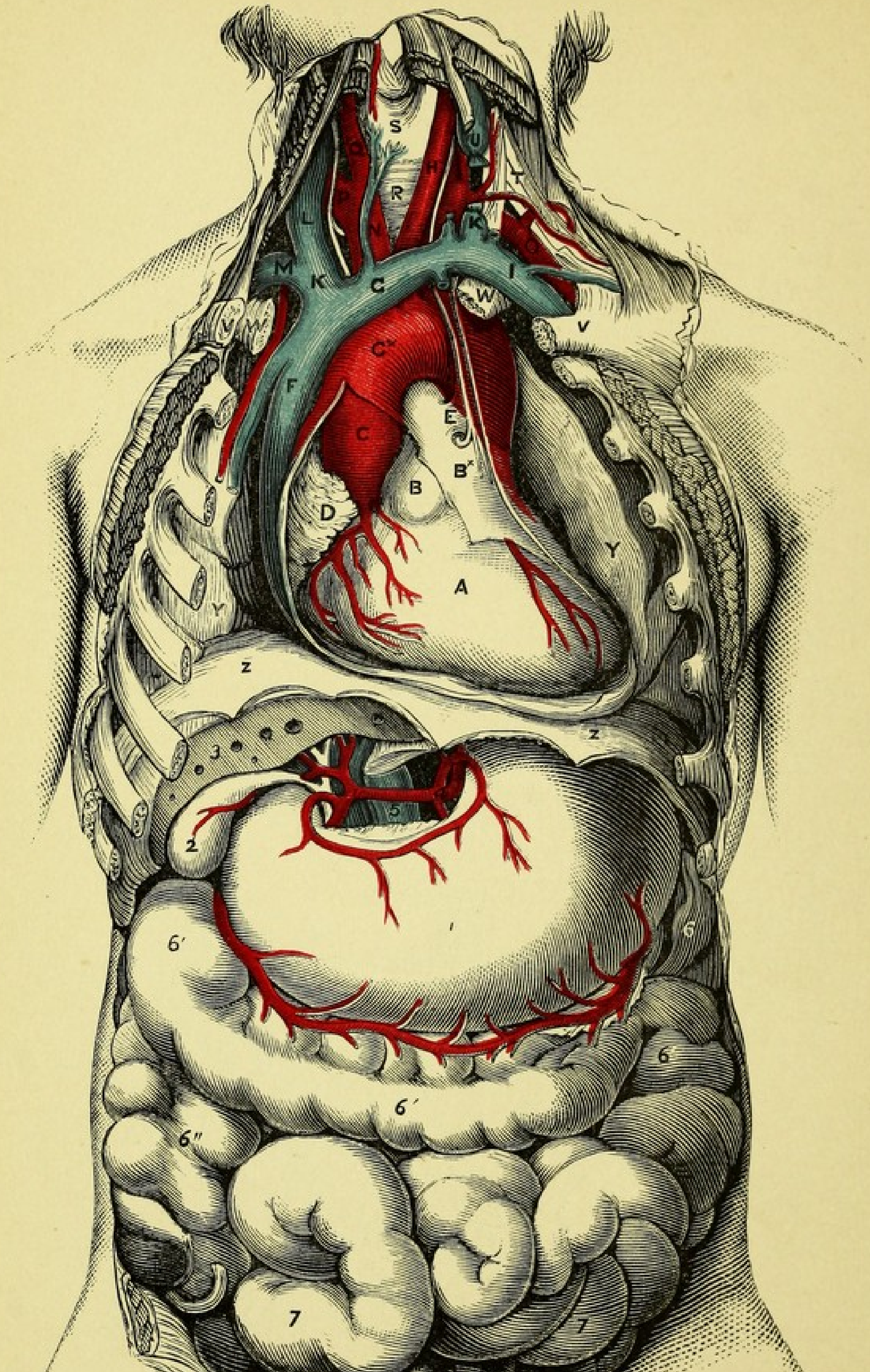


PLATE XIII.

SUPERFICIAL DISSECTION OF THORAX AND ABDOMEN.

(From Maclise's Surgical Anatomy.)

A. Right ventricle of Heart.
B. Pulmonary artery.
*B. Pericardium.
C. Ascending arch of Aorta.
*C. Transverse arch of Aorta.
D. Right auricular appendage.
E. Ductus arteriosus with recurrent laryngeal nerve.
F. Superior Vena Cava.
G. Left Brachio-cephalic vein.
H. Left Common Carotid.
I. Left Subclavian vein.
K. Left Internal Jugular (cut).
L. Right Internal Jugular.
M. Right Subclavian vein.
N. Innominate artery.
O. Left Subclavian artery.
P. Right Subclavian artery.
Q. Right Common Carotid.
R. Trachea.
S. Thyroid body.
T. Brachial plexus.
U. Internal Jugular vein (cut).
V. Clavicle.
W. First rib.
Y. Lung.
1. Stomach.
2. Gall-bladder.
3. Liver (cut).
4. Cœliac axis dividing into Gastric, Hepatic, and Splenic arteries.
5. Inferior Vena Cava.
6. Spleen.
6′. Large intestine.
6″. Caput cœcum coli.
7.7. Small intestines.

PLATE XIV.

DEEP DISSECTION OF THORAX AND ABDOMEN.

(From Maclise's Surgical Anatomy.)

A. Thyroid body.
B. Trachea.
C. First rib.
D. Clavicle.
E. Pectoralis major.
F. Coracoid process.
G. Arch of Aorta.
H. Right bronchus.
*H. Left bronchus.
I. Œsophagus.
K. Vena azygos major.
L. Thoracic duct.
M. Seventh rib.
N. Diaphragm.
O. Cardiac orifice of Stomach.
P. Liver, showing patent orifices of hepatic veins.
Q. Cœliac axis.
R. Inferior Vena Cava.
S. Gall-bladder.
T. Pyloric end of Stomach.
*T. Duodenum.
U. Spleen.
V. Pancreas.
W. Sigmoid flexure of Colon.
X. Caput cœcum coli.
Y. The mesentery.
Z. Small intestines.
2. Innominate artery.
3. Right Subclavian artery.
4. Right Common Carotid.
5. Left Subclavian artery.
6. Left Common Carotid.
7. Left Axillary artery.
8. Pectoralis minor.
9. Subscapularis.
10. Biceps.
11. Latissimus dorsi.
12. Inferior mesenteric artery.
13. Left kidney.

PLATE XIV.

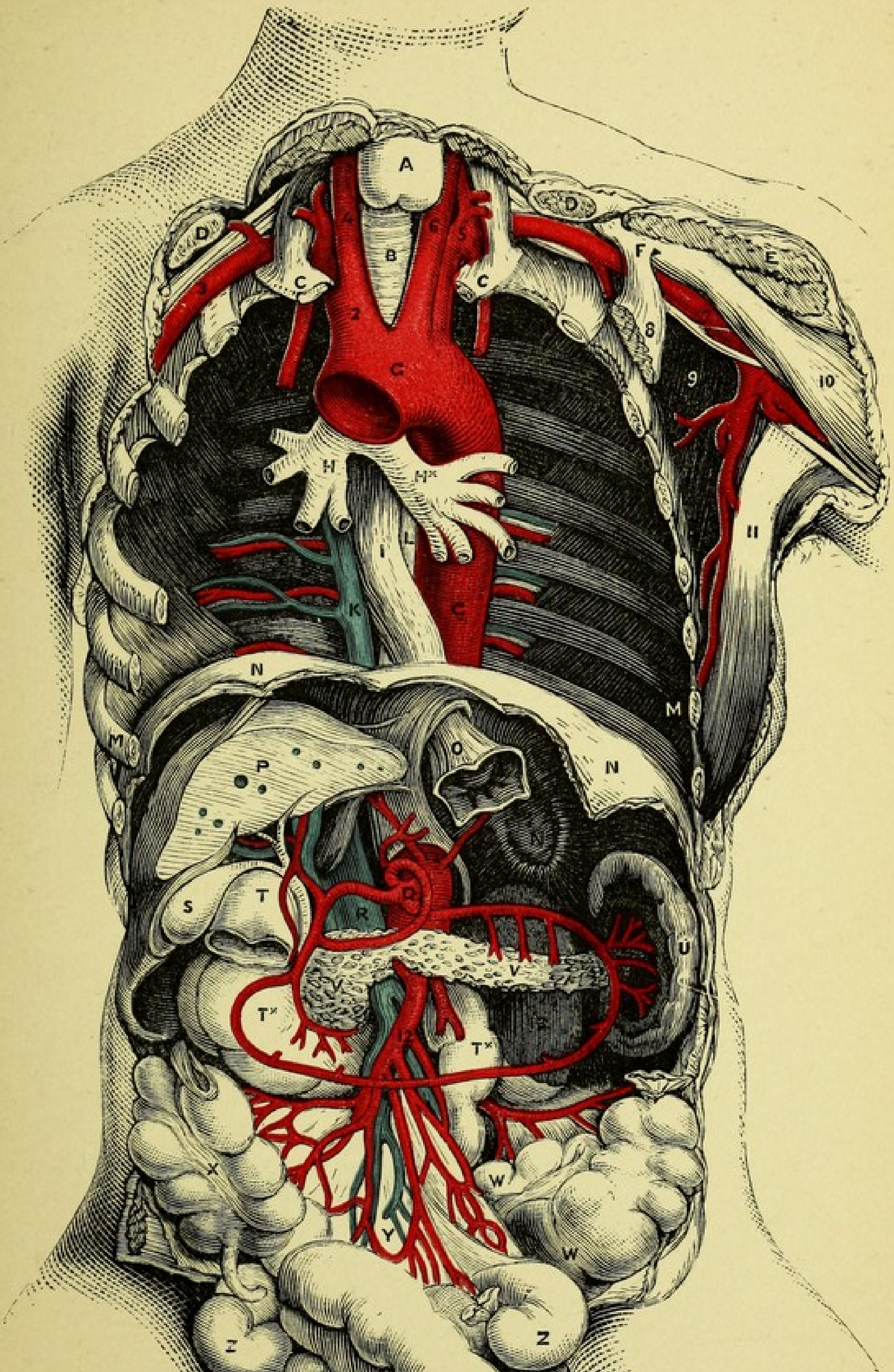


PLATE XV.

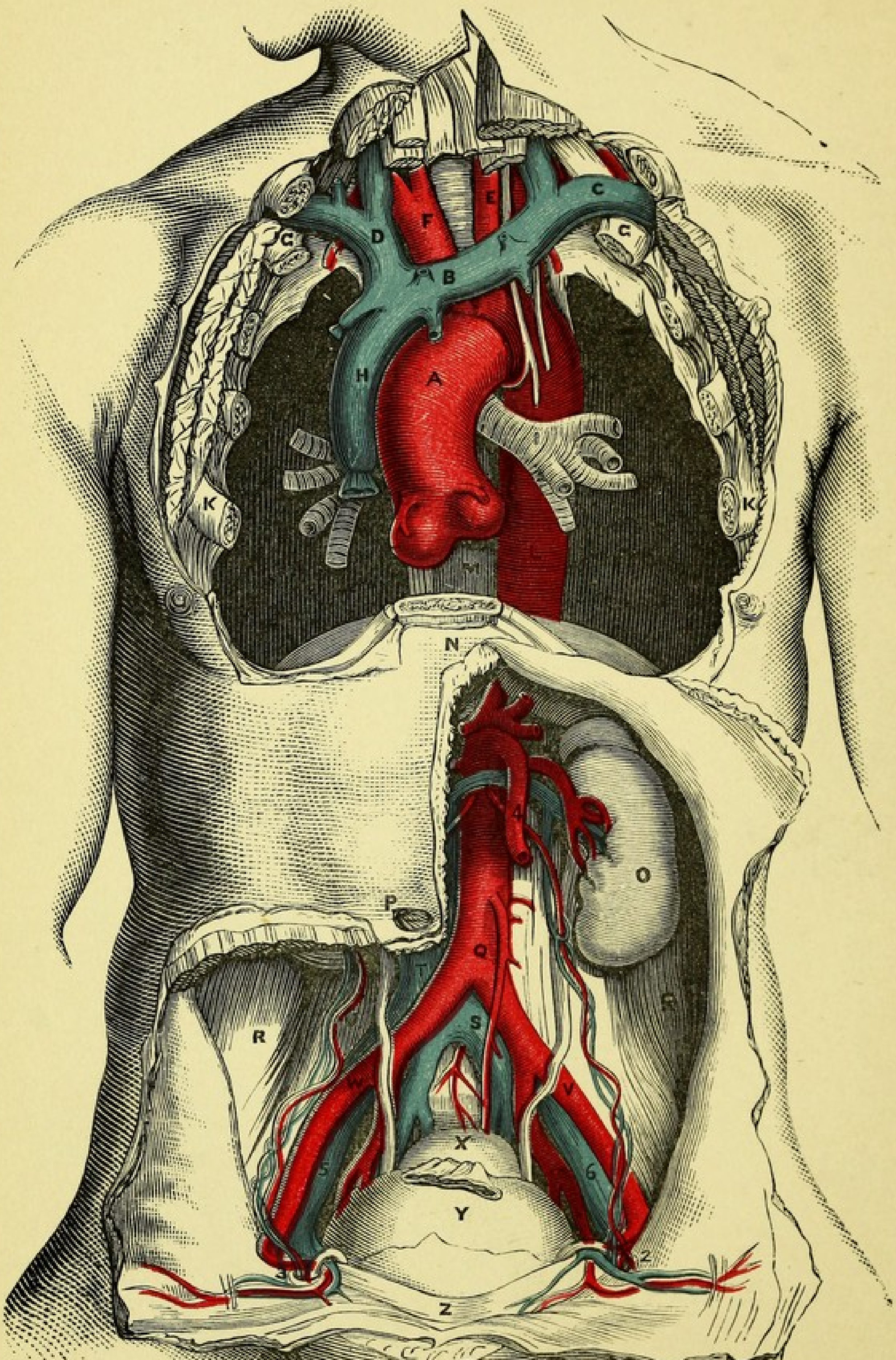


PLATE XV.

DEEP DISSECTION OF THORAX AND ABDOMEN.

(From Maclise's Surgical Anatomy.)

A. Aortic arch.
B. Left Innominate vein.
C. Left Subclavian vein.
D. Right Innominate vein.
E. Left Common Carotid.
F. Innominate artery.
G. First rib.
H. Superior Vena Cava.
I. Left bronchus.
K. Fourth rib.
L. Thoracic Aorta.
M. Œsophagus.
N. Ensiform cartilage.
O. Left kidney.
P. Umbilicus.
Q. Abdominal Aorta.
R.R. Iliac fossæ.
S. Left common Iliac vein.
T. Inferior Vena Cava.
U. Right psoas muscle.
V. Left external Iliac artery, crossed by ureter.
W. Right external Iliac artery, crossed by ureter.
X. Rectum, cut and tied.
Y. Bladder, distended.
Z. Symphysis pubis.
2. Left internal abdominal ring.
3. Right internal abdominal ring.
4. Superior mesenteric artery.
5. Right external Iliac vein.
6. Left external Iliac vein.

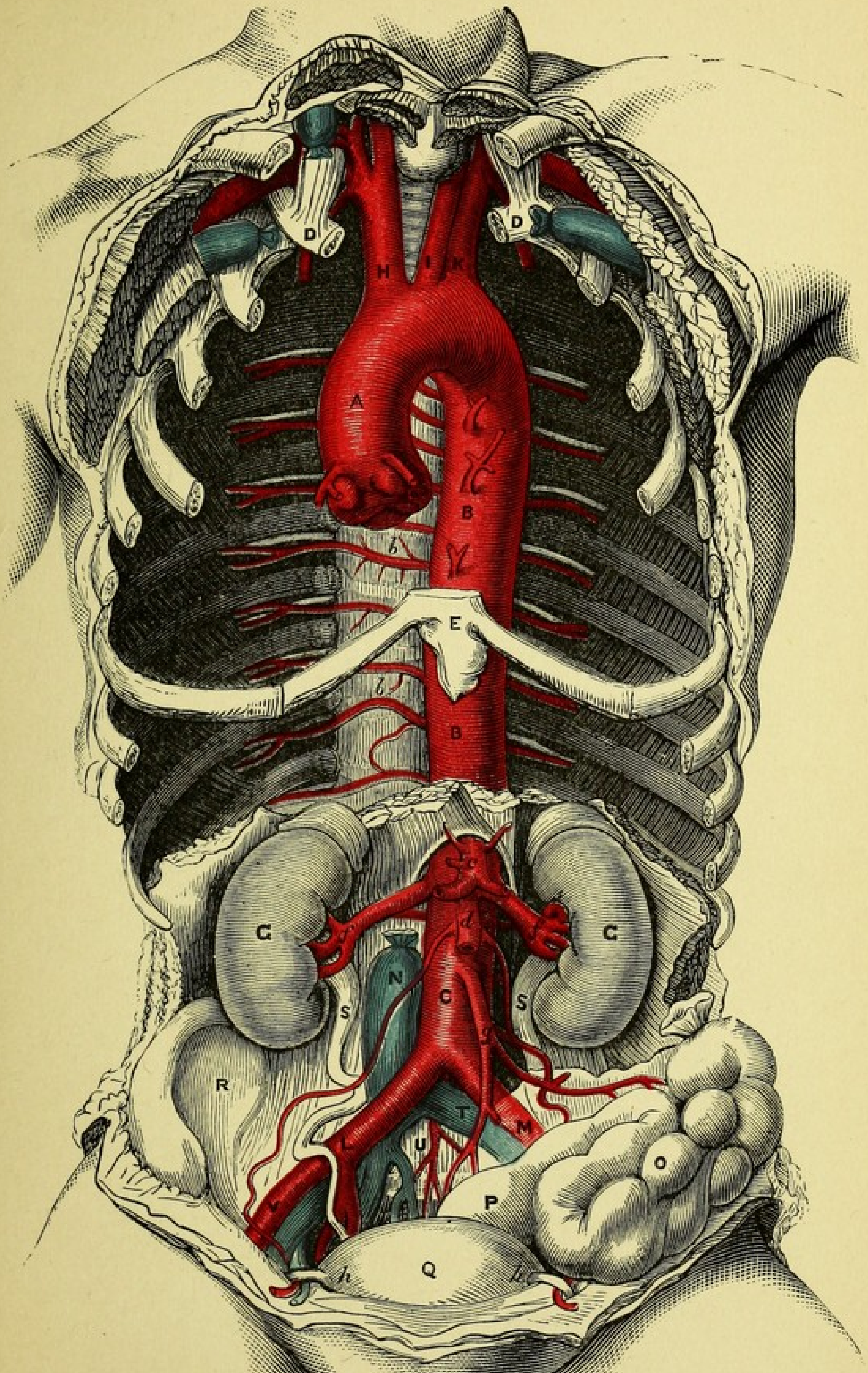
PLATE XVI.

DEEP DISSECTION OF THE THORACIC AND ABDOMINAL AORTA.

(From Maclise's Surgical Anatomy.)

A. Arch of Aorta.
B. Thoracic Aorta.
C. Abdominal Aorta.
D.D. First ribs.
E. Ensiform cartilage.
G.G. Kidneys.
H. Innominate artery.
I. Left Common Carotid.
K. Left Subclavian.
L. Right common Iliac.
M. Left common Iliac, covered by the meso-rectum.
N. Inferior Vena Cava, cut and tied.
O. Sigmoid flexure of Colon.
P. Rectum.
Q. Bladder.
R. Right Iliac fossa.
S.S. Ureters.
T. Left common Iliac vein.
U. Fifth lumbar vertebra.
V. Right external Iliac artery.
b.b. Aortic intercostal arteries.
c. Cœliac axis.
d. Superior mesenteric artery.
f.f. Renal arteries.
g. Inferior mesenteric artery.
h.h. Vas deferens, hooking round the epigastric artery close to the internal abdominal ring.

PLATE XVI.



FLATE XVII.

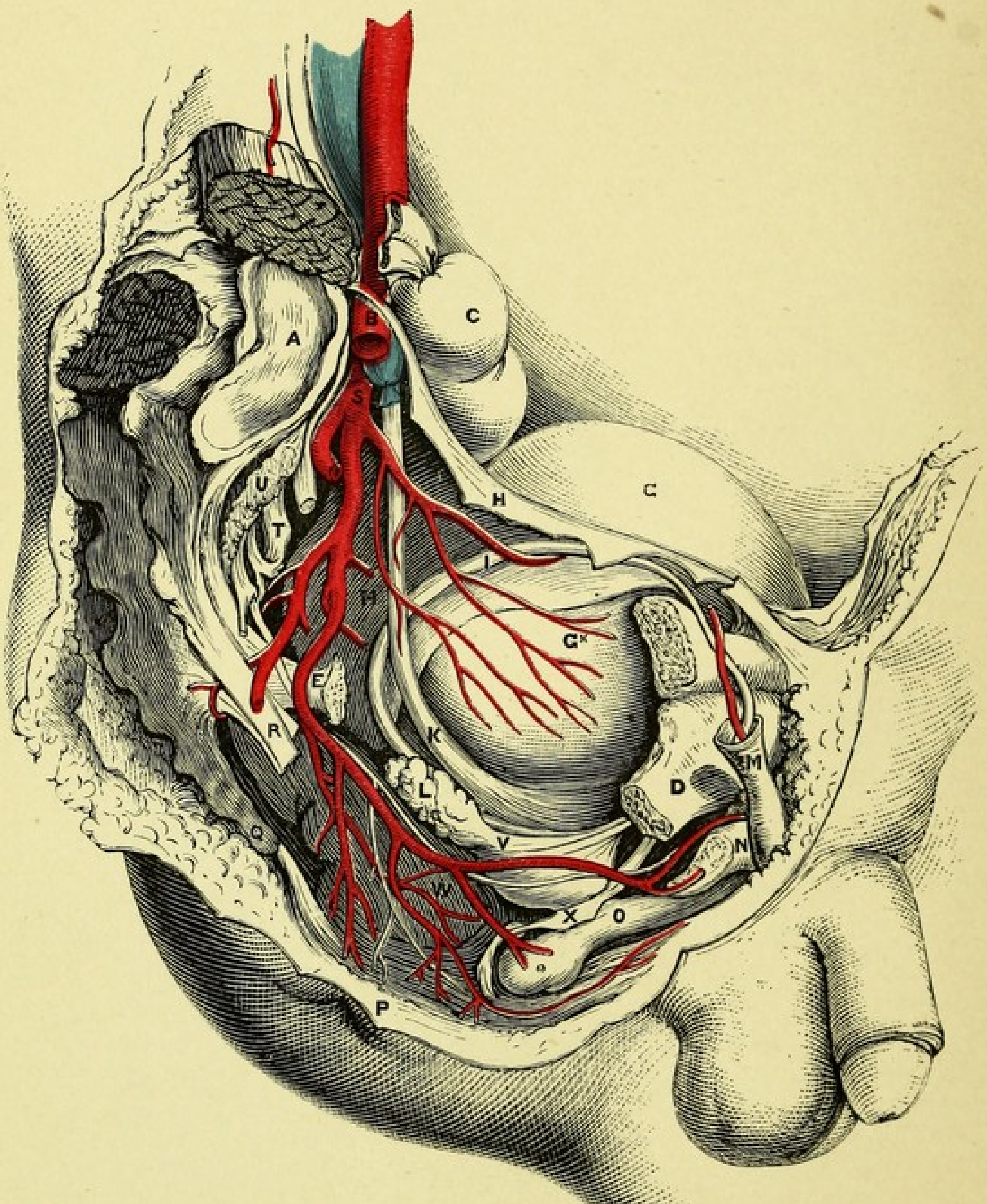


PLATE XVII.

SIDE VIEW OF MALE PELVIS.

(FROM MACLISE'S SURGICAL ANATOMY.)

A. Sacrum.
B. External Iliac artery.
C. Upper end of rectum.
D. Ramus of pubes.
E. Spine of ischium (cut off).
G. Bladder covered by peritoneum.
H. Bladder uncovered by peritoneum.
I. Vas deferens.
K. Ureter.
L. Vesicula seminalis.
M. Spermatic cord.
N. Crus penis. n. Its artery.
O. Urethra. o. Bulb.
P. Sphincter ani.
Q. Coccyx.
R. Sacro-sciatic ligament.
S. Internal iliac artery.
T. Sacral nerves.
U. Pyriformis.
W. Pudic artery and nerve.
X. Triangular ligament (cut).

PLATE XVIII.

SIDE VIEW OF THE FEMALE PELVIS.

(From Savage's Female Pelvic Organs.)

B. Bladder (turned down).
R. Rectum.
L. Round ligament.
U. Uterus.
O. Ovary.
V. Vagina.
S. Sacro-iliac synchondrosis.
K. Kidney.
T. Fallopian tube.
P. Pubic symphysis.
a. Pyriformis muscle (cut).
b. Gluteal muscles.
c. Coccygeus muscle.
d. Obturator internus.
e. Psoas magnus.
f. Linea alba.
g.g. Ureters.
h. Obturator nerve.
i. Internal abdominal ring.
1. Abdominal Aorta.
2. Inferior mesenteric artery.
3.3. Common Iliac arteries.
4. Left external Iliac artery.
5. Vena cava inferior.
6.6. Renal veins.
7.7. Common Iliac veins.
8. External Iliac vein.
9. Internal Iliac artery (cut).
10. Gluteal vein.
11. Ilio-lumbar vein.
12. Lateral sacral vein.
13. Sciatic vein.
14. Pudic vein.
15. Obturator vein.
16. Epigastric vein.
17. Uterine veins.
18. Vesico-vaginal veins.
19. Ovarian veins.
20. Bulb of the ovary.
21. Vein to round ligament.
22. Fallopian veins.

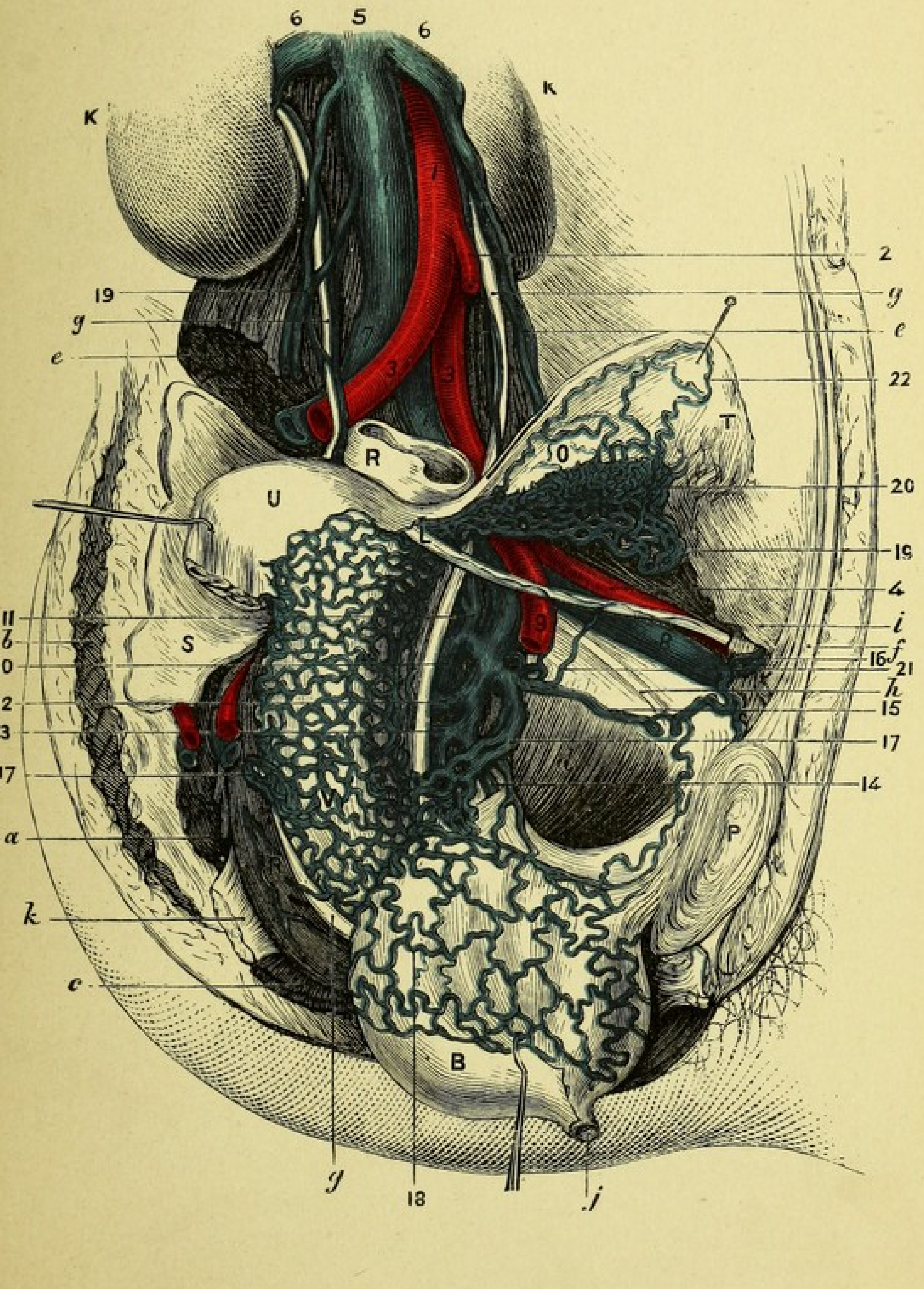

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PLATE XIX.

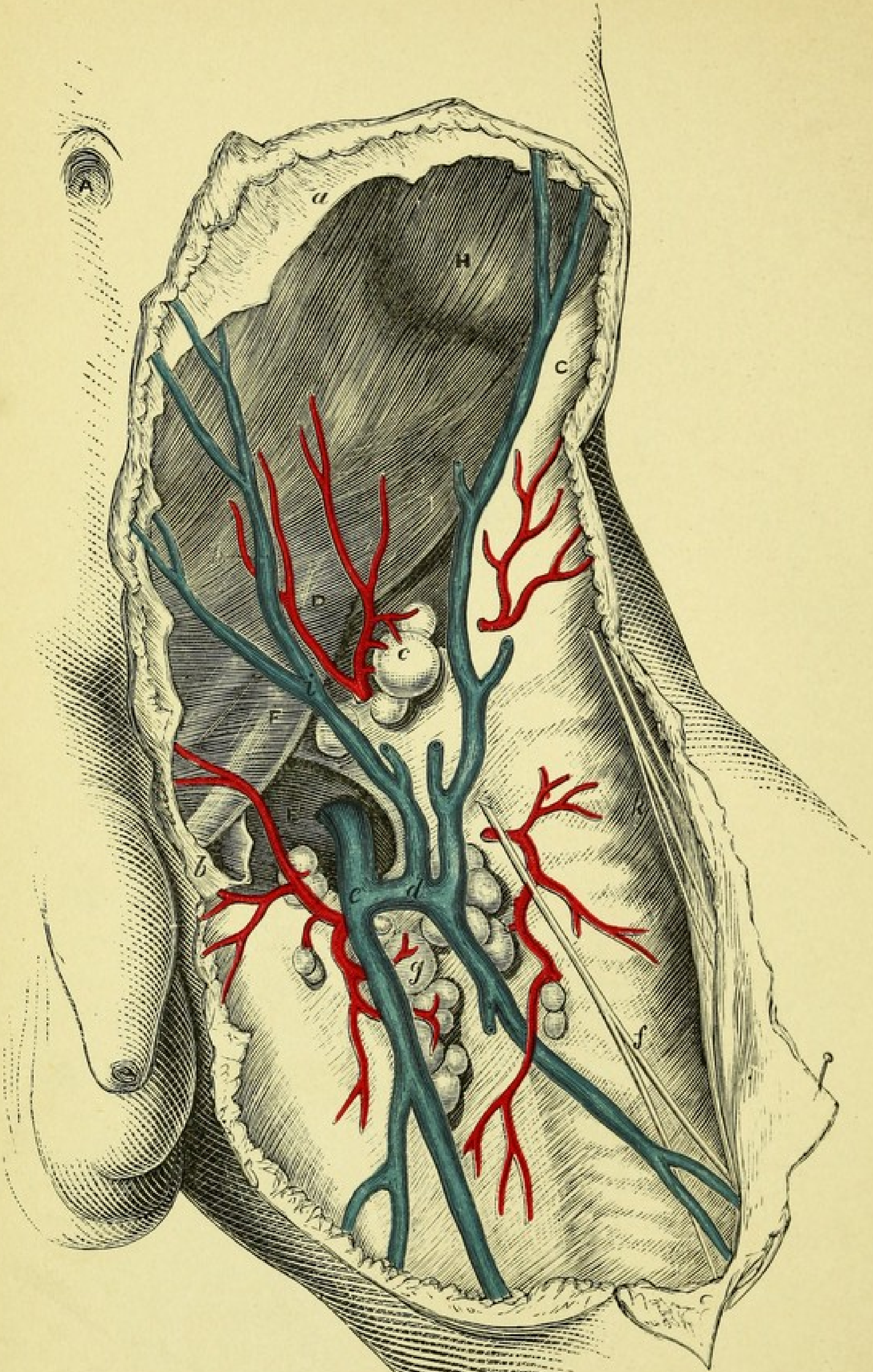

PLATE XIX.

SUPERFICIAL DISSECTION OF THE GROIN.

(From Maclise's Surgical Anatomy.)

A. Umbilicus.
C. Anterior superior iliac spine.
D. Position of internal abdominal ring.
E. Saphenous opening.
F. Cord appearing at external abdominal ring.
H. Fibres of external oblique.
a. Superficial fascia of abdomen.
b. Superficial fascia of thigh.
c. Inguinal lymphatic glands.
d. Junction of superficial veins with—
e. Internal saphenous vein.
f. Middle cutaneous nerve.
g. Femoral lymphatic glands.
i. Superficial epigastric vein.
k. External cutaneous nerve.

PLATE XX.

THE ANATOMY OF THE GROIN.

(From Maclise's Surgical Anatomy.)

A. Anterior superior iliac spine.
B. Umbilicus.
C. Spine of pubes.
D. Obliquus externus.
d. Its tendon.
E. Obliquus internus.
e. Its tendon.
F. Transversalis abdominis.
f. Its tendon (conjoint).
G. Rectus muscle, with sheath.
H. Internal spermatic fascia, continuous with *h*, the infundibular portion of the fascia transversalis.
I. Peritoneum.
K. Fascia transversalis.
L. Epigastric artery and veins.
M. Spermatic cord.
N. Femoral artery.
n. Profunda femoris.
O. Femoral vein.
P. Saphenous vein.
Q. Sartorius.
R. Sheath of femoral vessels.
S.S. Saphenous opening.
T. Anterior crural nerve.
U. Fascia lata, pubic portion.
V. Fascia lata, iliac portion.
W. Iliacus internus.

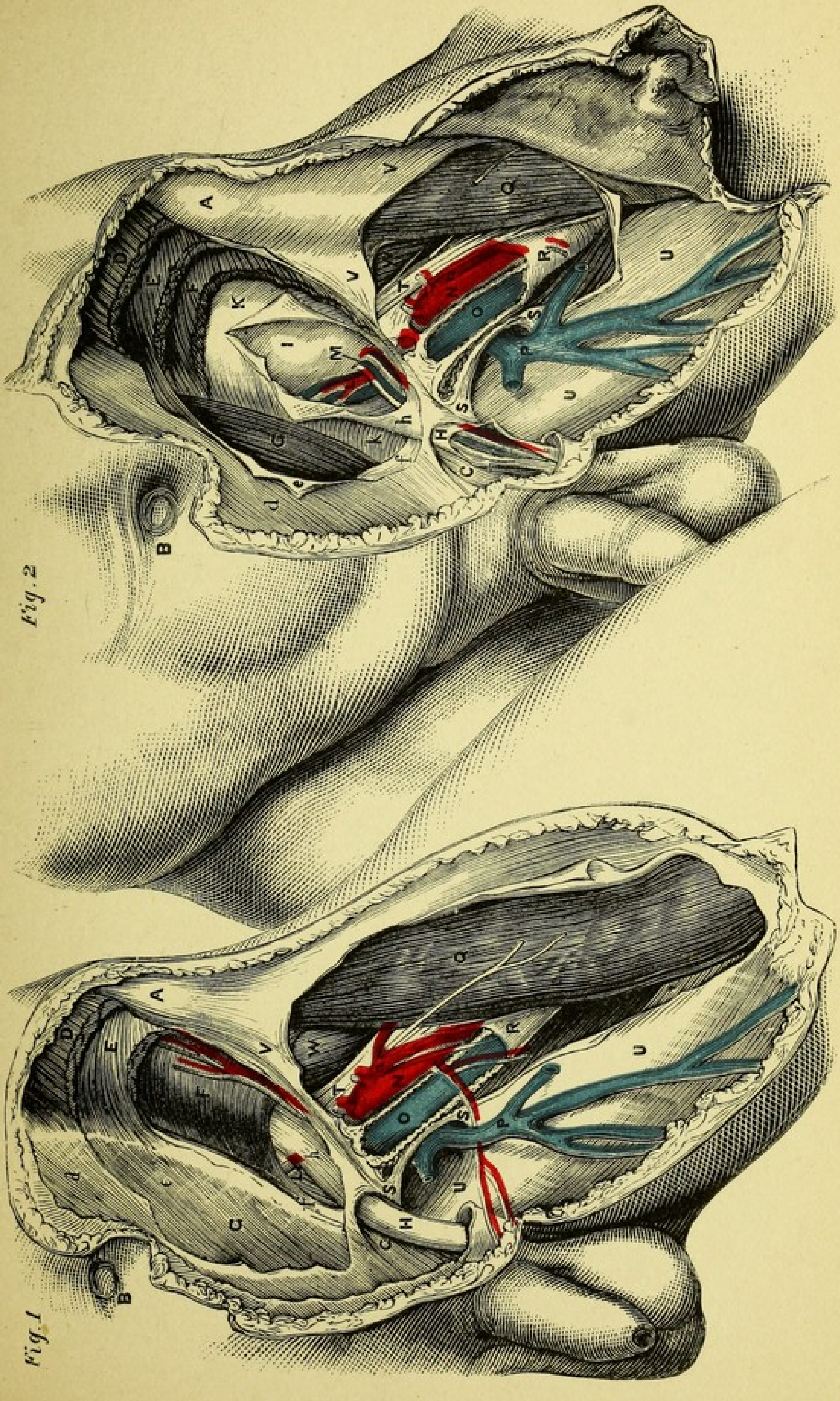

Fig. 2

Fig. 1

PLATE XXI.

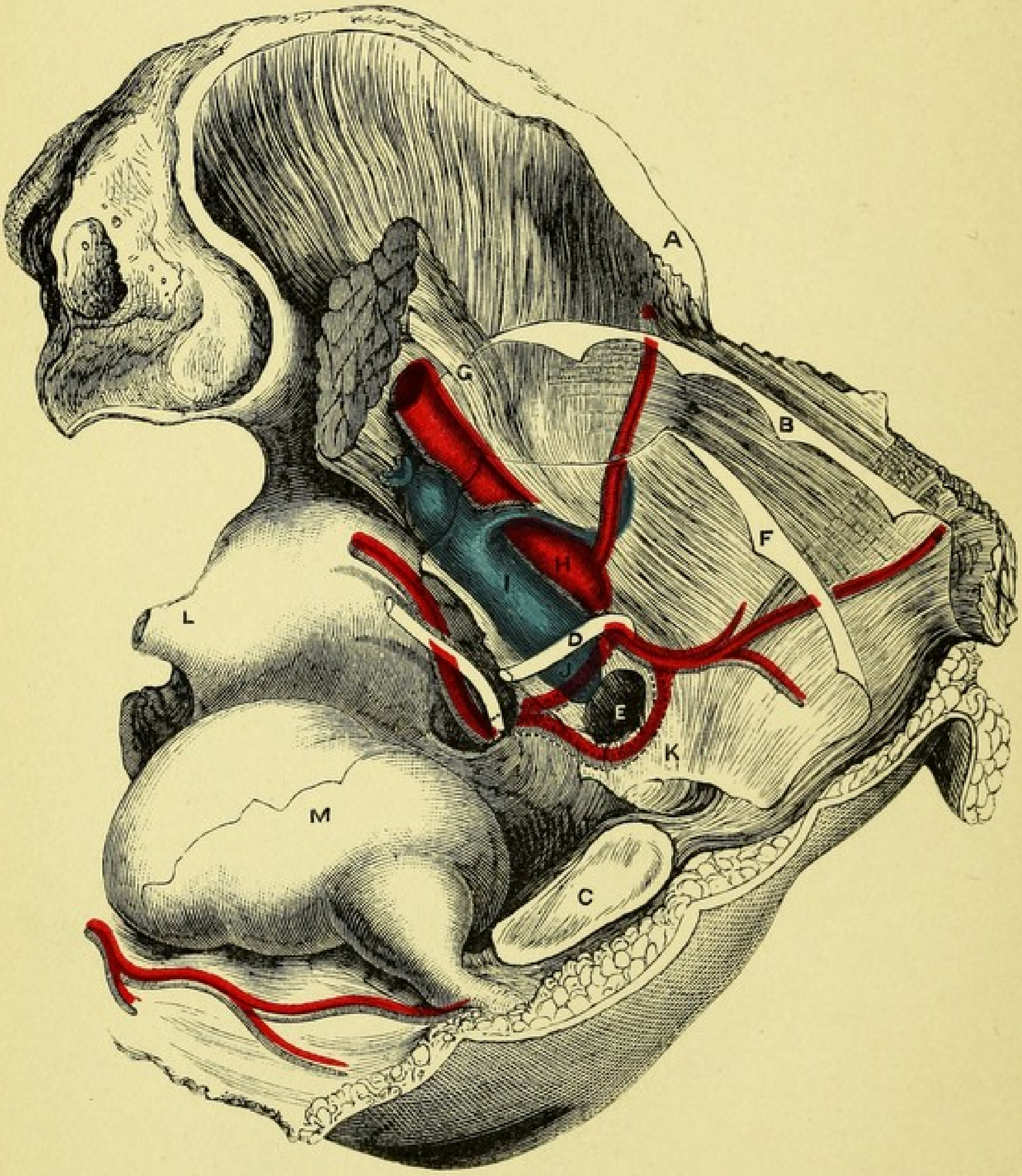

PLATE XXI.

INTERNAL VIEW OF THE FEMORAL RING AND ITS RELATION TO THE BLOOD-VESSELS.

(From Maclise's Surgical Anatomy.)

A. Anterior superior iliac spine.
B. Transversalis fascia.
C. Symphysis pubis.
D. Vas deferens.
E. Crural or femoral ring.
F. Peritoneum.
G. Psoas.
H. External Iliac artery.
I. External Iliac vein.
J. Obturator artery external to crural ring.
K. Obturator artery internal to crural ring.
L. Spine of ischium.
M. Bladder.

PLATE XXII.

THE ILIAC AND FEMORAL ARTERIES.

(From Maclise's Surgical Anatomy.)

A. Aorta at bifurcation.
B. Anterior superior iliac spine.
C. Symphysis pubis.
D. Poupart's ligament.
E. External cutaneous nerve.
F. Vena Cava inferior.
G.G. Common Iliac arteries.
H.H. Common Iliac veins.
I. External Iliac artery.
K. External Iliac vein.
L. Bladder.
M. Rectum.
N. Profunda femoris.
O. Femoral vein.
o. Saphenous vein.
P. Anterior crural nerve.
Q. Sartorius.
R. Rectus femoris.
S. Pectineus.
T. Adductor longus.
U. Gracilis.
V. Hunter's canal.
W. Femoral artery.

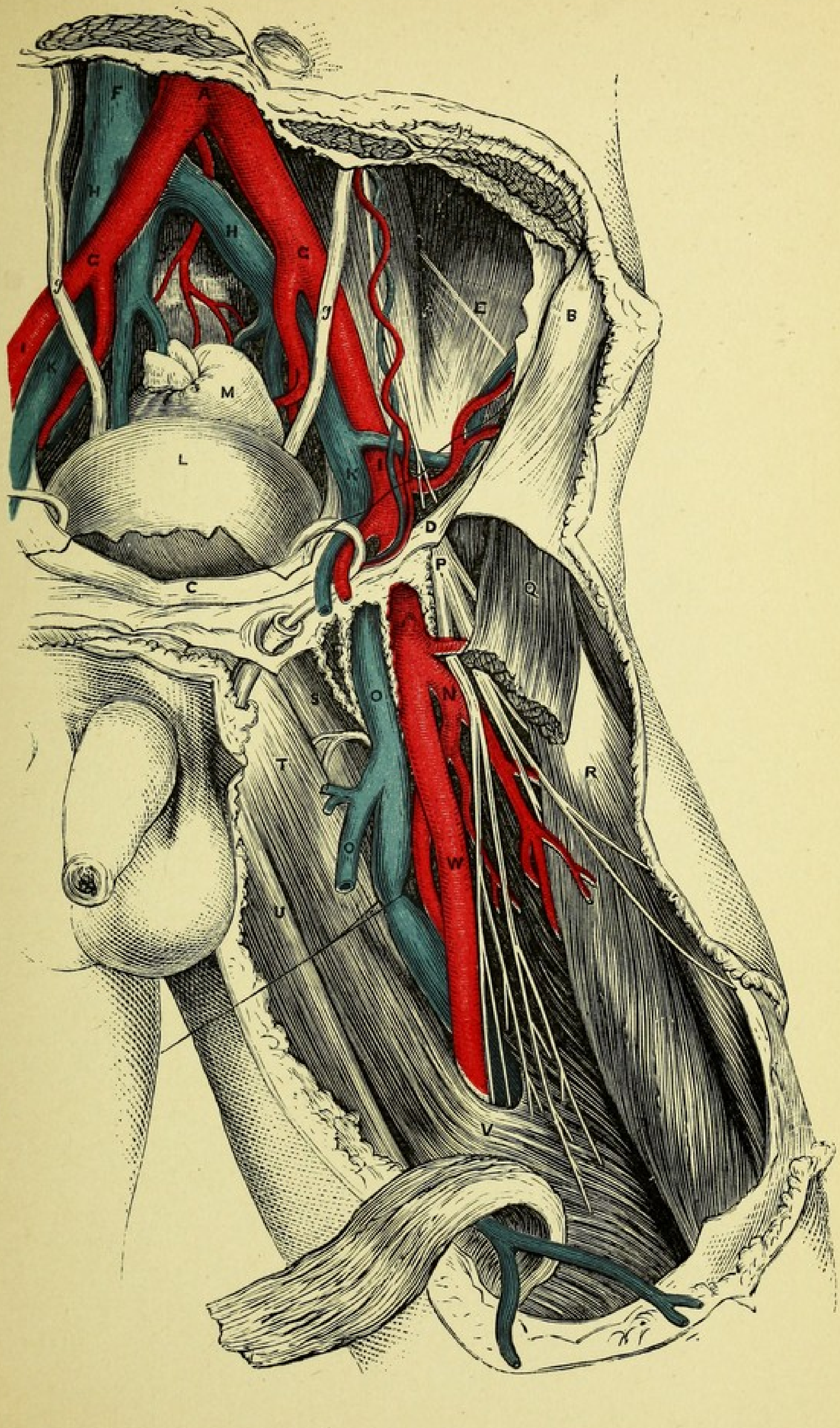
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PLATE XXIII.

Fig. 1

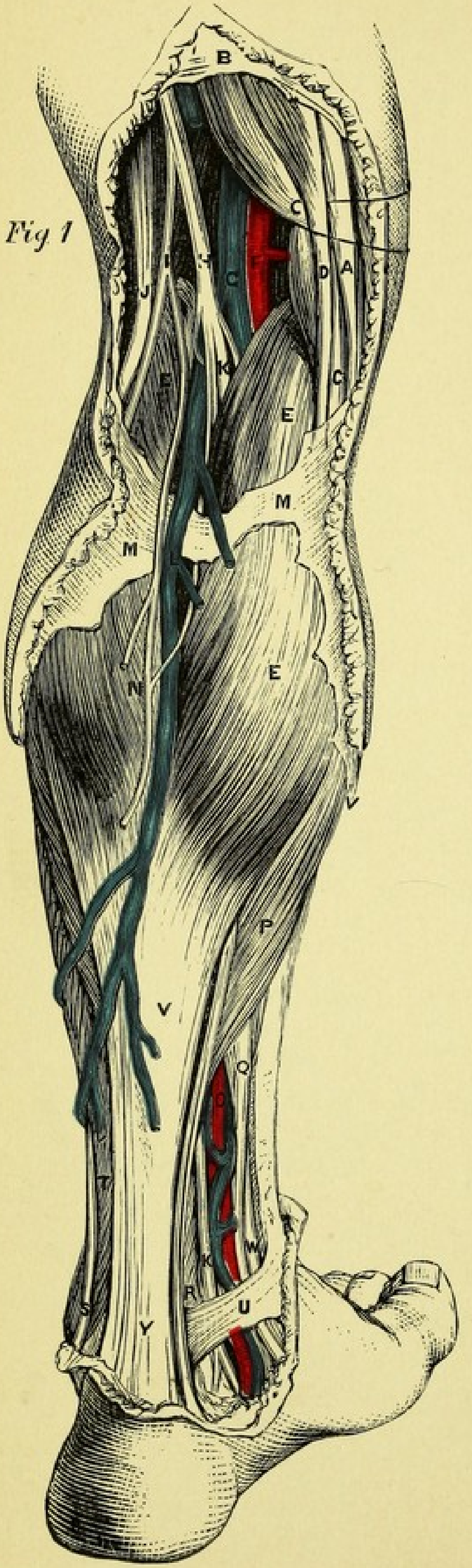


Fig. 2

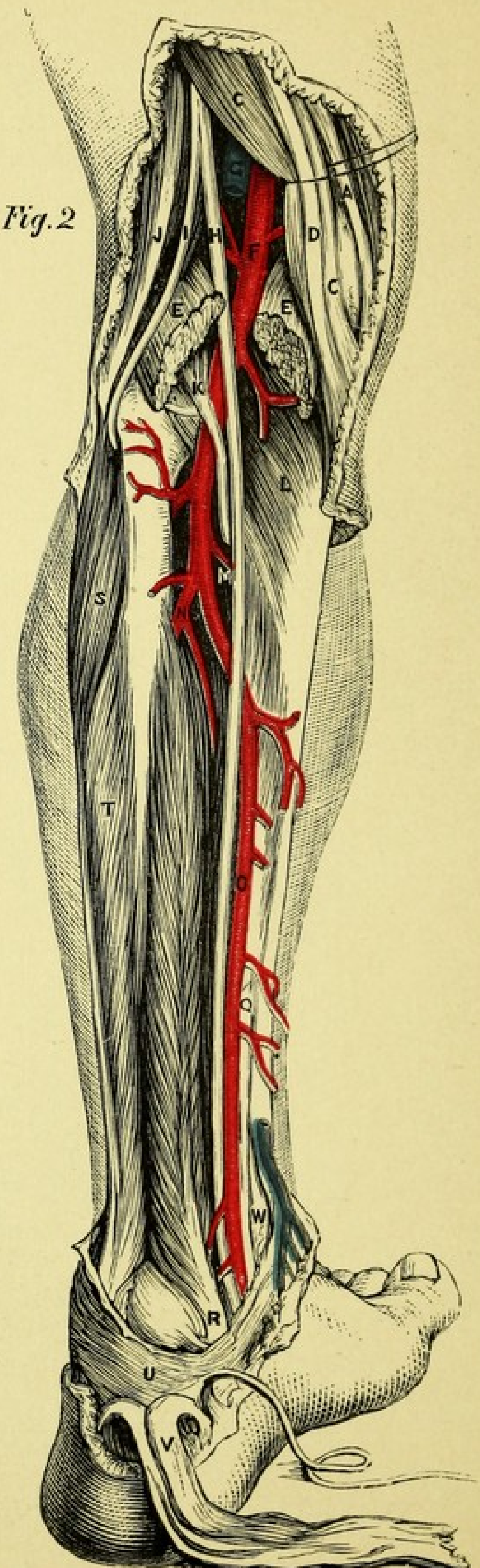


PLATE XXIII.

Fig. 1.—Superficial Dissection of the Back of the Leg;
,, 2.—Deep Dissection of the Back of the Leg.

(From Maclise's Surgical Anatomy.)

Fig. 1.

A. Tendon of gracilis.
B. Fascia lata of thigh.
C. Semi-membranosus.
D. Semi-tendinosus.
E. Gastrocnemius.
F. Popliteal artery.
G. Popliteal vein.
H. Internal Popliteal nerve.
I. External Popliteal nerve.
J. Biceps.
K. Posterior Tibial nerve.
L. External Saphenous vein.
M. Fascia of leg.
N. Internal Saphenous nerve.
O. Posterior Tibial artery.
P. Soleus.
Q. Flexor communis digitorum.
R. Flexor longus pollicis.
S. Peroneus longus.
T. Peroneus brevis.
U. Internal annular ligament.
V. Tendo Achillis.
W. Tibialis posticus.

Fig. 2.

K. Plantaris.
L. Popliteus.
M. Anterior Tibial artery.
N. Peroneal artery.

PLATE XXIV.

THE FRONT OF THE LEG AND SOLE OF THE FOOT.

(FROM MACLISE'S SURGICAL ANATOMY.)

Fig. 1.

A. Tibialis anticus.
a. Its tendon.
B. Extensor longus digitorum.
b. Its tendons.
C. Extensor longus pollicis.
c. Its tendon.
E. Fibula.
F. Peroneus longus.
G. Peroneus brevis.
K. Extensor brevis digitorum.
L. Anterior Tibial artery and nerve.

Fig. 2.

A. Calcaneum.
B. Plantar fascia.
C. Abductor minimi digiti.
D. Abductor pollicis.
E. Flexor accessorius.
F. Flexor longus digitorum.
G. Flexor longus pollicis.
H. Flexor brevis pollicis.
I. Lumbricales.
L. External Plantar artery and nerve.
M. Internal Plantar artery and nerve.

Fig. 3.

H. Metatarsal bone of great toe.
i. Tendon of Tibialis Posticus.
K. External Plantar nerve.
L. External Plantar artery.
M. Interosseous muscles.
P. Tendon of Peroneus longus.

PLATE XXIV.

Fig. 1

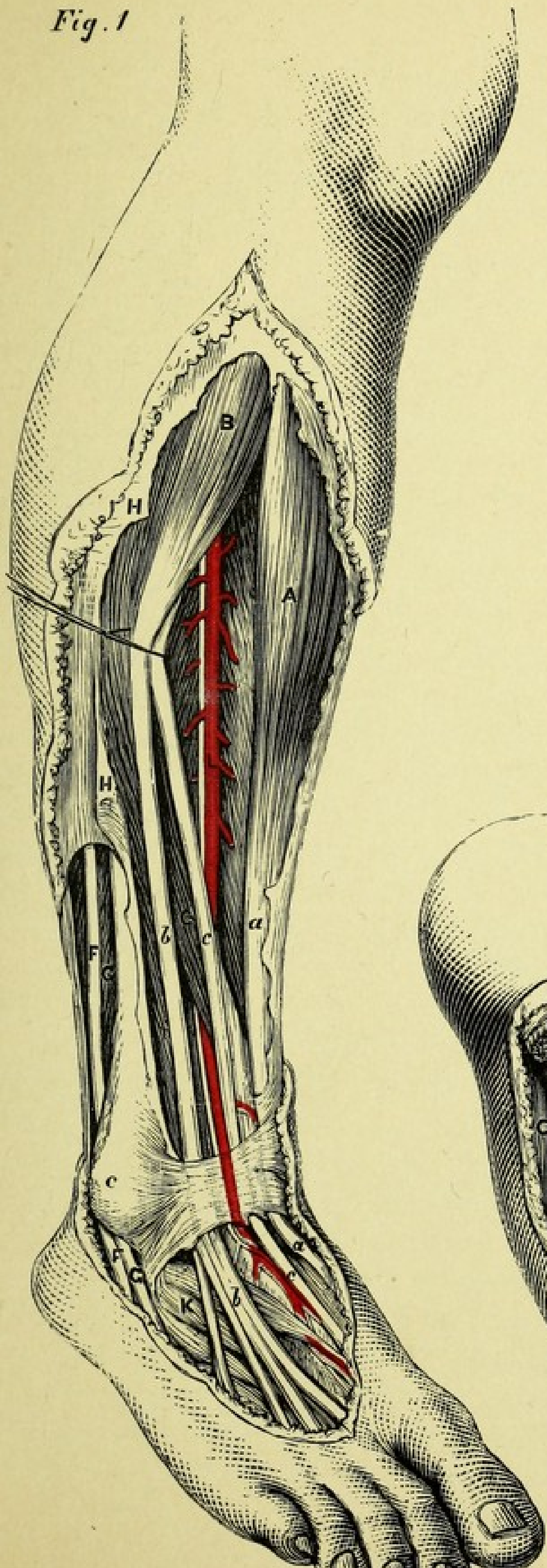


Fig. 2

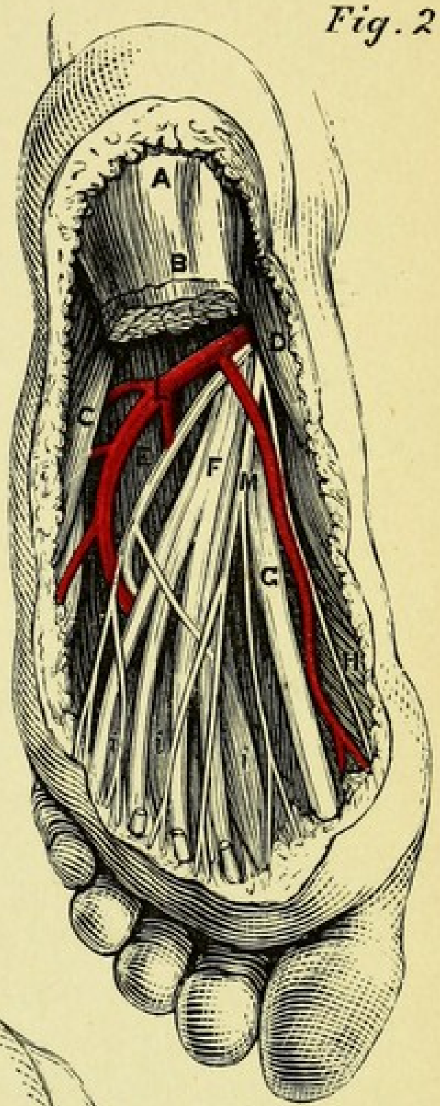
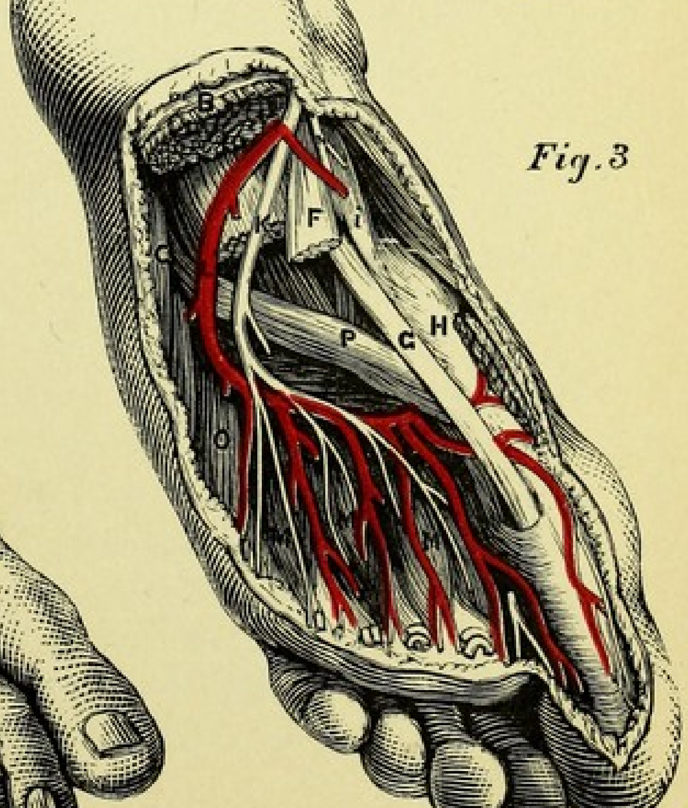


Fig. 3



MANUAL OF PRACTICAL ANATOMY.

INTRODUCTION.

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

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

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

Great variety exists in dissecting cases, both as to form and expense, but so long as the instruments themselves are strong and good, the simpler the case the better.

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

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

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

The SCISSORS should be large and strong, and it will be found to be advantageous to have one curved pair, which is very useful in preparing the ligaments.

SOUNDS and STAFFS will be required for the purpose of practising the introduction of instruments into the bladder; but these are found in most dissecting rooms, together with SAWS and other large tools requisite for dissection.

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

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

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

The DEEP FASCIA is a dense fibrous layer, white and glistening in appearance. It lies beneath the superficial fascia, and forms sheaths for the limbs; being attached to various ridges of bone, and sending processes (intermuscular septa) between the muscles.

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

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

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

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

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

PART I.

DISSECTION OF THE ARM.

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

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

The curves of the clavicle are generally seen with ease; but the finger should be carried along the bone to note any irregularity denoting old fracture, and to trace its articulation with the acromion process of the scapula, where the outer end of the bone usually forms a marked prominence. The sterno-clavicular joint should also be examined, and if the arm is freely moved, the extensive range of motion in that joint will be better appreciated. The development of the mammary region will vary according to the sex and age of the subject. In the case of a female subject, the advanced student should notice the condition of the nipple and its surrounding areola, as indicating previous pregnancies or the contrary, and may advantageously practise removal of the breast by two elliptical incisions, one above, the other below the nipple, taking great care to remove the whole of the breast, and not to leave any glandular tissue attached to the skin or the deeper structures. The position of the nipple varies considerably even in the male, but it is most commonly over the fourth intercostal space, though in the female often at a lower level.

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

The biceps muscle forms a prominence on the front of the arm, and the brachial artery and median nerve can be traced along its inner border to the bend of the elbow, and the shaft of the humerus can be readily felt. In front of the elbow is a hollow, corresponding to a space to be afterwards dissected, and occasionally the superficial veins stand out prominently, in which case venesection should be practised. The prominent internal condyle of the humerus and its relation to the olecranon process of the ulna are readily observed, and the ulnar nerve can be felt between the two points of bone. The rounded external condyle, with the ridge leading to it, can be felt in most subjects, and, immediately below it, the head of the radius, which should be rotated that its relation to the condyle may be better appreciated. The rounded posterior surface of the arm is formed by the triceps muscle.

In the fore-arm the radius can be but little felt, except at its lower extremity; but the olecranon process and sharp posterior margin of the ulna are always to be distinguished, even in very muscular subjects. It should be observed that the ulna is the more prominent of the two bones at the wrist, whilst the end of the radius is a little lower down than that of the ulna; the styloid process of each can be readily distinguished. The tendons of the flexor carpi radialis and flexor carpi ulnaris are usually prominent, and serve as guides to the radial and ulnar arteries, which may be felt (if injected) to the outer, or radial, side of each tendon. The metacarpus and the phalanges are to be examined, and the advanced student may advantageously amputate one or two fingers (middle or ring). It is to be borne in mind that the transverse markings, on either the palmar or dorsal aspect of the fingers, form no guide to the articulations, which in the case of the interphalangeal joints are nearer to the nails. When the finger is bent, the prominence at the articulation is due to the proximal phalanx, and the joint is below that point. The best rule, therefore, in amputating through the interphalangeal articulations, is to bend the phalanx which is to be removed to a right angle with the one above it, and to begin the incision on one side at a point midway in the thickness of the upper phalanx, cutting transversely to a corresponding point on the opposite side.

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

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

Beneath the skin is the subcutaneous fascia, which is often very fatty in the female. The mamma will also be exposed in the female, or its rudiment in the male subject, and an incision may be carried round the nipple so as to leave it attached to the gland in the former. In a well-developed body the fibres of the platysma myoides may be seen arising from the fascia below the clavicle.

The **Mamma**, or breast, is a gland of very variable bulk lying upon the great pectoral muscle, from which it is separated by a quantity of loose cellular tissue. Its base is nearly circular, and usually extends from the side of the sternum to the margin of the anterior wall of the axilla, reaching from the third to the seventh rib in the vertical direction. Immediately below its centre, and between the fourth and fifth ribs, is the *mamilla* or nipple, around which is the *areola* of discoloured skin, the tint of which becomes darker as pregnancy advances. The nipple, which is supplied with sensitive papillæ, may be shown to be pierced by numerous small lactiferous ducts by introducing bristles into their openings, and its skin is thin and delicate.

The gland consists of numerous lobules bound together by tough cellular tissue, and having a quantity of fat interspersed between them. Each lobule is abundantly supplied with blood-vessels and has a separate *galactoferous duct.* The ducts converge towards the nipple, and beneath the areola become straight and somewhat dilated so as to form *lacteal sinuses* or *ampullæ.*

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

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

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

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

The **Pectoralis Major** (Fig. 1, 2) consists of a sternal and a clavicular portion, separated at their origins by a cellular interval. The sternal portion *arises* from the whole length of one side of the sternum and from the cartilages of all the true ribs except the seventh, and is connected below with the aponeurosis of the external oblique muscle. The clavicular portion *arises* from the inner or sternal half of the anterior border and surface of the clavicle, and is separated from the deltoid muscle by another cellular interval, containing the cephalic vein and the humeral branch of the acromio-thoracic artery. The two portions are united at their *insertion* into the anterior or outer edge of the bicipital groove of the humerus, the muscle being doubled upon itself, so that the lower sternal fibres pass behind, and reach higher up the bone than those from the clavicle. The deeper portion of the insertion is more tendinous than the superficial, and sends a prolongation over the long head the biceps to the shoulder-joint; the superficial part is closely connected with that of the deltoid.

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

The Axilla.

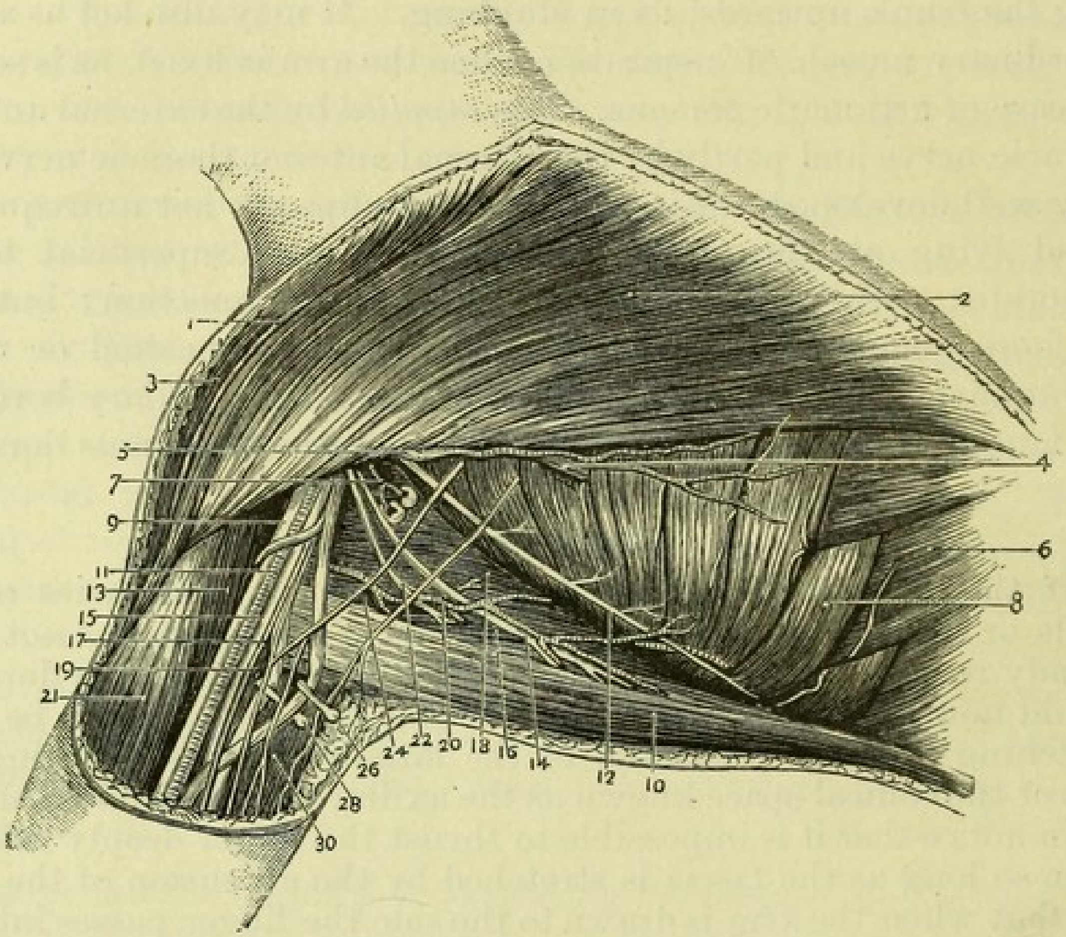
[If the arm is well drawn from the side the boundaries of the axilla or armpit will be readily seen, and if the skin has not been already removed from the posterior boundary (latissimus dorsi), it should now be turned back. The strong deep fascia will be seen stretching from the pectoralis to the latissimus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

Lateral Cutaneous Nerves and Vessels.—The first intercostal nerve has no lateral branch, but six lateral branches from the upper nerves (from 2nd to 7th) will be found appearing at the side of the chest, between the digitations of the serratus magnus, being accompanied by corresponding arterial twigs. Each lateral cutaneous nerve, except that of the second, divides into anterior and posterior branches, which turn forwards to the pectoral region, and backwards over the latissimus dorsi respectively.

The lateral cutaneous branch of the second nerve passes down the inner side of the arm to join the lesser internal cutaneous nerve, or nerve of Wrisberg, and is hence called the *intercosto-humeral nerve.* The posterior branch from the third nerve usually accompanies and joins this. These last must be found at once and are to be carefully preserved. (Fig. 1, 24.)

[All the fat is to be removed from the axilla, and the muscles cleaned so far as they are exposed. Care must also be taken not to injure the following structures whilst cleaning them :—the axillary

Fig. 1.



vessels (particularly the vein) and the large nerves, which are to the outer side of the space; the posterior thoracic nerve, which runs vertically upon the serratus magnus, about three inches from the edge of the pectoralis; the subscapular vessels at the edge of the subscapularis; the long thoracic artery, near the edge of the

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Fig. 1.—The Axilla (drawn by J. T. Gray).

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

pectoralis major; and the three subscapular nerves which cross the space, passing from above downwards and outwards. One or two of the numerous lymphatic glands should also be preserved.]

The **Axilla** is a conical space between the chest and upper arm, and has the following boundaries:—*In front* is the pectoralis major muscle, with the pectoralis minor beneath it; *behind* are the subscapularis, latissimus dorsi, and teres major muscles; to the *inner side* is the serratus magnus, with the four upper ribs and intercostal muscles; and to the *outer side* the upper part of the humerus and the coraco-brachialis and biceps muscles. The *base* of the cone has already been seen to be formed by the axillary fascia stretched between the anterior and posterior boundaries, and the *apex* will now be found with the finger in a triangular interval between the clavicle, the upper border of the scapula, and the first rib. The great vessels and nerves lie along the outer boundary of the space, the artery being between the nervous cords, and the vein to their inner side, whilst most of the branches of the artery take a general direction towards the thorax. On the inner side of the space, and imbedded in fat, are the glands, ten or twelve in number, which receive the lymphatics from the front of the chest and the mamma, and from the arm and part of the back; the superficial ones lie along the edge of the pectoralis, and the deeper ones mostly in close proximity to the axillary vessels, occasionally even surrounding them, but others are found at the back of the axilla along the subscapular vessels.

Opportunity is to be taken, before any further dissection is made, to expose the lower part of the axillary artery thoroughly, as that is the portion of the vessel to which a ligature may be best applied.

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

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

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

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

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

The **Costo-coracoid Membrane** (Fig. 3, 2) is a strong fascia consisting of two layers, which include the subclavian muscle between them. It is attached above to the two lips of the groove on the under surface of the clavicle, internally to the first rib, and externally to the coracoid process. The two layers meet below, forming a distinct curved edge with the concavity downwards. A thin prolongation downwards from it to the sheath of the axillary vessels is perforated by the cephalic vein and the acromio-thoracic artery, and by the external anterior thoracic nerve.

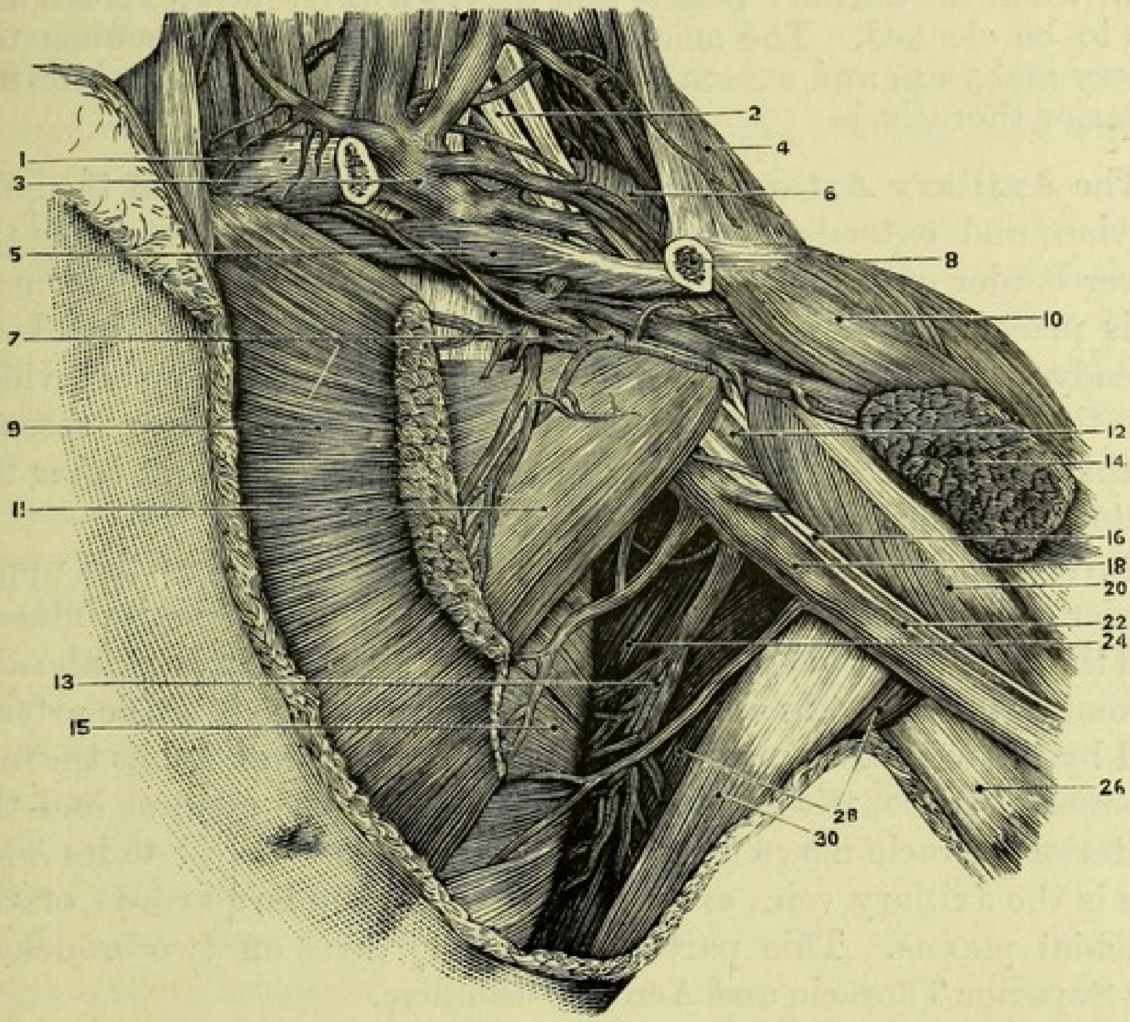
The **Subclavius** (Fig. 2, 5) is a small muscle which *arises* by a tendon from the first rib at the junction of bone and cartilage, and is *inserted* into the groove on the under surface of the middle-third of the clavicle. It is a depressor of the clavicle, and is *supplied* by a special branch of the brachial plexus above the clavicle.

The *sheath* of the axillary vessels is derived from the deep cervical fascia, and passes beneath the clavicle. It is strengthened by a process of the costo-coracoid membrane, and is gradually lost upon the vessels.

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

The **Pectoralis Minor** (Fig. 2, 11) is beneath the pectoralis major, and therefore assists in forming the anterior boundary of the axilla. It *arises* from the anterior extremities of the third, fourth, and fifth ribs, usually about an inch from their junctions with the

Fig. 2.



cartilages, and is *inserted* into the inner side of the coracoid process of the scapula, thus crossing obliquely the axillary vessels and nerves. The pectoralis minor draws the coracoid process down-

Fig. 2.—Deep Dissection of the Axilla (from Bonamy and Beau).

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

wards and forwards, and so tends to make the lower angle project backwards. It is also an extraordinary muscle of inspiration. It is *supplied* by the internal anterior thoracic nerve, which perforates it to reach the pectoralis major.

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

The **Axillary Artery** (Fig. 2, 12) is the continuation of the subclavian, and extends from the lower border of the first rib to the lower border of the insertion of the teres major. In its upper part it is placed deeply in the axilla, but its lower portion has been already seen to be comparatively superficial. The artery is divided into three parts, viz., first, or that *above* the pectoralis minor; second, or that *beneath* the pectoralis minor; and third, or that *below* the pectoralis minor.

First part (from the lower border of the first rib to the upper border of pectoralis minor) has *in front* the pectoralis major muscle and the costo-coracoid membrane, and is crossed by the cephalic and acromio-thoracic veins and branches of the acromio-thoracic artery, and by the external anterior thoracic nerve; *behind*, it has the first intercostal space, with a digitation of the serratus magnus and the posterior thoracic nerve (external respiratory of Bell); to its *inner side* is the axillary vein, and to the *outer* are the large cords of the brachial plexus. This part of the artery gives off two branches, the Superior Thoracic and Acromio-thoracic.

Second part (beneath the pectoralis minor) has *in front* the pectoralis major and the pectoralis minor; *behind*, at a little distance, is the subscapularis, with the posterior cord of the brachial plexus; to its *inner side* are the vein and the inner cord; and on the *outer side* is the outer cord of the plexus. The branches of this part of the artery are the Long Thoracic and the Alar Thoracic.

Third part (from the lower border of the pectoralis minor to the lower border of the teres major) has the pectoralis major *in front* except at the lowest portion, and is also embraced by the two heads of the median nerve, which itself lies for a short distance in front of the artery, having the large internal cutaneous nerve usually by its side; *behind*, it lies upon the lower part of the subscapularis, the tendon of the latissimus dorsi, and a small portion of the teres major muscle, together with the musculo-spiral and the circumflex nerves; to its *inner side* is the axillary vein, with the inner head of the median nerve (for a short distance), the ulnar, and the lesser internal cutaneous (Wrisberg) nerves; to the *outer side* is the coraco-brachialis muscle, with the outer head of the median at first, but lower down the entire nerve, and also the external cutaneous nerve until it pierces the coraco-brachialis. The branches of this portion are the Subscapular, Anterior Circumflex, and Posterior Circumflex.

Branches of the Axillary Artery (Fig. 3).*—

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

2. The *acromio-thoracic* (*thoracica-humeraria; thoracic axis*) (1) is a large branch arising from the artery at the upper border of the pectoralis minor, and immediately piercing the costo-coracoid membrane to divide into three branches. One (thoracic) runs forward to supply the serratus magnus and pectoralis muscles, a second (acromial) passes outwards to the acromion process and shoulder, and the third (humeral) downwards in the groove between the pectoralis major and deltoid by the side of the cephalic vein.

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

4. The *alar thoracic* (3) is a small branch to the axillary glands. It very seldom arises directly from the axillary, but generally from one of the other branches.

5. The *subscapular* (15) is a large branch which runs along the lower border of the subscapularis muscle to the side of the chest with the long subscapular nerve, and supplies the adjacent parts, anastomosing with the long thoracic artery. An inch or less from its origin this artery gives off a large branch, the *dorsalis scapulæ* (17), which winds round the lower border of the subscapularis muscle and, after giving an *infrascapular* branch, disappears through a triangular interval, bounded (as seen from the front) by the long head of the triceps, the teres major, and the subscapularis.

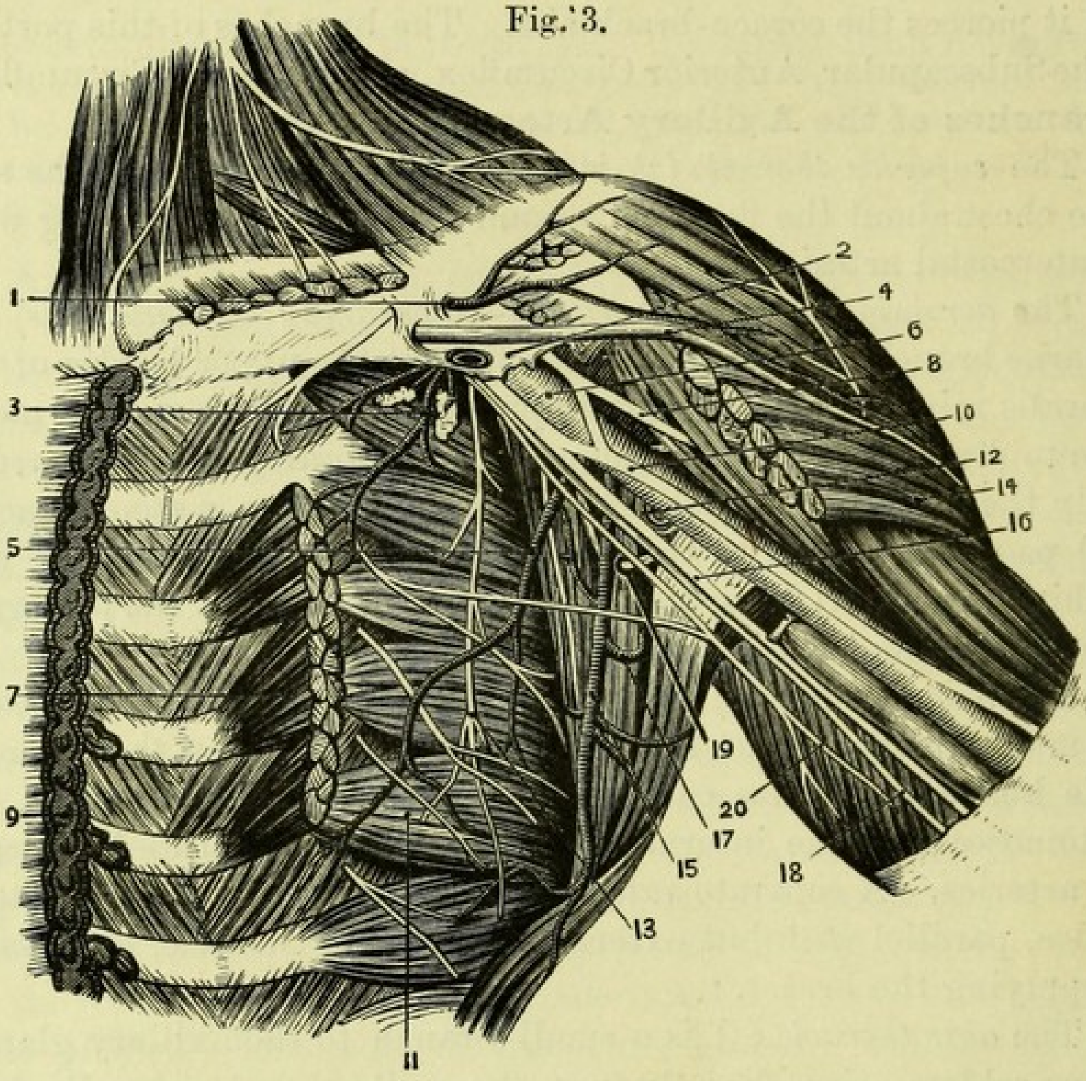
6. The *anterior circumflex* is a small branch winding round the neck of the humerus beneath the coraco-brachialis and biceps,

* The branches of the Axillary Artery may be kept in mind by the word SALASAP; thus:—Superior thoracic, Acromio-thoracic, Long thoracic, Alar thoracic, Subscapular, Anterior and Posterior circumflex.

which it supplies, giving also a branch up the bicipital groove to the shoulder-joint.

7. The *posterior circumflex* (12) is larger than the anterior, and

Fig. 3.



winds behind the neck of the humerus to supply the deltoid, passing through a quadrilateral space bounded (as seen in front) by the teres major, subscapularis, long head of the triceps, and the neck of the humerus.

Fig. 3.—The Axillary Artery and its Branches, the Pectoral Muscles being removed (drawn by G. E. L. Pearse).

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

The **Axillary Vein** (Fig. 2, 18) lies to the inner side of the artery, being the continuation of the basilic vein from the lower border of the teres major; at a variable point it is joined by the *venæ comites* of the brachial artery, and, having received tributaries corresponding to the branches of the axillary artery, and the cephalic vein immediately below the clavicle, it ends in the subclavian vein.

Brachial Nerves (Fig. 4).—The large cords of the brachial plexus are derived from the 5th, 6th, 7th, 8th cervical and the greater part of the 1st dorsal nerves, which make their appearance in the posterior triangle of the neck (Part IV.). The nerves coalesce and divide again in a manner which is not the same in all subjects (see Posterior Triangle of the Neck), but the result is that they enter the axilla as three cords (occasionally two), lying to the outer side of the first part of the axillary artery. The three cords are in relation respectively with the inner, outer, and posterior aspects of the second portion of that vessel; and the several branches derived from these trunks, and now to be examined, more or less surround the artery in its third part.*

Brachial plexus formed by 5th, 6th, 7th, 8th cervical, and 1st dorsal nerves	Outer cord . . .	External anterior thoracic. External cutaneous. Outer head of median.
	Inner cord . . .	Inner head of median. Ulnar. Internal cutaneous. Lesser internal cutaneous. Internal anterior thoracic.
	Posterior cord . .	Musculo-spiral. Circumflex. Three subscapular nerves.

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

The *External anterior thoracic nerve* (11) is a small branch derived from the outer cord, going to the under surface of the pectoralis major, which it supplies.

The *Internal anterior thoracic nerve* (10) is a small branch from

* The brachial plexus may consist occasionally of only two cords when it enters the axilla; in which case a third cord is formed below the clavicle by the union of branches derived from these two cords, the relations to the artery remaining the same as those given above.

the inner cord, which passes between the axillary artery and vein to supply the pectoralis minor and, after communicating with the preceding nerve, the pectoralis major.

The *Circumflex* (Fig. 3, 19) is a large nerve from the posterior cord, and lies behind the axillary artery for a short distance, leaving it then to accompany the posterior circumflex artery through the quadrilateral space already described, and winding round the humerus to the deltoid, to which it will be subsequently traced.

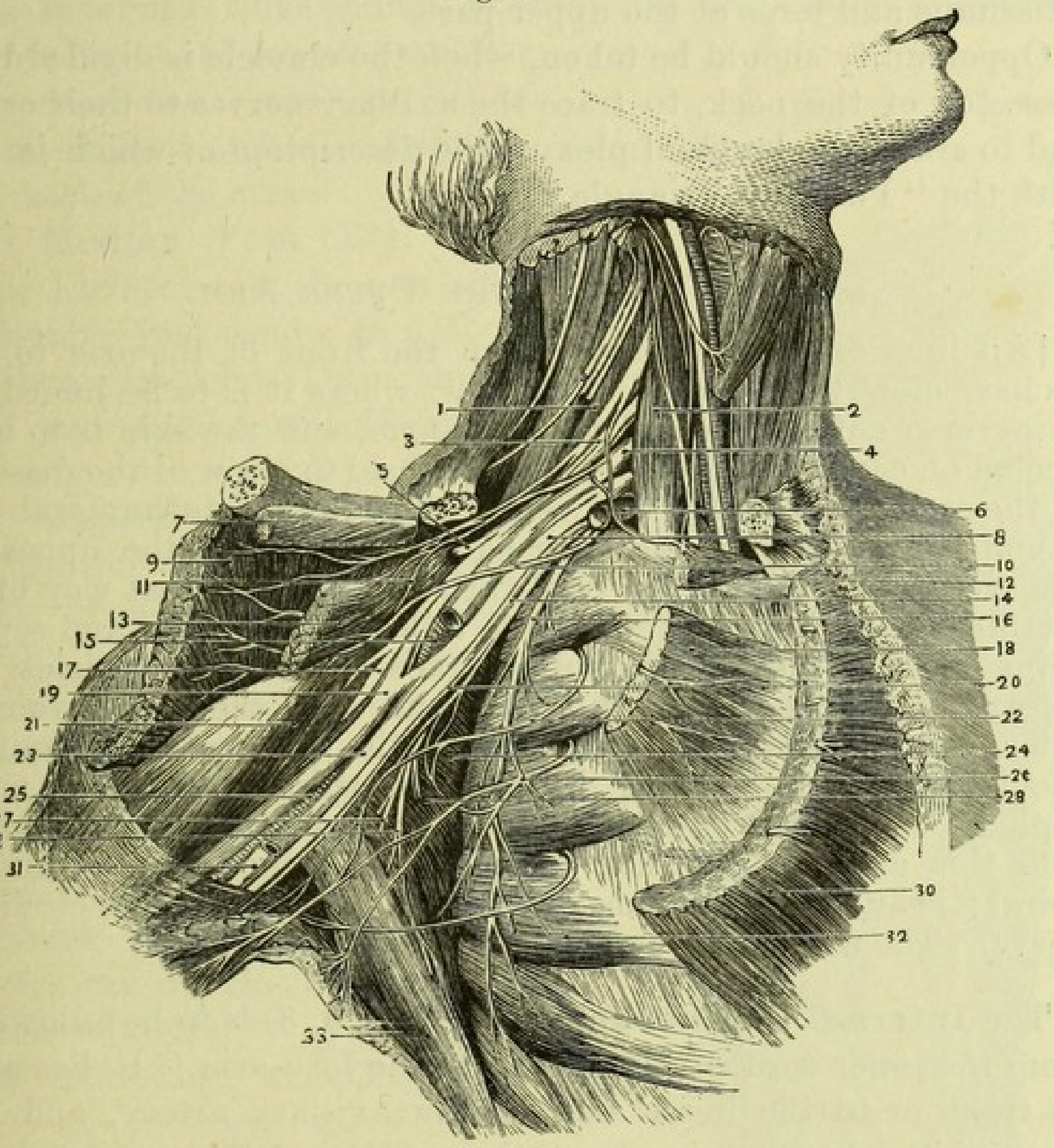
Three *Subscapular nerves* (Fig. 4, 27, 28, 29) are derived from the posterior cord. The long, or middle, subscapular nerve is seen at the lower border of the subscapularis muscle accompanying the subscapular artery, and ends in the latissimus dorsi. The two shorter subscapular nerves will be better dissected when the arm is removed; they enter the subscapularis and teres major muscles, and supply them.

The *Posterior* or *long thoracic nerve* (external respiratory of Bell) (16) lies upon the serratus magnus, which it supplies, and is one of the supra-clavicular branches of the brachial plexus, being derived from the fifth and sixth nerves, with an occasional branch from the seventh; it descends behind the brachial cords and axillary vessels to its distribution upon the surface of the serratus.

The **Serratus Magnus** (Fig. 4, 32) covers the side of the chest, *arising* by nine digitations from the outer surfaces of the eight upper ribs, there being two digitations attached to the second rib; or more exactly, the first digitation being attached to the first and second ribs. The fibres have a general direction backwards to the inner surface of the base of the scapula, where they are *inserted*, but the first two digitations unite to form a thicker portion corresponding to the surface at the upper angle, while the last four form a still larger bundle, corresponding to the surface at the inferior angle of the scapula. These last slips interdigitate with the external oblique muscle of the abdomen. The serratus magnus draws the scapula forwards, and as the lower and stronger fibres are attached to the lower angle, they draw this forward and so rotate the glenoid cavity upwards. With the rhomboids, it keeps the bone applied to the chest walls. In forced breathing the lower fibres may possibly assist inspiration if the arm be fixed.

Insertions of the Latissimus Dorsi and Teres Major.—The upper part of the latissimus winds round the lower angle of the scapula, which it envelopes in a sort of fold, and ends in a broad, thin tendon, which passes in front of the teres major to be *inserted* into the bottom of the bicipital groove of the humerus above the level of the teres major. As in the case of the pectoralis major, the fibres of the muscle are twisted so that those which were highest at

Fig. 4.



their origin are lowest at their insertion, and *vice versâ ;* it is the narrowest of the three tendons inserted into the bicipital groove.

The teres major passes behind the tendon of the latissimus, being

Fig. 4.—The nerves of the Axilla (from Hirschfeld and Leveillé).

1. Scalenus medius.
2. Scalenus anticus.
3. Cord formed by 5th and 6th cervical nerves.
4. 7th cervical nerve.
5. Suprascapular nerve.
6. Subclavian artery (cut).
7. Insertion of subclavius.
8. Cord formed by 8th cervical and 1st dorsal nerves.
9. Pectoralis major (reflected).
10. Internal anterior thoracic nerve.
11. External anterior thoracic nerve.
12. Origin of subclavius.
13. Pectoralis minor (reflected).
14. Internal cutaneous nerve.
15. Axillary artery (cut).
16. Posterior thoracic nerve.
17. Musculo-cutaneous nerve.
18. Origin of pectoralis minor.
19. Median nerve.
20. Nerve of Wrisberg.

more or less incorporated with it below, and is *inserted* into the inner or posterior edge of the bicipital groove, exactly opposite the pectoralis major, a bursa being found between the insertions of the latissimus and teres at the upper part.

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

The Front of the Upper Arm.

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

The **Internal Cutaneous Nerve** (Fig. 5, 8) is to be followed out from the inner cord of the plexus to the fore-arm. It lies at first in front or to the inner side of the axillary artery, and then, piercing the deep fascia about the middle of the arm, at or near the point at which the basilic vein enters, it runs in front of the inner condyle and, subdividing, sends branches both over and under the median basilic vein to the inner side of the fore-arm. A posterior branch winds above the inner condyle to the back of the fore-arm.

The **Lesser Internal Cutaneous Nerve** (nerve of Wrisberg) (Fig. 5, 2), after joining with the intercosto-humeral nerve, pierces

21. Coraco-brachialis.
22. Intercosto-humeral nerve.
23. Ulnar nerve.
24. Subscapularis.
25. Brachial artery.
26. Lateral cutaneous branch of 3rd intercostal nerve.
27. Middle subscapular nerve.
28. Short subscapular nerve.
29. Long subscapular nerve.
30. Pectoralis major (cut).
31. Basilic vein.
32. Serratus magnus.
33. Latissimus dorsi.

the fascia at a variable point, and supplies the lower third of the inner side of the upper arm behind the internal cutaneous nerve. It is not always present.

The **Internal Cutaneous Branch of the Musculo-spiral Nerve** (Fig. 5, 6) appears on the inner side of the upper arm, below the teres major, and is distributed to the back of the arm.

The **Median Vein** (Fig. 5, 14) is near the centre of the fore-arm, and divides just below the elbow into two branches, the *median basilic* and *median cephalic*, which pass obliquely inwards and outwards respectively, to assist in forming the basilic and cephalic veins. Piercing the deep fascia near the bend of the elbow is the *profunda vein*, which joins the median near its point of bifurcation, and forms a communication between the *venœ comites* of the arteries of the fore-arm and the superficial veins, the direction of the current of blood varying in different subjects.

The **Anterior and Posterior**

Fig. 5.

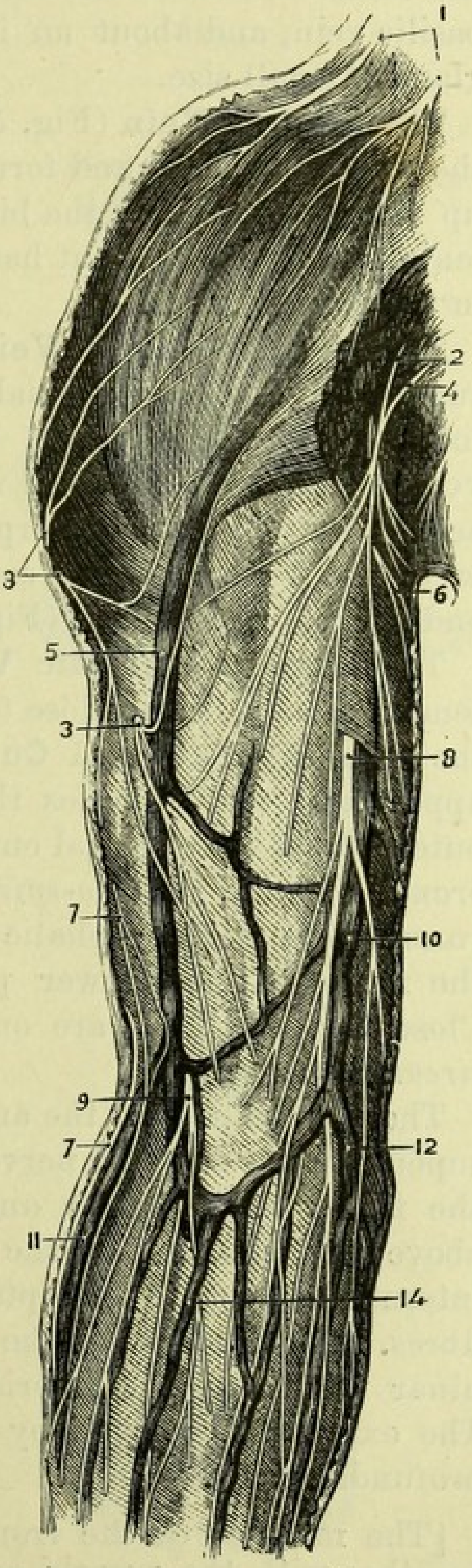


Fig. 5.—Superficial dissection of the arm (from Hirschfeld and Leveillé).
1. Acromial nerves from superficial cervical plexus.
2. Nerve of Wrisberg.
3, 3. Circumflex nerve.
4. Intercosto-humeral nerve.
5. Cephalic vein.
6. Internal cutaneous branch of musculo-spiral nerve.
7, 7. External cutaneous branches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

Ulnar Veins (Fig. 5, 12) end on the inner side of the fore-arm in a single trunk, which unites with the median basilic to form the basilic vein.

The **Basilic Vein** (Fig. 5, 10) runs up the inner side of the arm to about its middle, where it pierces the deep fascia and is continued up into the axillary vein, receiving, at a variable point, the venæ comites of the brachial artery. To the inner side of the basilic vein, and about an inch above the condyle, is a lymphatic gland of small size.

The **Radial Vein** (Fig. 5, 11) ascends on the outer side to join the median cephalic and form the **Cephalic Vein** (5), which passes up the outer side of the biceps, and then between the pectoralis major and the deltoid; it has already been traced to its termination in the axillary vein.

The **Median Basilic Vein** has important relations, since it lies superficially to the brachial artery, and crosses over or under the internal cutaneous nerve. It is the vessel usually selected for venesection on account of its size. Protection is afforded to the artery beneath by the interposition of a process of fascia (bicipital or semi-lunar), which is connected with the tendon of the biceps, and may now be defined (Fig. 6, 22).

The **Median Cephalic Vein** is of smaller size and crosses the tendon of the biceps, close to the outer side of which, and beneath the vein, the **External Cutaneous Nerve** (Fig. 5, 9) makes its appearance and supplies the adjacent parts. Above and to the outer side of the external cutaneous nerve are two *external cutaneous branches of the musculo-spiral nerve* (7), the upper and smaller one running along the cephalic vein to the upper part of the front of the fore-arm; the lower passing to the back of the fore-arm. Close to the deltoid are one or two cutaneous branches of the *circumflex nerve* (3).

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

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

The **Biceps** (Fig. 6, 9, 12) is the superficial muscle of the upper arm and arises by two heads, which generally unite in the upper third of the arm, but occasionally remain distinct nearly to their insertion. The *long* or *outer* head cannot be fully traced at present, since it *arises* within the capsule of the shoulder-joint from the top of the glenoid cavity, and also from the glenoid ligament. Traversing the joint and enclosed in a tube of synovial membrane, the tendon enters the bicipital groove of the humerus, and is seen to emerge from the capsular ligament and lie upon the tendon of the latissimus, and between the insertions of the pectoralis major and teres major muscles. The *short* or *inner* head *arises* from the tip of the coracoid process of the

Fig. 6.

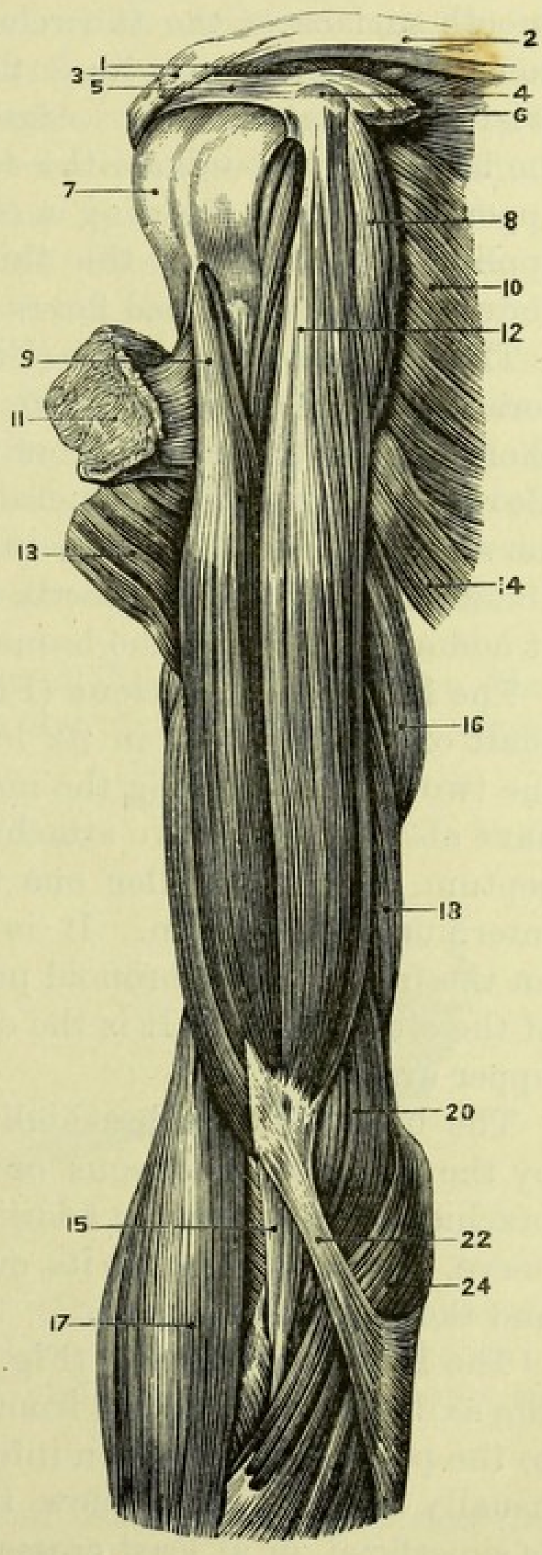


Fig. 6.—Muscles of the front of the upper arm (from Bonamy and Beau).
1. Coraco-clavicular ligament.
2. Clavicle.
3. Acromio-clavicular ligament.
4. Coracoid process.
5. Coraco-acromial ligament.
6. Pectoralis minor.
7. Head of humerus enclosed in capsule of shoulder joint.
8. Coraco-brachialis.
9. Long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

scapula, in common with, but to the outer side of, the coraco-brachialis, and the two heads unite to form a large fleshy belly. The fibres converge to a broad tendon, from which, immediately above the elbow-joint, an expansion, called the bicipital or semilunar fascia, is given off to join the fascia on the upper and inner part of the fore-arm (22). This would have to be divided in order to follow the tendon of the biceps (15), which passes deeply to be *inserted* into the back of the bicipital tubercle of the radius, a bursa being placed between the tendon and the upper smooth surface of the tubercle. It will be seen in a later dissection. The tendon becomes flattened near its insertion, and is twisted so that its *outer* edge becomes *anterior*. The action of the biceps is to supinate the fore-arm, and then flex it upon the upper arm (as in drawing a cork), being a good example of force applied to a lever of the third order. The long head slightly abducts, the short head flexes and adducts the humerus.

The **Coraco-brachialis** (Fig. 6, 8) *arises* from the tip of the coracoid process, in common with, but to the inner side of, the short head of the biceps, from the tendinous upper part of which it also takes origin. It is generally pierced by the external cutaneous nerve, and is *inserted* on the inner side of the shaft of the humerus about its middle, and exactly opposite the insertion of the deltoid. It adducts and flexes the humerus.

The **Brachialis anticus** (Fig. 8, 11) *arises* from the front of the shaft of the humerus in its lower half; the origin is bifid above, the two slips embracing the insertion of the deltoid; and the fibres have also an extensive attachment to the internal intermuscular septum, and a smaller one to the upper part of the external intermuscular septum. It is *inserted* into a triangular surface on the front of the coronoid process of the ulna, covering the front of the elbow-joint. It is the direct flexor of the fore-arm upon the upper arm.

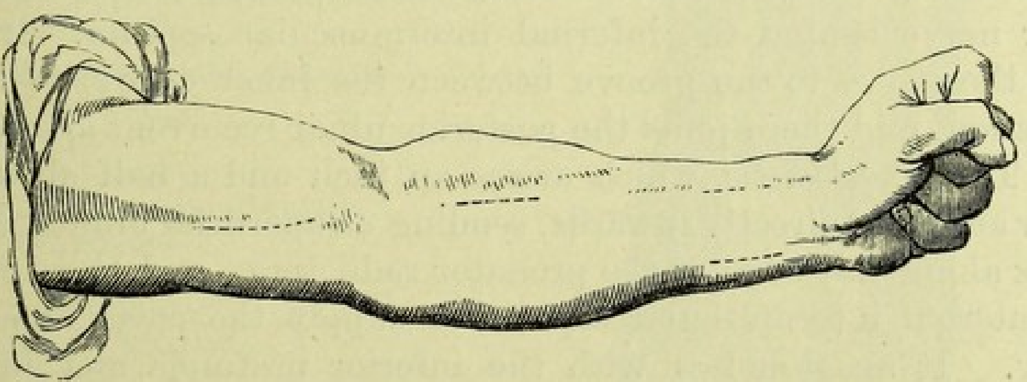
The biceps, coraco-brachialis, and brachialis anticus are *supplied* by the external cutaneous or musculo-cutaneous nerve; and the brachialis anticus has an additional supply from the musculo-spiral nerve, which is close to its outer border, lying deeply between it and the supinator longus.

The **Brachial Artery** (Fig. 8, 14) is the direct continuation of the axillary, and extends from the lower border of the teres major to the point of bifurcation into radial and ulnar arteries, which is usually half an inch below the bend of the elbow. The artery is superficial, or at least crossed by no muscle, in the whole of its course, and it gradually turns from the inner side of the arm to the middle of the bend of the elbow.

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

Surgery.—*To tie the brachial artery* (Fig. 7). An incision, three inches long, is to be made close to and exposing the inner edge of

Fig. 7.



the biceps in the middle third of the arm. A little dissection parallel to the muscle will expose the median nerve, and the artery will be found in close relation to it, and generally to its outer side

Fig. 7.—Incisions for tying the brachial, radial, and ulnar arteries (from Fergusson's "Practical Surgery").

in this position, but this will vary in different bodies. The needle is to be passed *from* the nerve, care being taken of the venæ comites.

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

The **Branches** of the brachial artery are—

1. *Muscular*, arising at various points to supply the adjacent muscles.

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

3. The *Superior profunda*, which comes off from the inner side of the artery, just below the teres major, and immediately joining the musculo-spiral nerve, accompanies it between the outer and inner heads of the triceps and, under cover of the long head, round the humerus to the outer side. It now may be seen with the nerve between the brachialis anticus and supinator longus in front of the elbow, where it anastomoses with the radial recurrent artery. It gives off muscular branches (principally to the triceps); one of these, which is larger than the continuation of the artery, running to the anconeus and back of the elbow, will be afterwards seen to anastomose with the interosseous recurrent artery.

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

5. The *Anastomotic*, which arises an inch and a half above the elbow and runs directly inwards, sending a superficial branch downwards along the edge of the pronator radii teres, and then pierces the internal intermuscular septum to supply the parts about the elbow. It anastomoses with the inferior profunda and anterior and posterior ulnar recurrent arteries, and gives a branch to join the superior profunda behind the humerus.

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

Venæ Comites are in close relation with the brachial artery, and receive twigs corresponding

Fig. 8.

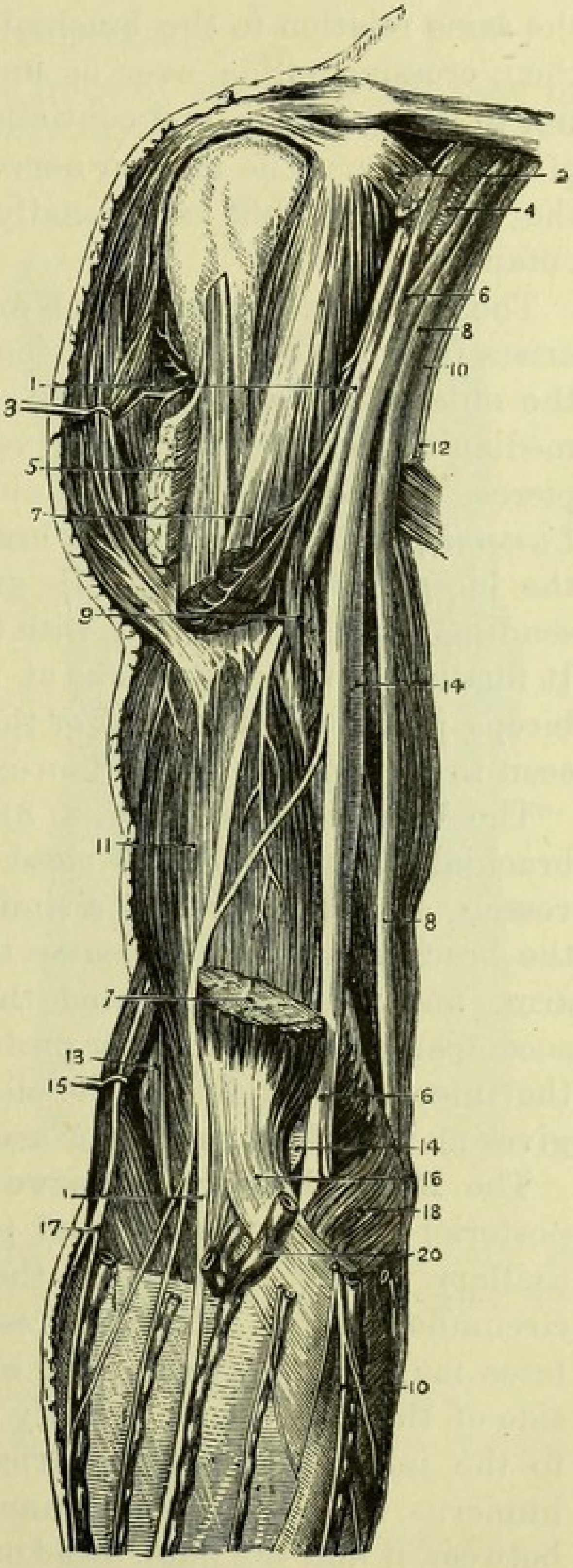


Fig. 8.—Deep dissection of the front of the upper arm (from Hirschfeld and Leveillé).

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

to its branches: they unite with the basilic to form the axillary vein.

Nerves of the Arm.

The **Median Nerve** (Fig. 8, 6) is derived from the outer and inner cords of the brachial plexus by two roots, which embrace the axillary artery in the third part of its course. The nerve afterwards lies to the outer side of the axillary artery, and continues in the same relation to the brachial artery for about half its length; then, crossing either over or under that vessel, the median nerve lies to its inner side, and continues in the same relation to the bend of the elbow. The median nerve ordinarily gives off no branch in the upper arm, but occasionally communicates with the external cutaneous nerve.

The **External Cutaneous Nerve** (musculo-cutaneous) (Fig. 8, 1) arises from the outer cord of the brachial plexus in common with the outer head of the median, and lies to the outer side of the median nerve and the axillary vessels for a short distance. It then pierces the coraco-brachialis obliquely (hence called *n. perforans Casserii*), and having given a branch to that muscle, it lies between the biceps and the brachialis anticus, both of which it supplies; sending also a minute twig with the nutrient artery to the humerus. It finally becomes cutaneous at the outer side of the tendon of the biceps just above the bend of the elbow, where it has been already seen to lie beneath the median-cephalic vein.

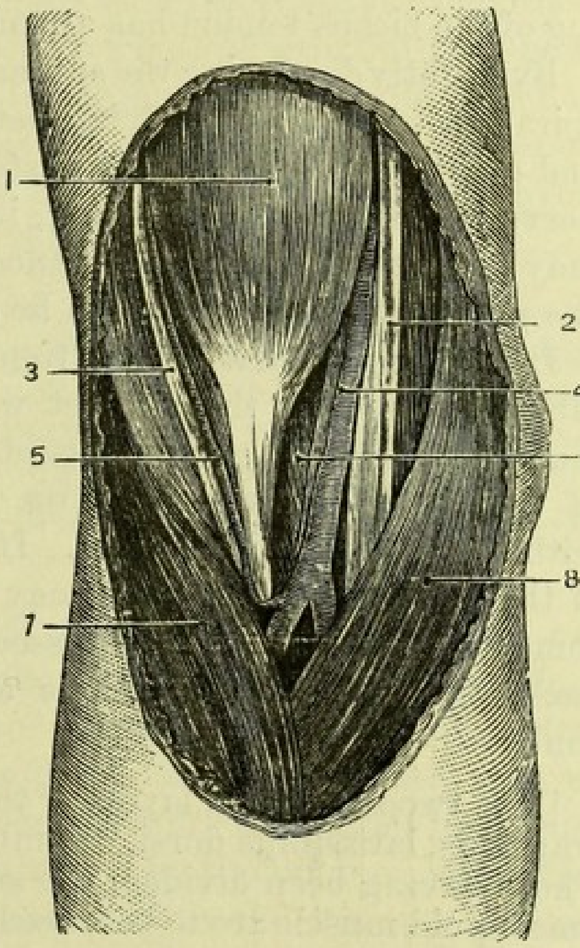
The **Ulnar Nerve** (Fig. 8, 8) arises from the inner cord of the brachial plexus, and lies close to the inner side of the axillary vessels, and afterwards in a similar relation with the upper part of the brachial artery. It leaves that vessel about the middle of the arm, and then runs behind the internal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

The **Musculo-spiral Nerve** (Fig. 8, 13) is derived from the posterior cord of the brachial plexus, and lies at first behind the axillary artery, and upon the subscapularis muscle with the circumflex nerve. It then rests upon the latissimus dorsi and teres major, and, after giving off a cutaneous branch to the inner side of the arm, which usually arises in common with the branch to the inner head of the triceps, winds backwards around the humerus, lying against the inner head of the triceps and afterwards between it and the outer head of that muscle. Branches supplying the triceps can now be seen, and in a subsequent dissection the nerve will be followed through the fibres of that muscle. Its lower portion is now visible between the supinator longus and brachialis anticus, to both of which and to the extensor carpi radialis longior branches may be traced; the division into *radial* and *posterior interosseous* nerves, in front of the external condyle, is also to be dissected out.

The Bend of the Elbow.

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

Fig. 9.



The **Triangle in front of the Elbow** (Fig. 9) is bounded *above* by an imaginary line drawn across the arm above the condyles, and *below* the apex is formed by the meeting of the pronator teres and supinator longus two inches below the joint. The *external* boundary is the supinator longus, the *internal* the pronator teres, whilst the

Fig. 9.—The bend of the elbow (from University College Museum).

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

floor is formed, first, by the lower part of the brachialis anticus, and afterwards by the oblique fibres of the supinator brevis, which, however, cannot be seen until the space is opened up. The relations of the superficial veins and nerves have been already examined (p. 27), and the *contents* of the space are now seen to be (1) the median nerve, (2) the brachial artery, and (3) the tendon of the biceps, which lie in that order from within outwards.* The median nerve (2) lies nearly vertically in the space, and disappears between the heads of the pronator teres: the brachial artery (4) usually bifurcates into radial and ulnar upon the insertion of the brachialis anticus, the radial resting against the tendon of the biceps and the supinator brevis, and the ulnar lying upon the brachialis till it disappears beneath the pronator teres. The twisting of the biceps tendon has already been referred to.

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

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

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

* Artificial memory, NAT.

PARTS ABOUT THE SCAPULA.

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

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

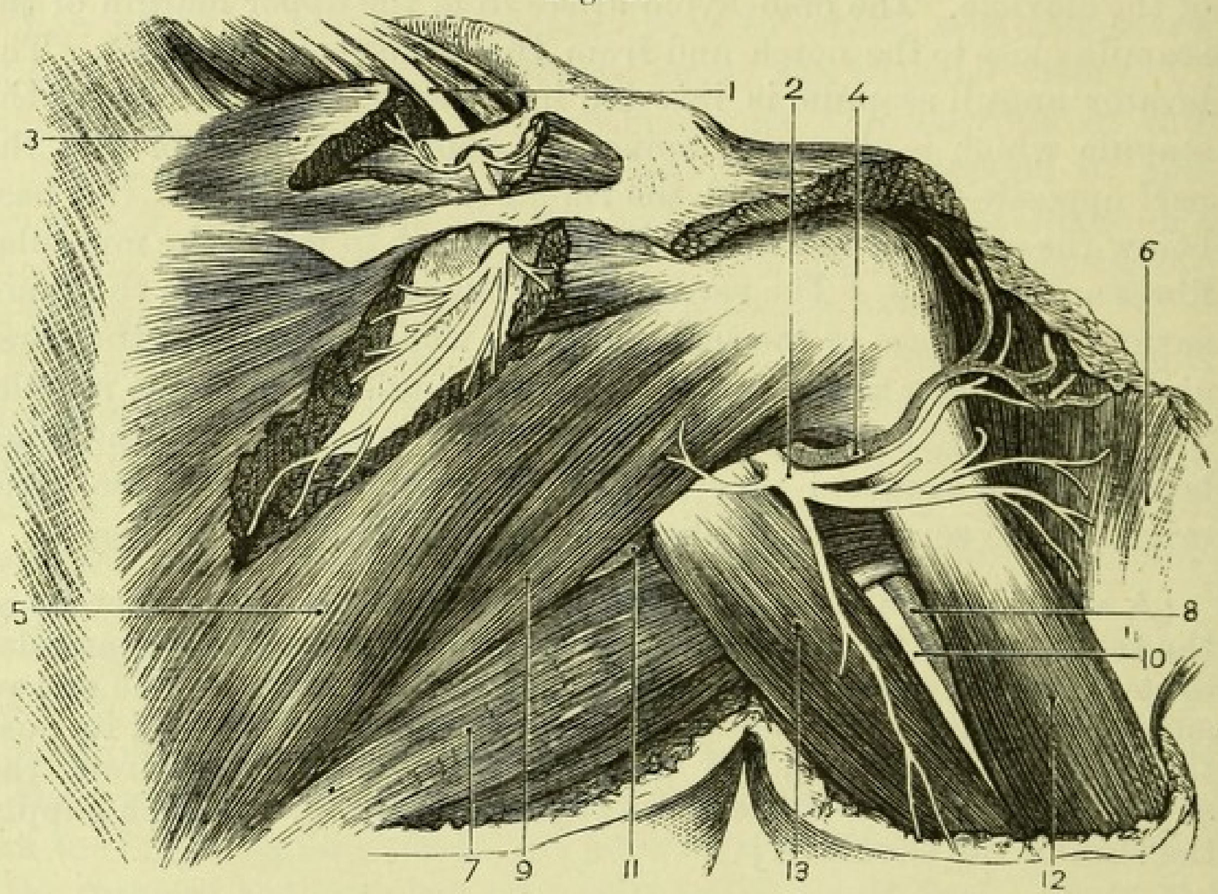
[A small block is now to be placed beneath the lower border of the scapula so as to put the deltoid on the stretch, and the remainder of its fibres are then to be cleaned, notice being taken of one or two small branches of the circumflex nerve which turn round its posterior border, and of a few descending *acromial* twigs from the superficial branches of the cervical plexus (Fig. 5, 1) which supply the skin of the shoulder.]

The **Deltoid Muscle** (Fig. 10, 6) *arises* from the outer half or third of the anterior border of the clavicle, and from the outer edge of the acromion, and the lower lip of the spine of the scapula. Its strong coarse fibres converge to a point, and are *inserted* into a rough surface of a triangular shape on the outer side of the humerus in the middle of the shaft, being embraced by the bifid origin of the brachialis anticus, and closely connected with the insertion of the pectoralis major. The action of the deltoid as a whole is to raise the arm to the level of the shoulder, *i.e.*, to abduct the humerus; but the anterior fibres will assist in flexion and the posterior in extension of the shoulder-joint. It is an example of power applied to a lever of the third order, and is *supplied* by the circumflex nerve.

[The deltoid is to be divided near its origin and turned down, the circumflex vessels and nerve being preserved. In doing this a large bursa lying between the deltoid and the shoulder-joint should be noticed. The remains of the trapezius muscle are to be cut close to the spine of the scapula, and the thin fascia covering the muscles above and below it removed, the humerus being rotated inwards to put their fibres on the stretch.]

The Sub-acromial Bursa lines the interval between the upper part of the shoulder-joint and the under surface of the deltoid, acromion

Fig. 10.



process, and coraco-acromial ligament. It thus forms an extensive sac and is important, as its enlargement may be confounded with disease of the joint.

The **Parts beneath the Deltoid Muscle** (Fig. 10) are—the Infra-spinatus, Teres Minor, and Teres Major muscles, and the long head of the Triceps, with the head and neck of the humerus, the

Fig. 10.—Scapular muscles, vessels, and nerves (from University College Museum).

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

coracoid process and the muscles attached to it, and the circumflex vessels and nerve; the tip of the coracoid process corresponding to the interval between the pectoralis major and deltoid.

The quadrilateral and triangular intermuscular spaces, referred to in the dissection of the axilla (p. 16), can now be seen *from behind*, when the quadrilateral or outer one will be found to be bounded by the teres major, teres minor, humerus, and long head of triceps; the triangular or inner one, by the teres major, teres minor, and long head of triceps; and the vessels and nerve they transmit are now to be traced out. (A triangular interval between the teres major and the long and external heads of the triceps must not be mistaken for this latter space.) The posterior circumflex artery and circumflex nerve pass through the quadrilateral space; the dorsalis scapulæ artery lies in the triangular space; and the large musculo-spiral nerve with the brachial artery will be seen between the heads of the triceps.

The **Supra-spinatus Muscle** (Fig. 10, 3) occupies the supra-spinal fossa, *arising* from the greater part of the fossa itself, from the upper surface of the spine, and from the fascia covering the muscle. The tendon passes beneath the acromion to be *inserted* into the uppermost facet on the great tuberosity of the humerus, and slightly into the capsular ligament of the shoulder-joint. In order to follow the tendon thoroughly, the acromial end of the spine of the scapula is to be divided with the saw, when a part of the subacromial bursa, before mentioned, will be found between it and the muscle.

The **Infra-spinatus Muscle** (Fig. 10, 5) *arises* from the whole of the infraspinal fossa except the part near the neck of the scapula; and from the fascia covering the muscle, and from the intermuscular septa between it and the teres muscles. It is *inserted* into the middle facet on the great tuberosity of the humerus and into the capsule of the shoulder-joint, being blended there with the supra-spinatus and teres minor. The supra- and infra-spinatus muscles are *supplied* by the suprascapular nerve.

The **Teres Minor Muscle** (Fig. 10, 9) *arises* from the dorsal aspect of the inferior costa or border of the scapula in nearly its whole length, from the fascia covering the muscle, and from the intermuscular septa between it and the infra-spinatus and teres major muscles. It is *inserted* into the lowest facet on the great tuberosity of the humerus and for nearly an inch below it, and also into the capsular ligament of the shoulder. The teres minor is *supplied* by a special branch of the circumflex nerve, which should be followed to it, and which is remarkable for having a gangliform enlargement upon it.

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

The **Teres Major Muscle** (Fig. 10, 7) *arises* from the triangular surface at the inferior angle of the scapula, and from the intermuscular septa between it and the teres minor and infra-spinatus muscles. Its close relation to the latissimus dorsi has been already noticed, but its *insertion* into the inner lip of the bicipital groove should be again clearly seen. The teres major is supplied by one of the subscapular nerves, and is an *internal rotator* and *adductor* of the humerus.

The **Posterior Circumflex Artery** (Fig. 10, 4) with its veins, and the **Circumflex Nerve** (Fig. 10, 2), appear through the quadrilateral space (see pp. 16 and 33), and are distributed to the under surface of the deltoid muscle, giving branches to the shoulder-joint; the nerve also supplies the teres minor muscle with a branch (on which may be found a gangliform enlargement), and gives a branch or two to the skin of the shoulder and arm. The posterior circumflex artery not unfrequently arises from, or in common with, the superior profunda, in which case it is below instead of above the teres major.

The **Dorsalis Scapulæ Artery** (dorsal branch of subscapular) (Fig. 10, 11), does not pass through the triangular space as seen from behind, but winds beneath the teres minor in a groove on the inferior costa of the scapula, to supply the infraspinal fossa and anastomose with the other scapular arteries. It gives off the *infra-scapular* artery, which will be afterwards traced beneath the subscapularis, and a superficial branch, which runs between the teres major and minor and down to the angle of the scapula, to anastomose with the subscapular and posterior scapular arteries.

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

The **Supra-scapular Artery** (from the thyroid axis) passes over the transverse ligament of the scapula, and is distributed to the supraspinal fossa, and also to part of the infraspinal fossa by a branch which winds in front of the spine and anastomoses with the dorsalis scapulæ and posterior scapular arteries. Before crossing the ligament, it sends a *subscapular* twig to the venter of the scapula.

The **Supra-scapular Nerve** (from the 5th and 6th nerves of the brachial plexus) (Fig. 10, I) passes through the supra-scapular notch and beneath the ligament, and is distributed to the supra- and infra-spinatus muscles.

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

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

The **Subscapularis Muscle** (Fig. 6, IO) is covered by a thin fascia, and has been already seen to form part of the posterior wall of the axilla. It *arises* from the whole of the venter scapulæ, except the part to which the serratus magnus is attached and the portion nearest the neck of the bone, and has several tendinous septa between its fibres, which are attached to the ridges on the surface of the bone. It is *inserted* into the lesser tuberosity of the humerus and the bone below it for an inch, and into the capsular ligament of the shoulder-joint, a large bursa intervening between the muscle and the neck of the scapula, which usually communicates with the cavity of the joint. The subscapularis is an *internal rotator* and *adductor* of the humerus, and is *supplied* by the short subscapular nerves.

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

The **Subscapular Nerves** (Fig. 4) are branches of the posterior cord of the brachial plexus, and are three in number. The long subscapular nerve has been already seen in the axilla, and can still be traced to the latissimus dorsi; the short subscapular nerves (upper and lower) are now to be followed, the upper to the subscapularis muscle, the lower giving a branch to the subscapularis and supplying the teres major.

The **Subscapular Artery** is still to be seen along the lower border of the scapula, and its branches should be thoroughly followed out.

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

The **Posterior Scapular Artery** is to be found between the serratus magnus and the rhomboidei, and its anastomoses should be defined.

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

The Back of the Arm.

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

Cutaneous branches of Musculo-spiral Nerve.—The upper smaller nerve (Fig 5, 7) appears about the middle of the outer side of the arm, and runs downwards and forwards along the cephalic vein to the upper part of the fore-arm; the lower branch, of larger size (Fig. 11, 6), appears close above the external condyle, and will be afterwards traced down the back of the fore-arm to the wrist.

Branches from the *internal cutaneous* and *lesser internal cutaneous* nerves will be found on the inner side of the limb and distributed over the olecranon.

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

The **Triceps Muscle** (Fig. 11) has of course three heads—the long or middle, the external, and the internal. The *long* (11) head *arises* from a somewhat triangular rough surface on the inferior border of the scapula immediately below the glenoid cavity.

It has been already partly examined both from the front and from behind in relation with certain spaces (pp. 16, 33), and its fibres are now seen to be separated by another somewhat triangular interval from the back of the upper third of the humerus, until it joins the fibres of the external head at the junction of the upper with the middle third of the bone. The *outer* head (4) *arises* from immediately below the insertion of the teres minor into the greater tuberosity of the humerus, and from the outer side of the posterior aspect of the bone, as far down as the musculo-spiral groove; also slightly from the external intermuscular septum which intervenes between it and the deltoid. The *inner* head (13) *arises* from the whole of the posterior aspect of the humerus below the insertion of the teres major and the musculo-spiral groove, to within half an inch of the elbow-joint on the inner side, and extending to the back of the condyle on the outer side. Its fibres arise, on each side,

Fig. 11.

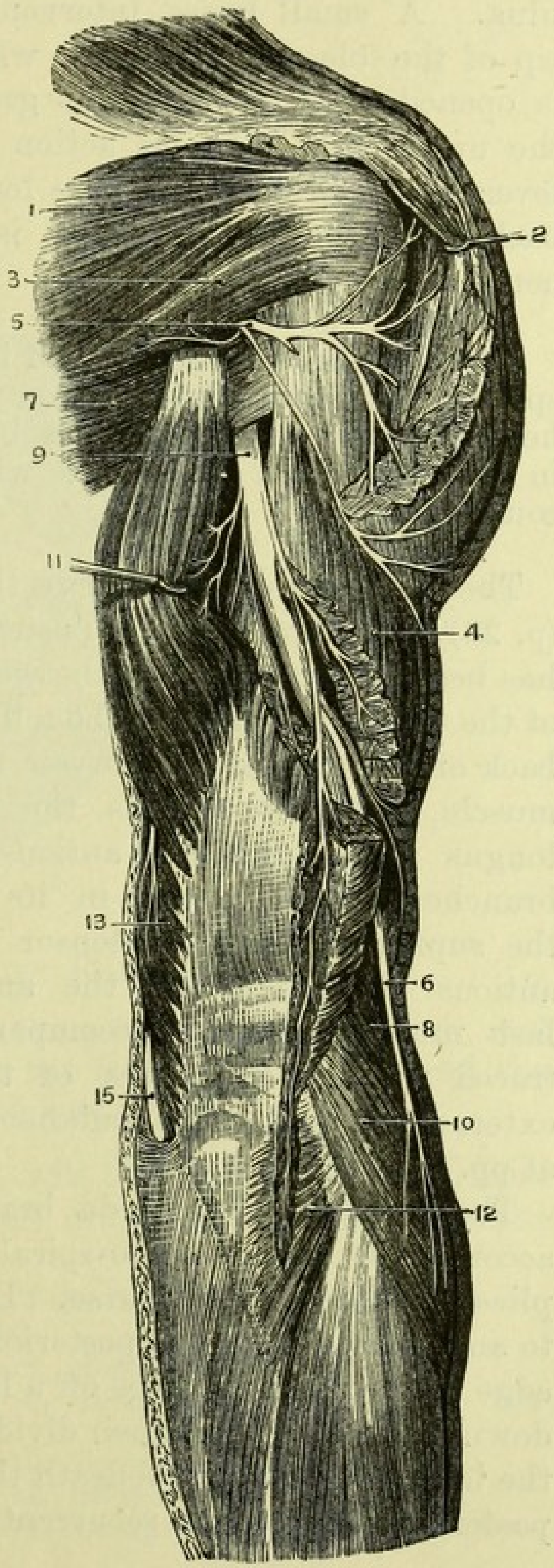


Fig. 11.—Dissection of back of upper arm (from Hirschfeld and Leveillé).

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

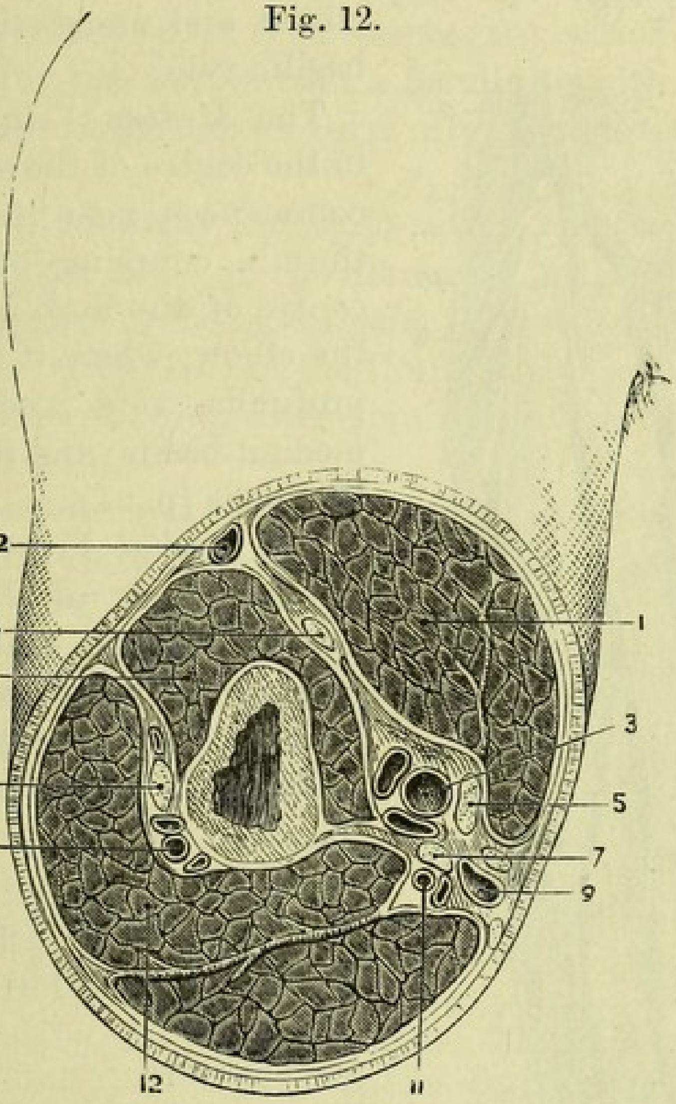
from the intermuscular septa which intervene between it and muscles of the front of the arm. The whole of the fibres converge to a strong tendon, which is *inserted* into the top of the olecranon process of the ulna, and also into the deep fascia of the fore-arm by means of a strong prolongation, which lies over the anconeus muscle, and is fixed to the posterior border of the ulna. A small bursa intervenes between the tendon and the tip of the olecranon process, which will be seen when the joint is opened. The triceps is the great *extensor* of the fore-arm upon the upper arm, and its action is that of a force applied to a lever of the first order. The long head also adducts and draws backwards the humerus. It is *supplied* by the musculo-spiral nerve.

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

The **Musculo-spiral Nerve** (Fig. 11, 9) has been already shown (p. 28) to be a branch of the posterior cord of the brachial plexus, and has been seen to disappear between the internal and middle heads of the triceps; it can now be followed in the oblique groove on the back of the humerus between the inner and outer heads of the muscle, until it reaches the interval between the supinator longus and brachialis anticus. It gives off numerous large branches to the triceps in its course, and afterwards supplies the supinator longus, extensor carpi radialis longior, brachialis anticus (in part), and the anconeus; and the branch to the last muscle with an accompanying artery should be at once traced through the fibres of the triceps at the back of the external condyle. The cutaneous branches have been described at pp. 21 and 36.

The **Superior Profunda** branch of the brachial artery closely accompanies the musculo-spiral nerve around the bone, and supplies the triceps in its course. Beneath the muscle a branch ascends to anastomose with the posterior circumflex artery. At the outer edge of the triceps it gives off a large superficial branch, which runs down to the elbow; it then divides into two branches, one going to the back of the elbow beneath the triceps to anastomose with the posterior interosseous recurrent and, across the back of the joint, with the anastomotic and inferior profunda arteries; the other running between the supinator longus and brachialis anticus to anastomose with the radial recurrent artery.

Fig. 12.



THE FRONT OF THE FORE-ARM.

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

The **Cutaneous Veins** (Fig. 13) will be found in the superficial fascia, and can be defined without injury to the nerves. The

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Fig. 12.—A section through the middle of the right upper arm (altered from Béraud).

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

Anterior Ulnar Vein (10) is pretty regular in its course, and will be found to commence in one or two small branches about the wrist; then running along the inner side of the fore-arm, it joins the *Posterior Ulnar Vein* (8) near the elbow, and assists in forming the basilic vein.

The *Median Vein* (9) is seldom in the centre of the arm at first, but commences near the root of the thumb, coursing obliquely to the centre of the limb near the bend of the elbow, where it is joined by the profunda vein and divides into median basilic and median cephalic branches (p. 21).

The *Radial Vein* (7) commences at the back of the hand, and appears on the outer side of the fore-arm about its middle. It has been seen to unite with the median cephalic to form the cephalic vein (p. 22). Besides these named veins there are numerous smaller branches which assist, and occasionally take the place of, the larger ones.

Fig. 13.

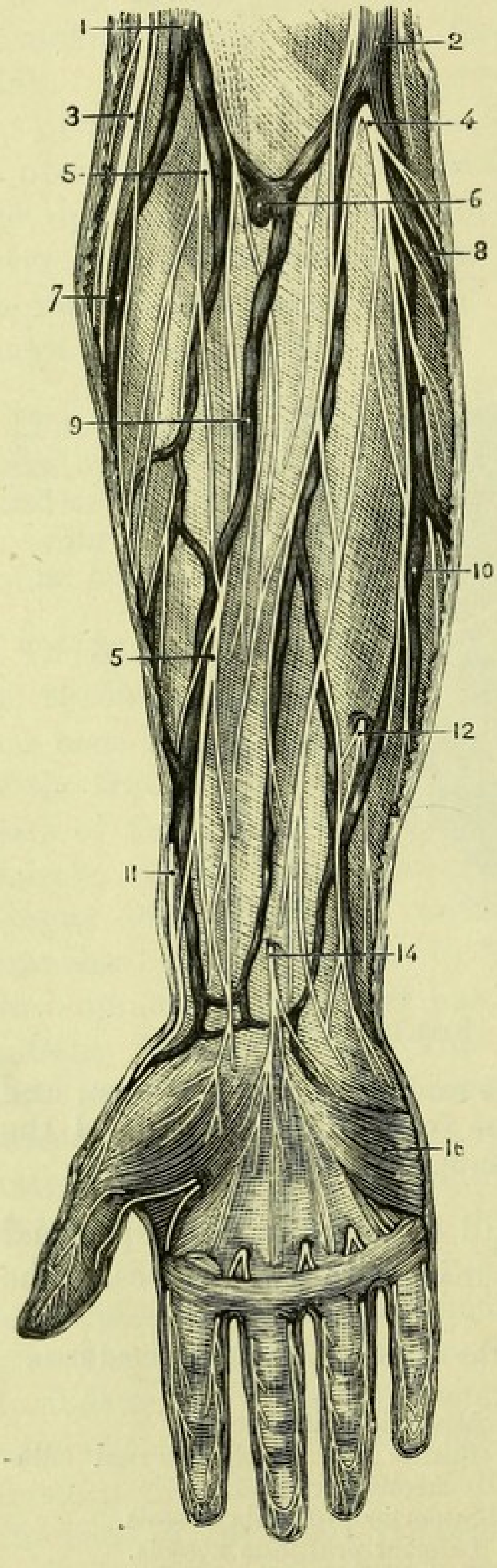


Fig. 13.—Cutaneous dissection of the front of the fore-arm (from Hirschfeld and Leveillé).

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

The **Cutaneous Nerves** (Fig. 13) are now to be followed out.

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

A *cutaneous branch of the Ulnar nerve* (12), which may, with care, be found piercing the fascia about a hand's breadth above the wrist, close to the edge of the flexor carpi ulnaris tendon, which can be readily felt.

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

A *cutaneous branch of the Median nerve* (14) pierces the fascia in the centre of the fore-arm about two inches above the wrist, and passes into the palm of the hand.

The **Deep fascia** is now to be cleaned, and will be found to be continuous with the deep fascia of the arm above, and with the annular ligament below. It gives numerous intermuscular septa in the fore-arm, which in a thin subject are seen as white lines, running more or less in the direction of the long axis of the limb.

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

The **Muscles** (Fig. 14) from the inner condyle are five in number, four being *flexors* of the carpus and fingers, and one a *pronator* of the fore-arm. Beginning from the outer side, their relative positions are:—1, pronator teres; 2, flexor carpi radialis; 3, palmaris longus (which may be absent); 4, flexor sublimis digitorum; 5, flexor carpi ulnaris. All these muscles have a common origin from (1) the internal condyle, (2) the fascia of the fore-arm, and (3) the intermuscular septa derived from it; but three of them, viz., the pronator teres, flexor sublimis digitorum, and flexor carpi ulnaris, have extra bony attachments.

The **Pronator Radii Teres** (Fig. 14, 8) *arises* from the internal condyle above the other muscles; from the fascia of the fore-arm over it; and from the intermuscular septum between it and the flexor carpi radialis. Its second head is from the inner side of the coronoid process of the ulna, the median nerve lying between the two heads. It is *inserted* by a broad tendon into the middle of the outer side of the radius, immediately below the supinator brevis. It pronates the hand by rolling the radius on the ulna, and flexes the elbow, and is *supplied* by the median nerve.

The **Flexor Carpi Radialis** (Fig. 14, 7) *arises* from the internal condyle in common with the other muscles; from the fascia of the fore-arm; and from the intermuscular septa between it and the pronator teres on one side, and the palmaris longus on the other. It ends about the middle of the fore-arm in a broad tendon, which soon becomes rounded,

Fig. 14.

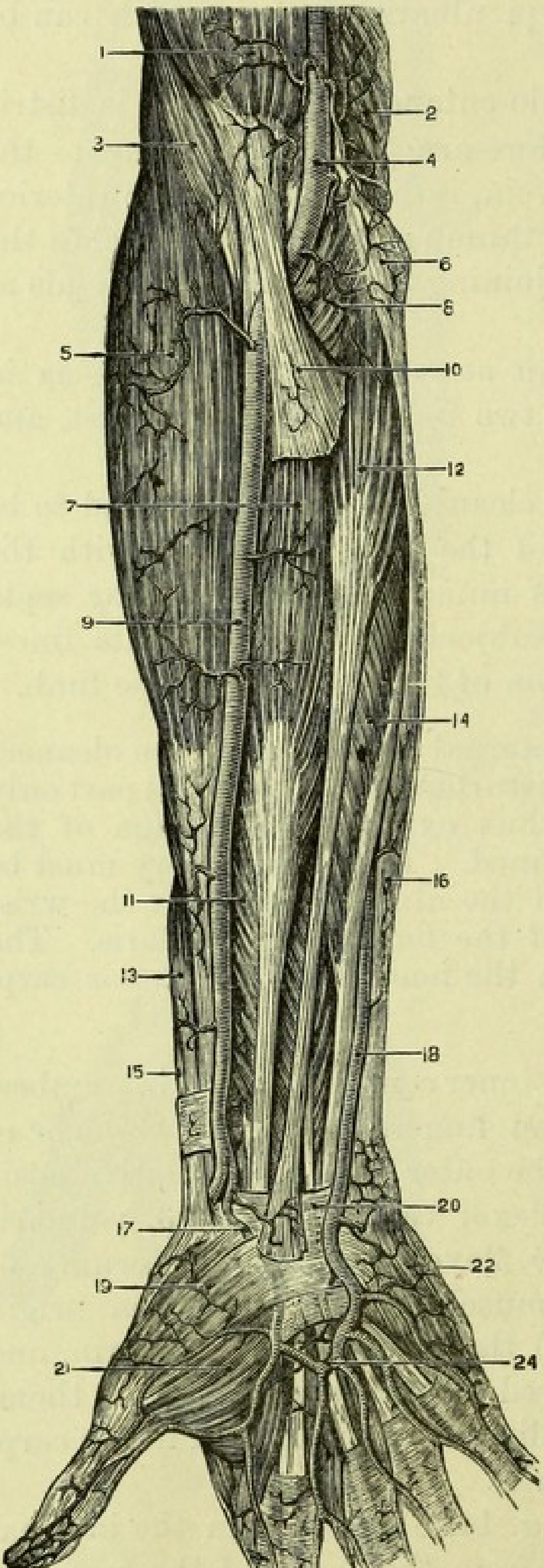


Fig. 14. — Superficial dissection of fore-arm and hand (from Bonamy and Beau).

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

and disappears at the root of the thumb, piercing the external attachment of the annular ligament and passing through the groove in the trapezium, to be *inserted* into the base of the second, and slightly into the base of the third metacarpal bone. It is a flexor of the carpus and abductor of the hand, and is *supplied* by the median nerve.

The **Palmaris Longus** (Fig. 14, 12) *arises* from the common attachment to the inner condyle; from the fascia of the fore-arm; and from the intermuscular septa on each side of it. Its long and narrow tendon passes superficially to be *inserted* into the strong palmar fascia in the centre of the hand, and sometimes sends a slip to the muscles of the thumb. It serves to make tense the palmar fascia and thus protect the deep tissues of the palm, and it may slightly flex the hand when largely developed. It is *supplied* by the median nerve.

The palmaris longus is subject to great variations; it is frequently wanting, but it is occasionally largely developed, the whole length of the tendon being covered with strong muscular fibres connected with the flexor carpi radialis.

The **Flexor Carpi Ulnaris** (Fig. 14, 16) *arises* from the common attachment to the internal condyle; from the fascia of the fore-arm; and from the intermuscular septum between it and the adjacent muscle. It has an additional aponeurotic origin from the inner side of the olecranon process and from the inner side of the posterior ridge of the ulna for two-thirds of its length, this latter origin being common to itself and the flexor profundus digitorum. The muscle is *inserted* by a flattened tendon (upon which the muscular fibres extend nearly to the wrist) into the pisiform bone, and slightly into the fifth metacarpal bone and the annular ligament. Between the two origins of this muscle the ulnar nerve enters the fore-arm, after winding close behind the internal condyle, and both ulnar artery and nerve will be seen beneath a process of the deep fascia close to the outer side of the tendon near the wrist. It is a flexor of the carpus and adductor of the hand, and is the only one of either the flexors or extensors of the carpus which is inserted directly into one of its bones. It is *supplied* by the ulnar nerve.

The **Radial Artery** (Fig. 14, 9) is the smaller of the divisions of the brachial artery, and the part in the fore-arm extends from the bifurcation at the bend of the elbow to the front of the styloid process of the radius. It is superficial in the whole of this course, except that at the upper part it is more or less overlaid by the supinator longus muscle, the extent varying with the muscular development of the arm. It lies at first *between* the supinator longus and the pronator teres, but in the lower half of the fore-arm between the tendons of the supinator longus and flexor carpi radialis, which latter tendon is generally taken as the guide to the vessel. To its *outer* side is the radial nerve, which in the upper third of the arm is at some little distance, in the middle third sometimes touches the artery, and in the lower third quits the vessel altogether by passing beneath the supinator longus. The radial artery *lies upon* (1) the tendon of the biceps (though

Fig. 15.

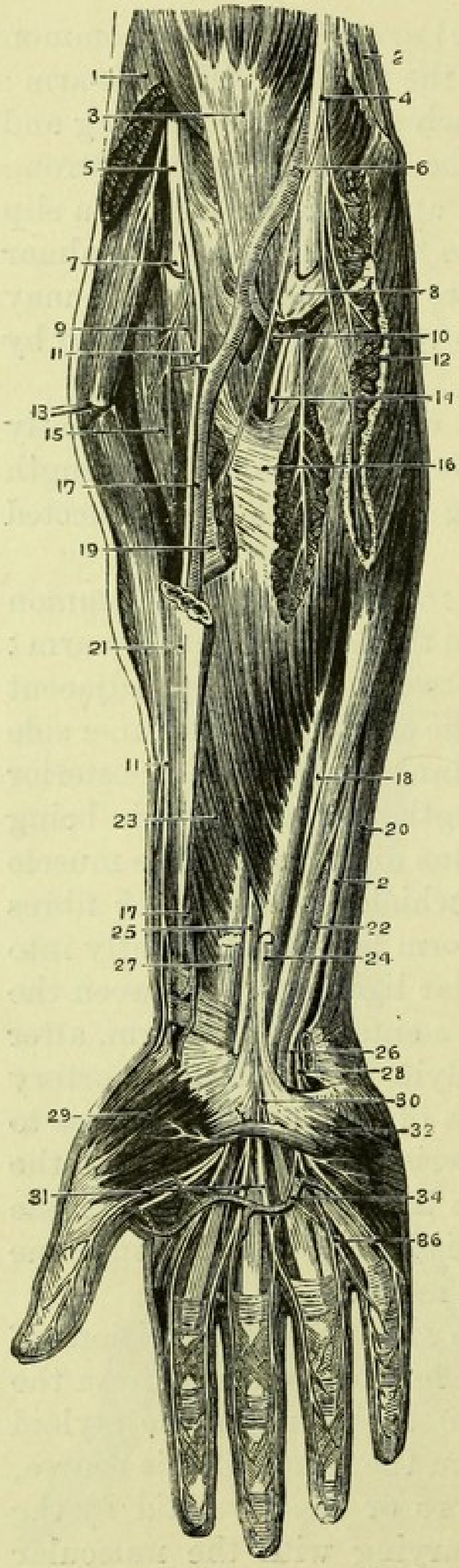


Fig. 15.—Superficial dissection of the front of the fore-arm (from Hirschfeld and Leveillé).

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

this will depend upon the point at which the bifurcation takes place); (2) the supinator brevis; (3) the insertion of the pronator teres; (4) the radial origin of the flexor sublimis; (5) the flexor longus pollicis; (6) the pronator quadratus; and (7) the end of the radius.* It has two venæ comites in close relation with it and gives the following branches:—

Branches.—1. The *radial recurrent* (Fig. 16, 9) runs transversely beneath the supinator longus and gives ascending and descending branches, the ascending anastomosing with the superior profunda branch of the brachial artery.

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

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

4. The *anterior carpal* is a small branch which runs across the wrist beneath the deep tendons, to join a corresponding branch of the ulnar artery at the level of the lower border of the pronator quadratus.

Surgery (Fig. 7).—The radial artery is readily tied, about an inch above the wrist, by an incision one inch and a half long, placed midway between the tendons of the flexor carpi radialis and supinator longus, when the vessel will be found lying immediately beneath the deep fascia, with the venæ comites in close connection but with no nerve near it. The artery may be exposed in the upper part by an incision, two inches long, at any point in a line drawn from the centre of the bend of the elbow to the front of the styloid process of the radius, the knife going at once down to the supinator longus, which must then be carefully turned outwards. The position of the radial nerve to the outer side, in the middle third of the fore-arm, is to be borne in mind and the ligature passed from it.

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

[The pronator teres is to be divided about its middle, without injuring the median nerve or the origin of the muscle from the ulna, which can now be thoroughly seen; and the flexor carpi radialis and palmaris longus are to be divided so as to expose thoroughly the flexor sublimis, which is to be cleaned. The skin of the front of one of the fingers is to be carefully removed without interfering with the

* The posterior relations of the radial artery are simply the muscles attached to the radius in their order from above downwards.

palm, and the sheath of the tendons dissected out (Fig. 15). Branches of the median nerve will be seen to enter the pronator radii teres, the palmaris longus and the flexor carpi radialis; the digital vessels and nerves on the side of the finger dissected must be preserved.]

The **Flexor Sublimis Digitorum** (perforatus) (Fig. 15, 16) is the only muscle of the fore-arm which has its origin from the three bones of the arm. It *arises* from the internal condyle of the humerus and slightly from the internal lateral ligament of the elbow; from the intermuscular septa between it and the more superficial muscles; from the inner side of the coronoid process of the ulna inside the pronator teres; and from the whole of the oblique line on the front of the radius and part of the anterior border of this bone. Between the radial and ulnar origins passes the median nerve. The muscle ends in four tendons, of which the two to the second and third fingers lie in front of those to the first and fourth fingers; all pass under the annular ligament and through the palm of the hand to the second phalanges of the four fingers.

The *sheath* of the finger which is exposed should be laid open along the centre, when it will be found to be thick opposite each phalanx (*ligamentum vaginale*), but thin at each joint, though here it is strengthened by fibres crossing obliquely. It is attached to the lateral ridges on the first and second phalanges and to the base of the third phalanx. The sheath is lined by a synovial membrane, which is continued into the palm and forms reflexions of two kinds between the back of the sheath and the tendons:—Some are long thread-like bands passing downwards from the phalanges to the tendons, *ligamenta longa* or *vincula vasculosa*—the others are short triangular folds at the insertions of the tendons, which have been called *ligamenta brevia* (Marshall). The tendon of the flexor sublimis (perforatus) will be seen to be flattened on the first phalanx, and split to give passage to the tendon of the flexor profundus (perforans), the two slips of the flexor sublimis being *inserted* into the sides of the second phalanx, and the tendon of the flexor profundus into the base of the third phalanx. The flexor sublimis is a flexor of the phalanges and then of the carpus; it is also a weak flexor of the elbow, and is *supplied* by the median nerve.

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

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

The **Deep Muscles** (Fig. 16) of the fore-arm are the flexor longus pollicis to the radial side, the flexor profundus digitorum to the ulnar side, and the pronator quadratus, a small square muscle with transverse fibres, to be afterwards seen above the carpus by drawing aside the tendons. These are now to be cleaned, all vessels and nerves being carefully preserved.

The **Flexor Longus Pollicis** (Fig. 16, 15) *arises* from the whole of the anterior surface of the radius between the oblique line and the attachment of the pronator quadratus, and from the outer half of the interosseous membrane in nearly its whole length. It very gene-

Fig. 16.

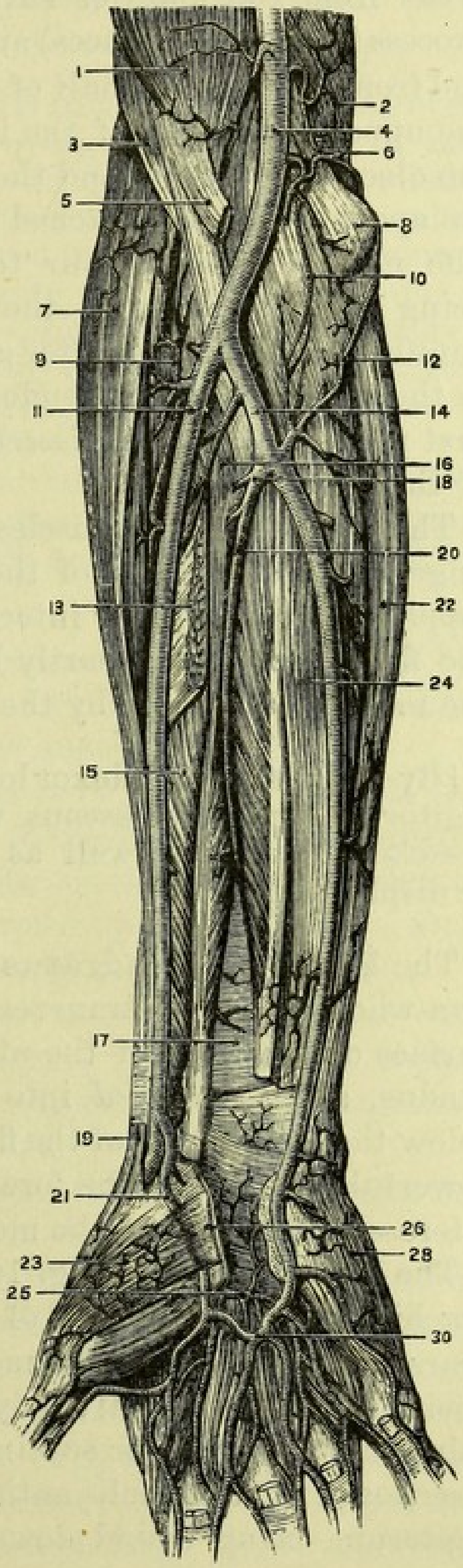


Fig. 16.—Deep dissection of fore-arm and hand (from Bonamy and Beau).

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

rally has a small additional origin, by a slip of very variable size, from the inner side of the coronoid process of the ulna. A single round tendon passes beneath the annular ligament, and through the palm of the hand between the two heads of the flexor brevis pollicis, to be *inserted* into the terminal phalanx of the thumb.

The **Flexor Profundus Digitorum** (perforans) (Fig. 16, 24) *arises* from the anterior surface of the ulna between the coronoid process (which it embraces) and the origin of the pronator quadratus, and from the adjacent half of the interosseous membrane ; also from the upper two-thirds of the inner surface of the ulna, extending to the olecranon process and the posterior border of the bone, to which an aponeurosis is attached giving rise to some of the fibres. The muscle ends in four tendons (that to the index finger alone being quite separate in the fore-arm), which pass beneath the annular ligament, and after giving origin to the lumbricales muscles in the palm, pierce the tendons of the flexor sublimis opposite the first phalanges, and are *inserted* into the bases of the third phalanges of the four fingers.

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

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

The **Pronator Quadratus** (Fig. 16, 17) is the only muscle in the arm whose fibres are transverse. It *arises* from a somewhat oval surface on the front of the ulna below the origin of the flexor profundus, and is *inserted* into the whole of the front of the radius below the attachment of the flexor longus pollicis. This muscle is a powerful pronator of the fore-arm, and is *supplied* by the anterior interosseous branch of the median nerve.

The **Ulnar Artery** (Fig. 16, 14) arises from the bifurcation of the brachial artery at the bend of the elbow, and at first takes an oblique course inwards *beneath* the median nerve and four of the muscles arising from the internal condyle (pronator teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum). It lies first *upon* the insertion of the brachialis anticus, and then upon the flexor profundus digitorum, being bound down by a process of deep fascia. It is joined in the middle of the fore-arm by the ulnar nerve, and here it is covered by the flexor carpi ulnaris, which lies to its ulnar side for the rest of its course. In the lower third both artery and nerve lie comparatively superficially between the tendons of the flexor carpi ulnaris and the flexor sublimis (but slightly overlapped by the former); they both rest on the flexor profundus digitorum until they pass forward over the annular ligament into the hand. Two venæ comites are in close relation with the artery.

Surgery (Fig. 7).—The ulnar artery is easily reached in its lower part by an incision two inches long upon the outer edge of the tendon of the flexor carpi ulnaris. The tendon being drawn a little inwards, it would only be necessary to divide the intermuscular layer of the deep fascia in order to expose the vessel with the nerve to its ulnar side. The operation for tying the artery in its upper part between the flexor muscles is impracticable on the living body, but the vessel may be reached on the subject by separating the flexor carpi ulnaris from the flexor sublimis digitorum until the ulnar nerve is exposed, when the artery will be found to its outer side.

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

Branches.—1. The *Anterior ulnar recurrent* (Fig. 16, 10) will be found between the brachialis anticus and pronator teres, running up in front of the elbow joint to join the anastomotic.

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

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

The *posterior interosseous* passes between the radius and ulna to the back of the fore-arm, where it will be dissected.

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

4. The *Carpal arteries*, anterior and posterior, supply the front and back of the carpus, and anastomose with corresponding branches from the radial. The anastomosis on the front of the wrist is joined by twigs from the anterior interosseous and the recurrent branches of the deep palmar arch.*

The **Median Nerve** (Figs. 15 and 17) after passing between the heads of the pronator teres, and then between the origins of the flexor sublimis digitorum, crosses the ulnar artery to lie between the flexor sublimis and flexor profundus muscles. It is placed superficially between the tendons of the flexor carpi radialis and palmaris longus near the wrist, and passes beneath the annular ligament into the hand.

Branches.—The median nerve supplies all the muscles of the front of the fore-arm except the flexor carpi ulnaris and half the flexor profundus, in the following manner:—As soon as it enters the fore-arm it gives branches to the pronator teres, flexor carpi radialis, flexor sublimis digitorum, and palmaris longus, and, after crossing the ulnar artery, gives off the *anterior interosseous nerve* (Fig. 17, 25). This passes down the front of the interosseous membrane, giving branches to the flexor longus pollicis and the outer half of the flexor profundus digitorum, and then beneath the pronator quadratus (which it supplies) to the front of the wrist-joint, where it gives a branch to the articulation.

A *cutaneous palmar* branch of the median (Fig. 15, 30) arises a short distance above the annular ligament, over which it passes to be distributed to the skin of the palm.

The **Ulnar Nerve** (Fig. 17, 2) enters the fore-arm behind the internal condyle, by passing between the heads of the flexor carpi ulnaris. It lies under cover of that muscle and upon the flexor profundus digitorum for the whole of its course in the fore-arm; and about the middle third of the fore-arm comes into close relation with the ulnar artery, and, keeping to its ulnar side, accompanies it over the annular ligament into the palm.

Branches (Fig. 17).—The ulnar nerve gives small articular branches to the back of the elbow, and supplies one and a half of

* Professor Ellis enumerates a metacarpal branch, which is usually the continuation of the posterior carpal artery to the back of the 5th metacarpal bone, as will be seen in the dissection of the back of the hand.

the muscles of the forearm, viz., the flexor carpi ulnaris and the inner half of the flexor profundus digitorum.

In the lower third of the forearm the nerve gives a *dorsal branch* (20), which turns backwards beneath the tendon of the flexor carpi ulnaris to be distributed to the back of the little and half the ring finger.

A *cutaneous palmar* branch of small size arises about the middle of the fore-arm, and, after running down the front of the ulnar artery, becomes cutaneous close above the an-

Fig. 17.

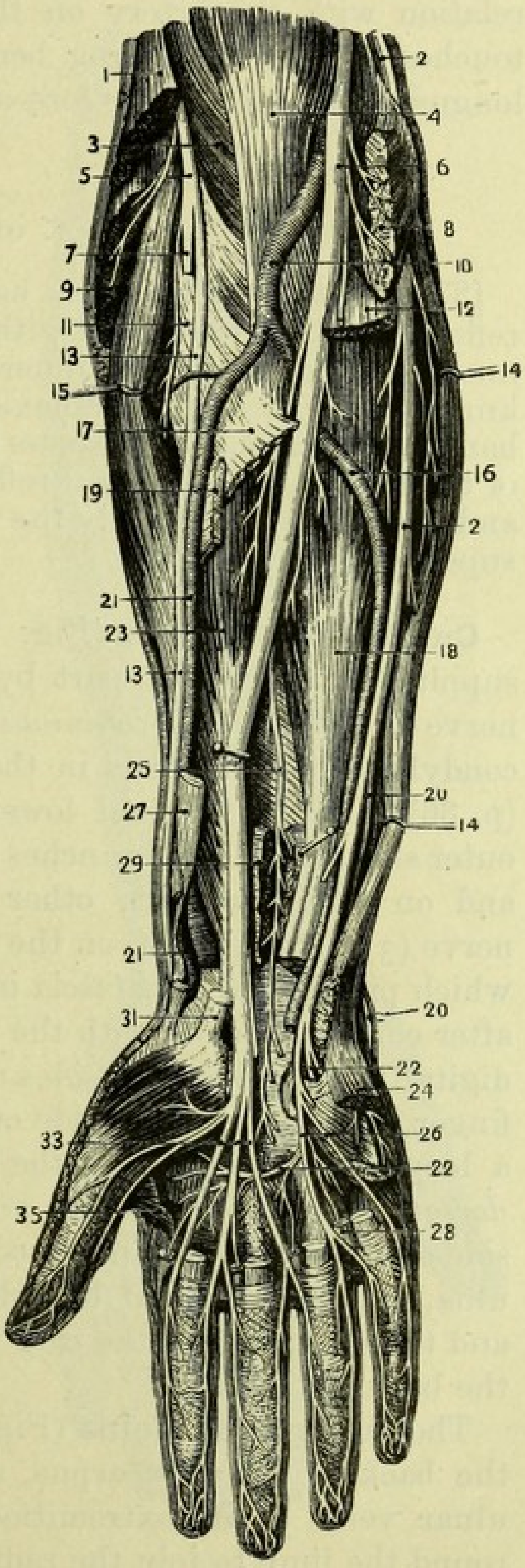


Fig. 17.—Deep dissection of the front of the fore-arm and hand (from Hirschfeld and Leveillé).

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

nular ligament, and is distributed to the skin of the palm on the ulnar side.

The **Radial Nerve** (Fig. 17, 13) is seen to arise from the musculo-spiral nerve opposite the elbow. It lies at first upon the supinator brevis, to the outer side of, and at some little distance from, the radial artery; but in the middle third of the arm it is in close relation with the artery on the pronator teres, and occasionally touches it; finally passing beneath the tendon of the supinator longus to the back of the fore-arm and hand.

The Back of the Fore-arm.

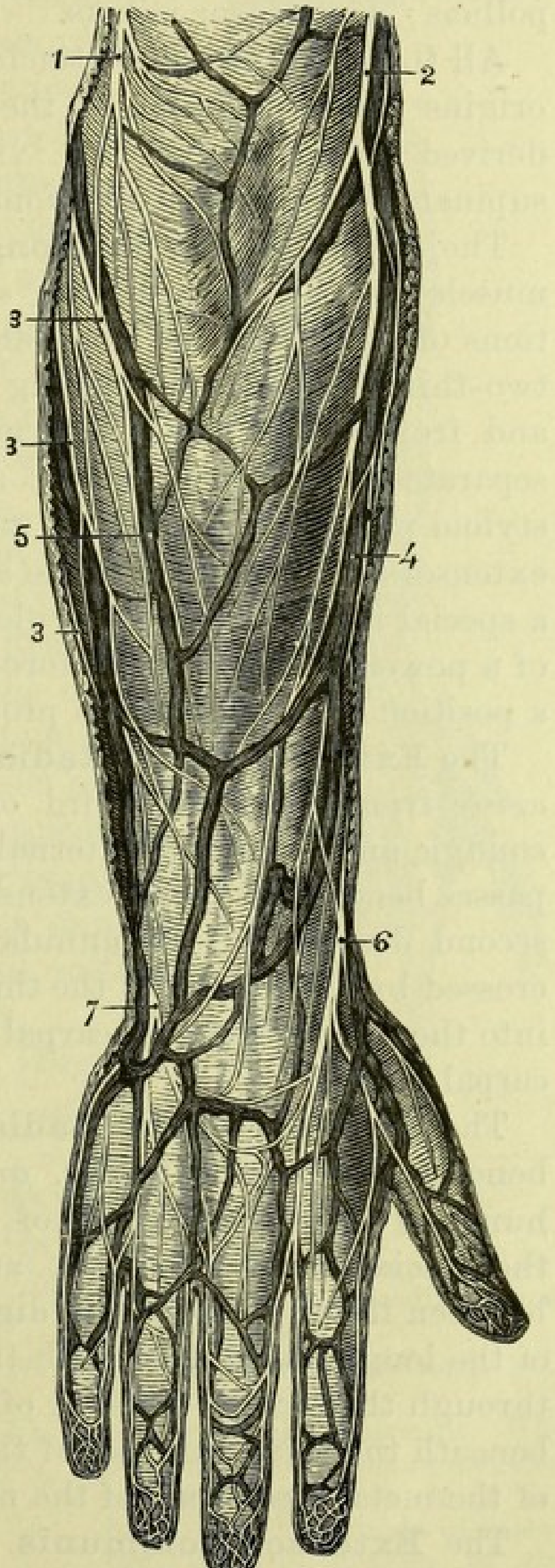
[The front of the fore-arm having been dissected, the skin can be reflected from the back of it without further incisions, but an incision must be made along the inner border of the hand and across the knuckles, to permit the reflexion of the skin from the back of the hand. An incision is also to be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

Cutaneous Nerves (Fig. 18).—The back of the fore-arm is supplied at the upper part by the branches of the *musculo-spiral* nerve (2) and *internal cutaneous* nerve (1), which were seen above the condyles of the humerus in the dissection of the back of the arm (p. 36). In addition and lower down, there will be found on the outer side of the limb branches from the *musculo-cutaneous* nerve (4), and on the inner side other branches of the *internal cutaneous* nerve (3); at the wrist, on the outer side, the large *radial* nerve (6), which pierces the deep fascia in the lower third of the fore-arm, and, after communicating with the musculo-cutaneous nerve, distributes digital branches to both sides of the thumb, fore-finger, and middle finger, and to the radial side of the ring finger, forming in addition a loop across the back of the hand with the following nerve; *the dorsal branch of the ulnar nerve* (7) which appears on the inner side of the wrist, at a point corresponding to the lower end of the ulna, and gives digital branches to both sides of the little finger and the ulnar side of the ring finger, joining the radial nerve across the back of the hand.

The **Superficial Veins** (Fig. 18) of the hand form an arch across the back of the metacarpus, which joins the radial and posterior ulnar veins at its extremities; the veins of the fore-arm wind round the limb to join the radial and ulnar veins respectively, and one or two branches form communications between them and across the back of the fore-arm.

[The deep fascia is to be removed from the back of the fore-arm and hand, with the exception of a band about an inch wide, which is to be left opposite the lower end of the radius, to form the *posterior annular ligament* (Fig. 19, 15). The slender posterior interosseous artery to the outer side of the extensor carpi ulnaris is to be preserved. It will be found to be impossible to remove the fascia entirely near the elbow, where it is incorporated with the muscles.]

Fig. 18.



Muscles of the Back of the Fore-arm (Fig. 19).—The muscles arising from the external condyle of the humerus are either *extensors** or *supinators*, and will be found in the following order, beginning from the radial side:—1, supinator longus; 2, extensor carpi radialis longior; 3, extensor carpi radialis brevior; 4, extensor communis digitorum; 5, extensor minimi digiti; 6, extensor carpi ulnaris; there are also two small muscles attached to the bone and not seen at present, viz., 7, anconeus (covered by fascia prolonged from the triceps), and

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

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

* Artificial memory, *Ex*-tensors from *Ex*-ternal condyle.

8, supinator brevis (under cover of the long muscles). Arising from the bones of the *fore*-arm alone and appearing from beneath the extensor communis digitorum, will be found four short extensor muscles, which hold the following position to one another from the radial side :—1, extensor ossis metacarpi pollicis ; 2, extensor primi internodii pollicis ; 3, extensor secundi internodii pollicis ; 4, extensor indicis.

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

The **Supinator Radii Longus** (Fig. 19, 4) is a long, narrow muscle, and has been already seen in great part in previous dissections of the bend of the elbow and fore-arm. It *arises* from the upper two-thirds of the ridge leading to the outer condyle of the humerus, and from the external intermuscular septum of the arm, which separates it from the triceps ; and is *inserted* into the base of the styloid process of the radius, its tendon being crossed by two short extensors of the thumb at the annular ligament. It is *supplied* by a special branch of the musculo-spiral nerve, and its action is that of a powerful flexor of the fore-arm ; it can also place the hand in a position midway between pronation and supination.

The **Extensor Carpi Radialis Longior** (Fig. 19, 5, Fig. 20, 3) *arises* from the lower third of the ridge leading to the external condyle and from the external intermuscular septum ; its tendon passes beneath the two extensors of the thumb and through the second division of the annular ligament, and having then been crossed by the tendon of the third extensor of the thumb, is *inserted* into the base of the metacarpal bone of the fore-finger (2nd metacarpal bone).

The **Extensor Carpi Radialis Brevior** (Fig. 19, 6), which is beneath the long extensor, *arises* from the outer condyle of the humerus ; from the surface of the external lateral ligament ; from the fascia of the fore-arm, and from the intermuscular septum between it and the extensor digitorum. Its tendon passes, with that of the long extensor, beneath the two extensors of the thumb and through the second division of the annular ligament ; and lastly beneath the third extensor of the thumb, to be *inserted* into the base of the metacarpal bone of the middle finger (3rd metacarpal bone).

The **Extensor Communis Digitorum** (Fig. 19, 8) *arises* from the external condyle with the preceding muscles ; from the fascia of the fore-arm, and from the intermuscular septa on each side of it. It ends in three tendons, which pass through the fourth division of the annular ligament with the extensor indicis and, the innermost having subdivided, the four tendons thus formed are *inserted* into the fingers in the following way:—Opposite the metacarpo-phalangeal joint each tendon sends slips to both sides of the base of the first phalanx, which are firmly bound to the phalanx and the metacarpo-phalangeal articulation; it then expands upon the phalanx, being joined by slips from the lumbricales and interossei; this expansion is stronger at the margins than in the middle, and its sides are prolonged to the third phalanx, whilst the middle portion is attached to the base of the second phalanx. This division is somewhat artificial and must be made with the scalpel, since the three parts are, in the natural state, united. The tendon of the *extensor indicis* joins the ulnar side of the first or outermost tendon opposite the first phalanx. The three innermost tendons of the extensor are joined together by tendinous slips on the back of the hand, those on either side of the ring finger being especially strong; and that to the little finger is joined by the two divisions of the extensor minimi digiti, both above and below the band uniting it with the tendon of the ring finger.

The **Extensor Minimi Digiti** (Fig. 19, 9) might be taken as a part of the

Fig. 19.

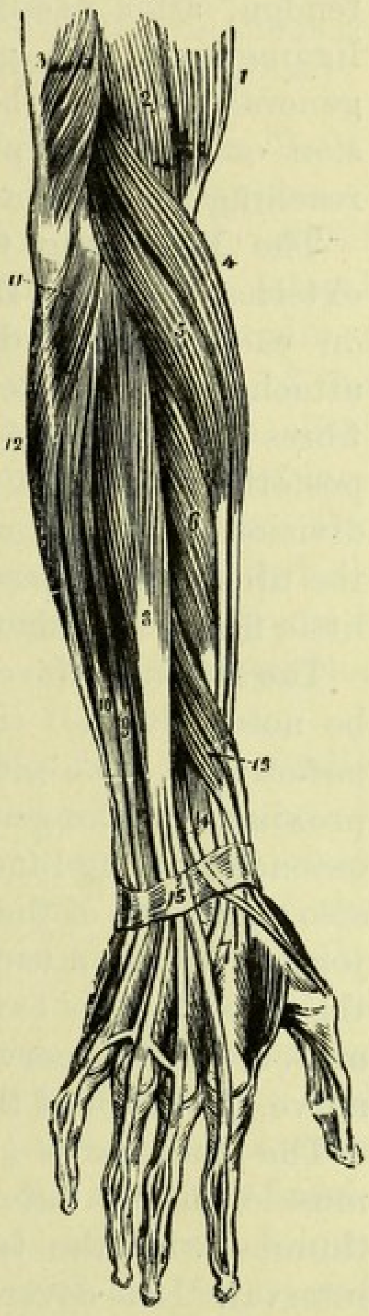


Fig. 19.—Superficial muscles of the back of the fore-arm (from Wilson).

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

common extensor, but it is separated from it by an intermuscular septum. It *arises* from the external condyle; from the fascia and from the intermuscular septa on each side; and its tendon, after passing through the fifth division of the annular ligament in the groove between the radius and the ulna, is generally divided, both slips being *inserted* into the common expansion on the first phalanx of the little finger, but the innermost reaching further forward than its fellow (Fig. 22, 19).

The **Extensor Carpi Ulnaris** (Fig. 19, 10) *arises* from the external condyle; from the fascia and from the intermuscular septa on each side; and has an additional origin from an expansion attached to the outer side of the posterior border of the ulna, the fibres covering, but not being attached to, all the inner part of the posterior surface of the bone. The tendon passes through the sixth division of the annular ligament, and behind the styloid process of the ulna, to be *inserted* into the base of the metacarpal bone of the little finger (5th metacarpal bone).

The action of the extensors is implied by their names, but it should be noted that all the extensors of the *carpus* are inserted into the *metacarpus*. The extensors of the fingers act most powerfully on the proximal phalanges, the two other phalanges being principally extended by the lumbricales and interossei; the radial extensors are also abductors of the wrist, the ulnar extensor is an adductor of this joint. All the muscles help to extend the wrist and feebly to extend the elbow. The extensor carpi radialis longior is *supplied* by the musculo-spiral nerve; all the others by the posterior interosseous nerve, a branch of the musculo-spiral.

The **Anconeus** (Fig. 19, 11, Fig. 20, 4) is a small triangular muscle on the outer side of the elbow, which is apparently continuous with the triceps, but is separated by a narrow cellular interval. It is covered by an expansion of the tendon of the triceps, which must be removed to expose it, when a branch of nerve from the musculo-spiral to the muscle is to be looked for and preserved. It *arises* from the back of the external condyle of the humerus by a separate origin, and spreads out to its fleshy *insertion* on the triangular surface upon the outer side of the olecranon and upper third of the ulna. The anconeus is an extensor of the fore-arm, and is *supplied* by a branch of the musculo-spiral nerve, which pierces its upper margin and is accompanied by a branch of the superior profunda artery.

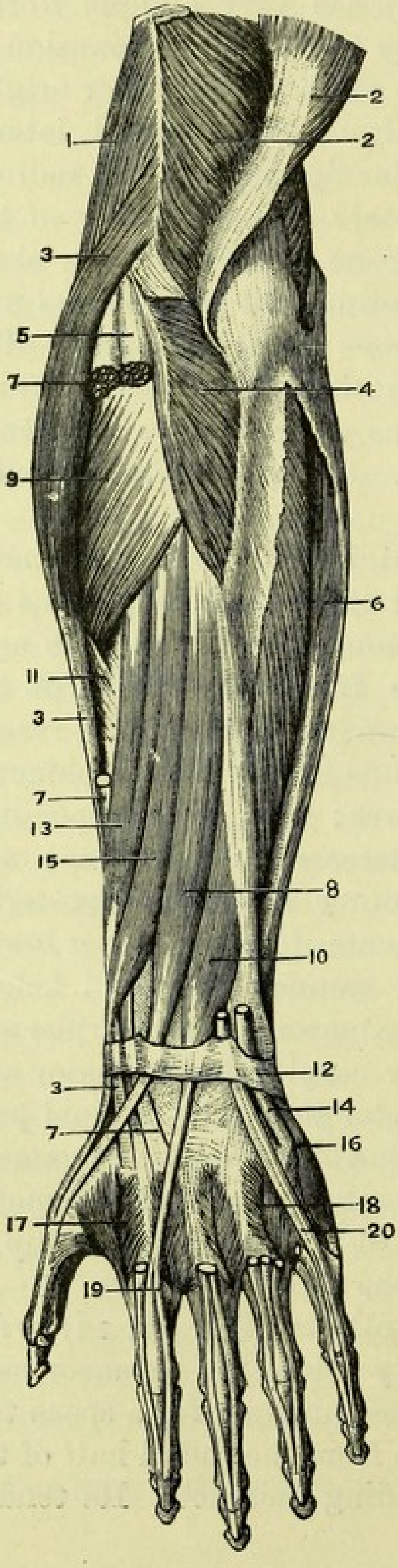
[The long extensors must be divided about the middle and turned aside in order to see the deep muscles thoroughly, but the supinator longus should be left uncut. The supinator brevis will require careful dissection beneath the origins of the other muscles, and the arm must be fully pronated in order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

The **Supinator Brevis** (Fig. 20, 9) has very oblique fibres, which are covered at the upper part by a tendinous expansion or intermuscular septum, from which some of them take their origin. It *arises* from the external condyle; from the external lateral ligament of the elbow; from the orbicular ligament of the radius; from the triangular space below the lesser sigmoid cavity of the ulna, and from the outer margin of bone below it for a short distance. Its fibres sweep round the radius, and are *inserted* into the outer and upper part of that bone above the oblique lines. The supinator is pierced by the posterior interosseous nerve (which *supplies* it), and the posterior interosseous artery passes between it and the extensor ossis metacarpi pollicis. It is a powerful supinator of the radius on the ulna.

The **Extensor Ossis Metacarpi Pollicis** (Fig. 20, 13) is usually the only one of the special extensors of the thumb which has an origin from both bones of the fore-arm, though occasionally the next muscle has a double origin. It *arises* from the middle of the posterior surface of the radius for about two inches, the origin reaching across the bone from the interosseous line to the attachments of the supinator brevis and pronator teres; from a corresponding portion of the posterior surface of the interosseous membrane; and from two inches of the middle of the outer side of the posterior surface of the ulna, between the attachments of the supinator brevis and anconeus above, and the extensor secundi internodii below. The muscle "crops out" between the extensors of the carpus and fingers, and having crossed the extensor carpi radialis longior and the brevior obliquely, it passes on the outer side of the styloid process of the radius, through the first division of the annular ligament and over the radial artery, to be *inserted* into the base of the metacarpal bone of the thumb (1st metacarpal bone), sending a slip to the trapezium and the short muscles of the thumb.

The **Extensor Primi Internodii Pollicis** (Fig. 20, 15) *arises* from the back of the radius immediately below the extensor ossis metacarpi pollicis and close to the interosseous line, for a space two inches long and half an inch wide; also from the radial half of the interosseous membrane for a corresponding distance. Its tendon lies to the ulnar side of the tendon of the extensor of the metacarpal bone in its whole course, passing through the same division of the annular ligament, and is prolonged to be *inserted* into the base of the first phalanx of the thumb.

Fig. 20.



The **Extensor Secundi Internodii Pollicis** (Fig. 20, 8) *arises* from the middle of the outer half of the posterior surface of the ulna (between the origins of the extensor ossis metacarpi pollicis above, and the indicator below), and from the ulnar half of the corresponding portion of the interosseous membrane. Its tendon becomes superficial just above the annulaı ligament, through which it passes very obliquely in a separate division (the third); then crossing the tendons of the long and short radial extensors and the radial artery,

Fig. 20.—Deep muscles of the back of the fore-arm (from Sappey).

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

it runs along the ulnar side of the extensor primi internodii to be *inserted* into the base of the terminal phalanx of the thumb. This muscle varies very much in size.

The **Extensor Indicis** (indicator) (Fig. 20, 10) *arises* from the posterior surface of the ulna below the preceding muscle (by the size of which its attachment is influenced), and slightly from the interosseous membrane. Its tendon is covered by those of the common extensor, and running through the fourth division of the annular ligament with them, is *inserted* into the common expansion on the back of the first phalanx of the fore-finger.

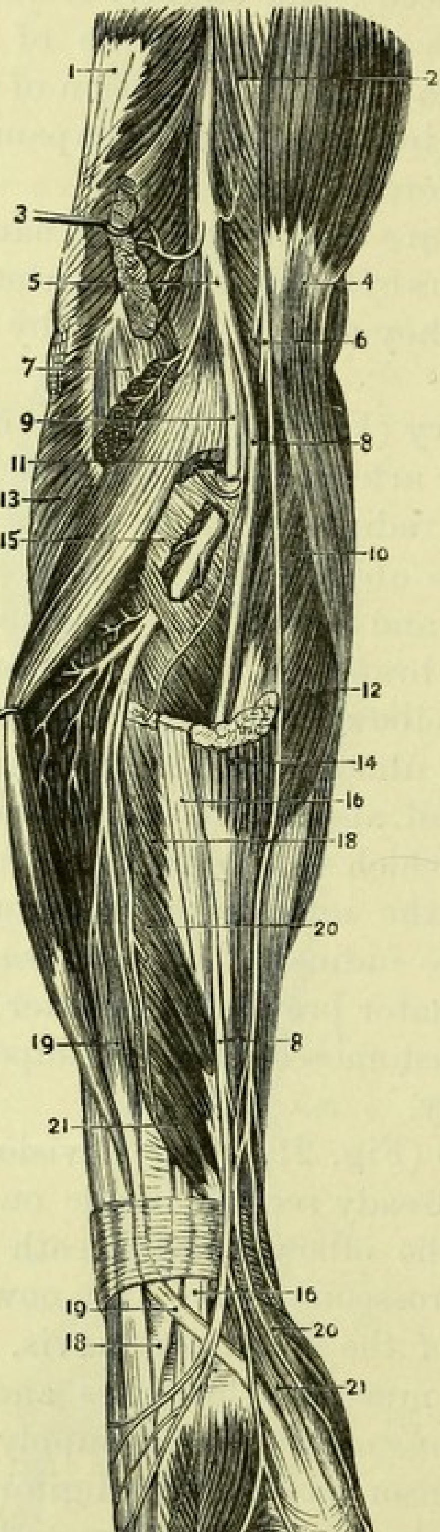
The actions of the special extensors are implied by their names. The extensors of the thumb are abductors of the wrist; the extensor indicis is an extensor of the wrist. They are all *supplied* by the posterior interosseous nerve.

The **Posterior Interosseous Artery** (Fig. 22, 8) arising from the interosseous, a branch of the ulnar artery, reaches the back of the fore-arm by passing between the radius and ulna above the interosseous membrane, but below the oblique ligament (p. 81). It appears between the supinator brevis and extensor ossis metacarpi pollicis (usually), giving muscular branches to the extensor muscles and a recurrent branch to the elbow-joint, it is continued downwards close to the extensor carpi ulnaris, and terminates by joining the posterior carpal arteries and also the terminal branch of the *anterior interosseous artery* (10), which will be found to reach the back of the fore-arm by piercing the interosseous membrane immediately above the lower end of the radius. The *recurrent* (6) branch runs upon or through the supinator brevis to the outer and back part of the elbow, where it anastomoses with the superior profunda and the recurrent radial artery.

The **Posterior Interosseous Nerve** (Fig. 21, 9) is a division of the musculo-spiral, which has been already seen to divide on the outer side of the space in front of the elbow and beneath the supinator longus. The posterior interosseous nerve can now be traced running obliquely in the fibres of the supinator brevis, and at its lower border breaking up into muscular branches and an articular branch to the wrist. The *muscular branches* supply the extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, the three special extensors of the thumb and the indicator; and the supinator brevis is supplied by a branch or two as the nerve passes through it, and must be divided to see them.

The *articular branch* to the wrist is a continuation of the nerve, and reaches the interosseous membrane between the extensors of the first and second phalanges of the thumb; passing beneath the latter muscle it runs to the back of the carpus, beneath the tendons of the extensor communis digitorum. Beneath the annular ligament a gangliform enlargement may be found.

Fig. 21.



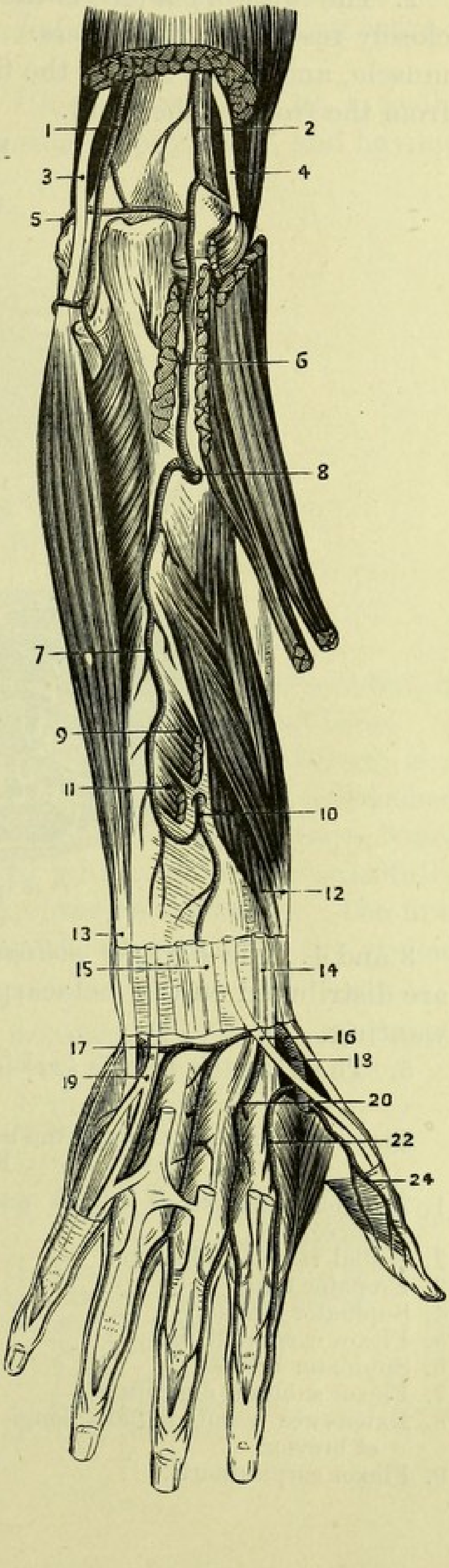
The **Radial Artery** at the wrist (Fig. 22, 18).—After leaving the front of the lower end of the radius (p. 43), the radial artery lies against the external lateral ligament of the wrist-joint, and beneath the extensors of the metacarpal bone and first phalanx of the thumb. It then winds over the back of the carpus, to the interval between the metacarpal bones of the thumb and forefinger, where it is crossed by the extensor of the second phalanx of the

Fig. 21.—Dissection of the musculo-spiral nerve and its branches (from Hirschfeld and Leveillé).

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

thumb, and lastly passes into the palm of the hand between the two heads of the abductor indicis (first dorsal interosseous muscle).

Fig. 22.



The **Branches** (Fig. 22) of the radial artery at the wrist very commonly vary, but should be five in number.

1. The *Posterior carpal* (17) is a small branch which runs transversely close upon the bones, immediately below the annular ligament, to join the posterior carpal branch of the ulnar and form an arch. From this two dorsal interosseous arteries are given, which run on the third and fourth interos-

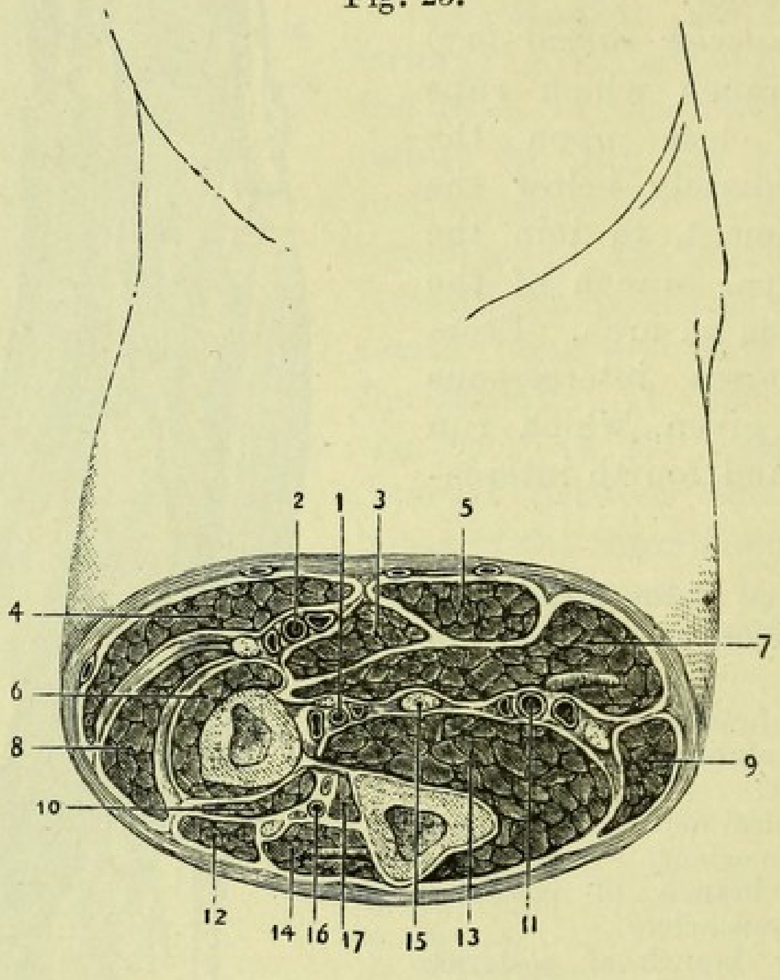
Fig. 22.—Arteries of the back of the fore-arm (drawn by G. E. L. Pearse).

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

seous muscles, and receive the perforating arteries which appear between their heads of origin.

2. The *Metacarpal* (20) is the first dorsal interosseous artery, and closely resembles the others. It runs on the second interosseous muscle, and at the root of the fingers often joins the digital branch from the front of the hand.

Fig. 23.



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

5. The *Dorsalis indicis* (22) is a similar branch, which runs along

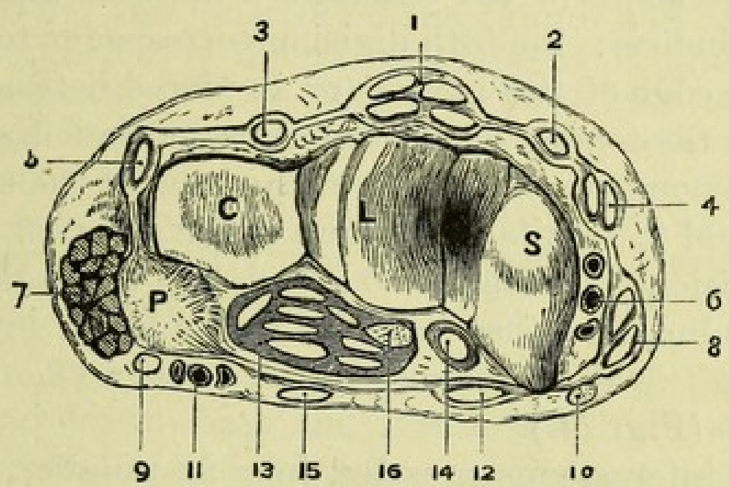
Fig. 23.—A section through the middle of the right fore-arm (altered from Béraud).

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

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

The *Posterior carpal branch of the Ulnar artery* (Fig. 22, 17) will be found appearing beneath the extensor carpi ulnaris, and having

Fig. 24.



completed the arch formed by the posterior carpal of the radial, it ends in a branch to the ulnar side of the fifth metacarpal bone.

The **Posterior Annular Ligament** (Figs. 19, 15; 20, 12) is a thickened portion of the deep fascia of the fore-arm; it is attached to the radius externally, and to the cuneiform and pisiform bones internally. It has six subdivisions, which should be carefully examined and compared with the grooves on the bones. The first division corresponds to the groove on the outer side of the styloid

Fig. 24.—A section of the right wrist in pronation between the rows of carpal bones (drawn by G. E. L. Pearse).

1. Tendons of extensor communis digitorum and extensor indicis.
2. Tendon of extensor secundi internodii pollicis.
3. Tendon of extensor minimi digiti.
4. Tendons of extensor carpi radialis longior and extensor carpi radialis brevior.
5. Extensor carpi ulnaris.
6. Radial vessels.
7. Portion of abductor minimi digiti.
8. Tendons of extensor ossis metacarpi and extensor primi internodii pollicis.
9. Ulnar nerve.
10. Radial nerve.
11. Ulnar vessels.
12. Tendon of flexor carpi radialis.
13. Tendons of flexor sublimis and flexor profundus digitorum.
14. Tendon of flexor longus pollicis.
15. Tendon of palmaris longus.
16. Median nerve.

S. Scaphoid bone.
L. Lunar bone.
C. Cuneiform bone.
P. Pisiform bone.

process of the radius, and transmits the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis: the second division corresponds to the groove on the back of the styloid process, and transmits the tendons of the long and short radial extensors of the wrist: the third division is placed obliquely, and corresponds to the oblique groove on the back of the radius; it transmits the tendon of the extensor secundi internodii pollicis: the fourth division, corresponding to the broad groove on the radius, transmits the tendons of the extensor communis digitorum and of the extensor indicis: the fifth division corresponds to a very slight groove on the edge of the radius (or is placed between the bones), and transmits the tendon of the extensor minimi digiti: the sixth division corresponds to the groove at the back of the styloid process of the ulna, and transmits the tendon of the extensor carpi ulnaris. Thus five divisions correspond to grooves on the radius and one to that on the ulna, and they may be remembered by the formula

R U
2 2 1 2 1; 1. (Fig. 24.)

The dorsal interosseous muscles, four in number, can be most conveniently dissected with those of the palm of the hand.

Palm of the Hand.

Surface-Marking.—The delicacy of the skin of the palm will depend very much upon the previous occupation of the individual, but in every case it will be found to present no hairs and to be ribbed by the rows of papillæ, upon which the orifices of the sweat-ducts can be seen with a magnifying glass. If decomposition has advanced rapidly, the cuticle will probably be detached in part, when upon examining its deep surface, depressions corresponding to the papillæ will be found. A fulness on each side of the palm corresponds to the special muscles of the thumb and little finger respectively, and the terms "thenar" and "hypo-thenar" eminences are sometimes applied to them. The palm presents three curved lines, the proximal and distal ones being curved in opposite directions, whilst the middle runs obliquely across the palm to join the proximal line at the outer side of the hand. It will be found on dissection that the point to which the superficial palmar arch reaches, corresponds pretty accurately with the centre of this middle line, whilst the point of bifurcation of the digital arteries is midway between the distal or anterior line and the web of the fingers.

[An incision is to be made down the middle of the palm to the roots of the fingers, where another is to be drawn across the whole width of the hand, and the two flaps of skin are to be dissected up and turned in opposite directions. It will be found easiest to pay little attention to the unimportant cutaneous palmar branches of nerves, and to carry the knife at once through the fine granular fat of the palm down to the glistening palmar fascia and annular ligament; but it should be remembered that three small palmar nerves have been already seen, viz., from the musculo-cutaneous (p. 41), the median (pp. 41 and 50), and from the ulnar (p. 51). The fascia covering the muscles of the thumb and little finger is much thinner than that in the centre of the hand, and will require care for its preservation. The skin may be at once reflected from over the outer side of the hand, but upon the inner side a small transverse muscle (palmaris brevis) is to be found just below the pisiform bone, and is to be preserved with the piece of skin into which it is inserted. Lastly, the skin must be carefully removed from the thumb and fingers.]

The **Palmar Fascia** (Fig. 13) consists of three portions. The central is triangular in shape and is attached to the annular ligament by its apex (into which the palmaris longus is inserted), whilst it expands at the roots of the fingers to become connected with the sheaths of the flexor tendons. Opposite the heads of the metacarpal bones it splits into four parts, and numerous transverse fibres will be found strengthening the membrane at these points, where also the digital vessels and nerves become subcutaneous; the strongest band of transverse fibres near the clefts of the fingers receives the name of the *superficial transverse ligament.* Each of the four slips which have been mentioned is prolonged on to the sheath of one of the flexor tendons, and sends backwards on each side a prolongation which is attached to the transverse metacarpal ligament. The lateral portions of the palmar fascia are much thinner, and simply form a covering for the muscles of the thumb and little finger.

The **Palmaris Brevis** (Fig. 13, 16) is a small muscle placed transversely below the pisiform bone and immediately beneath the skin. *Arising* from the inner edge of the central fascia it crosses the ulnar artery and nerve, and is *inserted* into the skin on the inner side of the hand. It is *supplied* by the ulnar nerve, and is often indistinct.

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

The **Superficial Palmar Arch** (Fig. 14, 24) is the direct continuation of the ulnar artery, which reaches the hand by passing over the annular ligament. The vessel is subject to very great variations, but if regular, forms an arch with the convexity forwards, reaching to about midway between the annular ligament and the root of the middle finger. The arch is completed on the radial side either by the *superficial volar* branch of the radial artery, which generally pierces a few of the fibres of the muscles of the thumb, or more commonly by the *radialis indicis* (p. 72), the superficial volar being absent. From the convexity of the arch, and principally from its ulnar side, are given off four *digital arteries*, the first of which runs to the ulnar side of the little finger, whilst the three others bifurcate about half an inch from the web of the fingers to supply the radial side of the little finger, both sides of the ring, both sides of the middle, and the ulnar half of the index finger. These branches should be traced along the sides of the fingers, and will be found to supply the cutaneous structures, the sheaths of the tendons and the joints, to be united by transverse branches, and to send twigs back to the dorsal aspect of the fingers; and finally they inosculate in the pulp of the terminal phalanx and supply a plexus beneath the nail. They are accompanied by the digital nerves; but their relative position differs in the palm and in the fingers,—in the former the arteries are superficial to, in the latter they are deeper than, the nerves.

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

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

The superficial palmar arch is subject to considerable variation, one of the most common irregularities being its non-completion by the superficial volar, in which case it generally joins the *radialis indicis* at the root of the index finger. The median artery from the anterior interosseous (p. 49) may be large and join the superficial palmar arch or supply digital branches.

The **Ulnar Nerve** (Fig. 15, 26) accompanies the ulnar artery over the annular ligament, lying to its ulnar side, and immediately divides into a superficial and a deep portion. The *deep branch* (28) accompanies the profunda branch of the ulnar artery between the muscles of the little finger, all of which it supplies, and will be seen again in the deep dissection of the palm. The *superficial division* sends a small twig to the palmaris brevis, and subdivides into two digital branches which supply one and a half fingers, the inner one running on the ulnar side of the little finger, and the other bifurcating at the roots of the fingers into branches for the radial side of the little and ulnar side of the ring finger, the latter uniting with a branch of the median nerve. The digital nerves can be traced along the sides of the tendinous sheaths, lying superficially to the arteries and joining one another in the pulp of the finger, where the corpuscles of touch (Paccini) are developed like little buds upon a twig. A large branch also passes backward at the tip of the finger to supply the matrix of the nail, and others, which unite with the digital nerves on the dorsal aspect, supply almost entirely the skin over the backs of the second and third phalanges.*

The **Anterior Annular Ligament** (Fig. 25, 1) is the broad band of fascia binding down the flexor tendons at the wrist. It is attached to the scaphoid bone and to the ridge of the trapezium on the outer side, and to the unciform process of the unciform bone, and slightly to the pisiform bone, on the inner side. The ulnar artery and nerve and the cutaneous palmar nerves cross it, and also the tendon of the palmaris longus in part. (The tendon of the flexor carpi ulnaris sends an expansion over the ulnar artery and nerve, which must not be mistaken for the annular ligament itself.) When divided in the middle, its outer attachment will be seen to be perforated by the tendon of the flexor carpi radialis, while beneath the ligament are the median nerve and the tendons of the flexors of the thumb and fingers. Beneath the annular ligament and closely connected with the tendons and median nerve, will be found a quantity of loose bursal tissue, containing a synovial

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

Ulnar artery	3½ fingers. }
Ulnar nerve	1½ fingers. }
Radial artery	1½ fingers. }
Median or Radial nerve . .	3½ fingers. }

cavity, which extends from just above the annular ligament to about the middle of the palm and generally, but not constantly, communicates with the special sheaths of the thumb and little finger. The use of this tissue is to facilitate the movements of the tendons, and it occasionally becomes diseased, when fluid is developed in it in considerable quantity, and forms a fluctuating tumour above and below the annular ligament, often containing numerous rice-like bodies. This tissue must be carefully dissected away.

The **Median Nerve** (Fig. 17, 33) is flattened as it passes beneath the annular ligament superficially to the tendons, and divides into two trunks which subdivide into four *digital nerves*, to supply three and a half fingers. The first or outermost, after giving a small branch to supply some of the short muscles of the thumb, bifurcates into branches to supply the two sides of the palmar aspect of the thumb ; the second digital nerve supplies the radial side of the index-finger, after giving a small twig to the first lumbricalis muscle ; the third, after supplying the second lumbricalis, bifurcates near the roots of the fingers to supply the ulnar side of the index and the radial side of the middle fingers ; the fourth bifurcates to supply the ulnar side of the middle finger and the radial side of the ring finger, this last branch joining the branch from the ulnar nerve previously seen. The digital branches of each finger unite in the pulp of the terminal phalanx, and have Paccinian corpuscles developed on them like those of the ulnar nerve, and also give branches to the matrix of the nail and the back of the finger.

[The ulnar artery is to be divided beyond the origin of the profunda and the arch turned down as far as possible, but the nerve may be left uncut. The median nerve is to be divided at the wrist and turned down, and the flexor tendons with the lumbricales muscles cleaned and traced to their insertions. The sheaths of the flexor tendons have been already described (p. 46), but at least one more should be laid open in order that the tendons may be well seen.]

The **Tendons of the Flexor Sublimis,** four in number, pass beneath the annular ligament and lie immediately beneath the median nerve in the palm. Each tendon becomes somewhat flattened, and on the first phalanx splits into two portions, which give passage to the tendons of the flexor profundus between them, and, after blending again by their edges, are *inserted* into the sides of the second phalanx. The *vincula vasculosa* or synovial slips which unite the tendons to the sheath (*ligamenta longa*), and also the short elastic bands (*ligamenta brevia*) connecting each tendon with the front of the phalanx should be observed.

The **Tendons of the Flexor Profundus** (Fig. 25, 7), also four in number, lie beneath the corresponding superficial tendons, which they perforate over the first phalanges; they then pass on to be *inserted* into the bases of the third phalanges.

Each pair of tendons is lubricated by a synovial sheath, which reaches about $1\frac{1}{2}$ inch above the cleft of the fingers; that of the little finger communicates with the general synovial cavity already described. The sheath of the flexor longus pollicis reaches above the annular ligament, and also usually communicates with the common sheath beneath it by a minute opening.

The **Lumbricales** (Fig. 25, 7) are four little muscles connected with the deep flexor tendons, and bear some resemblance to worms (lumbrici). The first lumbricalis, counting from the radial side (and sometimes the second), *arises* from the radial side of a single tendon, but the others *arise* by distinct slips from the adjacent sides of two deep tendons. The four muscles end in small tendons which wind to the radial side of the four fingers, and, passing over the transverse ligament of the metacarpus, are *inserted* into the expansions of the extensor tendons on the back of the first phalanges. The lumbricales act with the interossei as flexors of the first phalanges and extensors of the second and third phalanges. The first and second have been seen to be *supplied* by branches of the median nerve; the third and fourth receive twigs from the deep branch of the ulnar nerve, which will be seen in the deeper dissection.

The **Tendon of the Flexor Longus Pollicis** (Fig. 25, 9) is at the same level as the tendons of the flexor profundus, and can be traced between the halves of the flexor brevis pollicis to the base of the terminal phalanx of the thumb.

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

Muscles of the Little Finger.

The **Abductor Minimi Digiti** (Fig. 25, 10) is the most superficial and the innermost of these. It *arises* from the pisiform bone and slightly from the tendon of the flexor carpi ulnaris, and is *inserted* into the inner side of the base of the first phalanx.

The **Flexor Brevis Minimi Digiti** (Fig. 25, 8) is often inseparably united with the abductor; but the deep branches of the ulnar artery and nerve which pass between the two will serve as guides to the point of separation. It *arises* from the unciform process of the unciform bone and from the annular ligament, and is *inserted* with the abductor into the base of the first phalanx.

The **Opponens Minimi Digiti** is the deepest of the set, and *arises* from the unciform process close to the preceding muscle and from the annular ligament. It spreads into a triangular shape, and is *inserted* into the inner margin of the shaft of the fifth metacarpal bone, thus resembling the opponens pollicis as to insertion, although the power of "opposition" in the little finger is much more limited than in the thumb.

Muscles of the Thumb.

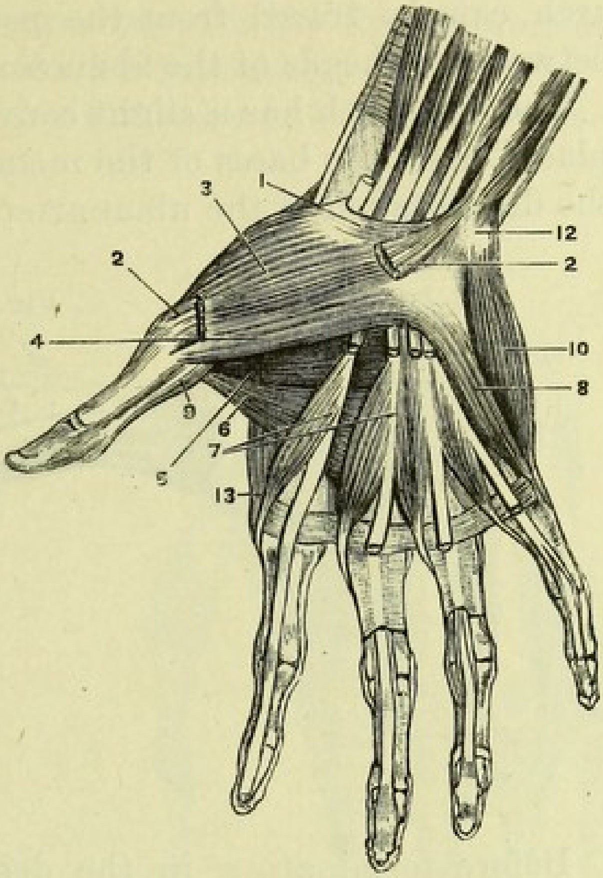
The **Abductor Pollicis** (Fig. 25, 2) is a slender muscle, and is the most superficial of the series. It *arises* from the ridge on the trapezium, and from the annular ligament. It is *inserted* into the outer side of the base of the first phalanx of the thumb, with the outer half of the flexor brevis. It must be divided to see the following:—

The **Opponens Pollicis** (Fig. 25, 3) *arises* from the front of the trapezium and from the annular ligament, and is *inserted* into the outer border of the shaft of the metacarpal bone of the thumb. Its action is to "oppose" the thumb to the fingers, an action peculiar to man and monkeys, the muscle being sometimes called the *flexor ossis metacarpi pollicis*.

The **Flexor Brevis Pollicis** (Fig. 25, 4) consists of two portions at its insertion, between which the tendon of the long flexor is placed, one head being more or less conjoined with the adductor, and the other with the abductor pollicis. It *arises* from the lower part of the annular ligament, from the front of the trapezium, trapezoides and os magnum, the bases of the second and third metacarpal bones, and the sheath of the flexor carpi radialis. The two heads are *inserted* into the sides of the base of the first phalanx of the thumb, and into the sesamoid bones which are developed at this point, sending slips forward to join the tendon of the extensor secundi internodii pollicis on the back of the first phalanx (Fig. 26). In this way, according to Duchenne, the small muscles of the thumb (with the exception of the opponens) extend the second phalanx whilst acting upon the first phalanx in the direction implied by their several names.

The **Adductor Pollicis** (Fig. 25, 6) *arises* from the anterior surface of the lower two-thirds of the shaft of the middle metacarpal bone, and is *inserted* into the inner side of the base of the first phalanx of the thumb with one part of the flexor brevis, the muscle forming a triangle with its base to the ulnar side. It necessarily covers the muscles in the first and second interosseous spaces (which may be seen in part at its anterior border), and will have to be divided subsequently to expose them thoroughly.

Fig. 25.



The **Deep Branch of the Ulnar Nerve** (Fig. 17, 22) is to be traced out, and will be found to arise from the ulnar trunk near the pisiform bone, and to pass between the flexor brevis and the abductor minimi digiti, giving branches to them and the opponens. It then forms an arch across the bases of the metacarpal bones, accompanying the deep palmar arch, and supplying the two innermost lumbricales and the seven interossei muscles (palmar and dorsal); and ends by supplying the adductor and the inner half of the flexor brevis pollicis.*

Fig. 25.—Muscles of the hand (from Wilson).

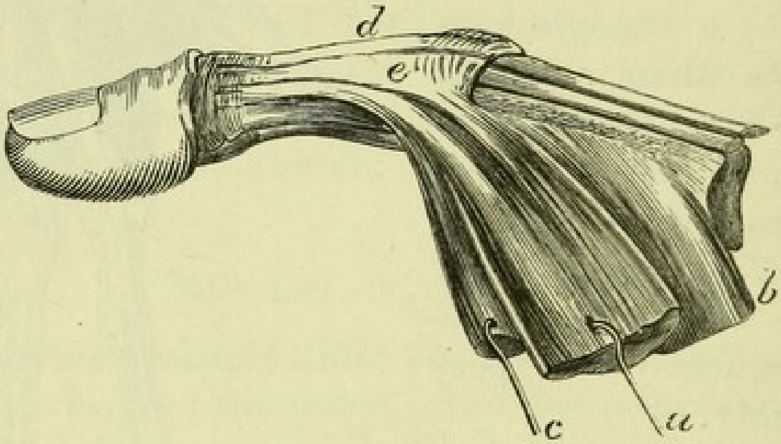
1. Annular ligament.
2, 2. Origin and insertion of the abductor pollicis muscle.
3. Opponens pollicis.
4. Superficial portion of the flexor brevis pollicis.
5. Deep portion of the flexor brevis pollicis.
6. Adductor pollicis.
7, 7. The lumbricales muscles, arising from the deep flexor tendons, upon which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

* It may assist the student in remembering the distribution of the ulnar nerve if he notices how it is governed by the number $1\frac{1}{2}$; thus, the nerve

The **Deep Palmar Arch**, the termination of the radial artery, will be seen appearing between the flexor brevis and the adductor pollicis, or piercing the anterior part of the former muscle; but by dividing the adductor near its origin and turning it aside, the entire arch can be traced from the point at which it enters the palm, between the heads of the abductor indicis.

The deep arch has a slight convexity towards the fingers, and is placed upon the bases of the metacarpal bones, being completed by the deep branch of the ulnar artery.

Fig. 26.



Before terminating in the deep palmar arch the radial artery gives off two branches, viz.:—

1. *Princeps pollicis*, a large branch of uncertain origin, and frequently arising from the radial at the back of the abductor indicis; it passes along the metacarpal bone of the thumb, and then bifurcates to supply both sides of the thumb superficially.

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

Fig. 26.—Insertion of muscles of thumb (from Duchenne).

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

supplies one and a half muscles in the fore-arm; gives branches to one and a half fingers on both palmar and dorsal aspects; and lastly, supplies one and a half muscles of the thumb.

The deep arch gives some small *recurrent* branches to the carpus; three *perforating* arteries to the dorsum, which pass between the heads of the three inner interosseous muscles; and three *interosseous arteries* which run on the three palmar interosseous muscles to the roots of the fingers, and then anastomose with the digital branches of the superficial arch at their points of bifurcation.

The tendon of the *Flexor carpi radialis* can now be easily traced

Fig. 27.

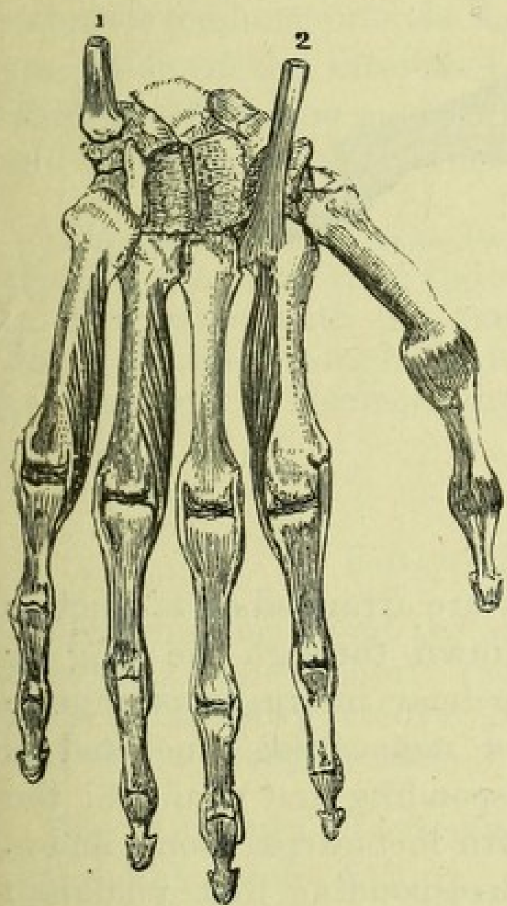
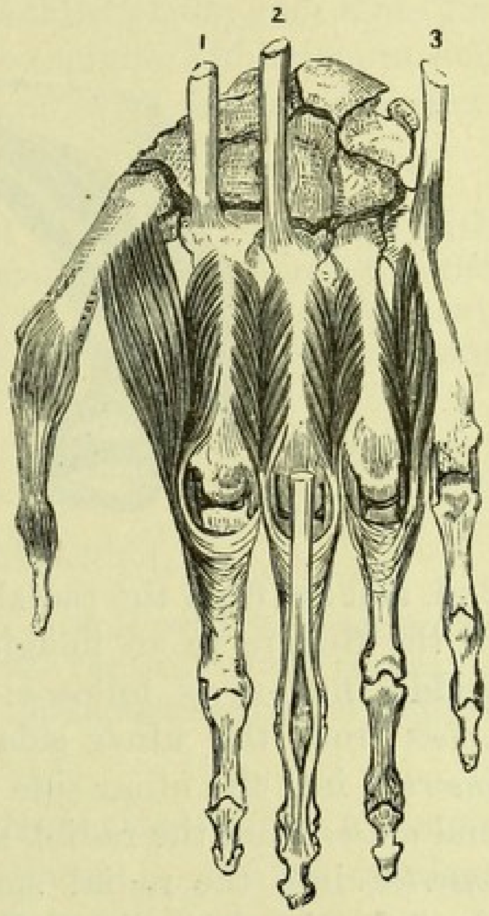


Fig. 28.



through the groove in the trapezium to its insertion into the base of the second metacarpal bone.

The **Transverse Metacarpal Ligament** passes in front of the heads of the metacarpal bones, and is closely connected with the

Fig. 27.—The three palmar interosseous muscles of the hand (drawn by J. T. Gray).

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

Fig. 28.—The four dorsal interosseous muscles of the hand (drawn by J. T. Gray).

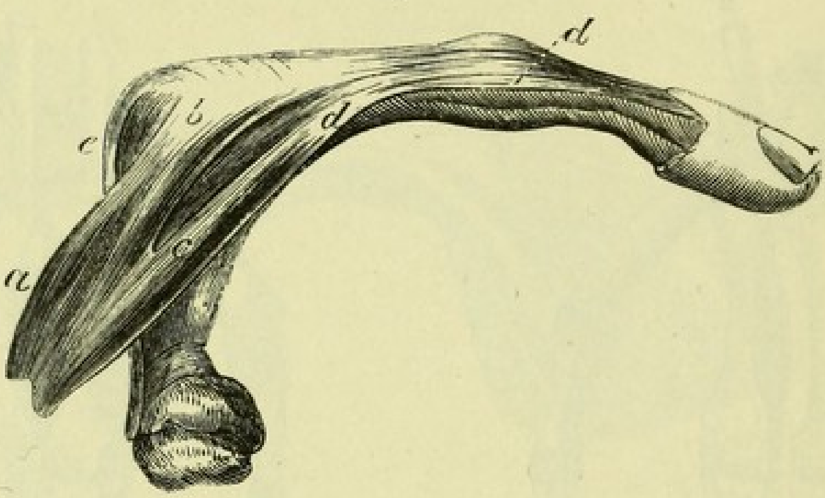
1. Tendon of extensor carpi radialis longior.
2. Tendon of extensor carpi radialis brevior.
3. Tendon of extensor carpi ulnaris.

sheaths of the flexor tendons. It must be divided to follow out the palmar interossei, which pass beneath it.

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

The *Three palmar interossei* (Fig. 27) are muscles placed in the three metacarpal spaces between the fingers, and are numbered 1st,

Fig. 29.



2nd, and 3rd from the radial side. They are arranged as *ad*-ductors of the fingers to an imaginary line drawn through the long or middle finger, as follows:—The 1st palmar interosseous muscle *arises* from the ulnar side of the 2nd metacarpal bone, and is *inserted* into the ulnar side of the corresponding first phalanx; the 2nd *arises* from the radial side of the 4th metacarpal bone, and is *inserted* into the radial side of the corresponding first phalanx; the 3rd *arises* from the radial side of the 5th metacarpal bone, and is *inserted* into the radial side of the corresponding first phalanx.

The *Four dorsal interossei* (Fig. 28) are penniform muscles *arising* from the adjacent sides of the metacarpal bones, and therefore showing by the sides of the palmar muscles to some extent, but are best dissected from behind. They are arranged as *ab*-ductors from an imaginary line drawn through the middle or long finger, and are therefore *inserted* as follows:—The 1st (abductor indicis) into the radial side of the base of the first phalanx of the forefinger; the

Fig. 29.—Attachment of an interosseous muscle (from Duchenne).

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

2nd into the radial side of the first phalanx of the middle finger; the 3rd into the ulnar side of the same phalanx; the 4th into the ulnar side of the first phalanx of the ring-finger. These muscles vary slightly as to their attachments, but the following points respecting them have been elucidated by Duchenne's electrical investigations:—The insertion into the base of the first phalanx (Fig. 29), enables the interossei to act as flexors of that phalanx, whilst giving lateral movement to the fingers to which they are attached. The slip (*d*) sent forward to join the expansion of the extensor tendons extends the second and third phalanges; and thus the action of the interossei is shown to include adduction to and abduction from the median line of the hand, with flexion of the first and extension of the second and third phalanges.

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

Ligaments of the Scapula.

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

The **Acromio-Clavicular Articulation** (Fig. 30) is a simple arthrodial joint, though occasionally there is a fibro-cartilage developed in it, dividing the synovial cavity into two parts.

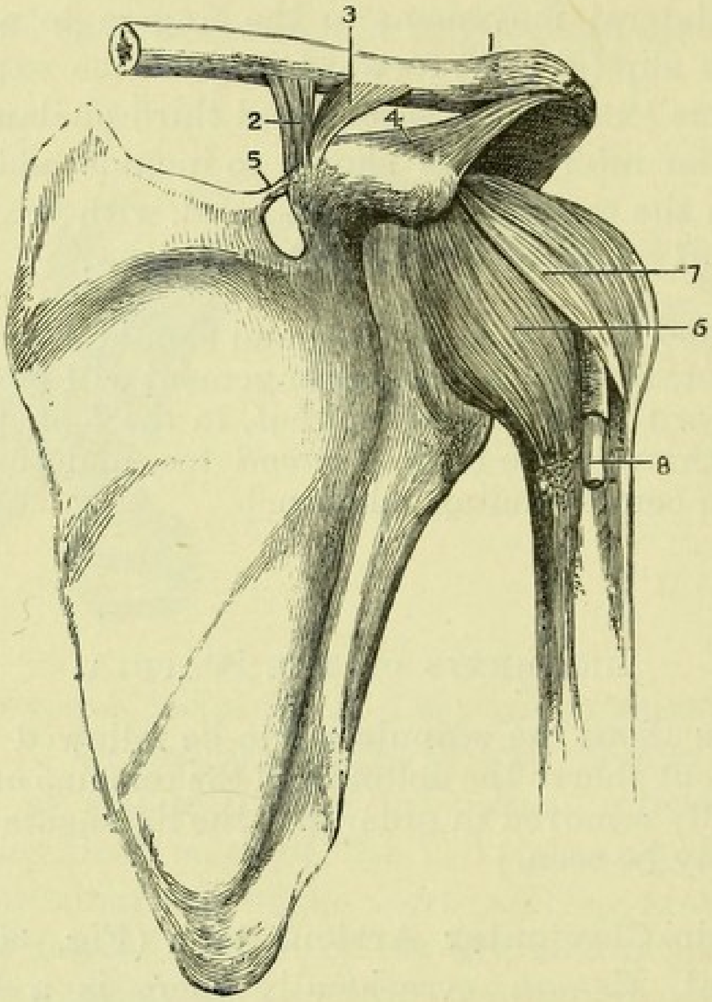
The *Superior acromio-clavicular ligament* (Fig. 30, 1) is a quadrilateral band of short strong fibres more or less connected with the fibres of the trapezius and deltoid. It is in reality continuous with the *inferior acromio-clavicular ligament*, which is similar in shape, but placed below the joint.

The **Coraco-Clavicular Ligament** (Fig. 30, 2, 3) is really but one ligament twisted upon itself so as to present two surfaces, to which the names Conoid and Trapezoid have been given; if the spine of the scapula has been divided, this twisted arrangement can be readily undone.

The *Conoid ligament* (Fig. 30, 3) is the posterior portion, and resembles a cone with the base upwards. It is attached to the posterior and inner part of the base of the coracoid process *below*, and to the tubercle on the under surface of the clavicle and part of the adjacent bone *above.*

The *Trapezoid Ligament* (Fig. 30, 2) might be more suitably called rhomboid from its shape. It is a quadrilateral band of fibres attached to the line on the posterior part of the upper surface of

Fig. 30.



the coracoid process *below,* and to the line leading to the tubercle on the under surface of the clavicle *above.* It is anterior and external to the conoid ligament.*

Fig. 30.—Ligaments of the scapula and shoulder-joint (from Wilson).

1. Superior acromio-clavicular ligament.
2. Coraco-clavicular ligament (trapezoid).
3. Coraco-clavicular ligament (conoid).
4. Coraco-acromial ligament.
5. Transverse ligament.
6. Capsular ligament.
7. Coraco-humeral ligament.
8. The long tendon of the biceps issuing from the capsular ligament and entering the bicipital groove.

* The relation of the ligaments may be remembered by the letters *a e* in *trapezoid,* which is *a*nterior and *e*xternal to the conoid.

The **Coraco-Acromial Ligament** (Fig. 30, 4) is a triangular band attached to the outer side of the coracoid process, and by its smaller end to the tip of the acromion process, and is often divided into two portions. It arches above the shoulder joint and prevents dislocation upwards.

The **Transverse Ligament** (Fig. 30, 5) is a short band converting the supra-scapular notch into a hole, and giving origin to part of the omo-hyoid muscle. The supra-scapular artery goes over the ligament, but the nerve beneath it.

The movements between the scapula and clavicle are very slight, but the two bones move freely together upon the thorax, the sterno-clavicular joint (*vide* Side of Neck) admitting of movement in every direction. The scapula is raised by the trapezius (upper part), levator anguli scapulæ and rhomboid muscles; being again depressed by the weight of the arm, assisted by the pectoralis minor, the lower fibres of the trapezius, and (indirectly) by the latissimus dorsi. It is drawn forward by the serratus magnus and backward by the rhomboidei. The rotation of the scapula upon the ribs, by which the head of the bone is elevated and the arm is raised beyond a right angle with the trunk, is due to the trapezius and to the strong lower fibres of the serratus magnus; the upper fibres of the latter muscle, the rhomboidei and the pectoralis minor acting in the opposite direction.

The Shoulder Joint.

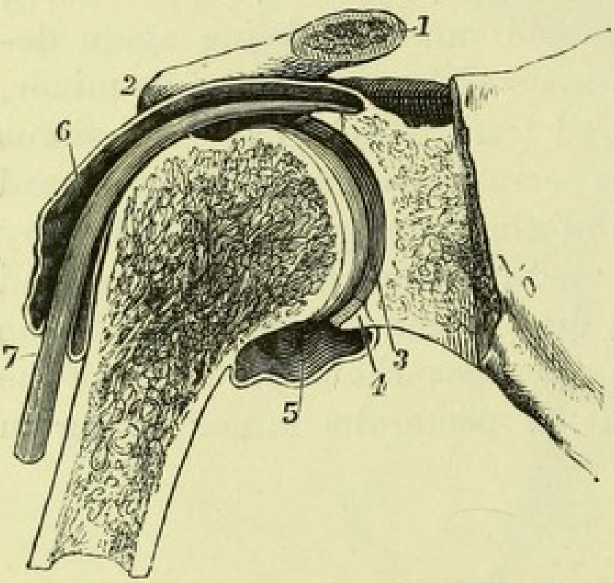
[The muscles surrounding the shoulder are to be carefully removed, those which are inserted into the tubercles of the humerus being dissected as close to the capsular ligament as possible without injuring it, and then cut short.]

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

The shoulder-joint admits of the following movements—flexion extension, abduction, adduction, rotation, and circumduction, which may be conveniently taken to resemble the same movements in the hip-joint. Thus the humerus is *flexed* (in front of the trunk) by the pectoralis major and coraco-brachialis muscles, and the anterior fibres of the deltoid. It is *extended* (behind the trunk) by the latissimus dorsi, teres major, and posterior fibres of the deltoid. It is *adducted* by the weight of the limb, by the action of the pectoralis major, latissimus dorsi, the two teres muscles, and coraco-brachialis, and *abducted* by the deltoid and supra-spinatus. Rotation of the humerus upon the glenoid cavity is produced *outwards* by the infra-spinatus and teres minor, *inwards* by the subscapularis, teres major, latissimus dorsi, and pectoralis major muscles. The last two muscles are antagonistic in the fact that the pectoralis major draws the arm forward across the chest, after rotating it, whilst the latissimus dorsi draws it behind the back.

The **Capsular Ligament** (Fig. 30, 6) is seen to be loose, allowing partial dislocation of the humerus now that all the muscles are divided, and rough, owing to the insertion of some of the muscles of the scapula into it. There is frequently an opening on its inner side, by which the bursa of the subscapularis communicates with the articular cavity. It is attached *above* to the outer margin of the glenoid cavity of the scapula, and *below* to the anatomical neck of the humerus, and is pierced at its lower margin by the long tendon of the biceps (Fig. 30, 8). It is thickened in front by a band of fibres attached to the root of the coracoid process and called the *Coraco-humeral ligament* (Fig. 30, 7).

Fig. 31.



The tendon of the biceps is to be followed into the articulation by laying open the capsular ligament, when it will be found to be surrounded by a tube of synovial membrane, and having become flattened, to be attached to the glenoid ligament and upper part of the glenoid cavity. This tube can be demonstrated before the capsule is opened by making traction upon the tendon, when the tube will be everted (Fig. 31).

Fig. 31.—Section through the shoulder-joint (from Wilson).

1. The cut end of the clavicle.
2. Acromial end of clavicle.
3. Articular surface of the glenoid cavity covered with cartilage and synovial membrane.
4. Cross section of the glenoid ligament.
5. Lower part of capsule and synovial sac.
6. Synovial membrane prolonged on biceps tendon.
7. Tendon of biceps.

The **Glenoid Ligament** (Fig. 31, 4) is a fibrous ring continuous with the tendon of the biceps and surrounding the glenoid cavity, which it therefore deepens.

There is a single **Synovial Membrane** in the shoulder joint, which is reflected over the articular surfaces and capsular ligament; it forms a tube around the tendon of the biceps, which is prolonged into the bicipital groove.

The Elbow Joint.

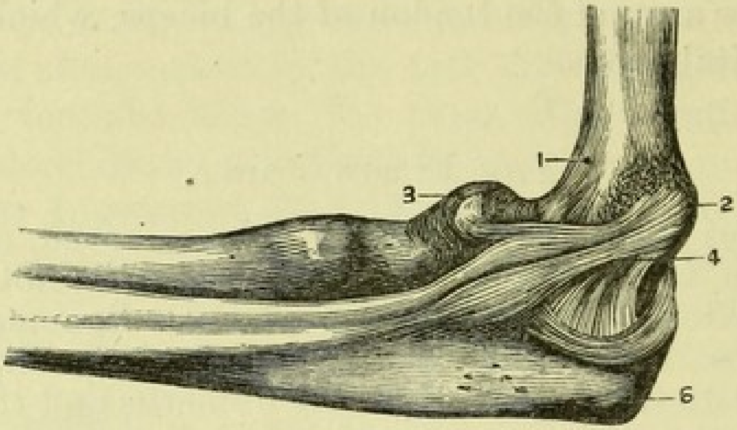
[The muscles about the elbow are to be removed, and great care must be taken, in detaching the supinator brevis, not to remove or damage the external lateral and the orbicular ligaments. Beneath the triceps close to the joint may be found a little slip of muscular fibre attached to the lower end of the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

The articulation of the humerus and ulna is a good example of *ginglymus*, or hinge-joint, and therefore has lateral ligaments; the articulation of the upper end of the radius is an example of *diarthrosis rotatorius*, the head being surrounded by a ring partly of bone and partly of ligament; and the articulation between the head of the radius and the outer condyle of the humerus is an example of simple *arthrodia*. The ligaments of the elbow are united together and form one general capsule, but may be divided into anterior, posterior, external lateral, and internal lateral.

The elbow-joint has *in front* the brachialis anticus with the brachial artery and median nerve; *behind* are the triceps and anconeus muscles. To the *inner* side are the muscles arising from the internal condyle, and the ulnar nerve with the inferior profunda artery lies upon the internal lateral ligament. *Externally* the muscles arising from the external condyle, with the musculo-spiral nerve and superior profunda artery, are in relation, and the supinator brevis is closely connected with the external lateral ligament.

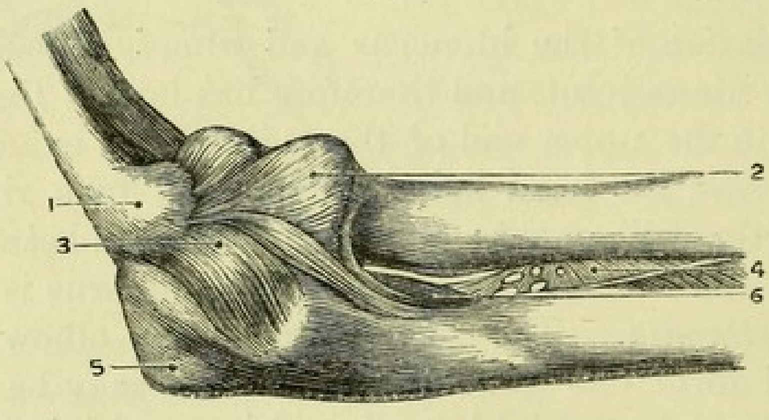
The fore-arm is *flexed* by the biceps, brachialis anticus, and supinator longus, and indirectly by the flexors of the wrist and fingers. It is *extended* by the triceps and anconeus, and indirectly by the extensors of the wrist and fingers. Rotation of the radius upon the ulna and humerus, and consequently pronation and supination of the hand, are produced as follows,—*Pronation* by the pronator quadratus and pronator teres, *supination* by the biceps, supinator brevis, and very feebly by the supinator longus.

Fig. 32.



The **Anterior Ligament** (Fig. 32, 1) is a broad membrane attached to the humerus immediately above the coronoid fossa, and

Fig. 33.



to the edge of the coronoid process of the ulna, and partly to the orbicular ligament.

The **Posterior Ligament** is thin and loose, and is attached to

Fig. 32.—Ligaments of the elbow from the inner side (from Sappey).

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

Fig. 33.—Ligaments of the elbow from the outer side (from Sappey).

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

the upper margin of the olecranon fossa of the humerus, and to the edge of the olecranon process of the ulna.

The **Internal Lateral Ligament** (Fig. 32, 4) is triangular, the apex being attached to the prominent internal condyle, and the base reaching all along the inner margins of the coronoid and olecranon processes, and bridging across the notch between them.

The **External Lateral Ligament** (Fig. 33, 3) is a short thick band attached to the outer condyle, and radiating slightly at its attachment to the upper border of the orbicular ligament of the radius.

The **Synovial Membrane** will be seen by removing the anterior ligament, and will be found to be reflected between the humerus, radius, and ulna, and also into the small joint between the head of the radius and the lesser sigmoid cavity. The articular surfaces of all the bones are encrusted with cartilage, but occasionally a groove across the bottom of the sigmoid cavity separates that covering the olecranon from that covering the coronoid process.

Radio-Ulnar Articulations.

Superior (Fig. 33, 2).—This is a part of the elbow joint, and consists of the *Orbicular ligament* (Fig. 34, 3), a strong flat band of fibres attached to the extremities of the lesser sigmoid cavity and giving insertion to the external lateral ligament of the elbow, which must be removed to see the orbicular ligament satisfactorily.

Middle (Fig. 33, 4).—The *Interosseous ligament* or membrane is the great bond between the shafts of the bones of the fore-arm, its fibres running obliquely downwards from the radius to the ulna. It is attached to the sharp interosseous borders of both bones in all their lower part, a space being left between the bones above, through which the posterior interosseous vessels go. The membrane has a large opening in it, near the lower part, for the anterior interosseous artery, and one or two smaller ones for its branches (Fig. 35, 4).

The *Round* or *oblique ligament* (Fig. 33, 6) is very rarely seen, but is a band attached to the outer side of the coronoid process of the ulna and to the radius below the bicipital tubercle. Its direction is therefore the reverse of that of the interosseous membrane.

Inferior (Fig. 35, 3) is formed by *anterior* and *posterior* ligaments, which are short fibrous bands passing between the extremities of the radius and ulna, and by an *inter-articular fibro-cartilage* which will be seen when the joint is opened (Fig. 37, 3).

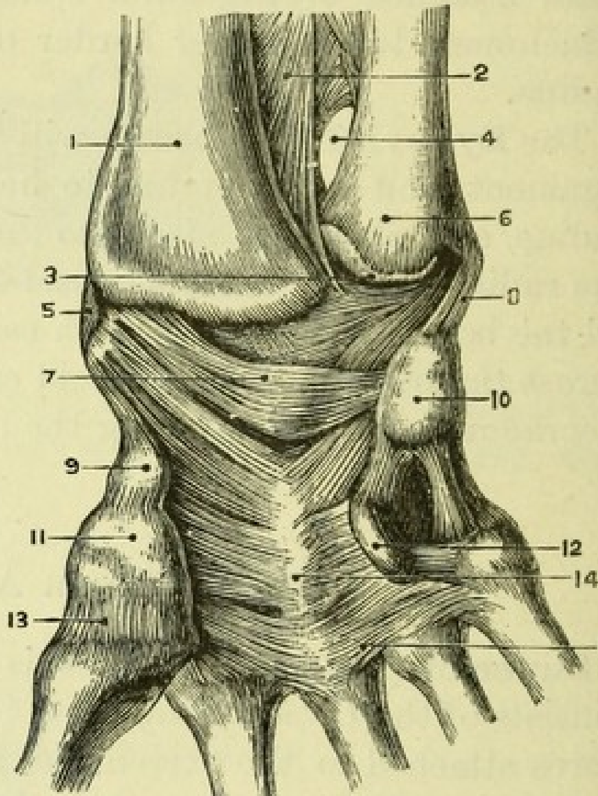
The Wrist Joint.

This is a condyloid joint or hinge-joint admitting of considerable lateral movement, and has anterior, posterior, and two lateral ligaments.

The wrist joint has *in front* the radial artery, the tendons of the

Fig. 34.

Fig. 35.



flexor longus pollicis, flexor carpi radialis, palmaris longus, flexor sublimis and profundus, with the median nerve, ulnar artery and nerve, and flexor carpi ulnaris. To the *outer* side, the tendons of

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Fig. 34.—Upper part of ulna with orbicular ligament (from Wilson).
1. Olecranon. 2. Tip of coronoid process. 3. Orbicular ligament.

Fig. 35.—Ligaments of the anterior aspect of the wrist and hand (from Sappey).

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

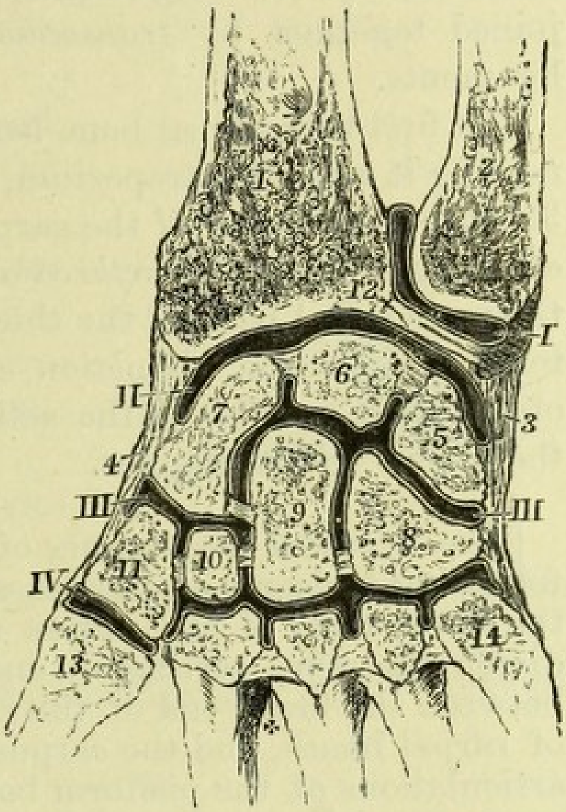
the extensor ossis metacarpi and primi internodii pollicis, with the radial artery and nerve. *Behind*, the extensor carpi radialis longior and the brevior, extensor secundi internodii pollicis, extensor communis digitorum, indicis, and minimi digiti, and the extensor carpi ulnaris (Fig. 24).

The **Anterior and Posterior Ligaments** (Fig. 35, 7) are broad bands attached to the front and back of the lower end of the radius and to the front and back of the first row of carpal bones, being united with the ligaments of the carpus.

The **External Lateral Ligament** (Fig. 35, 5) is a thick band attached to the styloid process of the radius, and to the outer side of the scaphoid and trapezium.

The **Internal Lateral Ligament** (Fig. 35, 8) is longer than the external, and is attached to the styloid process of the ulna, and to the upper surface of the cuneiform bone.

Fig. 36.



The **Bones of the Carpus** (Fig. 35) are bound together by vertical and transverse *dorsal* and *palmar*, and at each side by slender *lateral* ligaments, which will not repay a special dissection; also by *interosseous* ligaments which bind together the several bones

Fig. 36.—Section showing the disposition of the chief synovial membranes of the wrist-joint (from Wilson).

I. Sacciform membrane.
II. Second synovial membrane.
III. Third or large synovial membrane.
IV. Synovial membrane between the trapezium and metacarpal bone of thumb. That of the pisiform bone is not visible in this view.
1. Radius.
2. Ulna.
3. Internal lateral ligament.
4. External lateral ligament.
5. Cuneiform bone.
6. Semilunar.
7. Scaphoid.
8. Unciform.
9. Os magnum.
10. Trapezoid.
11. Trapezium.
12. Interarticular fibro-cartilage.
13. Metacarpal bone of thumb.
14. Metacarpal bone of little finger.
×. Interosseous metacarpal ligaments. Interosseous ligaments are also seen connecting the bones of each row of the carpus.

of each row (except the pisiform, which has a separate capsular ligament), and will be seen when the joints are opened (Fig. 36).

The **Metacarpal Bones** (Fig. 35, 16) (with the exception of the first) are connected with the second row of the carpus by *dorsal* and *palmar* ligaments, and the four metacarpal bones are joined together by *transverse* dorsal, palmar, and interosseous ligaments.

The first metacarpal bone has a separate capsular ligament connecting it with the trapezium, this joint being enarthrodial (Fig. 35, 13). The bones of the carpus and metacarpus are capable only of a slight gliding or *arthrodial* movement, with the exception of the metacarpal bone of the thumb, which is capable of flexion, extension, adduction, abduction, and circumduction. The movements of the wrist are due to the actions of the flexors and extensors of the carpus and phalanges.

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

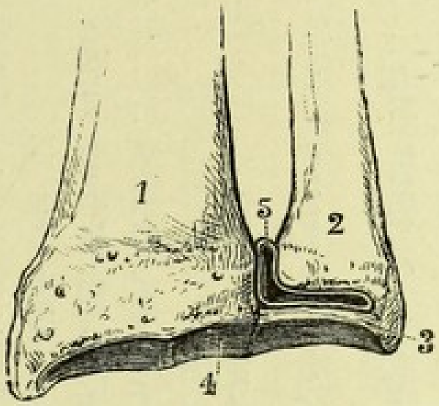
The **Synovial Membranes of the Wrist** (Fig. 36) are five in number. The 1st or *membrana sacciformis* is between the lower ends of the radius and ulna, and extends between the ulna and the triangular fibro-cartilage; the 2nd is between the radius and the under surface of the triangular fibro-cartilage above, and the three outer bones of the first row of the carpus below; the 3rd is between the first and second rows of carpal bones, passing between the several bones as well; it is prolonged between the bones of the second row to the metacarpal bones, and is reflected over the bases of the four inner bones as well as between them; the 4th is between the cuneiform and pisiform bones; the 5th between the trapezium and the metacarpal bone of the thumb.

The **Triangular Fibro-cartilage** (Fig. 37, 3) is best seen by removing the carpus altogether. It is attached by its base to the margin of the radius, between the surfaces for articulation respectively with the ulna and the carpus, and passes transversely between the lower end of the ulna and the carpus, to be attached by its apex to the root of the styloid process of the ulna.

The **Metacarpus and Phalanges** are connected by anterior, posterior, and lateral ligaments.

The *Anterior ligaments* are strong fibro-cartilaginous bands passing from the head of the metacarpal bone to the base of the phalanx, and closely connected with the transverse metacarpal ligament and the sheaths of the tendons.

Fig. 37.



The *Posterior ligament* is a distinct structure beneath the expansion of the extensor tendons.

The *Lateral ligaments* are strong bands which are attached to the sides of the heads of the metacarpal bones, and pass obliquely to the anterior margins of the phalanges.

Each joint has a separate synovial membrane.

The **Phalangeal Articulations** are similar to those between the metacarpus and phalanges.

The articulations of the carpus and metacarpus may be remembered by the formula—

$$\begin{array}{ccccc} & R & R & & \\ & 4 & 4 & 3 & 1 \\ & 4 & 4 & 7 & 5 \\ \hline 1 & 3 & 1 & 2 & 1 \end{array}$$

Thus the Scaphoid and Semilunar articulate each with 4 carpal bones and the Radius; the Cuneiform with 3, and the Pisiform with 1 carpal bone each. The Trapezium and Trapezoides with 4, the Magnum with 7, and the Unciform with 5, carpal and metacarpal bones respectively. The numbers in the third row give the articulations of the several metacarpal bones with the carpus only, but in addition the adjacent bones of the four fingers articulate with each other.

Fig. 37.—Lower end of radius and ulna with triangular fibro-cartilage (from Wilson).

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

TABLE I.
MUSCLES OF UPPER EXTREMITY.

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

Pronator quadratus	Ulna, anterior lower $\frac{1}{4}$	Radius, anterior lower $\frac{1}{4}$	Anterior interosseous (median).
Supinator radii longus	Humerus, supracondyloid ridge $\frac{2}{3}$. Septum	Radius, base of styloid process	Musculo-spiral.
Extensor carpi radialis longior	Humerus, supracondyloid ridge $\frac{1}{3}$. Septum	Metacarpal bone, 2nd	Musculo-spiral.
Extensor carpi radialis brevior	Humerus, external condyle. Fascia	Metacarpal bone, 3rd	Posterior interosseous(musculo-spiral).
Extensor communis digitorum	Humerus, external condyle. Fascia	Four fingers, 2nd and 3rd phalanges	Posterior interosseous.
Extensor minimi digiti	Humerus, external condyle. Septa	Little finger, 2nd and 3rd phalanges	Posterior interosseous.
Extensor carpi ulnaris	Humerus, external condyle. Fascia	Metacarpal bone, 5th	Posterior interosseous.
Anconeus	Humerus, external condyle. Fascia	Ulna, upper $\frac{1}{3}$ of outer surface	Musculo-spiral.
Supinator brevis	Humerus, external condyle. Ulna below lesser sigmoid. Ext. lat. ligt. of elbow. Orbicular ligament	Radius, anterior and outer surfaces above oblique lines	Posterior interosseous (musculo-spiral).
Extensor ossis metacarpi pollicis	Radius, middle posterior. Ulna, middle posterior. Interosseous membrane	Thumb, metacarpal	Posterior interosseous.
Extensor primi internodii pollicis	Radius, posterior. Interosseous membrane $\frac{1}{2}$	Thumb, 1st phalanx	Posterior interosseous.
Extensor secundi internodii pollicis	Ulna, posterior. Interosseous membrane $\frac{1}{2}$	Thumb, 2nd phalanx	Posterior interosseous.
Extensor indicis	Ulna, posterior. Interosseous membrane	Fore finger, common expansion	Posterior interosseous.
Palmaris brevis	Palmar fascia	Skin of palm	Ulnar.
Lumbricales (4)	Tendons of flexor profundus digitorum	Expansion of extensors	Median. Ulnar (deep).
Abductor minimi digiti	Pisiform. Flexor carpi ulnaris tendon	Little finger, 1st phalanx	Ulnar.
Flexor brevis minimi digiti	Unciform. Annular ligament	Little finger, 1st phalanx	Ulnar.
Opponens minimi digiti	Unciform. Annular ligament	Little finger, metacarpal bone	Ulnar.
Abductor pollicis	Trapezium. Annular ligament	Thumb, 1st phalanx	Median.
Opponens pollicis	Trapezium. Annular ligament	Thumb, metacarpal	Median.
Flexor brevis pollicis	Trapezium. Trapezoides. Annular ligament. Magnum. Metacarpals, 2nd and 3rd	Thumb, 1st phalanx (sesamoids)	Median. Ulnar (deep).
Adductor pollicis	Middle metacarpal	Thumb, 1st phalanx	Ulnar (deep).
Palmar interossei (3)	Metacarpals, 2nd, 4th, 5th	Corresponding 1st phalanges	Ulnar (deep).
Dorsal interossei (4)	Adjacent sides of metacarpals	1st, 2nd, and 3rd fingers, 1st phalanges	Ulnar (deep).

PART II.

DISSECTION OF THE LEG.

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

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

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

The crest and anterior superior spine of the ilium will be readily seen and felt, the anterior inferior spine less so, on account of the muscles covering it; the spine and crest of the pubes can also be distinguished. The great trochanter is easily recognised from three to four inches below the crest of the ilium, and should be thoroughly manipulated so that its relation to the upper border of the pelvis and surrounding parts may be clearly appreciated during the movements of the limb; and the two sides of the body should be compared if any morbid change about the hip is suspected.

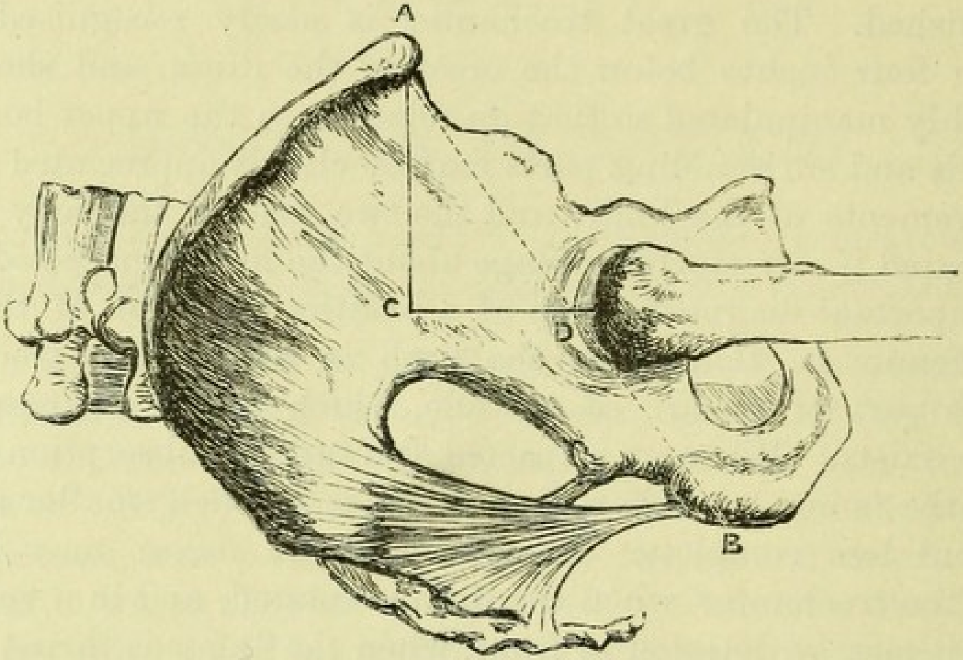
An important diagnostic sign of a healthy condition of the neck of the femur is, that when the limb is rotated the trochanter describes part of the arc of a circle, which is not the case when fracture exists. When an impacted fracture or absorption of the neck of the femur has taken place, the arc is much smaller and the movement less complete. The head of the femur may be felt behind the trochanter when the limb is rotated, and in a very thin subject it may be detected in front, when the finger is thrust deeply into Scarpa's triangle.

Nélaton's test line for dislocation of the head of the femur upwards or backwards is one drawn from the anterior superior iliac spine to the tuberosity of the ischium (Fig. 38, A B), which in health touches the top of the great trochanter. Bryant's test line for fracture of the neck of the femur is one taken vertically from the anterior superior iliac spine when the body is recumbent (Fig. 38, A C), from which the distance (C D) to the top of the great trochanter can be accurately measured.

The condyles of the femur and the patella are to be examined, and it should be noticed how large a part of the articular end of the femur is uncovered by the patella when the knee is flexed. The ligament of the patella and its attachment to the tibia are to be noticed, and the finger should be carried along the subcutaneous surface of the tibia, the shin, down to the ankle. The head of the fibula is readily felt, but it lies in a hollow when the knee is extended. The hand carried to the back of the joint will recognise the outer and inner hamstrings attached to it and to the tibia, and when the knee is flexed may feel the popliteal artery behind the joint. The lower third of the fibula is subcutaneous and terminates in the prominent external malleolus, behind which the peroneal tendons can be felt. On the inner side, the inner malleolus is to be examined, with the tendons behind it, and at the back of the limb the Achilles tendon attached to the heel.

The foot is to be moved freely, when it will be found that the amount of lateral motion in the ankle joint is greatest when the toe

Fig. 38.



is thoroughly pointed. In the same position the broad upper articular surface of the astragalus becomes subcutaneous, and is readily seen beyond the margin of the tibia.

In the foot, the following points of practical utility should be thoroughly recognised; first, on the inner side, the tuberosity of the scaphoid bone, to which the tendon of the tibialis posticus may be traced, and which is the guide in Chopart's amputation of the foot; secondly, the slighter prominence of the internal cuneiform bone and base of the first metatarsal bone in front of it, to which the tendon of the tibialis anticus may be traced, and which serves as a guide in Hey's amputation; and thirdly, on the outer side, the prominent base of the fifth metatarsal bone, which serves the same purpose. The toes are commonly much distorted owing to the long pressure of ill-fitting shoes, and the metatarso-phalangeal articulation of the great toe is not unfrequently diseased, forming a bunion.

The Front of the Thigh.

[An incision is to be made along Poupart's ligament and carried down the inner border of the thigh, for half its length, and this is

Fig. 38.—A B, Nélaton's test line; A C D, Bryant's ilio-femoral triangle.

to be joined by another across the limb at that point; the flap of skin thus marked out is to be carefully reflected to the outer side of the thigh. The superficial fascia is to be first examined.]

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

The **Superficial Vessels** (Fig. 39) are branches of the femoral artery with their accompanying veins, and are three in number, viz.:—

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

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

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

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

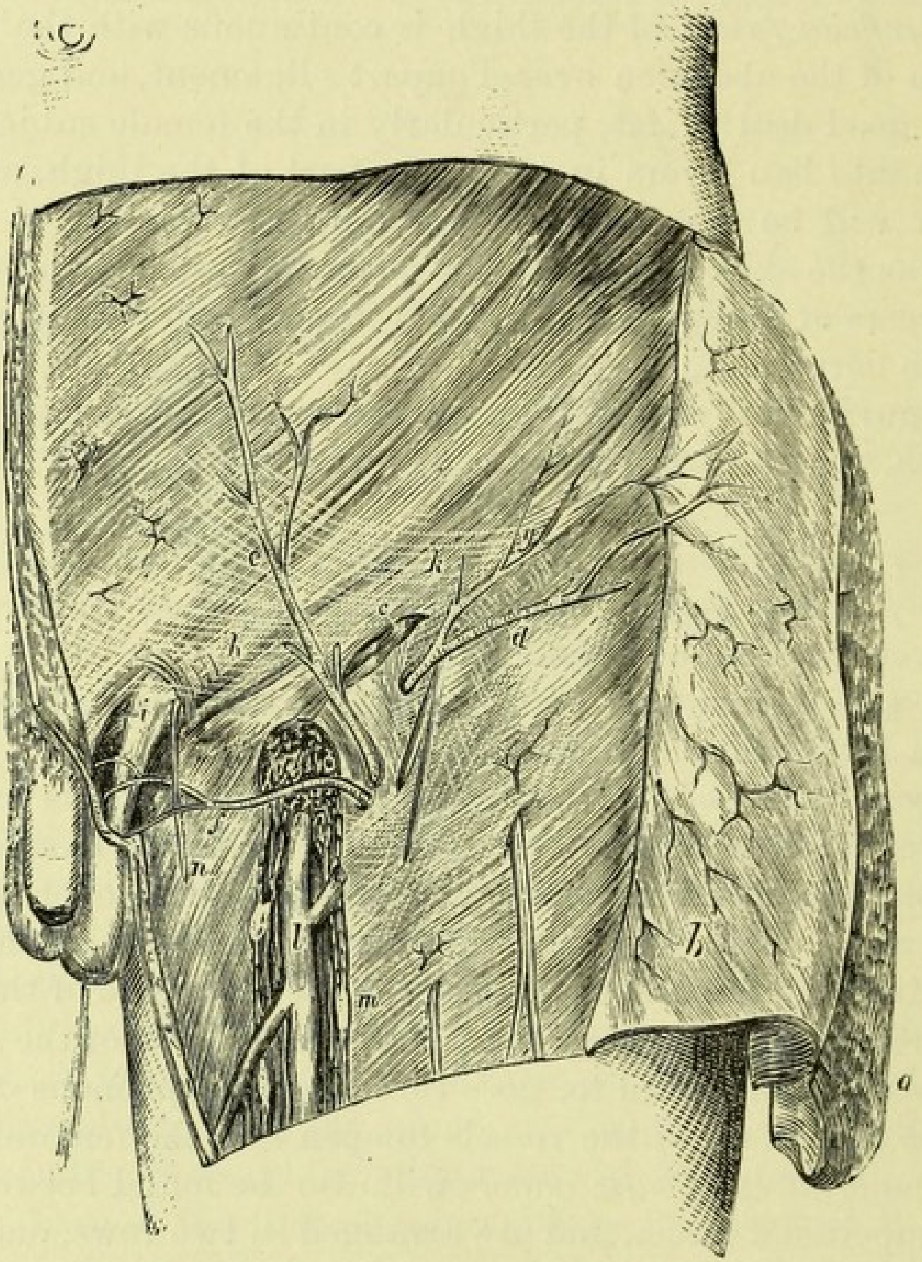
The *Superficial lymphatic glands* will also be found between the layers of superficial fascia, and are arranged in two rows, one along the groin, to which the lymphatics of the penis, scrotum and anus pass, and another below the groin in the direction of the thigh, into which the lymphatics of the limb empty themselves. The relation of the lymphatics to these glands is to be borne in mind, since the position of a bubo will vary according to the part primarily affected,—genitals and perinæum or lower limb.

A few *Deeper lymphatic glands* will be afterwards met with surrounding the femoral vessels, one of which occupies the crural canal.

The *Nerves* are the terminations of the *ilio-inguinal* and crural branch of the *genito-crural*, from the lumbar plexus.

The *Deep layer of superficial fascia* is more membranous than the superficial layer, and will be best seen by raising it from the deep fascia beneath, beginning about four inches below the groin and

Fig. 39.



reflecting it on to Poupart's ligament. The deeper layer of superficial fascia will be found to be bound down to the fascia lata below

Fig. 39.—Superficial dissection of the inguinal and femoral regions (from Wood "On Rupture").

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

Poupart's ligament, and around the margin of the opening through which the saphenous vein disappears, called the *Saphenous opening*. Great care must be taken not to destroy this opening in removing the deep layer of the superficial fascia, which, unlike the superficial layer, does not pass over Poupart's ligament, and therefore has some influence in directing a large femoral hernia along the groin. This layer receives the name of *Cribriform fascia* at the part where it crosses the saphenous opening, because it is perforated by numerous small openings for the passage of vessels and lymphatics.

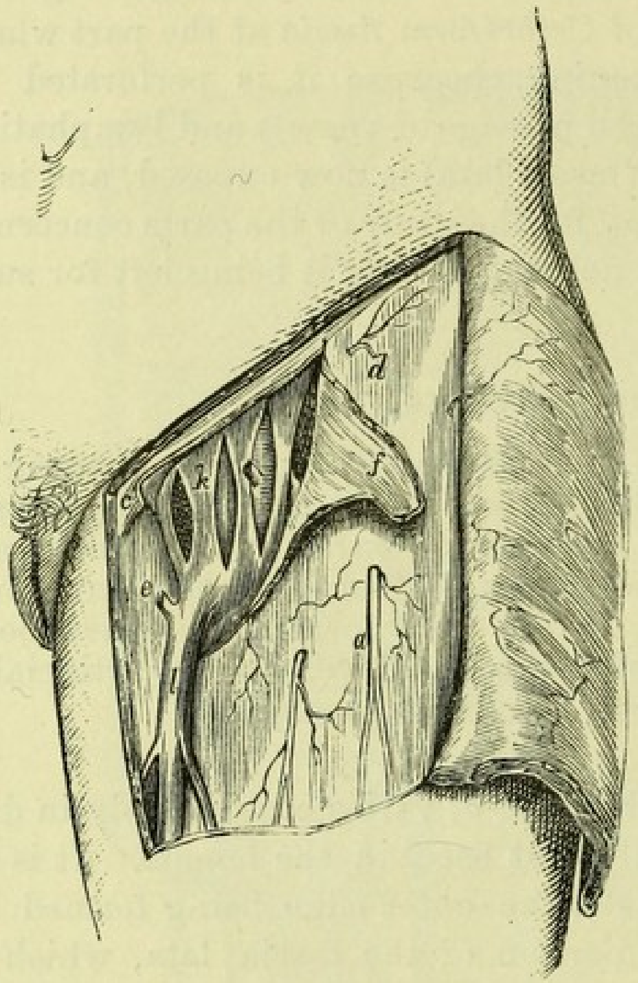
The *Deep fascia of the thigh* (fascia lata) is now exposed, and is to be cleaned as far as is necessary for the study of the parts concerned in femoral hernia, the several nerves piercing it being left for subsequent examination.

Femoral Hernia.

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

The **Saphenous opening** (Fig. 39, *o*) varies considerably in different subjects, and is generally best seen in the female. It is an oval opening half an inch wide, the outer edge being formed by what is known as the *iliac* portion of the fascia lata, which is attached to the whole length of Poupart's ligament, whilst the inner and deeper part is formed by the *pubic* portion of the fascia lata, which, passing beneath the femoral vessels, binds down the pectineus muscle and is attached to the pectineal line. Below the saphenous opening the pubic and iliac portions are continuous with one another. The outer border of the opening, which can be made sharp and semicircular with the scalpel, and overlies the femoral vessels, is known as the *falciform* or sickle-shape margin (process of Burns), and over the lower part of this the saphenous vein passes to open into the femoral vein. The superior extremity of this margin, where it joins Gimbernat's ligament, is sometimes called Hey's ligament. The saphenous opening is the external aperture through which femoral hernia passes, and might therefore well be called the external femoral ring, although strictly speaking there is in the undissected condition no definite ring, but merely a weak point in the fascia through which the hernia protrudes, pushing before it the cribriform fascia. The position of the thigh has considerable influence upon the condition of the saphenous opening, and its edges will be found to be relaxed when the thigh is flexed and adducted, the position in which the patient is placed when the "taxis" is applied for the reduction of a hernia.

Fig. 40.



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

Sheath of the Vessels (Fig. 40, *k*).—Beneath the fascia lata in the upper part of the thigh will now be seen a delicate fascia, containing a little fat and covering the femoral vessels, called the *sheath of the femoral vessels.* This sheath is a tube, broader above than below and becoming gradually lost upon the vessels, the anterior part of which is continuous with the fascia transversalis, and the posterior part with the fascia iliaca of the abdomen, beneath Poupart's ligament. Three vertical incisions, one in the centre and one at each side of the tubular sheath, will enable the dissector to see that it is divided by two slender septa into three

Fig. 40.—Crural sheath laid open (from Wood "On Rupture").

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

compartments, the femoral artery occupying the outermost, the femoral vein the middle, and the innermost or smallest one being occupied only by a lymphatic gland. This last division of the femoral sheath is the *femoral* or *crural canal.*

The **Femoral** or **Crural Ring** (Fig. 41, 12).—If the finger be passed upwards along the crural canal it will enter the *Crural* or *Femoral Ring* beneath Poupart's ligament, displacing a lymphatic gland and a little piece of subperitoneal fat, which occupy it, the latter forming the *septum crurale.* The boundaries of the crural ring can be better felt than seen, and are, *in front*, Poupart's ligament, or crural arch (with occasionally a distinct band of fascia transversalis beneath it, called the *deep crural arch*); *behind*, the ilio-pectineal line and body of the pubes; *externally*, the femoral vein separated by the septum; and *internally*, the sharp margin of Gimbernat's ligament. The crural ring is the aperture through which a femoral hernia leaves the abdomen, and the point at which strangulation most commonly occurs; the finger should therefore thoroughly explore it.

Fig. 41.

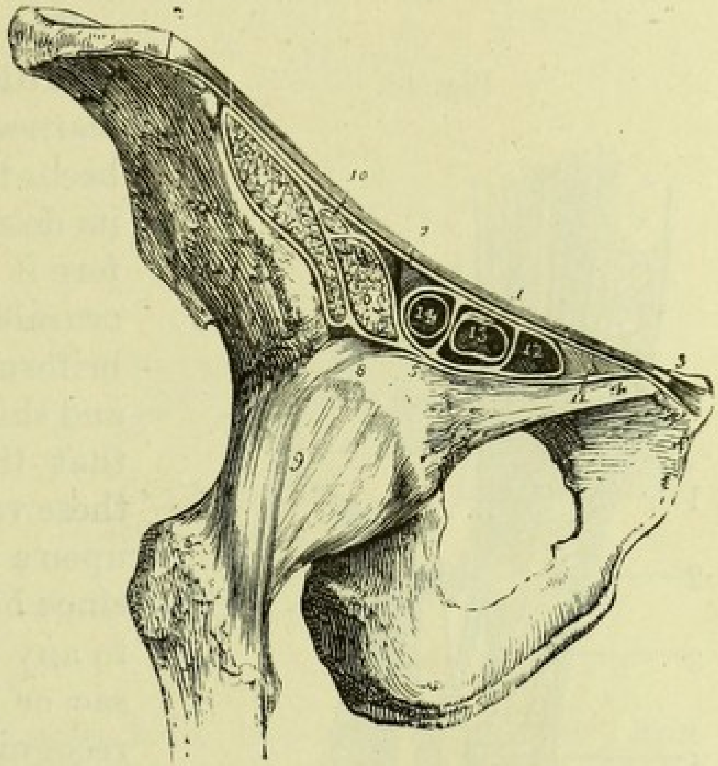
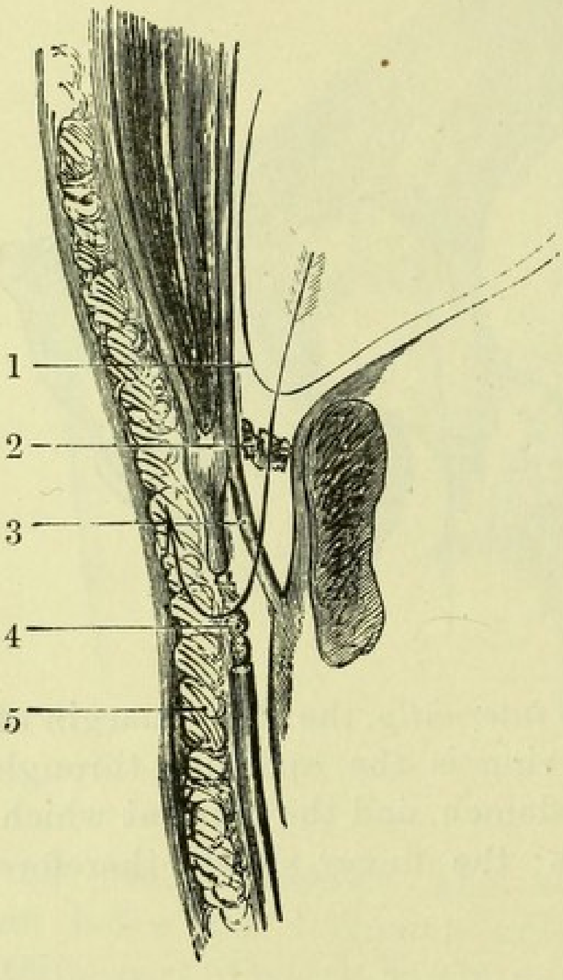


Fig. 41.—Section of the structures which pass beneath the femoral arch (from Wilson).

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

The **Crural** or **Femoral Canal** (Fig. 40) is the canal, half an inch in length, along which femoral hernia *descends* from the crural ring to the saphenous opening; but as soon as the hernia has forced its way through that spot, it *ascends*, owing to the close attachment of the superficial fascia to the lower margin of the saphenous opening, and lies along Poupart's ligament; or, if of large size, may stretch the fascia sufficiently to mount over the ligament and simulate an inguinal hernia.

Fig. 42.



The **Coverings of a Femoral Hernia** (Fig. 42) will be readily learned if the course it takes has been thoroughly understood. In its descent the intestine pushes before it (1) peritoneal sac, (2) septum crurale, (3) femoral sheath, (4) cribriform fascia, (5) superficial fascia and skin. It must not be supposed that the surgeon will meet with these various coverings in operating upon a strangulated femoral hernia, since he usually pays no attention to any of them until he reaches the sac or peritoneum, which is to be recognised by its thin bluish appearance, and by the fluid generally to be seen through its slightly transparent wall.*

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

Fig. 42.—Imaginary section of crural canal to show the course and coverings of a femoral hernia (drawn by J. T. Gray).

1. Peritoneum.
2. Septum crurale.
3. Femoral sheath.
4. Cribriform fascia.
5. Integuments.

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

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

The only possible danger which can be met with in the deep incision is an abnormal distribution of the obturator artery

Fig. 43.

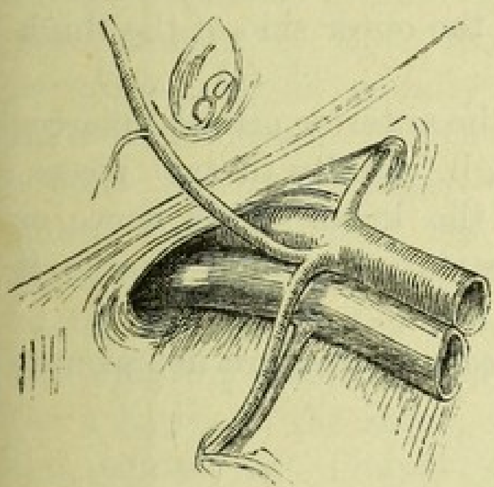
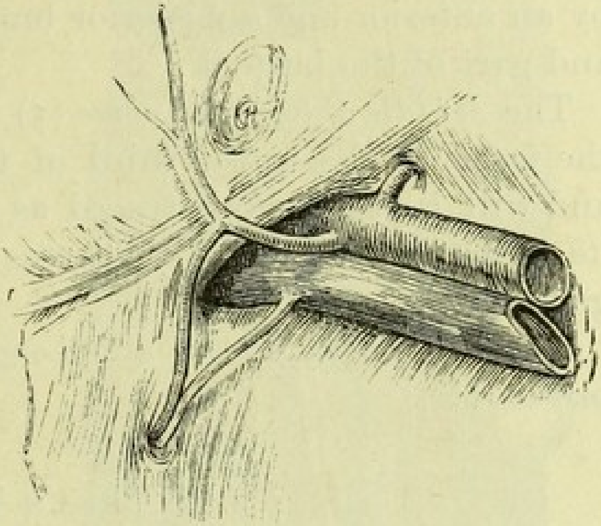


Fig. 44.



(Figs. 43 and 44), which, if it arise from the epigastric artery and wind close to the *inner* side of the neck of the sac, might be divided and give rise to troublesome hæmorrhage. Fortunately this vessel, if it exists, is seldom damaged by a cautious use of the knife, and, as it is impossible to ascertain its presence beforehand, its existence may be ignored in practice.

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

The *Fascia lata* of the thigh is a dense white membrane attached to Poupart's ligament and the crest of the ilium above, and to the pubes internally, and will be afterwards seen to enclose and support all the muscles of the thigh. The terms pubic and iliac as applied to this fascia have been already explained (p. 93).

Fig. 43.—Irregular origin of obturator artery from epigastric. 1st variety (1 in 4) external to crural ring (from Wood "On Rupture").

Fig. 44.—Irregular origin of obturator artery from epigastric. 2nd variety (1 in 80) internal to crural ring (from Wood "On Rupture").

Cutaneous nerves (Fig. 45).—The *Ilio-inguinal nerve*, which emerges from the external abdominal ring, in its course to the scrotum or labium gives one or two small branches to the thigh.

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

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

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

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

Scarpa's Triangle.

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

Scarpa's triangle is the space in the upper third of the front of the thigh containing the first part of the femoral vessels. The *base* of the triangle is upwards, and is formed by Poupart's ligament; the *outer border* is formed by the sartorius muscle, which crosses the thigh obliquely; the *inner border* corresponds to the inner margin of the adductor longus; and the *apex* of the triangle is formed by the meeting of the inner borders of the two above-named muscles. The space has been seen to be covered in by the superficial fascia and fascia lata, and its *floor* will now be seen to be formed by the psoas and iliacus on the outer side, the pectineus and adductor longus on the inner side, with (in some subjects) a small portion of the adductor brevis between the two.

Scarpa's triangle *contains* the upper part of the femoral artery and vein with their branches; the origin of the profunda artery with its vein; the anterior crural nerve with some of its branches; and the termination of the saphenous vein. The saphenous vein itself is not one of the contents of the space, since it is superficial to the fascia lata.

The **Femoral Artery in Scarpa's Triangle** (Fig. 45, 4).—The femoral artery is the continuation of the external iliac artery, and extends from Poupart's ligament to the opening in the adductor magnus, through which it passes to the popliteal space. The part now exposed is that above the sartorius, and is usually nearly half of the whole length of the vessel. When the thigh is slightly flexed and abducted, the artery runs from a point midway between the symphysis pubis and the anterior superior iliac spine (or a little to the inner side of the centre of Poupart's ligament), through the middle of the triangle in a line with the prominent tubercle on the inner condyle of the femur; but when

Fig. 45.

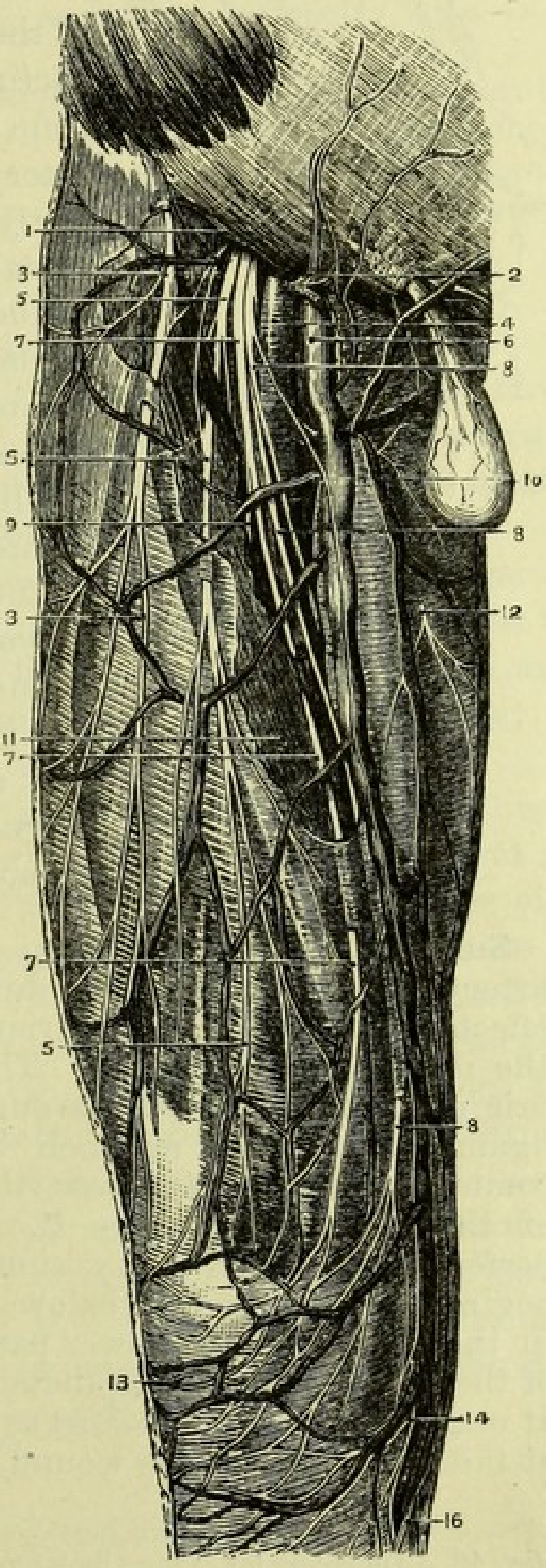
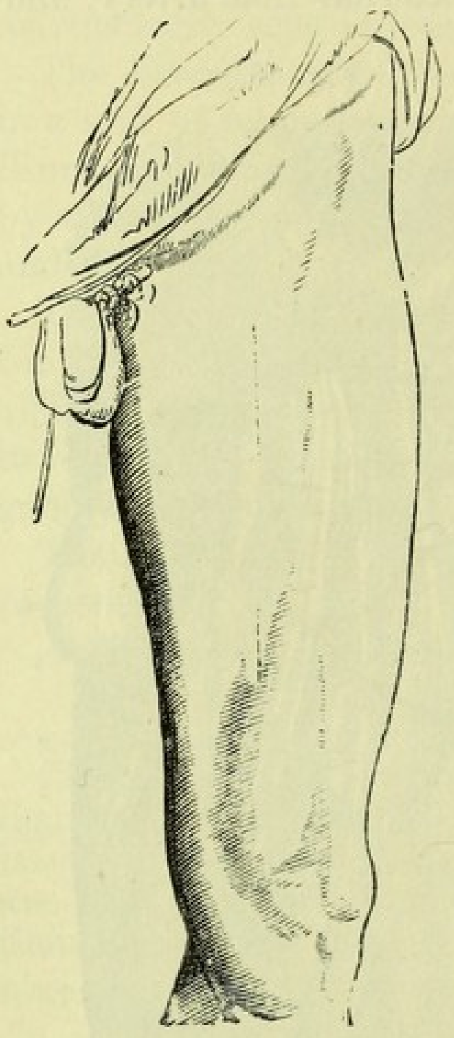


Fig. 45.—Superficial dissection of the front of the thigh (from Hirschfeld and Leveillé).

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

the thigh is fully extended it will be seen to wind slightly to the inner side of the limb. This portion of the artery is *covered* only by the superficial fascia and fascia lata, except near Poupart's ligament, where it has been seen to be enclosed in the femoral sheath.

Fig. 46.



One or two branches of the internal cutaneous nerve cross the vessel at variable points. *Behind* the artery from above downwards are, the psoas (with a portion of the femoral sheath and the nerve to the pectineus); the pectineus, but separated from the femoral artery by the profunda artery and vein and the femoral vein; lastly the adductor longus, and, occasionally between the pectineus and the adductor longus, a small portion of the adductor brevis. To the *outer* side throughout is the anterior crural nerve, but separated at the upper part by a small piece of the psoas; the long saphenous branch is in close relation with it at the lower part of the space, and the nerve to the vastus externus (Fig. 50, 19) is just external to the long saphenous nerve. The femoral vein is to the *inner* side near Poupart's ligament, but lower down is *behind* the artery, forming one of its posterior relations.

Surgery (Fig. 46).—From its superficial position the femoral artery can be readily felt during life, and compression may be effected in any part of the triangle, but most satisfactorily against the margin of the pubes. The artery has been tied above the origin of the profunda, through an incision parallel to Poupart's ligament and half an inch below it, but the vessel is more commonly tied just below the point at which the inner edge of the sartorius crosses it. The latter operation is readily performed through an incision, from three to four inches long, beginning two inches below Poupart's ligament and running in the middle of the lower part of the space, and in the direction of the limb, which is to be abducted. The incision should be carried at once through the fascia so as to expose the fibres of the sartorius at the lower part of the wound, which are readily recognisable by

Fig. 46.—Incisions for tying the femoral artery (from Fergusson's "Surgery").

their oblique direction. The muscle being turned a little outwards, the fibrous sheath of the vessels will be seen, and must be carefully opened with the scalpel, when the artery can be isolated and secured. The needle may be passed from either side, great care being taken not to include the vein which is behind, or the long saphenous nerve which is to the outer side of the vessel.

When the femoral artery above the profunda (common femoral) is tied, the circulation is carried on by the obturator, gluteal, and sciatic arteries, which anastomose with the circumflex and perforating branches of the profunda, and thus indirectly with the articular branches of the popliteal.

When the femoral artery below the profunda (superficial femoral) is tied, the circulation is carried on directly through the branches of the profunda, which anastomose with the *anastomotica magna* and the branches of the popliteal, in addition to those anastomoses given above.

Branches (Fig. 45).—The small (1) *superficial epigastric;* (2) *superficial circumflex iliac;* and (3) *superior external pudic*, have been already examined. A larger branch (4) the *inferior external pudic*, arises from the upper part of the artery and passes beneath the fascia lata to the scrotum or labium and perinæum.

The largest branch, (5) the *profunda* artery, arises from one to two inches below Poupart's ligament and is now seen lying first to the outer side of, and then behind, the femoral artery and vein, and resting upon the iliacus and pectineus. It is the great artery to the muscles of the thigh, and will be afterwards dissected.

The *Femoral Vein* at the lower part of Scarpa's triangle lies a little to the outer side of the artery. It then ascends behind it, and after being joined by the profunda vein, lies to the inner side of the femoral artery at the upper part of the space, where it receives the saphenous vein, which has previously been joined by the veins corresponding to the four small branches of the artery.

The **Anterior Crural Nerve** (Fig. 50, 5) is derived from the 2nd, 3rd, and 4th nerves of the lumbar plexus, and enters Scarpa's triangle beneath Poupart's ligament, between the psoas and iliacus muscles. It divides into a superficial and deep part, the superficial giving off the middle and internal cutaneous nerves and supplying the sartorius and pectineus; the deep supplying muscular branches, and the long or internal saphenous nerve, which becomes cutaneous at the inner side of the knee.*

* This last is often described as coming from the superficial division, but the above is the more common arrangement.

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

The *Bursa patellæ* is the subcutaneous synovial sac in front of the knee-cap, which will be seen by making a vertical incision into it. When inflamed, this bursa forms what is commonly known as "housemaid's knee."

The *Fascia lata* or deep fascia of the thigh is now thoroughly exposed. It has been seen to be attached to Poupart's ligament and the crest of the pubes, and can now be followed to the crest of the ilium. The fascia is strongest on the front and outer side of the thigh, and on each side of the prominent extensor muscles may be seen a white line marking the positions of the external and internal intermuscular septa. The fascia blends with the capsule of the knee, and is continued over the patella to the heads of the tibia and fibula, being incorporated with the several tendons attached to those parts. A strong part of the fascia lata on the outer side of the thigh is called the *ilio-tibial band;* it is attached above to the crest of the ilium and below to the outer tuberosity of the tibia, and in its upper part gives attachment to fibres of the tensor vaginæ femoris in front, and of the gluteus maximus behind.

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

The *Internal cutaneous nerve* (Fig. 45, 7, 8) is a branch of the anterior crural, it gives two or three small twigs to the upper and inner parts of the thigh, and crosses the femoral artery in Scarpa's triangle. Either before or after doing so it divides into two branches, *anterior* and *posterior*. The *anterior* branch becomes cutaneous in the lower third of the thigh, the branches reaching as far as the patella. The *posterior* branch appears close to the saphenous vein a little above the knee, and its branches unite with those of the other branch and with the internal saphenous nerve; it is distributed to the inner side of the knee and leg. Occasionally a junction between this nerve and the obturator may be traced on the inner side of the middle of the thigh.

The *Long* or *Internal Saphenous nerve* (Fig. 45, 16) (the course of which will be afterwards seen) becomes cutaneous at the inner side of the knee-joint, where it lies at first in front of the saphenous vein. Before becoming cutaneous it sends a large branch forward to the skin of the patella (*ramus cutaneus patellæ*) (14) which pierces the sartorius, and unites with branches of the internal and middle cutaneous nerves to form what has been called the *plexus patellæ*.

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

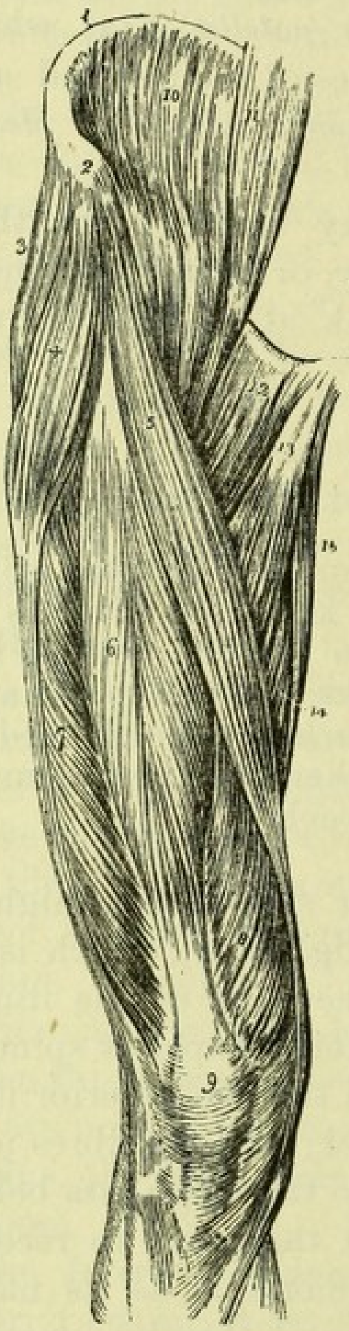
Muscles of the Front of the Thigh.

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

Connected with the fascia lata on the outer side of the thigh is the **Tensor Fasciæ** or **Vaginæ Femoris** (Fig. 47, 4), which is to be exposed by removing the fascia below the crest of the ilium. The muscle *arises* from the outside of the anterior superior spine of the ilium and from part of the notch between the two anterior iliac spines, and from a small portion of the crest; and the fibres pass downwards and backwards to be *inserted* into the fascia lata below the great trochanter, the fascia being split at this point to receive the muscular fibres. The tensor vaginæ femoris is, as its name implies, a tensor of the fascia of the thigh, and thereby supports and assists the other muscles of the limb, especially the gluteus maximus, by fixing its fascial insertion; it is also an internal rotator of the femur. It is *supplied* by a branch of the superior gluteal nerve, which may be seen entering the deep surface of the muscle when it is reflected.

The **Sartorius** (Fig. 47, 5) is the longest muscle of the body, and when dissected lies loosely upon the subjacent muscles. It *arises* from the anterior superior spine of the ilium and from the notch below it, and crossing obliquely over the thigh, winds to the inner side of the knee and is *inserted* into the broad and subcutaneous surface below the inner tuberosity of the tibia. The insertion of the sartorius is by a broad tendinous expansion, which is incorporated with the fascia of the limb and overlaps the insertions of the gracilis and semi-tendinosus muscles (of which the latter is the lower), a bursa intervening between them; it also sends a slip beneath the other tendons. The sartorius (tailor-muscle) is a flexor of the leg upon the thigh, and a flexor and rotator outwards of the thigh upon the pelvis, thus crossing the legs, and hence the name. It is *supplied* by the middle cutaneous branch of the anterior crural nerve.

Fig. 47.



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

The **Rectus Femoris** (Fig. 47, 6) has no attachment to the femur, but stretches over it from the pelvis to the patella. It *arises* by a double tendinous origin from the anterior inferior spine of the ilium and from the rough depression above the acetabulum, but the outer or reflected tendon cannot be thoroughly seen at present. The two heads unite to form a fusiform penniform muscle, which is tendinous on its under surface at the ower part, and passes to be inserted into the upper border of the patella in conjunction with the other extensor muscles.

Fig. 47.—Muscles of the anterior femoral region (from Wilson).

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

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

The **Vastus Externus** (Fig. 47, 7) is the largest of three muscles in front of the femur. It *arises* from the root of the great trochanter and the line leading from it to the linea aspera; from the outer side of the upper half of the linea aspera and slightly from the adjacent part of the shaft of the femur; and from the external intermuscular septum. Its fibres end in a broad aponeurosis which is *inserted* into the outer side of the patella, blending with the rectus and with the capsule of the knee joint.

The **Vastus Internus** (Fig. 47, 8) is more or less united with the crureus. It *arises* from the inner side of the linea aspera and from the line leading from it to the lesser trochanter, as high as the insertion of the iliacus; from the upper half of the line leading from the linea aspera to the internal condyle, from the tendons of the adductor longus and magnus, and from the internal intermuscular septum. Its tendon resembles that of the vastus externus, and is *inserted* into the inner side of the patella, the rectus tendon, and the capsule of the knee joint. The origin of the lower part of the muscle cannot be seen quite distinctly at present, since its inner border is united by a piece of fascia with the tendon of the adductor longus, to form a tendinous covering to the femoral vessels (Hunter's canal).

The **Crureus** covers the front of the femur between the two vasti, with the inner of which it is often so united as to form one muscle. It *arises* from the anterior intertrochanteric line and the anterior and outer surfaces of the femur, to about four inches from the lower end of the bone, as well as the lower part of the external intermuscular septum, and is *inserted* into the patella with the other extensor muscles. Its surface is tendinous, to allow free movement of the rectus upon it.

The small *subcrureus* muscle will be best dissected with the knee joint.

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

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

The **Femoral Artery in Hunter's Canal** (Fig. 48, 19).—Hunter's canal is formed by a tendinous expansion derived from the adductors longus and magnus and the vastus internus, which encloses the femoral vessels and long saphenous nerve in the middle third of the thigh. It is bounded behind by the two adductors, externally by the vastus internus, and internally and anteriorly by the aponeurosis. The canal begins at the crossing of the sartorius muscle and ends at the opening in the adductor magnus, where the artery enters the popliteal space, being covered by the sartorius in its whole length. On laying open the canal, the femoral artery will be found to have its vein behind and slightly to the outer side until it reaches the opening in the adductor magnus; the saphenous nerve, at first to the outer side, crosses the artery to wind round the tendon of the sartorius and become cutaneous on the inner side of the knee.

The *Opening in the Adductor Magnus*, as it is commonly called, is in reality an opening between the round tendon of the adductor magnus on the inner side, and the fibres of the vastus internus and the femur on the outer side, the tendinous fibres of the adductor forming the remainder of its circumference. The only structures passing through it are the femoral artery and vein.

Except some unnamed muscular twigs, the *Anastomotica magna* is the only vessel arising from the femoral artery in Hunter's canal, but its branches not unfrequently come off at two or more separate places. The anastomotica has a superficial and deep branch : the superficial accompanying the saphenous nerve to the skin, the deep branch entering the vastus internus, through which it descends to the knee to anastomose with the internal articular branches of the popliteal artery ; it also sends a branch across above the patella to anastomose with the external circumflex and the superior external articular.

Surgery (Fig. 46).—Deligation of the femoral artery in Hunter's canal is not frequently performed in the present day, but the vessel is readily reached by an incision to the inner side of the vastus internus in the middle third of the thigh, by which the outer edge of the sartorius muscle is met with. The sartorius is turned inwards, when the tendinous canal is brought into view, and by laying it open the artery will be exposed. It is most convenient to pass the aneurism-needle from without inwards, the vein lying to the outer side.

The **Anterior Crural Nerve** (Fig. 50, 5) supplies branches to all the muscles of the front of the thigh except the tensor fasciæ femoris, and also gives a branch to the pectineus on the inner side of the limb. The branch to the sartorius has been already seen to arise from the middle cutaneous nerve, and the remaining branches can now be traced from the deep division. The nerve to the vastus internus (19) and that to the vastus externus both supply small twigs to the knee joint. The nerve to the pectineus, which is often double, (10) crosses transversely beneath the femoral vessels to the surface of the pectineus muscle. From several of the upper muscular branches twigs are given to the hip-joint.

The **Internal Saphenous Nerve** (Fig. 50, 22) is the longest branch of the deep division of the anterior crural nerve. It lies close to the outer side of the femoral artery, and enters Hunter's canal with it; then crossing the artery it pierces the sheath, appearing beneath the sartorius at the inner side of the knee. In the thigh it gives a *communicating* branch to the subcutaneous plexus on the inner side, and at the knee its *patellar* branch pierces the sartorius and ends in the patellar plexus. The nerve becomes cutaneous between the sartorius and gracilis, and runs down the inner side of the leg.

Inner Side of the Thigh.

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

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

The **Adductor Longus** (Fig. 47, 13) *arises* by a round tendon from the front of the os pubis immediately below the crest, and expands to be *inserted* into the inner border of the linea aspera, in the middle third of the bone. It is *supplied* by the obturator nerve.

The **Gracilis** (Fig. 48, 20) is the most internal of the muscles of the thigh, and *arises* from the rami of the pubes and ischium by a broad thin tendon between two and three inches wide. It is a long riband-shaped muscle, and is *inserted* into the inner surface of the tibia beneath the sartorius, but higher than the semi-tendinosus, a bursa intervening between it and the internal lateral ligament of the knee. It is *supplied* by the obturator nerve.

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

The **Pectineus** (Fig. 47, 12) has been already seen in relation with the femoral artery and forming part of the floor of Scarpa's triangle. It *arises* from the upper part of the triangular surface immediately in front of the ilio-pectineal line, and from a part of the line itself, and winds to the back of the femur to be *inserted* into the upper part of the line leading from the trochanter minor to the linea aspera, a bursa intervening. It is *supplied* by the anterior crural nerve.

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

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

The **Adductor Brevis** (Fig. 48, 18) has the superficial division of the obturator nerve lying upon it, and the deep division of the same nerve appearing between it and the adductor magnus. It *arises* from the front of the pubes below the adductor longus and between the gracilis and obturator externus, and is *inserted* into the whole of the line leading from the lesser trochanter to the linea aspera, behind the pectineus. It is *supplied* by the obturator nerve.

The action of the adductors is implied by their name, but they act at the same time as external rotators of the thigh. The power

Fig. 48.

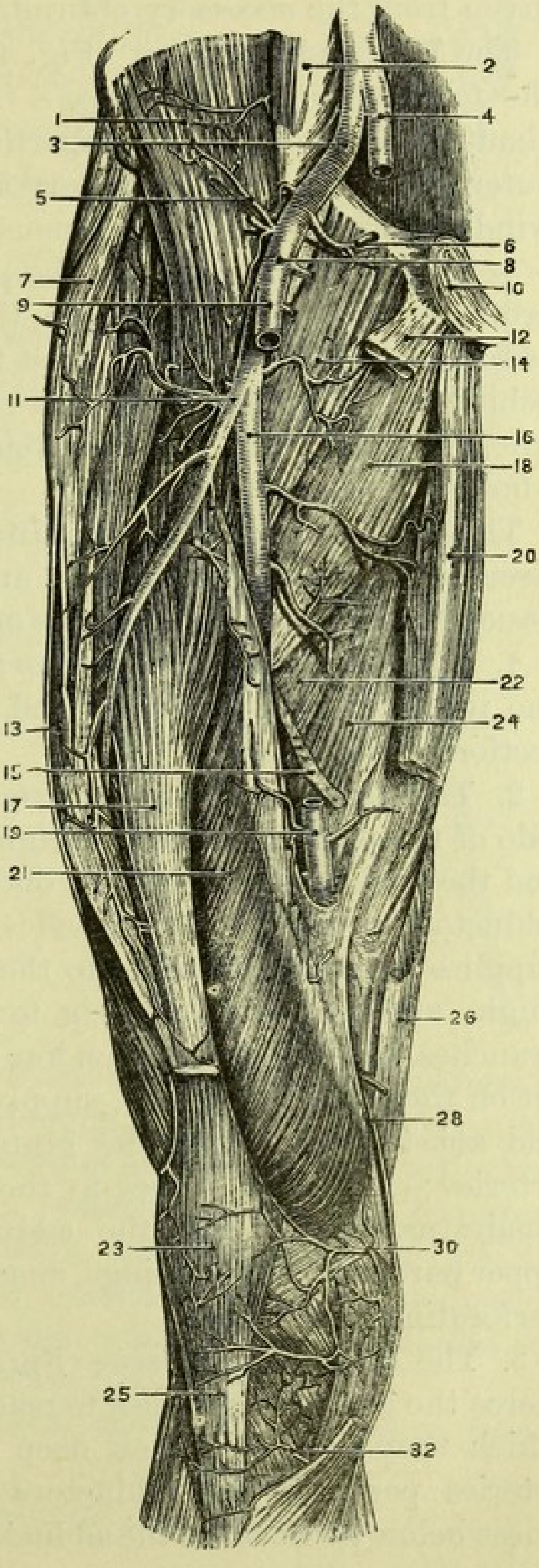


Fig. 48.—Profunda artery and its branches (Bonamy and Beau).

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

of adduction can be carried beyond the middle line so as to cross one thigh over the other. The pectineus is an adductor and a flexor of the thigh, and the gracilis is in addition a flexor of the knee. All the muscles of the inner side of the thigh are supplied by the obturator nerve, except the pectineus, which receives its nerve from the anterior crural, an additional twig being sometimes given from the accessory obturator.

The **Profunda Artery** (Fig. 48, 16) has been seen to arise from the femoral artery in Scarpa's triangle; its origin being usually about two inches below Poupart's ligament. It lies at first to the outer side of the femoral artery and against the iliacus, but then winds inwards on to the pectineus behind the femoral artery, which is separated from it by both the profunda and femoral veins. The profunda next winds between the borders of the pectineus and adductor longus, and lies against the adductor brevis; then passing behind the adductor longus, it runs on to the adductor magnus, where it ends. The profunda vein is superficial to its artery in the whole of its course.

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

1. The *External Circumflex artery* arises from the outer side of the profunda near its origin, and has been already seen in the dissection of the thigh (p. 105).

2. The *Internal Circumflex artery* (Fig. 49) arises from the inner side of the profunda near its origin, and passing between the psoas and the pectineus, reaches the obturator externus muscle above the adductor brevis, where it divides into two terminal branches. It supplies muscular branches to the muscles on the inner side of the thigh, and an articular twig to the hip-joint. Of the terminal branches, one follows the tendon of the obturator externus to the pit on the great trochanter, supplying the external rotator muscles and anastomosing with the gluteal, sciatic and first perforating arteries; the other passes to the back of the thigh between the quadratus femoris and the adductor magnus, and supplies the upper part of the ham-strings, anastomosing with the sciatic and first perforating arteries.

3. The *Perforating arteries* (Fig. 49), which are three in number, pierce the adductor muscles to reach the ham-strings and the vasti, which they supply on their deep surfaces. The *upper* and *middle* arteries perforate the adductors brevis and magnus; the *lowest* arises below the level of the adductor brevis, and therefore perforates

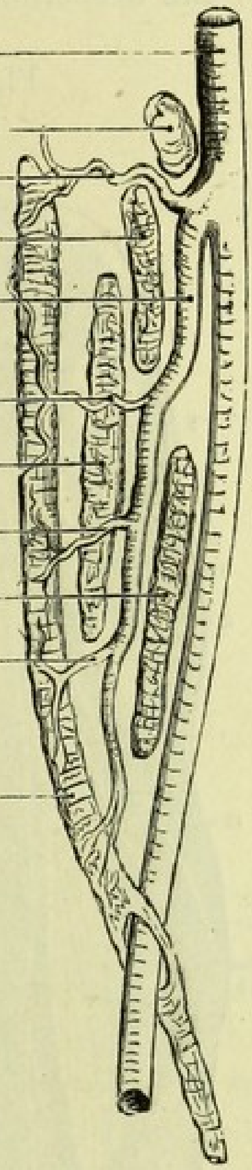
only the adductor magnus. The nutrient artery to the femur generally comes from the middle perforating artery, and when entering the foramen in the linea aspera has a direction from the knee joint.

4. The *Terminal branch* (Fig. 49) ends in the fibres of the adductor magnus.

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

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

Fig. 49.



The **Obturator Nerve** (Fig. 50, 8) is the last branch of the lumbar plexus, being derived from the third and fourth lumbar nerves. It leaves the pelvis at the upper part of the obturator foramen with the obturator artery, and immediately divides into superficial and deep portions. The superficial division lies upon the adductor brevis and supplies the adductor longus, the adductor brevis, and the gracilis, giving off a few cutaneous branches and an articular branch to the hip-joint. The deep division pierces the obturator externus and lies on the adductor magnus, both of which it supplies, and gives an articular branch through the adductor magnus to the back of the knee, which affords one explanation of the pain referred to the knee in disease of the hip-joint.

An *Accessory Obturator nerve* is occasionally found passing, from

Fig. 49.—Diagram of the profunda artery of the thigh (drawn by J. T. Gray).

the third and fourth nerves of the lumbar plexus, over the pubes beneath the pectineus. When this exists it more or less replaces the superficial division of the obturator nerve.

The **Adductor Magnus** (Fig. 48, 22) *arises* from the lower part of the descending ramus of the pubes; from the ascending ramus of the ischium; and from the lower part of the tuberosity. Its upper fibres pass with different degrees of obliquity to be *inserted* into the back of the femur immediately below the quadratus femoris, into the whole length of the linea aspera, and a small portion of the line leading from it to the internal condyle. The posterior fibres (24) form an almost distinct muscle, and end in a round tendon which is

Fig. 50.

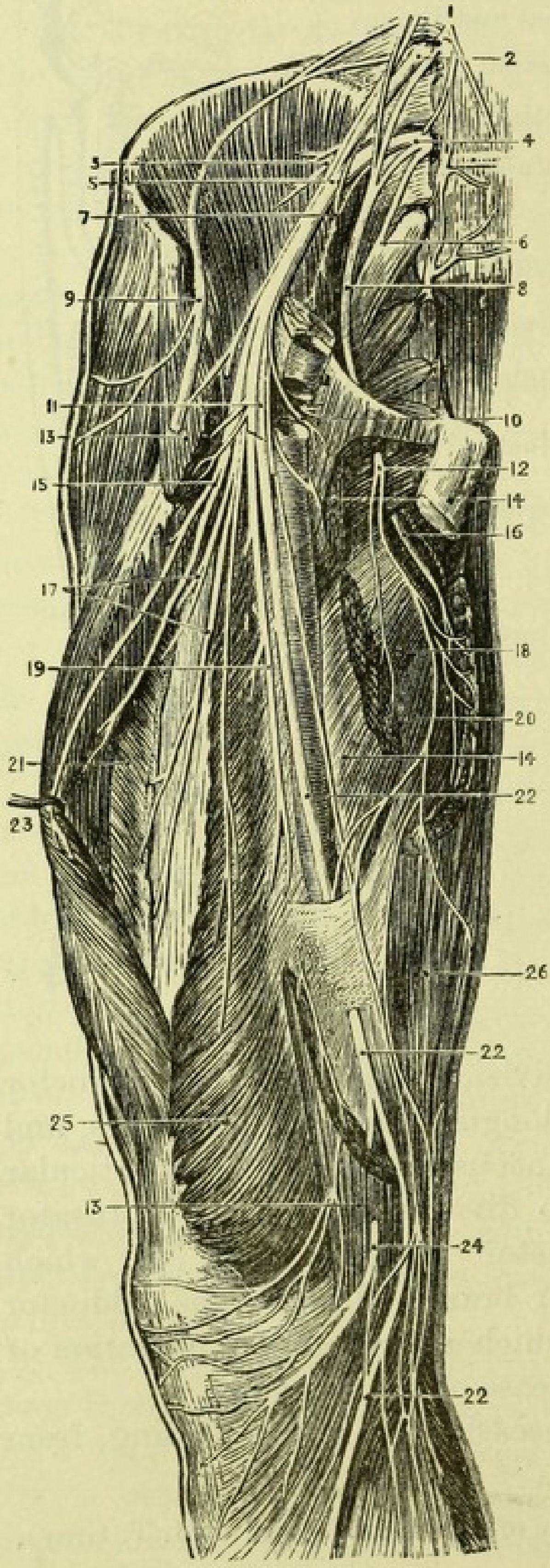


Fig. 50.—Nerves of the thigh (from Hirschfeld and Leveillé).

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

13, 13. Sartorius muscle.
14, 14. Adductor longus.

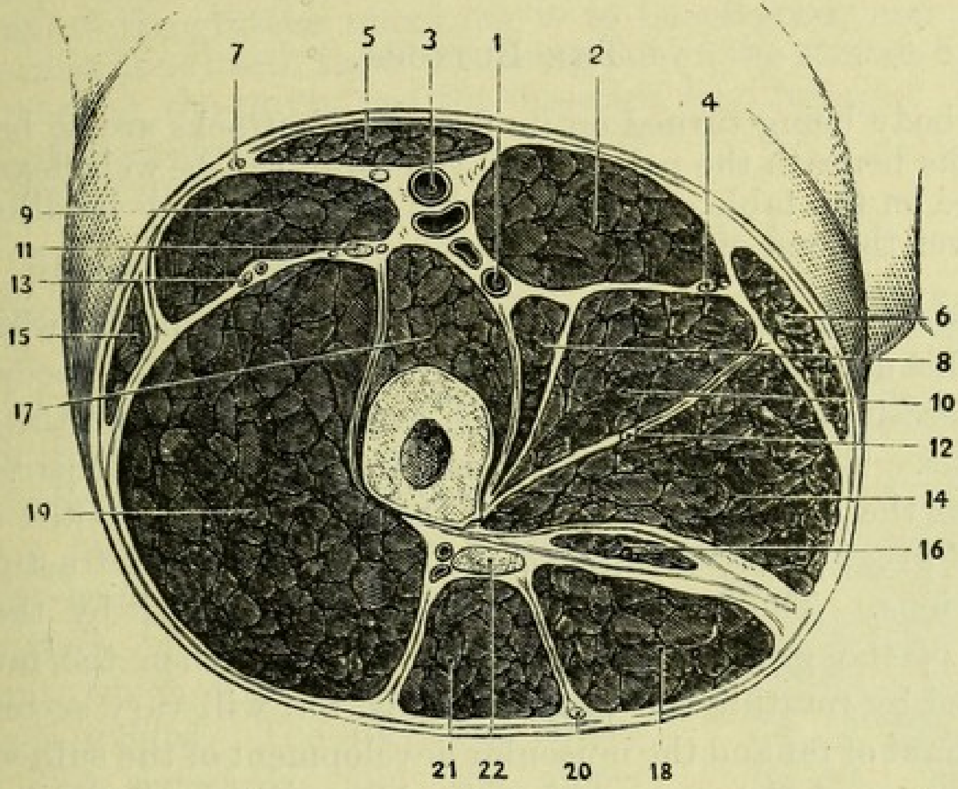
15. Branch to rectus.
16. Deep division of obturator nerve.
17. Branches to vastus externus and crureus.
18. Adductor brevis.
19. Branch to vastus internus.
20. Adductor magnus.
21. Vastus externus.

22, 22. Internal saphenous nerve.

23. Rectus femoris.
24. Patellar branch of saphenous nerve.
25. Vastus internus.
26. Gracilis.

inserted into the tubercle above the inner condyle of the femur, and, by means of an expansion, into the lower part of the line leading to it. It is this tendon which bounds the "opening in the

Fig. 51.



adductor magnus." The muscle is *supplied* by the obturator nerve, and also by the great sciatic.

Above the upper border of the adductor magnus a portion of the **Obturator Externus** can be seen. It *arises* from the margin of the anterior half of the obturator foramen, and from the corresponding portion of the outer surface of the obturator membrane. The fibres are directed backwards, and end in a tendon which passes below the acetabulum, to be *inserted* into the digital fossa of the femur, as will be seen in the dissection of the buttock.

Fig. 51.—Section of the right thigh at the apex of Scarpa's triangle (drawn by G. E. L. Pearse).

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

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

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

The Buttock.

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

The dissector should recognize the crest of the ilium, which will bound his dissection superiorly, also the sacrum and coccyx, and the tuberosity of the ischium, which can be felt through the gluteus maximus. The relation of the trochanter to the several parts of the pelvis in the different positions of the limb is to be noted also, as being of great practical importance in the diagnosis of fractures and dislocations. The "fold of the buttock" formed by the lower border of the gluteus maximus will be seen when the muscle is stretched by rotating the thigh inwards, but will vary according to the amount of fat and the muscular development of the subject. The prominences of the inner and outer hamstrings and the hollow of the ham will be readily seen, and it should be noted how much deeper the space appears when the knee is flexed, and how readily, under these circumstances, the popliteal vessels can be felt, owing to the relaxation of the fascia.

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

The amount of fat beneath the skin of the buttock varies considerably, and if there is a large quantity it will be waste of time to look for cutaneous nerves.

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

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

The *ascending* branches turn round the lower border of the gluteus maximus, and are branches of the lesser sciatic nerve.

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

Fig. 52.

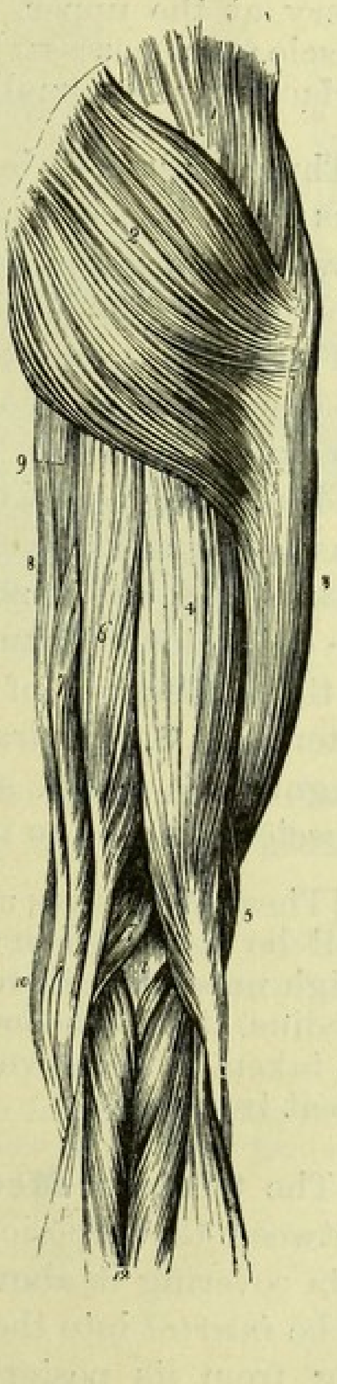


Fig. 52.—Muscles of the posterior femoral and gluteal region (from Wilson).

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

The **Gluteus Maximus** (Fig. 52, 2) *arises* from the rough triangle between the posterior third of the crest of the ilium and the superior curved line on the dorsum ilii;* from the side of the lower part of the sacrum, and the side of the coccyx; from the tendinous expansion over the back of the sacrum; and from the surface of the great sacro-sciatic ligament, which will be seen when the muscle is divided. The fibres run downwards and outwards, and the upper half of the muscle is *inserted* into the fascia lata covering the great trochanter (ilio-tibial band), the lower being also attached superficially to the fascia, but deeply to the rough ridge leading

* In describing the glutei the dorsum ilii is considered to have *three* curved lines, and not *two* as given by some authors.

from the back of the trochanter major to the linea aspera of the femur.

The gluteus maximus is one of the most important muscles for raising the body into the erect position. When the pelvis is the fixed point, the muscle is a powerful extensor of the thigh, and at the same time rotates it outwards. It is *supplied* by the inferior gluteal branches of the small sciatic nerve.

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

Three *bursæ* will be found in connection with the gluteus maximus: one between its fascia and the great trochanter; a second between the fascia and vastus externus; and the third over the tuberosity of the ischium.

The **Parts beneath the Gluteus Maximus** (Fig. 53) can now be seen, although covered by loose cellular tissue which is to be afterwards removed. They are from above downwards:—1, gluteus medius; 2, superficial branches of the gluteal vessels; 3, pyriformis muscle; 4, sciatic vessels and nerves (great and small); 5, pudic vessels and nerve, and nerve to obturator internus; 6, tendon of the obturator internus with the gemelli muscles above and below it; 7, the upper end of the femur and the tendon of the obturator externus; 8, quadratus femoris and upper border of adductor magnus; 9, great sacro-sciatic ligament; 10, tuber ischii and muscles attached to it.

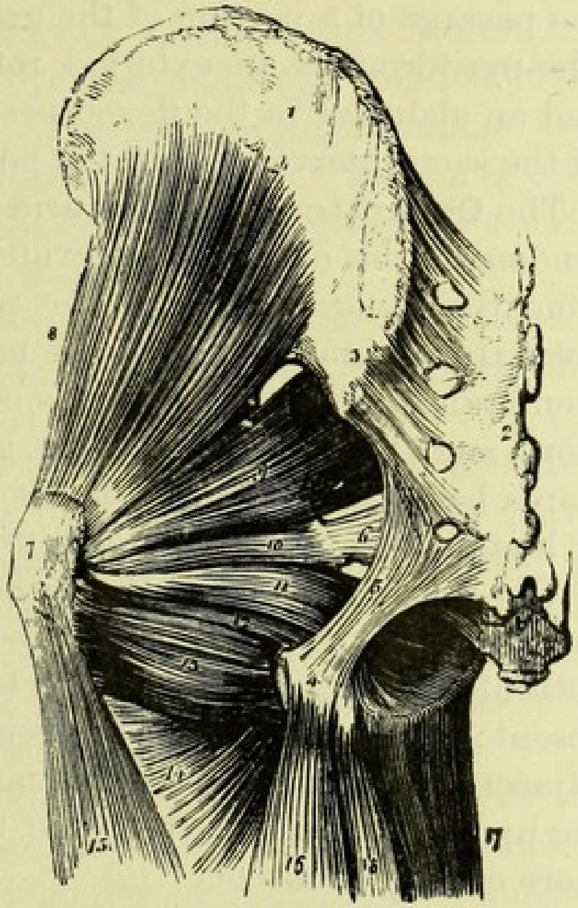
[These structures are to be cleaned as far as possible at once, and will be examined in succession. In order to clean the muscles, the thigh must be well rotated inwards, and in the case of the gluteus medius, it must be crossed beneath the opposite limb. Care should be taken to preserve an anastomosis of arteries at the back of the great trochanter.]

The **Gluteus Medius** (Fig. 52, 1) *arises* from the dorsum ilii between the superior and middle curved lines, and from the fascia lata covering it above the gluteus maximus. The fibres converge to be *inserted* into the outer surface of the great trochanter, extending from its posterior superior angle obliquely downwards and forwards.

The anterior border of the gluteus medius is united with that of the minimus, which lies beneath it. The insertion of the gluteus medius is best seen when the muscle has been divided.

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

Fig. 53.



The **Gluteus Minimus** (Fig. 53, 8) *arises* from the dorsum ilii between the middle and inferior curved lines, being united by its anterior border with the gluteus medius. It is *inserted* into the anterior border of the great trochanter.

The two smaller glutei assist in maintaining the erect posture by fixing the pelvis on the femur, or, if the pelvis be fixed, they act as abductors and rotators of the thigh, the anterior portions of both muscles rotating inwards, the posterior portions rotating outwards. They are both *supplied* by the superior gluteal nerve.

The **Pyriformis** (Fig. 53, 9) is only partly seen in the dissection of the buttock. It *arises* from the front of the lateral mass of the

Fig. 53.—Deep muscles of the gluteal region (from Wilson).

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

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

sacrum between the 1st, 2nd, 3rd, and 4th sacral foramina, slightly from the upper part of the great sciatic notch, and often from the great sacro-sciatic ligament; passing out of the great sacro-sciatic foramen it ends in a round tendon, which is *inserted* into a distinct depression at the posterior part of the upper margin of the great trochanter. The muscle is occasionally divided into two parts by the passage of a portion of the great sciatic nerve through its fibres. The pyriformis is an external rotator of the thigh in the extended, and an abductor in the flexed position, and is *supplied* by branches of the sacral nerves within the pelvis.

The **Obturator Internus and Gemelli** (Fig. 53, 11).—Only the tendon of the obturator internus is now seen, the muscle *arising* from the inner surface of the pelvis in front of and behind the obturator foramen, and also from the inner surface of the obturator membrane. The tendon winds out of the lesser sacro-sciatic foramen, and, being joined by the gemelli, passes forwards and outwards beneath the tendon of the pyriformis (with which it is more or less united) to be *inserted* into a depression at the anterior part of the upper margin of the great trochanter. The gemelli (twin muscles) (10, 12) are placed above and below the tendon of the obturator internus and are *inserted* into it, but one or both may be absent; the superior *arises* from the spine of the ischium and adjacent portion of the lesser sciatic notch; the inferior *arises* from the upper and back part of the tuber ischii, and is the larger and more constant muscle.

If the tendon of the obturator internus be divided near its insertion without disturbing the gemelli, and drawn up from the margin of the sciatic foramen, a large bursa will be found, which, when opened, will be seen to lubricate the under surface of the tendon and the margin of the lesser sacro-sciatic foramen. The under surface of the obturator tendon is subdivided into from three to five small tendons, and the margin of the bone is encrusted with cartilage and grooved to correspond with these.

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

The **Tendon of the Obturator Externus** (Fig. 54, 20) will be found lying deeply between the inferior gemellus and the quadratus muscle. The origin of the muscle has been already seen

(p. 113), and the tendon, after passing through the groove below the acetabulum, is *inserted* into the digital fossa at the root of the great trochanter. The obturator externus is a rotator outwards of the thigh, and is *supplied* by the obturator nerve.

The **Quadratus Femoris** (Fig. 54, 24), so named from its quadrilateral shape, *arises* from the outer side of the tuberosity of the ischium externally to the hamstring muscles, and passes horizontally to be *inserted* on the back of the femur behind the great trochanter, immediately above the adductor magnus, with which it is sometimes continuous. The point of insertion has been termed the 'linea quadrati' (though a distinct line seldom if ever exists at the spot), which must not be confounded with the well-marked posterior intertrochanteric line.

The quadratus femoris is an external rotator of the thigh, and is *supplied* by a special branch from the sacral plexus, which also gives a twig to the gemellus inferior.

The **Gluteal Artery** (Fig. 54, 5) is a branch of the posterior division of the internal iliac artery, and emerges from the pelvis through the great sacro-sciatic foramen above the pyriformis. It appears at the lower border of the gluteus minimus, and divides into a superficial and a deep portion. The *superficial* division is distributed to the under surface of the gluteus maximus; the *deep* subdivides into superior and inferior branches.

The *superior branch* (4) runs along the middle curved line of the ilium between the gluteus medius and minimus; both of which it supplies, and ends at the anterior border of the ilium by anastomosing with the superior branch of the external circumflex artery of the thigh. The *inferior branch* (6) crosses the gluteus minimus to the great trochanter, to supply the parts in its neighbourhood, and end in the tensor vaginæ femoris.

Venæ comites accompany the branches of the artery and open into the internal iliac vein.

The **Sciatic Artery** (Fig. 54, 13) is a branch of the anterior division of the internal iliac artery, and emerges from the pelvis through the great sacro-sciatic foramen below the pyriformis. It gives large *gluteal* branches to the gluteus maximus, and *muscular* branches to the other smaller muscles of the neighbourhood, accompanying their respective nerves; and anastomoses with both the external and internal circumflex arteries of the profunda femoris. Its named branches are, 1, the *coccygeal* (15), which pierces the great sacro-sciatic ligament to supply the parts about the coccyx; 2, the *comes nervi ischiadici* (28), which runs upon the great sciatic nerve for a variable distance, and appears to be the direct continuation of the main trunk; and 3, the *anastomotic branch* (16), which passes to the root of the great trochanter to anastomose with the gluteal and internal circumflex arteries.

Fig. 54.

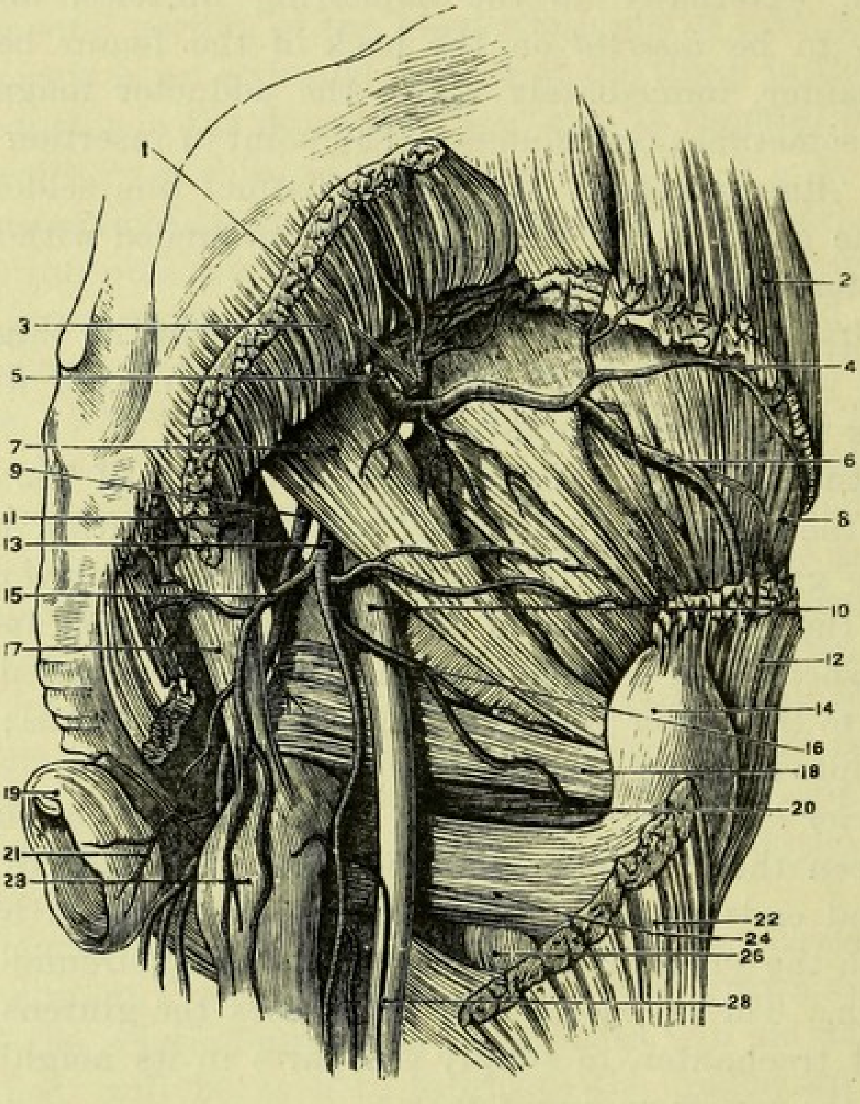


Fig. 54.—Arteries of the buttock (from Henle).

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

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

The **Pudic Artery** (Fig. 54, 9) is only seen in its course over the spine of the ischium, as it winds out of the great sacro-sciatic foramen below the pyriformis to re-enter the pelvis by the lesser sacro-sciatic foramen, above the tendon of the obturator internus. The artery is accompanied by its vein and by two nerves, the pudic nerve lying to its inner side and the nerve to the obturator internus to its outer side.

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

The **Superior Gluteal Nerve** (Fig. 55, 3) is a branch of the lumbo-sacral cord, and emerges from the pelvis with the gluteal artery above the pyriformis. It divides into two branches, which lie between the gluteus medius and minimus and supply them, the lower one going forward to the tensor fasciæ femoris.

The **Small Sciatic Nerve** (Fig. 55, 8) is one of the main branches of the sacral plexus, and appears at the lower border of the pyriformis to become the cutaneous nerve at the back of the thigh. As soon as it emerges from the pelvis it gives cutaneous branches to the skin over the gluteus maximus, and *inferior gluteal* branches to the under surface of the muscle itself. It then gives cutaneous branches to the thigh, one of the largest of which winds below the tuberosity of the ischium to the perinæum, and is called the *inferior pudendal* or nerve of Soemmering (13); and the nerve itself may be traced as far as the popliteal space. The *inferior gluteal* nerve very frequently has a distinct origin from the sacral plexus, and is not very intimately connected with the small sciatic.

The **Great Sciatic Nerve** (Fig. 55, 16) is the largest trunk of the sacral plexus, and appears at the lower border of the pyriformis, or occasionally through its fibres. It runs midway between the tuberosity of the ischium and the great trochanter, and disappears beneath the hamstring muscles. Properly speaking this nerve gives no branches in this region, but frequently the nerves to the quadratus and hip-joint are derived from it, instead of from the sacral plexus itself.

The **Nerve to the Obturator Internus** (Fig. 55, 5) arises from the upper part of the sacral plexus, and leaves the pelvis below the pyriformis, taking the same course as the pudic vessels and nerve over the spine of the ischium, but lying to their outer side. As it winds into the lesser foramen it gives a branch to the superior gemellus, and then supplies the fibres of the obturator within the pelvis.

The **Nerve to the Quadratus** (Fig. 55) arises from the anterior surface of the sacral plexus, and passes with a branch from the sciatic artery, beneath the obturator internus tendon to the quadratus and inferior gemellus. It lies against the back of the hip-joint, to which it gives a branch.

Fig. 55.

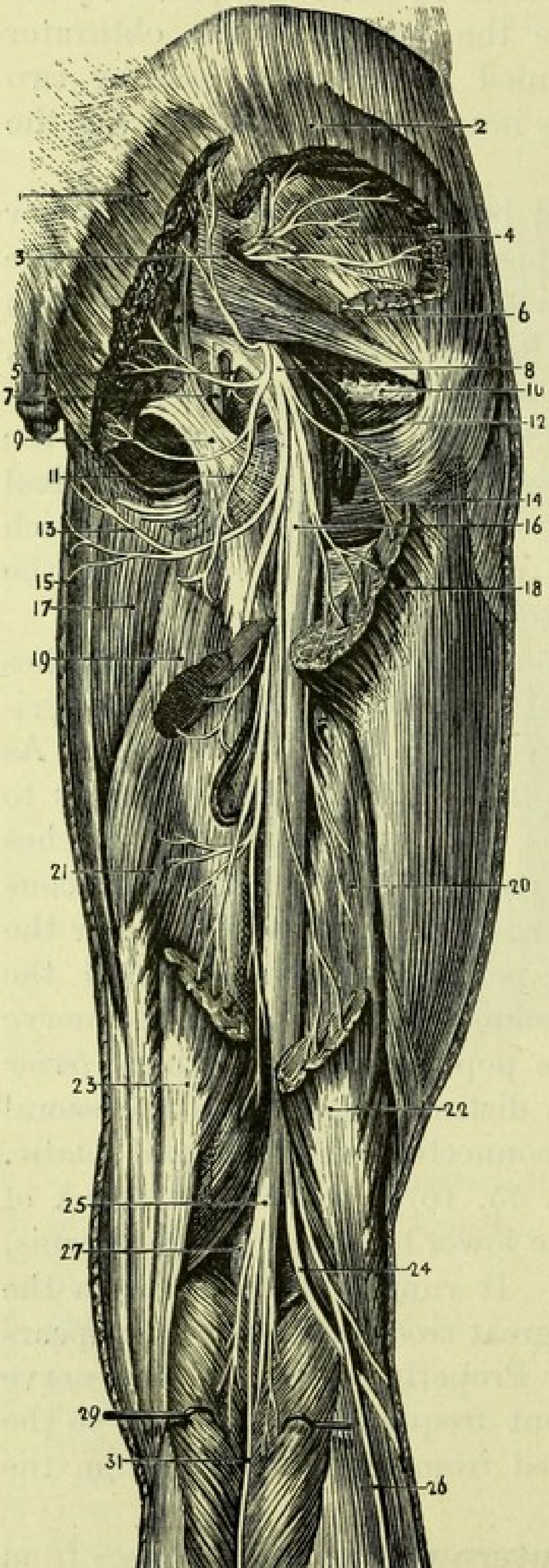


Fig. 55.—Nerves of the buttock and back of the thigh (from Hirschfeld and Leveillé).

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

The **Pudic Nerve** (Fig. 55, 7) from the sacral plexus, is seen lying on the spine of the ischium internally to the pudic artery. If the inferior hæmorrhoidal nerve should happen to arise separately from the sacral plexus, it will be found accompanying the pudic in this position.

The Popliteal Space.

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

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

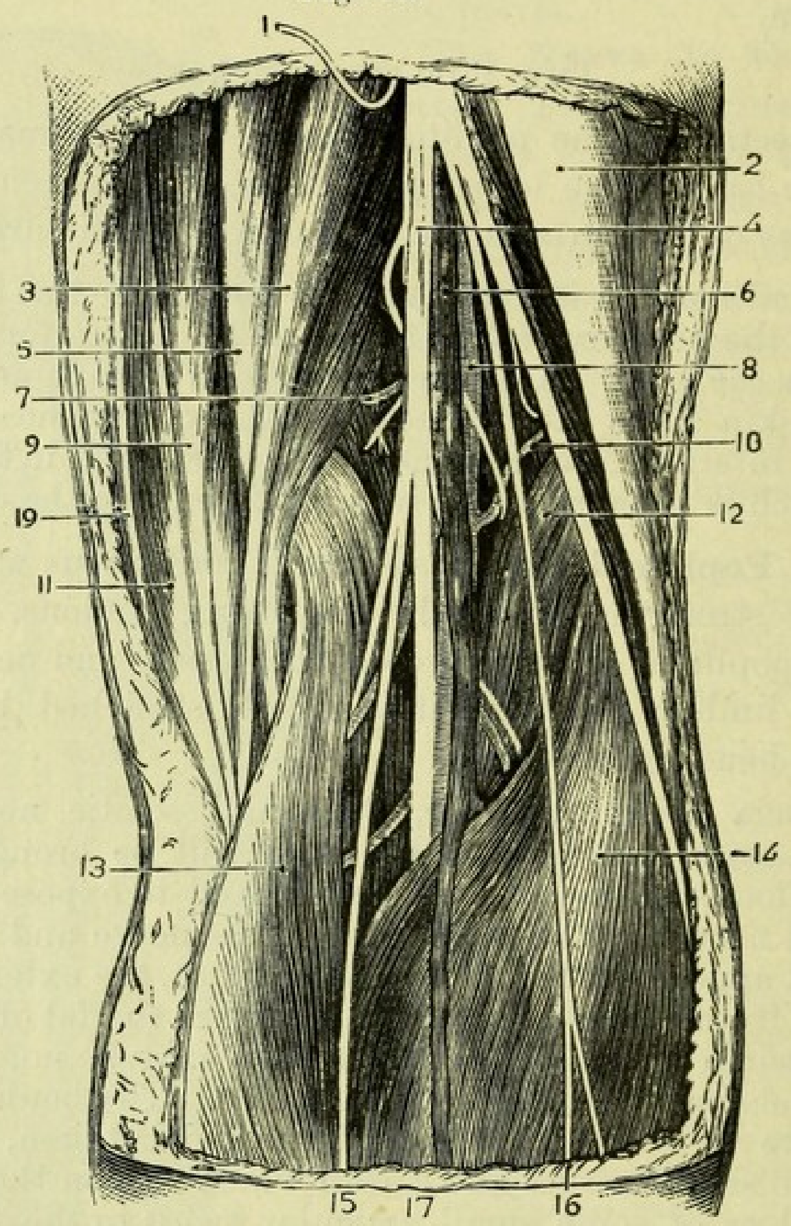
Deep or **Popliteal Fascia.**—This is continuous with the fascia lata, being strengthened by the hamstring tendons, and stretches across the popliteal space to protect the vessels and nerves beneath. When the limb is extended it is tightly stretched, but is at once relaxed on bending the knee.

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

The **Popliteal Space** (Fig. 56) is a lozenge-shaped cavity at the back of the knee, which in the dissected state extends for some distance above and below the joint. Its upper part is bounded *externally* by the tendon of the biceps; *internally* by the tendons of the semi-tendinosus and semi-membranosus muscles, with the gracilis and sartorius more superficially. Its lower part has one of the fleshy heads of the gastrocnemius muscle on *each* side, and on the *outer* side there is, in addition, the small plantaris muscle.

The *floor* of the space is formed at the upper part by that portion of the back of the femur which is between the divisions of the linea aspera; next by the posterior ligament of the knee-joint; and at

Fig. 56.



the lower part by the popliteus muscle and the fascia covering it. These last can only be felt between the heads of the gastrocnemius.

Fig. 56.—The popliteal space (from University College Museum).

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

but if the inner head of that muscle be divided near its origin and turned down, the popliteus will be sufficiently displayed.

The **Internal Popliteal Nerve** (Fig. 56, 4) is the most superficial of the important structures in the ham. It is one of the divisions of the great sciatic nerve, and passes down the middle of the space, disappearing beneath the gastrocnemius muscle. It thus crosses from the outer to the inner side of the popliteal artery, which it accompanies to the lower border of the popliteus muscle. Its branches are (1) *articular*, three in number, which pierce the posterior surface of the knee-joint, and accompany the two internal and the azygos articular arteries; (2) *muscular* to the gastrocnemius, soleus, plantaris, and popliteus; and (3) the *external saphenous nerve* or *ramus communicans tibialis*, which lies in the groove between the heads of the gastrocnemius (sometimes beneath a few of its fibres), and will be traced in the dissection of the back of the leg.

The **External Popliteal Nerve** or **Peroneal** (Fig. 57, 8), the other division of the great sciatic, is altogether under cover of the biceps at the upper part of the space, but becomes visible close to

Fig. 57.

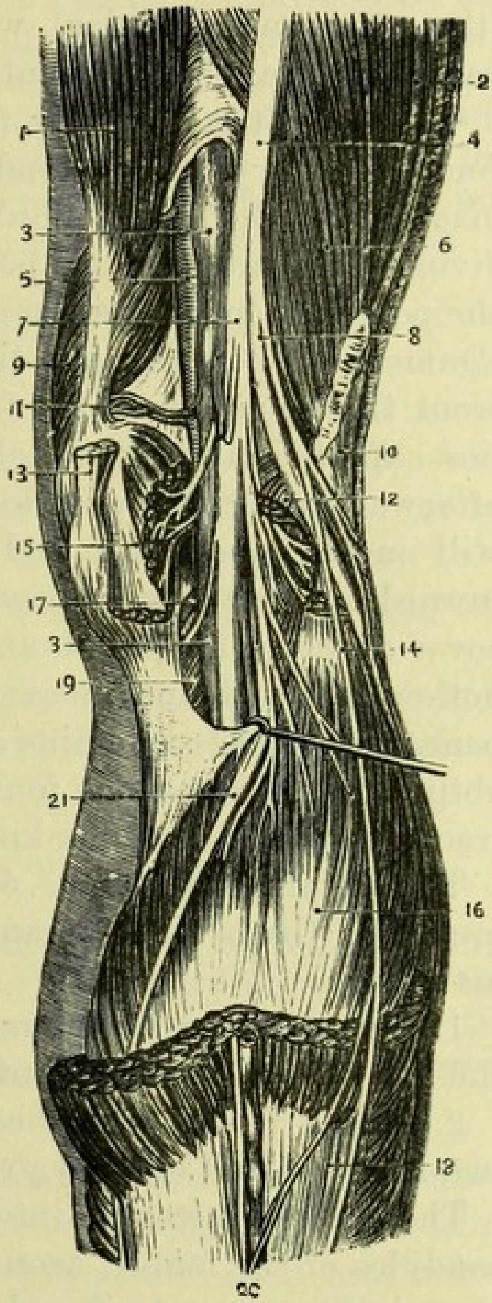


Fig. 57.—Deep dissection of the popliteal space (from Hirschfeld and Leveillé).

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

its tendon near the head of the fibula. It gives a communicating branch (*ramus communicans peronei vel fibularis*) down the back of the leg to join the external saphenous nerve, and two or three *articular* branches. Of these two, sometimes arising together, accompany the two external articular branches of the popliteal artery; the other (the recurrent articular), winds to the front of the joint with the recurrent branch of the anterior tibial artery.

The **Popliteal Artery** (Fig. 57, 5) is the continuation of the femoral artery, and extends from the opening in the adductor magnus to the lower border of the popliteus muscle, where it divides into anterior and posterior tibials. It lies at the bottom of the popliteal space, resting upon the back of the femur, the posterior ligament of the knee, and the popliteus muscle, and has a direction from the inner side of the femur to the middle of the leg. Its vein lies superficially in its whole course, but first to its outer side and afterwards to its inner side, whilst the internal popliteal nerve is still more superficial, and also crosses the artery from without inwards. The commencement of the popliteal artery is under cover of the semi-membranosus, the middle of the vessel is in the hollow of the ham, uncovered by muscles, and its lower part is beneath the gastrocnemius and plantaris muscles. A branch of the obturator nerve may be found on the upper part of the artery, and traced to the back of the knee.

The **Branches** (Figs. 56 and 57) of the popliteal artery are muscular (both to the hamstrings and muscles of the calf) and articular.

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

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

The *superior* arteries, internal and external, arise just above the condyles of the femur, around which they wind to the front of the knee-joint to supply it and to anastomose with one another, with the anastomotica magna and the descending branch of the external circumflex and the other arteries about the joint. The external passes beneath the tendon of the biceps, the internal beneath that of the adductor magnus. The *inferior* articular arteries arise on the popliteus, and do not correspond on the two sides of the limb. The internal (the lower of the two) winds below the inner tuberosity of the tibia and beneath the internal lateral ligament; the external passes altogether above the head of the fibula but beneath the external lateral ligament, to the front of the joint. The *azygos* arises about the middle of the artery and pierces the posterior ligament to join the other branches.

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

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

The **Popliteal Vein** (Fig. 57, 3) is formed by the junction of the anterior and posterior tibial veins at the lower border of the popliteus. The vein lies superficially to the artery, and to its inner side at the lower part of the space, but crosses to the outer side above. It receives tributaries corresponding to the branches of the artery and, at a variable point, the *external saphenous vein*, which lies on the back of the leg between the heads of the gastrocnemius, opens into it.

Some lymphatic glands are placed close to the artery, into which lymphatics from the back of the leg and heel discharge themselves.

The Back of the Thigh.

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

The **Hamstring Muscles** (Figs. 55 and 56) are three in number, viz., the biceps on the outer side, and the semi-tendinosus and semi-membranosus on the inner side. The biceps and semi-tendinosus, which arise in common, are superficial to the semi-membranosus near the tuber ischii, and the semi-tendinosus maintains this relation to the semi-membranosus throughout. The short head of the biceps will be found on the outer side of the lower part of the femur.

The **Biceps** (Fig. 55, 19) or outer hamstring *arises* by its long head from the internal or lower of the two surfaces on the tuber ischii, in common with the semi-tendinosus, and from the great sacro-sciatic ligament. It crosses the great sciatic nerve and, by diverging from the semi-membranosus in the lower fourth of the thigh, forms the outer boundary of the popliteal space. The short head (20), which is fleshy, *arises* from the outer side of the linea aspera, as high as the insertion of the gluteus maximus, and from its outer division to within two inches of the condyle, and from the external intermuscular septum. The two heads having united opposite the lower end of the femur, the muscle is *inserted* into the outer side of the head of the fibula. The tendon splits to enclose the long external lateral ligament, and one portion of it therefore intervenes between the long and the short external lateral ligaments of the knee-joint (Fig. 56, 2).

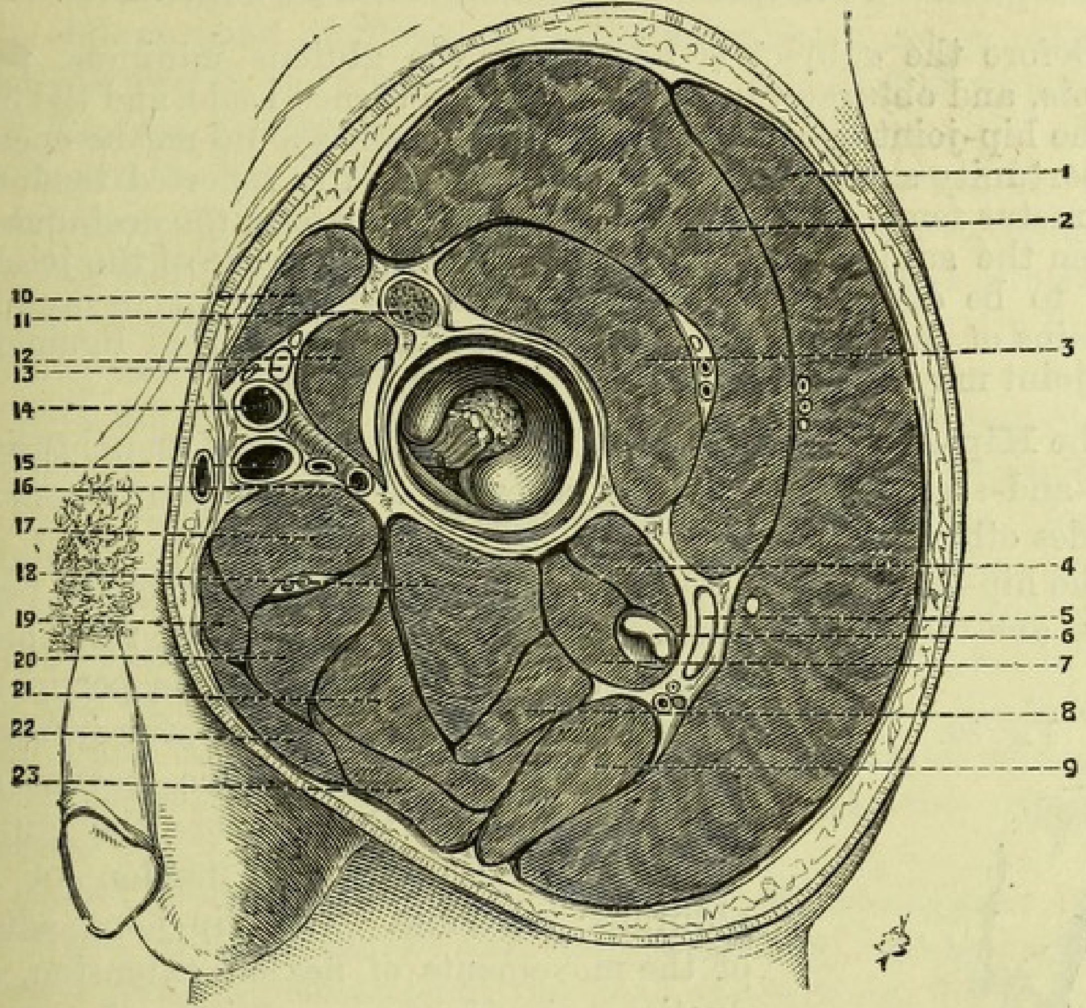
The **Semi-tendinosus** (Fig. 55, 19) *arises* by fleshy fibres in common with the tendinous origin of the biceps, from the inner of the two surfaces on the back of the tuber ischii. It forms one of the inner boundaries of the popliteal space, and ends in a long slender tendon, which lies on the semi-membranosus and passes beyond it to be *inserted* into the anterior or inner side of the tibia below the inner tuberosity, lying beneath the tendon of the sartorius and below that of the gracilis. Its fibres are crossed by a tendinous intersection (Fig. 56, 3).

The **Semi-membranosus** (Fig. 55, 21), though one of the internal hamstrings, is external to the biceps at its origin. It *arises* by a strong tendon from the outer and upper surface on the tuber ischii, and passing beneath the origins of the biceps and semi-tendinosus, spreads into a broad tendon from which the muscular fibres arise to form a thick belly. It is *inserted* by a strong tendon, which passes horizontally, and partly beneath the internal lateral ligament of the knee to the groove on the inner and back part of the inner tuberosity of the tibia, and gives off two expansions, one to form the posterior ligament of the knee-joint, and the other to cover the popliteus muscle (Fig. 56, 5).

The hamstring muscles flex the leg upon the thigh, and then extend the thigh upon the pelvis, as in walking or running; a very important action, however, is when the knee is extended and the leg is their fixed point: they then prevent the pelvis and trunk from falling forward, and thus maintain the erect posture of the body. When, taking the pelvis as their fixed point, they act upon the leg or (the knee being fixed) upon the thigh, their power is applied to a lever of the third order; when, taking their fixed point below, they act upon the pelvis, their power is applied to a lever of the first order. The hamstrings are *supplied* by the great sciatic nerve.

The **Great Sciatic Nerve** (Fig. 55, 16) is continued from the buttock and, after leaving the quadratus femoris, lies on the posterior surface of the adductor magnus, to which it gives a branch, and passes beneath the biceps. At a variable point, but generally about the middle of the thigh, the nerve divides into the

Fig. 58.



internal and external popliteal trunks, which have been already traced.

Muscular branches to the hamstring muscles are given off by the nerve in this part of its course.

Fig. 58.—Section through the hip and gluteal region (altered from Béraud).

1. Gluteus maximus.
2. Gluteus medius.
3. Gluteus minimus.
4. Pyriformis.
5. Great sciatic nerve and sciatic vessels.
6. Obturator internus.
7. Gemelli.
8. Biceps.
9. Quadratus femoris.
10. Sartorius.
11. Reflected tendon of rectus.
12. Psoas and iliacus and bursa.
13. Anterior crural nerve.
14. Common femoral artery.
15. Common femoral vein.
16. Profunda vessels.
17. Gracilis.
18. Semi-membranosus.
19. Adductor brevis.
20. Semi-tendinosus.
21. Obturator externus.
22. Adductor longus.
23. Adductor magnus.

Beneath the sciatic nerve will be seen the posterior surface of the adductor magnus, and piercing the muscle at various points are the terminations of the *perforating arteries* from the profunda, which are now seen to supply the hamstring muscles (*v.* p. 110). The terminal branch of the internal circumflex artery, between the quadratus and the adductor magnus, can now also be more fully traced out.

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

The **Hip-Joint** is the best example in the body of enarthrosis or ball-and-socket joint, and of necessity has a capsular ligament, besides other internal ligaments.

The hip-joint has *in front* the united psoas and iliacus, the pectineus, and the rectus muscles, with the femoral vessels, these being separated from the joint by the pectineus; *behind*, the pyriformis, obturatur internus, and gemelli, with the sciatic nerves and vessels lying upon them; *above*, the gluteus minimus, and *below*, the tendon of the obturator externus. The hip-joint admits of the movements of flexion, extension, abduction and adduction, rotation and circumduction. *Flexion* is performed by the psoas and iliacus, and indirectly by the rectus femoris; *extension* by the gluteus maximus, and indirectly by the hamstrings. The femur is *adducted* by the adductor muscles and pectineus, which at the same time rotate the bone outwards; it is *abducted* by the gluteus medius, minimus, and tensor vaginæ femoris. Rotation *outwards* is due to the gluteus maximus and the posterior fibres of medius and minimus, to the pyriformis, obturator and gemelli, and quadratus femoris; rotation *inwards* to the anterior fibres of the gluteus medius, the gluteus minimus, and tensor vaginæ femoris.

Fig. 59.

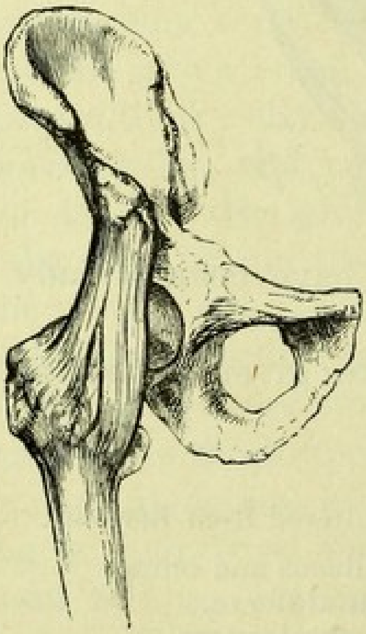


Fig. 59.—The ilio-femoral or Y-ligament of Bigelow (from Bryant).

The **Capsular Ligament** (Fig. 60, 1, 7) when seen from behind, will be found to be attached to the margin of the acetabulum, but to extend only about halfway down the posterior surface of the neck of the femur, the point to which it reaches varying in different subjects. In front, the capsule extends from the margin of the acetabulum to the anterior inter-trochanteric line, and is strengthened by an oblique band of fibres extending from the anterior inferior spinous process to the anterior inter-trochanteric line, to which the name *ilio-femoral* ligament has been given (Fig. 41, 9). The inferior attachment of the ilio-femoral ligament is by two more or less definitely divergent slips, into the upper and lower extremities of the anterior inter-trochanteric line, thus forming what Professor Bigelow has called the Y-ligament (Fig. 59). The inner slip limits especially extension and rotation inwards; the outer slip rotation outwards and adduction of the femur, and both have an important influence on the production of the several forms of dislocation of the head of the femur. A strengthening band is also found posteriorly, passing from the ischium below the acetabulum to the back of the capsule (*ischio-femoral*); and another (*pubo-femoral*) from the pubic part of the margin of the obturator foramen to the lower part of the capsule. A bursa intervenes between the tendon of the psoas and the front of the hip-joint, which occasionally communicates with the synovial cavity through the capsular ligament.

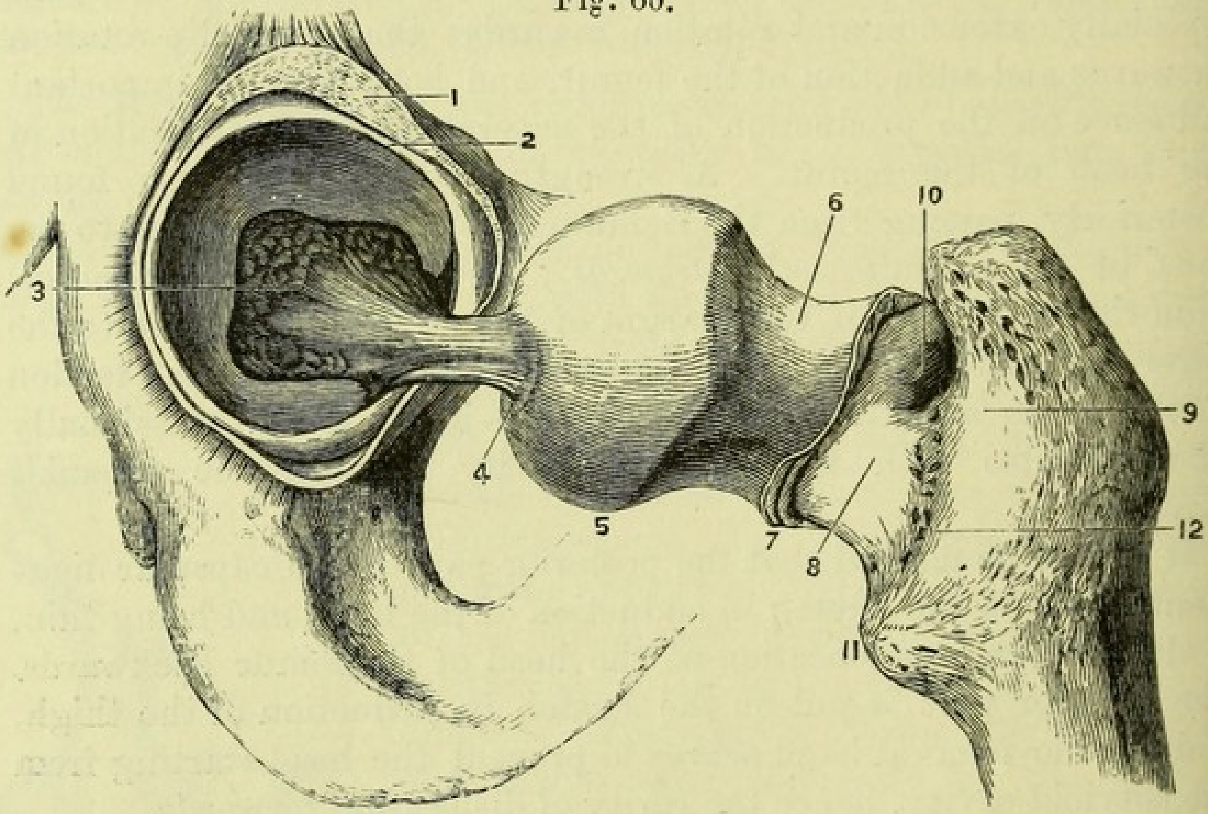
It should be noticed that the posterior part of the capsular ligament is put on the stretch in adduction of the limb, and being thin, is always torn in dislocation of the head of the femur backwards. The anterior part is put on the stretch in abduction of the thigh, and the ilio-femoral band serves to prevent the head starting from the cotyloid cavity, hence the rarity of dislocation forwards.

The capsular ligament having been divided, the thigh will be seen to be held by the so-called *ligamentum teres*, which will be brought into view by abducting and everting the limb. In doing this a squeaking noise will probably be heard, which is due to the sudden separation of the moist articular surfaces of the femur and pelvis, which are covered with cartilage. The inter-articular ligament (teres) being divided, the limb can be removed.

The *single synovial membrane* of the joint will be seen to be reflected over the inner surface of the capsular ligament on to the neck of the femur, and to be prolonged over the ligamentum teres to the bottom of the acetabulum, which it lines. In the bottom of the cavity it is loosely folded over some fat, and is of a darker colou than elsewhere; this part has been termed the Haversian gland, in the fat the articular vessels ramify.

The **Ligamentum Teres** (Fig. 60, 3) is not round, but prismatic or flattened. It is attached above to the non-articular portion of the acetabulum by two slips, which reach the margins of the notch in the cotyloid cavity and the transverse ligament, and below to the pit in the head of the femur (4). This ligament, though it would assist in preventing absolute dislocation, particularly forwards, has but little effect upon the movements of the joint, since it has been shown conclusively that it is only put upon the stretch during flexion, adduction, and rotation outwards of the thigh.

Fig. 60.



The **Cotyloid Ligament** (Fig 60, 2) is a fibro-cartilaginous ring, thinner at its free edge than at the point of attachment,

Fig. 60.—Ligaments of the hip-joint (from Sappey).

1. Capsular ligament, cut across.
2. Cotyloid ligament.
3. Ligamentum teres.
4. Insertion of ligamentum teres into pit on the head of the femur.
5. Head of the femur.
6. Neck of the femur.
7. Attachment of capsular ligament to the back of the neck of the femur.
8. Neck of the femur external to attachment of capsular ligament.
9. Great trochanter.
10. Pit on the great trochanter.
11. Small trochanter.
12. Posterior inter-trochanteric line.

which is fixed to the brim of the cotyloid cavity and serves to deepen it, fitting closely also against the head of the femur. That part of it which is carried across the notch on the inner side of the margin of the acetabulum is called the *transverse ligament*, and beneath it the articular vessels pass to the interior of the joint.

The Back of the Leg.

[A vertical incision through the centre of the remaining portion of skin on the back of the leg, joined by a short transverse cut at the heel, will permit the reflection of the skin to each side.]

The **External Saphenous Nerve** (Fig. 61, 8) (*communicans tibialis*) will be found piercing the deep fascia of the leg about half-way down the limb, to join the *communicans fibularis* (4), which becomes cutaneous near the knee. The nerve thus formed runs along the outer side of the tendo Achillis, to pass behind the external malleolus to the outer side of the foot.

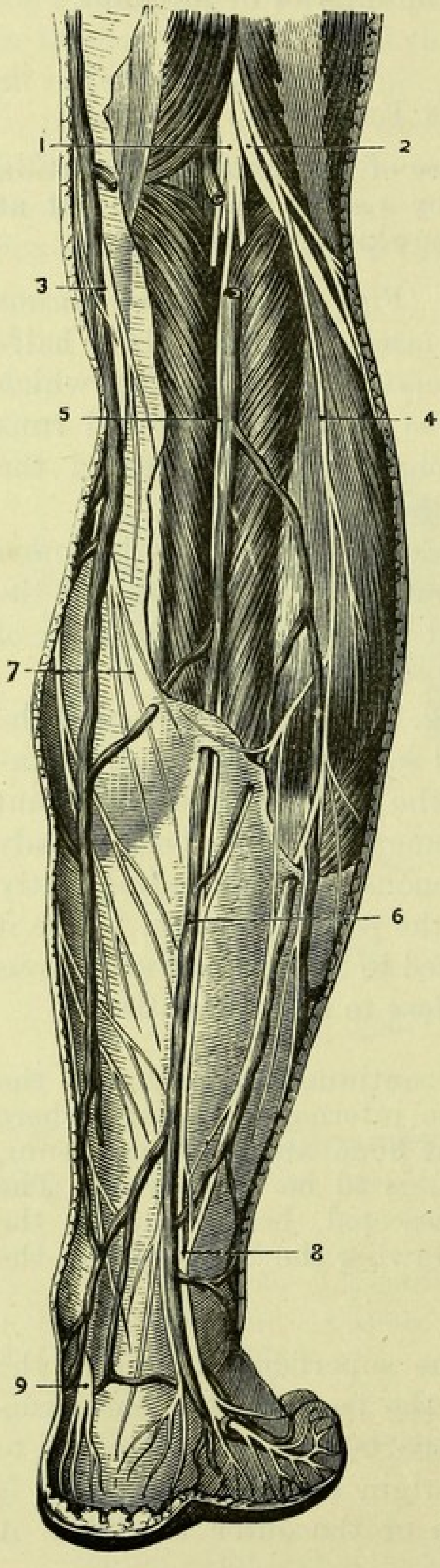
A branch or two of the *internal saphenous nerve* (7) may be found on the inner side of the back of the leg. The termination of the small sciatic nerve may also be seen at the middle of the back of the leg.

The **External Saphenous Vein** (Fig. 61, 6) appears behind the external malleolus close to the external saphenous nerve, and running up the centre of the leg, pierces the deep fascia at the point where the communicans tibialis nerve emerges; it has been already traced to the popliteal vein. The saphenous vein not unfrequently runs superficially to the upper part of the popliteal space, before it joins the popliteal vein. It is often joined to the internal saphenous vein by a large trunk which leaves it close to its termination.

[The deep fascia of the leg, which is continuous with that of the thigh, is to be removed, except near the internal malleolus, where a thickened part passing between that bone and the calcaneum, called the internal annular ligament, is to be preserved. The muscles of the calf are then to be dissected, being put on the stretch by supporting the knee and drawing the toes towards the front of the leg.]

The **Gastrocnemius** (Fig. 62, 4), the superficial muscle of the calf, has a double-headed *origin* from the back of the femur immediately above the condyles, both heads being firmly attached to the capsule of the knee-joint; the origin of the outer head is principally from the external surface of the outer condyle. A bursa, sometimes communicating with the knee-joint, lies between the inner head and the tendon of the semi-membranosus. The two heads are the lower boundaries of the popliteal space, and unite to form one large muscle, the fibres of which end about the middle of the leg in a broad tendon, which contracts near the heel into the thick rounded *tendo Achillis* (6). This, which is the common insertion of the gastrocnemius and the subjacent soleus, expands again slightly, to be *inserted* into the lower part of the posterior surface of the calcaneum, a bursa intervening between it and the upper part of this surface of the bone.

Fig. 61.



[The inner head of the gastrocnemius has previously been cut; if the remaining head be now carefully divided near its origin, and the muscle turned down as far as possible, the plantaris and soleus, with the popliteus covered by its fascia, will be brought into view.]

The **Plantaris** (Fig. 56, 12) *arises* from above the external condyle of the femur and from the line leading to it from the linea aspera, the muscle lying internally to the outer head of the gastrocnemius. Its fleshy fibres are about three inches long, but its tendon is the longest in the body and is very slender. It is placed between

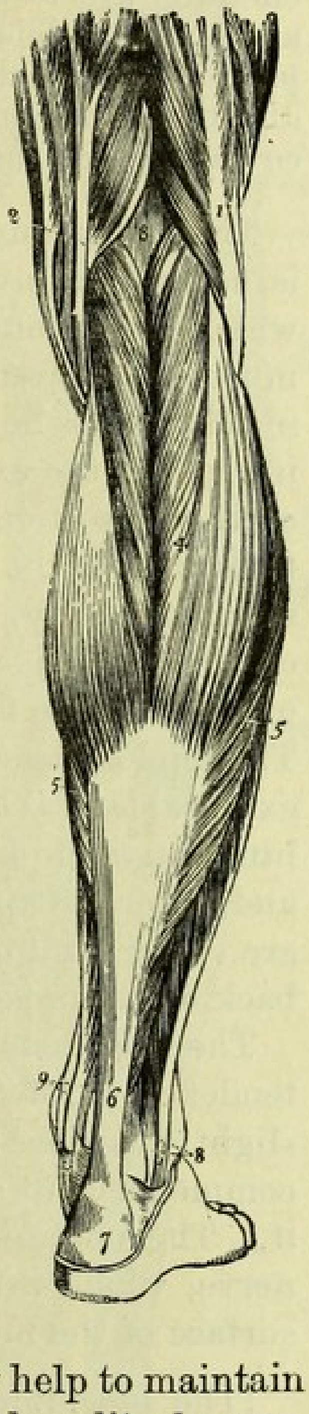
Fig. 61.—Superficial nerves of the back of the leg (from Hirschfeld and Leveillé).

1. Internal popliteal nerve.
2. External popliteal nerve.
3. Internal saphenous vein.
4. Nervus communicans fibularis.
5. Nervus communicans tibialis.
6. External saphenous vein.
7. Branch of internal saphenous nerve.
8. External saphenous nerve.
9. Calcanean branch of posterior tibial nerve.

the gastrocnemius and soleus, and crosses obliquely so as to get to the inner side of the tendo Achillis, by the side of or in common with which it is *inserted* into the os calcis. It is homologous to the palmaris longus of the upper extremity (Fig. 57, 21).

The **Soleus** (Fig. 62, 5) is tendinous on its surface, to allow the corresponding tendinous expansion on the deep surface of the gastrocnemius to move freely upon it, and between the two is a quantity of loose areolar tissue. It *arises* from the oblique line of the tibia, and from the inner border of the tibia in its middle third; also from the posterior surface of the head and upper third or more of the fibula, and from a deep tendon which arches over the tibial vessels and nerves. The fibres end in a broad tendon, which joins that of the gastrocnemius in the lower third of the leg to form the tendo Achillis, the *insertion* of which has been seen. The muscular fibres are inserted into the deep surface of the tendon to within two inches of the heel.

Fig. 62.



By dividing the fibres of the soleus vertically and with care, a tendinous expansion on the deep surface of the muscle will be brought into view, which stretches across the posterior tibial vessels and nerve, and protects them from pressure during the movements of the limb. This deep tendon is an important guide in the operation of tying the posterior tibial artery, and must be divided to reach it.

The muscles of the calf extend the foot, *i.e.*, point the toes, the gastrocnemius and plantaris, in addition, flexing the leg upon the thigh; or, when taking their fixed point below, in combination with the muscles on the front of the leg, they help to maintain the erect posture. They are *supplied* by the internal popliteal nerve.

Fig. 62.—Superficial muscles of the back of the leg (from Wilson).

1. Tendon of biceps.
2. Tendons of inner hamstrings.
3. Popliteal space.
4. Gastrocnemius.
5, 5. Soleus.
6. Tendo Achillis.
7. Tuberosity of os calcis.
8. Tendons of the peroneus longus and brevis.
9. Tendons of the tibialis posticus and flexor longus digitorum.

The form of club-foot known as 'talipes equinus' is due in part to contraction of the muscles of the calf, and division of the tendo Achillis is practised for its relief.

[The plantaris is to be divided and the soleus cut near its attachments to the tibia and fibula, when those muscles and the gastrocnemius are to be turned down, and the bursa between the tendon and the os calcis noticed. The posterior tibial vessels and nerve, partially covered by the deep layer of fascia, will now be exposed, and beneath them the deep muscles of the leg, with the popliteus covered by its fascia above.]

The **Popliteus** (Fig. 63, 9) is covered by a strong fascia which is derived from the tendon of the semi-membranosus, and upon which the lower parts of the popliteal vessels and nerve rest. This must be removed to expose the oblique fibres of the muscle, and an incision must be made through the capsule of the knee immediately in front of the external lateral ligament if it be desired at this stage of the dissection to see its tendinous origin. The popliteus *arises* from within the general capsule of the knee (though outside the synovial cavity) by a round tendon, which is fixed to a distinct pit on the outer side of the external condyle, below and a little in front of the tubercle for the attachment of the external lateral ligament. The tendon passes through a groove in the bone and beneath the external lateral ligament. It touches and grooves the external semilunar cartilage and receives some fibres from the posterior ligament, and, after quitting the joint, the fleshy fibres are developed, which are *inserted* into nearly the whole of the triangular surface on the back of the upper part of the tibia, above the oblique line.

The popliteus is a flexor of the leg upon the thigh, and has a tendency to rotate the tibia inwards. It is supposed to produce that slight rotation inwards of the tibia, which takes place at the commencement of flexion of the knee and is in a way essential to it. The popliteus is *supplied* by a branch of the internal popliteal nerve, which winds round the lower border to reach the anterior surface of the muscle.

[The incomplete intermuscular layer of fascia of the leg being removed, the posterior tibial vessels and nerve are to be cleaned, when the subjacent muscles will be found in the following positions:—flexor longus digitorum most internally, tibialis posticus in the middle, and flexor longus pollicis to the outer side.]

The **Flexor Longus Digitorum** (Fig. 63, 13) *arises* from the posterior surface of the tibia below the oblique line, and internally to the attachment of the tibialis posticus (from which it is separated by an indistinct vertical ridge and an intermuscular septum attached to it), the lower fibres of the muscle reaching to within three inches of the lower end of the tibia. It ends in a single tendon, which lies to the outer side of that of the tibialis posticus at the ankle, and passes through a separate division of the internal annular ligament to the sole of the foot.

The **Tibialis Posticus** (Fig. 63, 15) is the only one of the deep muscles which is attached to both bones of the leg, between which it therefore lies, the aponeurosis covering it forming septa between it and the adjacent muscles. It *arises* from the posterior surface of the tibia, below the oblique line and externally to the flexor longus digitorum, its origin extending to within two inches of the ankle;

Fig. 63.

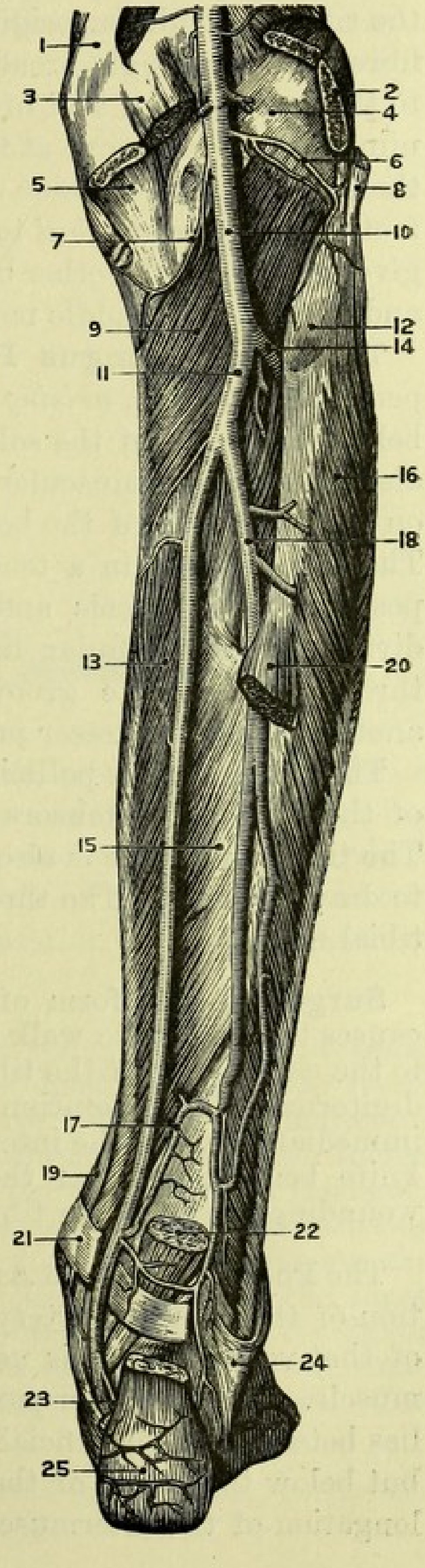


Fig. 63.—Arteries of the back of the leg (from Bonamy and Beau).

1. Adductor magnus.
2. Outer head of gastrocnemius.
3. Inner head of gastrocnemius.
4. Capsule of knee-joint.
5. Semi-membranosus.
6. Inferior external articular artery.
7. Inferior internal articular artery.
8. Tendon of biceps.
9. Popliteus.
10. Popliteal artery.
11. Posterior tibial artery.
12. Head of fibula.
13. Flexor longus digitorum.
14. Anterior tibial artery.
15. Tibialis posticus.
16. Peroneus longus.
17. Communicating branch with peroneal.
18. Peroneal artery.
19. Tendon of tibialis posticus.
20. Flexor longus pollicis.
21. Internal annular ligament.
22. Tendon of flexor longus pollicis.
23. Calcanean branch of posterior tibial artery.
24. External annular ligament.
25. Anastomosis on the back of the os calcis.

from nearly the whole length of the interosseous membrane; and from the whole of the internal surface of the fibula immediately behind the interosseous line, as well as from the intermuscular septa on each side, which are continuous with the aponeurosis over it. The muscle is overlapped by the flexor digitorum, and between the tibial and fibular origins the anterior tibial vessels pass. The fibres end in a single broad tendon, which passes beneath and then to the inner side of that of the flexor digitorum at the ankle, running through a groove at the back of the internal malleolus and in the most internal division of the annular ligament to the sole of the foot, where it is *attached* to the tuberosity of the scaphoid bone and gives slips to all the other bones of the tarsus, except the astragalus, and to the three middle metatarsal bones.

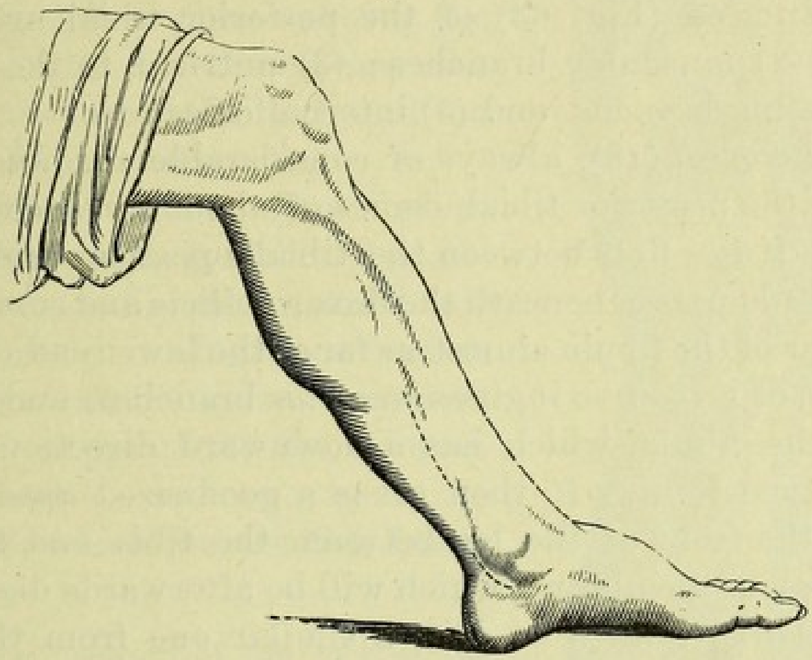
The **Flexor Longus Pollicis** (Fig. 63, 20) is a well-marked penniform muscle, *arising* from the posterior surface of the fibula below the origin of the soleus to within an inch of the ankle; and also from the intermuscular septa between it and the peronei muscles on the outer side of the bone, and the tibialis posticus internally. The muscle ends in a tendon which lies to the outer side of the posterior tibial vessels and nerve, and, passing through a separate division of the annular ligament, winds to the sole of the foot through an oblique groove at the back of the astragalus and another below the lesser process of the os calcis.

The flexor longus pollicis and flexor digitorum are direct flexors of the toes and extensors of the foot, *i.e.*, they point the toes. The tibialis posticus is also an extensor of the foot, which it tends to draw inwards. The three muscles are *supplied* by the posterior tibial nerve.

Surgery.—The form of club-foot called 'talipes varus' which causes the patient to walk on the outside of the foot, is due in part to the contraction of the tibialis posticus and sometimes of the flexor digitorum. The operation of dividing these tendons is performed immediately above the internal malleolus, a blunt-pointed tenotomy knife being used after the first incision, to avoid all danger of wounding the posterior tibial artery.

The **Posterior Tibial Artery** (Fig. 63, 11) is the direct continuation of the popliteal artery, and begins at the point of bifurcation of that vessel, which is usually the lower border of the popliteus muscle. In the upper part of its course the posterior tibial artery lies between the superficial and deep muscles of the back of the leg, but below the origin of the soleus it is only bound down by a prolongation of the intermuscular layer of fascia, and lies by the side of the tendo Achillis. It rests upon (in the position for dissection) the tibialis posticus for two-thirds of its length, but then upon the flexor digitorum; and at the ankle it lies upon the tibia between the tendons of the flexor digitorum and flexor longus pollicis. The vessel afterwards passes through a division of the annular ligament to the interval between the inner malleolus and the heel, where it

Fig. 64.



divides into internal and external plantar arteries. The posterior tibial nerve has a close relation to the artery throughout, lying first to its inner side and then crossing to its outer side, in which relation it continues to the foot. The posterior tibial artery has two *venæ comites*, which join those of the anterior tibial artery to form the popliteal vein.

Surgery (Fig. 64).—The operation of tying the posterior tibial artery is seldom performed except on the dead body, but the vessel may be reached in three parts of its course. Behind the malleolus the artery is readily exposed by a semilunar incision two inches long, made three quarters of an inch behind the margin of the bone, the edge of the knife being directed towards the tibia so as to divide the internal annular ligament. At the lower part of the leg the vessel may be reached by a vertical incision a little to the inner side of the tendo Achillis, and will be found lying upon the flexor digitorum. In the middle of the leg the operation is one of some difficulty, and somewhat damages the dissection if performed. The

Fig. 64.—Incisions for tying the posterior tibial artery (from Fergusson's "Practical Surgery").

best mode of proceeding is to make a vertical incision four inches long, parallel to, and half an inch behind, the edge of the tibia; the gastrocnemius slips aside and the soleus is then to be divided, especial care being taken to cut through the tendon on its under surface, but to go no deeper. A little dissection, close beneath this tibial attachment and towards the fibula, will expose the posterior tibial artery lying upon the tibialis posticus, with the posterior tibial nerve to its outer side.

The **Branches** (Fig. 63) of the posterior tibial artery are (1) peroneal; (2) muscular branches; (3) nutrient to the tibia; (4) a communicating branch; and (5) internal calcanean.

1. The *Peroneal* (18), always of considerable size and sometimes larger than the posterior tibial, comes off about two inches below the popliteus. It lies first between the tibialis posticus and the soleus, but afterwards passes beneath the flexor pollicis and runs close to the inner border of the fibula almost as far as the lower end of that bone. In this part of its course it gives *muscular* branches, and the *nutrient* artery to the fibula, which has a downward direction; *i.e.*, runs *from* the knee-joint. It then gives a good-sized *anterior peroneal* branch to the front of the leg between the tibia and fibula below the interosseous membrane, which will be afterwards dissected; and a *communicating* branch to join a similar one from the posterior tibial. The peroneal artery ends below the external malleolus by anastomosing with the malleolar and plantar arteries.

2. *Muscular* branches are given to the deep muscles and also to the soleus, one of which sends a twig to join the anastomosis about the knee.

3. The *Nutrient* artery to the tibia is of large size, and enters the foramen on the posterior surface of that bone; it arises from the upper part of the posterior tibial, and has a direction *from* the knee-joint.

4. A *Communicating* (17) branch runs transversely immediately above the ankle to join a corresponding branch of the peroneal artery.

5. The *Internal Calcanean* (23) is a branch of variable size, and may be replaced by two or more separate arteries. It arises from the posterior tibial beneath the internal annular ligament, which it pierces to supply the inner side of the os calcis with the muscles attached to it, and to anastomose with the other arteries in the neighbourhood.

The **Posterior Tibial Nerve** (Fig. 65, 19) is the continuation of the internal popliteal trunk, and passes with the artery beneath the soleus to lie on the deep muscles of the back of the leg. It is placed at first to the inner side of the posterior tibial artery, but crosses that vessel in the upper part, and lies to its outer side at the ankle in the same division of the annular ligament. The nerve divides into internal and external plantar nerves for the sole of the foot, and the division not unfrequently takes place above the inner malleolus, in which case the plantar nerves are usually found on either side of the artery.

The posterior tibial nerve gives *muscular* branches to the tibialis posticus, flexor longus digitorum, and flexor longus pollicis; it also gives a branch to the soleus, which muscle receives its principal supply from the internal popliteal; and a *cutaneous* nerve to the heel (20), which pierces the fascia

Fig. 65.

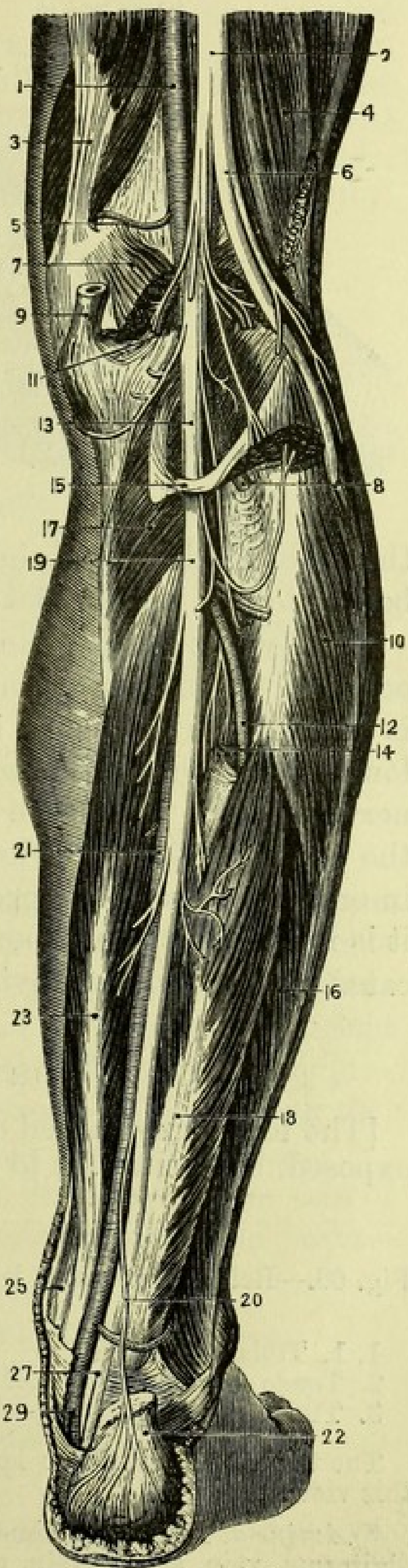


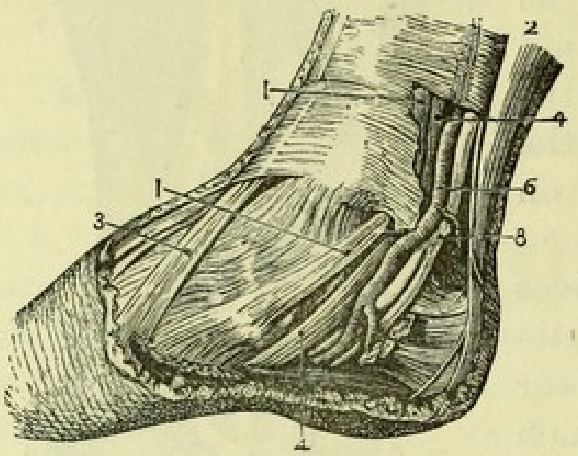
Fig. 65.—Deep dissection of the back of the leg (from Hirschfeld and Leveillé).

1. Popliteal artery.
2. Great sciatic nerve.
3. Adductor magnus.
4. Biceps.
5. Superior internal articular artery.
6. External popliteal nerve.
7. Gastrocnemius (cut).
8. Anterior tibial artery.
9. Tendon of semi-membranosus.
10. Peroneus longus.
11. Sural arteries and nerves.
12. Peroneal artery.
13. Internal popliteal nerve.
14. Tibialis posticus.
15. Portion of soleus.
16. Peroneus brevis.
17. Popliteus.
18. Flexor longus pollicis.
19. Posterior tibial nerve.
20. Calcanean branch of posterior tibial nerve.
21. Posterior tibial artery.
22. Tendo Achillis.
23. Flexor longus digitorum.
25. Tendon of tibialis posticus.
27. Plantar nerves.
29. Plantar arteries.

to the inner side of the tendo Achillis and may be traced to the skin of the sole of the foot.

Parts behind the Inner Malleolus (Fig. 66). Although the several parts behind the internal malleolus are only continuations of those which have been already dissected, especial notice should be taken of them in this part of their course, as their relations are important.

Fig. 66.



A portion of the skin on the inner side of the heel and sole of the foot is to be reflected if necessary, so as to expose the whole breadth of the *internal annular ligament*, which is a thickened portion of the deep fascia of the leg stretching from the inner malleolus to the os calcis and giving origin by its lower border to one head of the abductor pollicis.

The divisions in the annular ligament are four in number, and are occupied as follows, beginning from the tibia. In the first division is the tibialis posticus; in the second the tendon of the flexor longus digitorum; in the third the posterior tibial vessels and nerve, though the nerve is generally divided; and in the fourth the tendon of the flexor longus pollicis,* but this last lies so deeply, in order to pass in the grooves in the astragalus and os calcis, that it is not readily seen from the side. Each of the tendons is lubricated by a distinct synovial membrane.

The Sole of the Foot.

[The foot being raised on a block so that the sole may be fully exposed, an incision is to be made down its centre from the heel to

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Fig. 66.—Relation of parts behind the inner malleolus (from Hirschfeld and Leveillé).

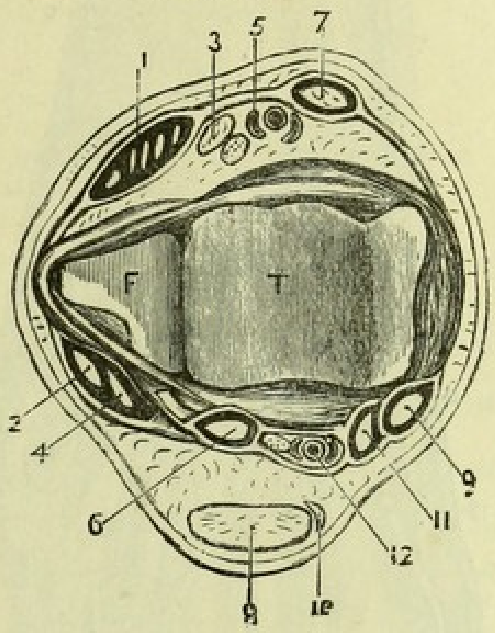
1, 1. Tibialis posticus.
2. Tendo Achillis.
3. Tibialis anticus.
4, 4. Flexor longus digitorum.
6. Posterior tibial artery.
8. Posterior tibial nerve.

The tendon of the flexor longus pollicis is too deeply placed to be shown in this view.

* *Artificial Memory;* Timothy Does Vex All Very Nervous Pupils (tibialis, digitorum, vein, artery, vein, nerve, pollicis).

the bases of the toes, the knife being carried at once down to the glistening plantar fascia through the thick lobulated fat which is always found beneath the skin in this region. A transverse incision at the roots of the toes will allow the skin and fat to be reflected to each side, which may be readily accomplished if the knife is kept close to the fascia and parallel to its fibres. Near the toes care must be taken of the divisions of the plantar fascia and of the digital nerves which appear between them, especially of those to the inner side of the first and the outer side of the fifth toes, which pierce the fascia further back than the others; but no attempt need be made, except by the advanced dissector, to trace out the minute cutaneous branch from the posterior tibial nerve near the heel or the still smaller twigs of the internal plantar nerve distributed to the sole.]

Fig. 67.



In the description the terms superficial, deep, &c., necessarily refer to the position of the parts as seen in the dissection, and not to that which they would hold if the body were in the upright position.

The **Plantar Fascia** (Fig. 68, 2) closely resembles the fascia of the palm, and is divisible into three portions. The central, which is the strongest, is attached to the under surface of the great tuberosity of the os calcis, but expands as it passes forwards to nearly the entire width of the foot. It splits into five portions opposite the heads of metatarsal bones, and at this point distinct transverse fibres will be seen passing across the foot. The five processes are attached to the sheaths of the flexor tendons of each toe, and between them the several digital vessels and nerves pass.

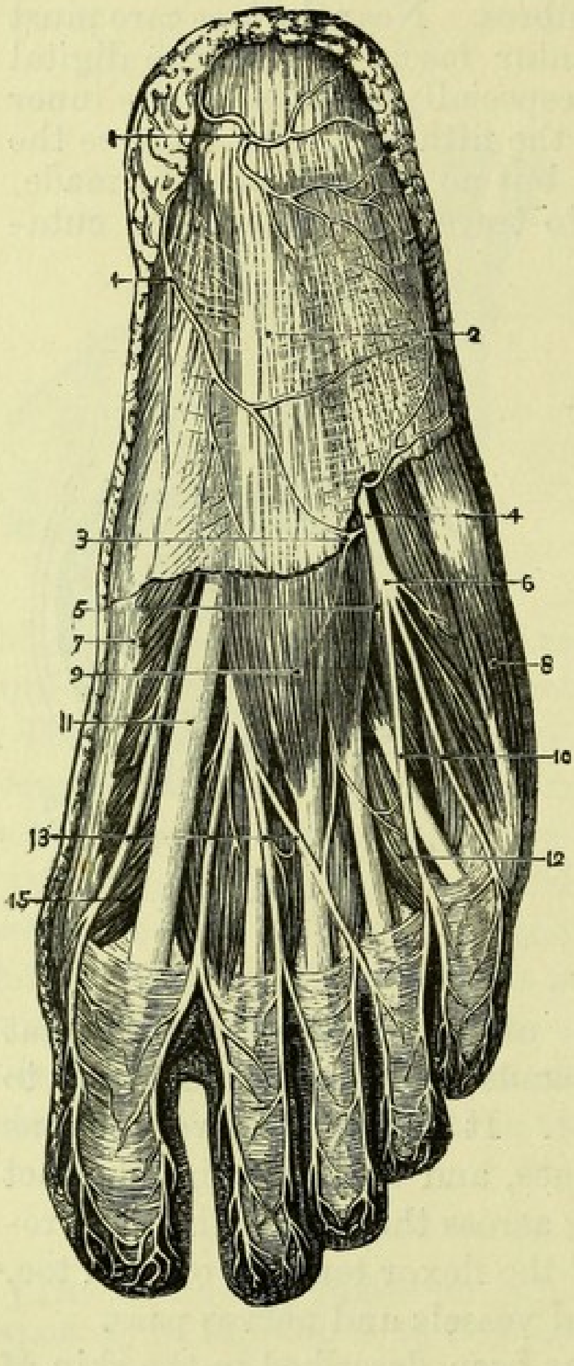
A *superficial transverse ligament* has been described in the skin of the web of the toes, passing over the digital vessels and nerves.

Fig. 67.—Section of the right ankle (drawn by G. E. L. Pearse).

1. Extensor longus digitorum and peroneus tertius.
2. Peroneus longus.
3. Extensor proprius pollicis.
4. Peroneus brevis.
5. Anterior tibial vessels and nerve.
6. Flexor longus pollicis.
7. Tibialis anticus.
8. Tendo Achillis.
9. Tibialis posticus.
10. Plantaris.
11. Flexor longus digitorum.
12. Posterior tibial vessels and nerve.

This is hardly worthy of a special description, as it is merely a slight extra development of the cutis, and has nothing to do with the true plantar fascia.

Fig. 68.



The central portion of the fascia gives origin to muscular fibres by its deep surface, and also by two intermuscular septa, which will subsequently be seen on each side of the flexor brevis digitorum. The lateral portions of the plantar fascia are much thinner than that in the centre, and mainly cover the muscles of the great and little toes on the inner and outer sides of the foot, but there is also a strong band on the outer side running from the outer tubercle of the calcaneum to the base of the fifth metatarsal bone.

[The central portion of the fascia is to be cut across about two inches from the heel, and may then be turned down over the toes without injuring the digital nerves, when the flexor brevis digitorum will be exposed in part, and the intermuscular septa on each side may be seen. The lateral portions of the fascia are to be removed, and the abductor pollicis and abductor minimi digiti cleaned.]

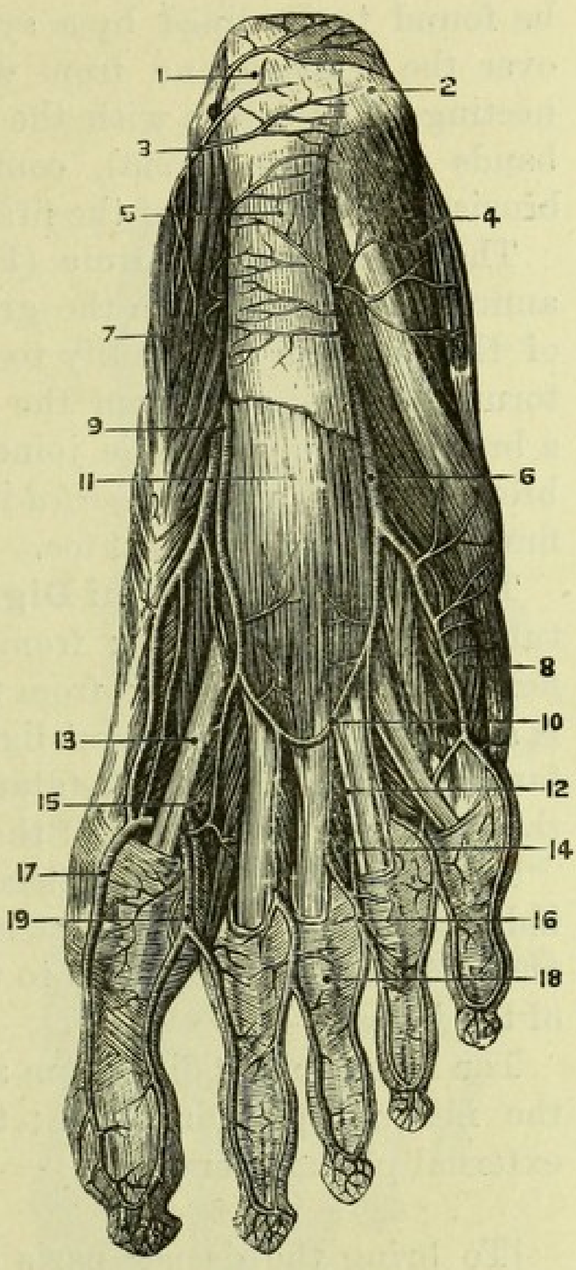
Fig. 68.—Superficial nerves of the sole of the foot (from Hirschfeld and Leveillé).

1, 1. Cutaneous plantar branches of posterior tibial nerve.
2. Plantar fascia.
3. Cutaneous branch of external plantar nerve.
4. External plantar nerve.
5. Its deep division.
6. Its superficial division.
7. Abductor pollicis.
8. Abductor minimi digiti.
9. Flexor brevis digitorum.
10. Digital branches of external plantar nerve.
11. Tendon of flexor longus pollicis.
12. One of the lumbricales muscles.
13. Digital branches of internal plantar nerve.
15. Flexor brevis pollicis.

The **First Layer of Muscles** consists of the flexor brevis digitorum in the middle, the abductor pollicis to the inner side, and the abductor minimi digiti to the outer side.

The **Flexor Brevis Digitorum** (Fig. 69, 11) *arises* from the great tuberosity of the os calcis; from the plantar fascia covering it (which has therefore been left undisturbed); and from the intermuscular septa on each side. It divides into four tendons, which pass through tendinous sheaths on the under surfaces of the four smaller toes, and are *inserted*, each by two slips, into the bases of their second phalanges. Passing between the subdivisions of each tendon is the corresponding tendon of the long flexor, which goes to the terminal phalanx; and thus the arrangement is precisely similar to that found in the hand, and the flexor brevis might be spoken of as *perforatus*, and the flexor longus as *perforans*.

Fig. 69.



The sheaths of the tendons also resemble those of the hand, but are smaller. Beginning over the heads of the metatarsal bones,

Fig. 69.—Superficial dissection of the sole of the foot (from Bonamy and Beau).

1. Greater tuberosity of os calcis.
2. Lesser tuberosity of os calcis.
3. Calcanean branch of posterior tibial artery.
4. Abductor minimi digiti.
5. Plantar fascia.
6. External plantar artery.
7. Abductor pollicis.
8. Flexor brevis minimi digiti.
9. Internal plantar artery.
10. Arch between plantar arteries (not constant).
11. Flexor brevis digitorum.
12. Third tendon of flexor longus digitorum.
13. Flexor longus pollicis.
14. Lumbricalis of 3rd space.
15. Flexor brevis pollicis.
16. Digital artery of 3rd space.
17. Digital branch from dorsal artery of foot.
18. Sheath of tendons.
19. Digital artery of 1st space (from dorsal artery of foot).

each sheath is joined by a process of plantar fascia, and then extends to the base of the terminal phalanx. The sheath is strong opposite each phalanx (*ligamentum vaginale*), but thinner over the joints, so as not to impede their motion; and when divided, will be found to be lined by a synovial membrane which is reflected over the tendons, and from which bands (*vincula vasculosa*) connecting the tendons with the sheath are derived. Small elastic bands (*ligamenta brevia*), connecting each tendon of the flexor brevis with the front of the first phalanx, exist as in the hand.

The **Abductor Pollicis** (Fig. 69, 7) *arises* from the internal annular ligament, from the greater tubercle on the under surface of the os calcis (internally to the origin of the flexor brevis digitorum), and slightly from the plantar fascia. The muscle ends in a broad tendon, which is joined by the inner head of the flexor brevis pollicis, and is *inserted* into the inner side of the base of the first phalanx of the great toe.

The **Abductor Minimi Digiti** (Fig. 69, 4) *arises* from the lesser tubercle of the os calcis; from the greater tubercle in front of the flexor brevis digitorum; from the plantar fascia and septum; and is attached to the subjacent ligamentous structures of the foot as far forward as the fifth metatarsal bone. Its tendon is *inserted* into the outer side of the base of the first phalanx of the little toe.*

The actions of the superficial muscles of the foot are sufficiently indicated by their names, but it should be remarked that abduction and adduction are from and to the median plane of the foot and not of the body.

The flexor brevis digitorum and abductor pollicis are *supplied* by the internal plantar nerve; the abductor minimi digiti by the external plantar nerve.

[To bring the deeper parts into view, the best way will be to remove with the saw a thin slice of the os calcis, including the attachments of the superficial muscles, when, if the attachment of the abductor pollicis to the internal annular ligament be divided, they can be turned forwards, and the plantar nerves and vessels will be seen.]

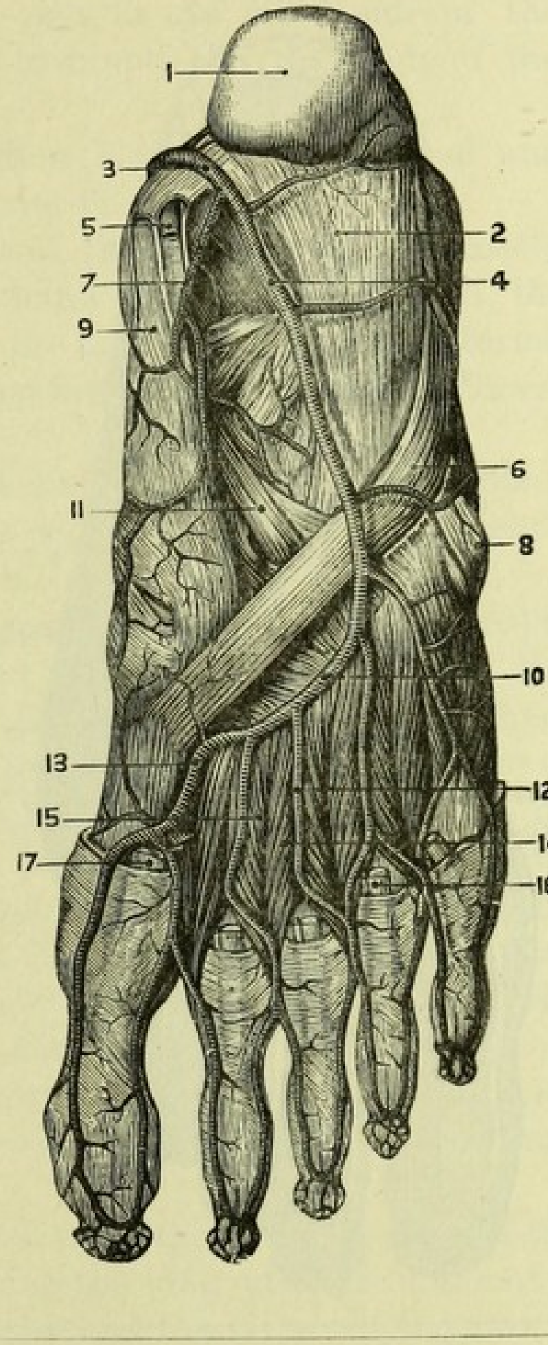
The **Plantar Arteries** (Fig. 70) internal and external, are the terminal branches of the posterior tibial, and enter the foot beneath the abductor pollicis and in close relation with the plantar nerves.

* Mr. John Wood has described an *abductor ossis metatarsi quinti*, which is occasionally found beneath the abductor and attached to the base of the fifth metatarsal bone.

The internal plantar artery, which is the smaller of the two, is accompanied by the large internal plantar nerve, the large external plantar artery going with the smaller external nerve.

The *Internal plantar artery* (7) is usually of small size, and runs forward to the great toe, where it anastomoses with the digital arteries derived from the dorsal artery of the foot, and distributed to the inner side of the great toe and the cleft between this and the second toe. If well-injected it may sometimes be traced with the nerve to the third interosseous space, giving muscular branches and digital branches to the three inner toes. Two *venæ comites* accompany it.

Fig. 70.



The *External plantar artery* (4) runs obliquely outwards across the foot between the flexor brevis digitorum and the accessorius muscle, and turning round the outer border of the latter muscle takes a deep course inwards towards the great toe, where it will be subsequently traced. It is accompanied by the external plantar nerve, which also gives a deep branch across the foot, and by *venæ comites;* and supplies the adjacent muscles, giving a branch to

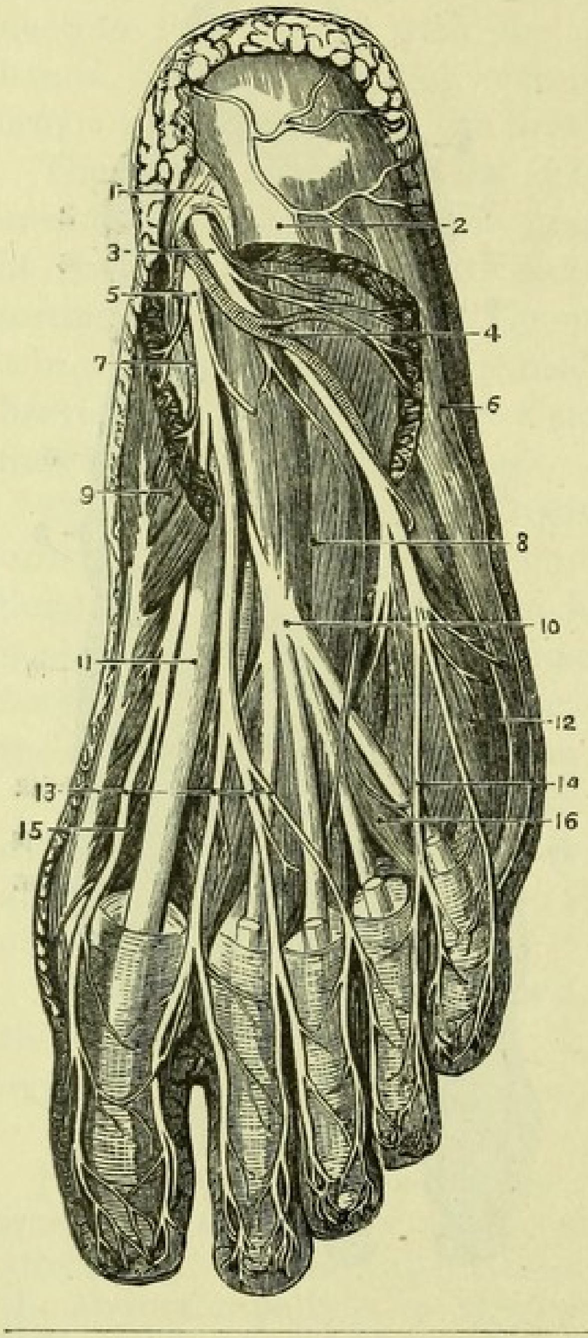
Fig. 70.—Deep dissection of the sole of the foot (from Bonamy and Beau).

1. Os calcis.
2. Ligamentum longum plantæ.
3. Posterior tibial artery.
4. External plantar artery.
5. Tendon of flexor longus pollicis.
6. Tendon of peroneus longus.
7. Internal plantar artery.
8. Base of 5th metatarsal bone.
9. Tendon of tibialis posticus.
10. Plantar arch.
11. Prolongation of tendon of tibialis posticus.
12. Digital artery.
13. Communicating branch of dorsal artery of foot.
14. Plantar interosseous of 2nd space.
15. Dorsal interosseous of 2nd space.
16. Tendon of flexor longus digitorum.
17. Tendon of flexor longus pollicis.

the outer side of the foot to anastomose with the peroneal artery.

The **Plantar Nerves** (Fig. 71) internal and external, are the branches of the posterior tibial nerve; their relation to the arteries has been mentioned.

Fig. 71.



The *Internal plantar nerve* (5) is the larger of the two, and after supplying small cutaneous twigs to the sole and muscular branches to the abductor pollicis and flexor brevis digitorum, gives off a digital branch to the inner side of the great toe, and breaks up into three other digital branches; each of these bifurcates at the roots of the toes, and they thus *supply* the outer side of the great toe, both sides of the second and third toes, and half the fourth toe. The first digital branch supplies the flexor brevis pollicis, the second and third supply the first and second lumbricales respectively, the fourth is joined by a twig from the external plantar nerve.

The *External plantar nerve* (3) crosses the foot with and in front of the external plantar artery, giving branches to the abductor minimi digiti and accessorius in its course. At

Fig. 71.—Deep nerves of the sole of the foot (from Hirschfeld and Leveillé).

1. Internal annular ligament.
2. Flexor brevis digitorum (cut).
3. External plantar nerve.
4. External plantar artery.
5. Internal plantar nerve.
6. Abductor minimi digiti.
7. Internal plantar artery.
8. Accessorius muscle.
9. Abductor pollicis.
10. Flexor longus digitorum.
11. Flexor longus pollicis.
12. Flexor brevis minimi digiti.
13. Digital branches of internal plantar nerve.
14. Digital branches of external plantar nerve.
15. Flexor brevis pollicis.
16. One of the lumbricales.

the outer border of the accessorius it divides into superficial and deep portions; the deep accompanies the artery, and will be seen in a later dissection. The superficial portion *supplies* the flexor brevis minimi digiti and the interosseous muscles in the fourth or outer-most space, and gives cutaneous branches to the sole. It then divides into two digital branches,—one to the outer side of the little toe, and the other bifurcating to supply the inner side of the little and half the next toe.

A slender branch of communication between the internal and external plantar nerves may sometimes be found.

It may be noticed that the nerves of the sole of the foot closely resemble those of the palm of the hand in their distribution, the internal plantar corresponding to the median, and the external plantar to the ulnar nerve; the deep branches of the latter nerves also correspond.

The **Second Layer of Muscles** includes the tendons of the flexor longus digitorum and flexor longus pollicis, with the small acces-sorius and the lumbricales, all of which should now be cleaned.

The tendon of the **Flexor Longus Digitorum** (Fig. 71, 10) is single at the annular ligament and lies to the inner side of the vessels and nerves, but it will now be seen to cross beneath them and over the tendon of the flexor longus pollicis to the centre of the foot, where it has the fibres of the accessorius attached to its deep surface; a few fibres from the flexor longus pollicis also blend with it at a somewhat higher level. It then divides into four tendons, which give origin to the lumbricales muscles and pass beneath the digital nerves to the four small toes, where they enter the digital sheaths, lying beneath the tendons of the short flexor. Each deep tendon then passes through the slit in the superficial tendon, and is *inserted* into the base of the third or terminal phalanx.

The **Accessorius** (Fig. 71, 8) *arises* from the under surface of the os calcis by two heads, between which the long plantar ligament is seen. The inner head, which is fleshy and the larger of the two, is attached to the hollow in front of the greater tubercle; the outer head, which is tendinous, is attached to the bone in front of the lesser tubercle and to the long plantar ligament. The muscle is *inserted* into the deep surface of the tendon of the flexor longus digitorum, or rather, is connected with it, and then sends slips to the tendons connected with the second, third, and fourth toes.

The **Lumbricales** (Fig. 71, 16) are four small muscles, which are so named from their fancied resemblance to earth-worms.

They *arise* from the tendons of the flexor longus digitorum, the most internal from one, and the rest from two tendons each, and wind to the inner sides of the four small toes to reach their dorsal aspects, where they join the expansions of the extensor tendons.

The action of the accessorius is to bring the line of traction of the flexor tendons into the centre of the foot. The use of the lumbricales, according to Duchenne, is similar to that of those in the hand, viz., to flex the proximal joints and extend the two other joints of the toes. The accessorius is *supplied* by the external plantar nerve; the two inner lumbricales by the internal plantar, and the two outer lumbricales by the external plantar nerve.

The tendon of the **Flexor Longus Pollicis** (Fig. 71, 11), after lying in the groove below the lesser process of the os calcis, runs forward to the great toe, lying beneath the plantar vessels and nerves, and being crossed by the tendon of the flexor digitorum, to which it is connected by a few fibres. The tendon lies between the two heads of the flexor brevis pollicis and then enters a sheath, in which it is enclosed until its *insertion* into the base of the terminal phalanx of the great toe.

Fig. 72.

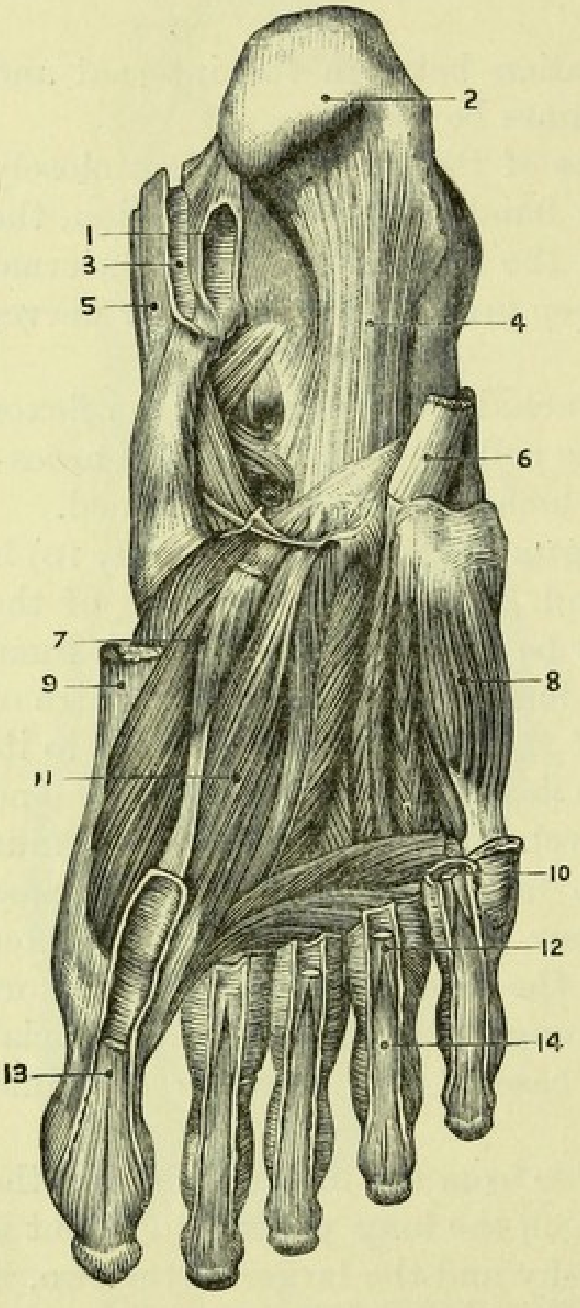


Fig. 72.—Deep muscles of the sole of the foot (from Sappey).

1. Sheath of flexor longus pollicis.
2. Os calcis.
3. Sheath of flexor longus digitorum.
4. Ligamentum longum plantæ.
5. Sheath of tibialis posticus.
6. Tendon of peroneus longus.
7. Flexor brevis pollicis.
8. Flexor brevis minimi digiti.
9. Tendon of abductor pollicis.
10. Transversus pedis.
11. Adductor pollicis.
12. Tendon of flexor brevis digitorum to 4th toe.
13. Tendon of flexor longus pollicis.
14. Tendon of flexor longus digitorum to 4th toe.

[The long tendons and the accessorious muscle are to be cut about the middle of the foot and turned down, when the muscles of the third layer are to be cleaned. In doing this the external plantar vessels and nerve will be more fully, but not yet completely exposed.]

The **Third Layer of Muscles** consists of the flexor brevis pollicis, adductor pollicis, flexor brevis minimi digiti, and transversus pedis.

The **Flexor Brevis Pollicis** (Fig. 72, 7) *arises* by a narrow tendinous origin from the inner surface of the cuboid, and from the prolongation of the tendon of the tibialis posticus to the external and middle cuneiform bones. Its fibres form two heads, which diverge from each other and separate near the head of the metatarsal bone, to be *inserted* into opposite sides of the base of the first phalanx of the great toe with the abductor and adductor respectively. Each head has a sesamoid bone developed in its tendon, entering into the formation of the metatarso-phalangeal joint, which must be opened to see them distinctly. The tendon of the long flexor lies between the two heads of this muscle.

The **Adductor Pollicis** (Fig. 72, 11) *arises* from the bases of the second, third, and fourth metatarsal bones, and from the sheath of the peroneus longus tendon; and is *inserted* into the outer side of the base of the first phalanx of the great toe, with the outer head of the flexor brevis.

The **Flexor Brevis Minimi Digiti** (Fig. 72, 8) *arises* from the under surface of the projecting base of the fifth metatarsal bone and the sheath of the peroneus longus, and is *inserted* into the outer side of the base of the first phalanx of the little toe with the abductor.*

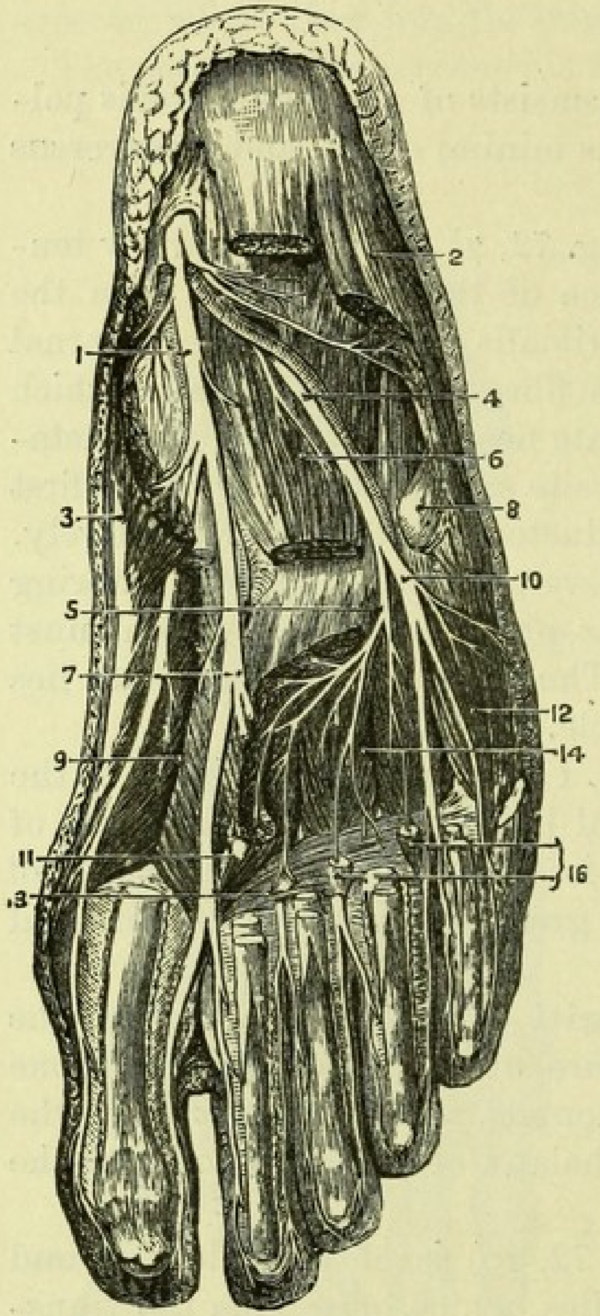
The **Transversus Pedis** (Fig. 72, 10) is of variable size, and consists of three or four small bundles, which *arise* from the transverse metatarsal ligament over the heads of the three or four outer metatarsal bones. It is *inserted* into the outer side of the first phalanx of the great toe, with the adductor and part of the flexor brevis pollicis.

The action of the flexor brevis pollicis and flexor minimi digiti is obvious; the adductor pollicis acts towards the median plane of the foot, and the transversus draws the toes together and narrows the foot. The flexor brevis pollicis is *supplied* by the internal plantar nerve, the other muscles by the external plantar nerve.

* An *opponens minimi digiti* attached to the metatarsal bone may occasionally be found.

[The adductor and flexor brevis pollicis are to be cut near their origins and turned down when the plantar arch of the external plantar artery with the accompanying nerve is to be fully traced out, and the lower aspect of the interossei may be defined.]

Fig. 73.



The **External Plantar Artery** (Fig. 70, 4) after turning round the accessorius muscle takes a deep course beneath the adductor and flexor brevis pollicis, but upon the interosseous muscles, to the base of the metatarsal bone of the great toe. This deep portion of the artery has been called the *plantar arch*, which is completed by the *communicating* branch of the dorsal artery of the foot entering the sole between the first and second metatarsal bones.

Branches. Small twigs pass backward from the concavity of the arch to supply the tarsus. Three small *posterior perforating arteries* are given off by the plantar arch; they pierce the interosseous muscles to anastomose with the interosseous arteries on the dorsum of the foot.

Four *digital arteries* arise from the anterior part of the arch; the outer one goes to the outer side of the little toe, the others

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Fig. 73.—Deep dissection of the sole of the foot (from Hirschfeld and Leveillé).

1. Internal plantar nerve.
2. Abductor minimi digiti.
3. Abductor pollicis.
4. External plantar nerve.
5. Its deep division.
6. Accessorius muscle.
7. Digital branches of internal plantar nerve.
8. Tendon of peroneus longus.
9. Flexor brevis pollicis.
10. Superficial division of external plantar nerve.
11. Adductor pollicis.
12. Flexor brevis minimi digiti.
13. Transversus pedis.
14. Interosseous muscles.
16. Two outer lumbricales.

bifurcate to supply the adjacent sides of two toes each, and, at the point of bifurcation, send *anterior perforating* arteries to the back of the foot. The digital arteries run on the sides of the toes with the digital nerves, and anastomose in the pulp of the terminal phalanges.

The *communicating branch of the dorsalis pedis* artery (13) enters the sole between the heads of the first dorsal interosseous muscle, and besides completing the plantar arch, gives off a digital branch, which bifurcates to supply the adjacent sides of the great and next toe; and also a branch to the inner side of the great toe.

The **External Plantar Nerve** (Fig. 73, 5).—The deep portion of the nerve accompanies the artery beneath the adductor pollicis, in which it ends. It gives small branches to the two outer lumbricales, to the transversus pedis, and to all the interosseous muscles both plantar and dorsal, except those of the fourth or outermost interosseous space, which are supplied by the superficial portion.

The **Fourth Layer of Muscles** consists of the plantar interossei, which will be better seen when the dorsal interossei are dissected.

Front of the Leg and Foot.

[The skin remaining on the front and outer side of the leg and on the back of the foot is to be removed, and the superficial veins and nerves dissected out of the superficial fascia, after which the deep fascia should be cleaned.]

The **Superficial Veins** form an arch across the back of the foot, ending in the internal and external saphenous veins on opposite sides. The *internal saphenous vein* is to be traced in front of the internal malleolus to the inner side of the knee. The *external saphenous vein* passes behind the external malleolus to the back of the leg.

Cutaneous Nerves. On the outer side of the leg are a few cutaneous branches from the *external popliteal nerve.*

The **Musculo-Cutaneous Nerve** (Fig. 77, 13) pierces the deep fascia about the lower third of the outer side of the leg, and at once divides into two branches, which however often appear at different points. The internal division (15) gives branches to the inner side of the great toe, the outer side of the second, and the inner side of the third toe; frequently also giving a small branch to join the anterior tibial nerve between the first and second toes. The outer division (17) supplies the outer side of the third toe, both sides of the fourth, and either one or both sides of the fifth toe.

The **External Saphenous Nerve** (Fig. 77, 21) winds round the external malleolus from the back of the leg, and is distributed to the outer side of the little toe, or occasionally to both sides of the little toe and half the next, joining the musculo-cutaneous nerve.

The **Anterior Tibial Nerve** (Fig. 77, 16) appears in the interval between the great and the second toes, the adjacent sides of which it supplies, often joining with a branch of the musculo-cutaneous nerve.

The **Internal Saphenous Nerve** lies in front of the internal malleolus with the internal saphenous vein, which it accompanies. It may be traced along the inner side of the foot, but it is of small size.

The **Fascia of the Leg** is dense and white, and is attached to the tibia on the inner side and to the fibula on the outer side, forming an intermuscular septum between the extensors and the peronei. It gives origin to muscular fibres at the upper part of the leg, where it should therefore be allowed to remain undisturbed; the rest of the fascia should be removed, except a thickened band over the ankle joint, the *anterior annular ligament*. The anterior annular ligament consists of two parts, one passing from the tibia to the fibula, and having a separate compartment lined by a synovial sheath for the tibialis anticus, distinct from the rest of the structures passing beneath it; the other being attached externally to the upper surface of the os calcis in front of the interosseous ligament, and reaching internally, by two more or less distinct bands, the inner malleolus and the inner row of tarsal bones. The latter has three compartments lined by synovial sheaths, for (1) the tibialis anticus, (2) extensor proprius pollicis, and (3) extensor longus digitorum and peroneus tertius; the anterior tibial vessels and nerve pass beneath the ligament. A similar band between the external malleolus and the calcaneum is called the *external annular ligament*, and encloses the tendons of the peroneus longus and brevis in one sheath. (Fig. 67).

[After defining the anterior annular ligament, the fascia is to be taken from the muscles on the front of the leg, and the latter, together with their tendons on the dorsum of the foot, as well as the vessels and nerves, are to be cleaned.]

The **Extensor Muscles** (Fig. 74) are the tibialis anticus to the inner side; the extensor longus digitorum with an extra slip (the peroneus tertius) to the outer side; and between the two, the extensor proprius pollicis appearing about the middle of the leg.

The **Tibialis Anticus** (Fig. 74, 3) *arises* from the upper two-thirds of the outer surface of the shaft of the tibia and from its outer tuberosity; from the inner half of the interosseous ligament for the same distance; and from the fascia covering the muscle. The fibres end in a broad tendon, which becomes narrower near the ankle and passes through the most internal division of the annular ligament, to be *inserted* into the under surface of the internal cuneiform bone and the base of the metatarsal bone of the great toe. The tibialis anticus is a flexor of the foot and draws up its inner side. It is one of the muscles which helps to produce the form of club-foot called 'talipes varus.' It is *supplied* by the anterior tibial nerve.

The **Extensor Longus Digitorum** (Fig. 74, 4) *arises* from the upper three-fourths of the anterior surface of the fibula and for about an inch from the adjacent interosseous membrane; from the outer tuberosity of the tibia close to the tibialis anticus; from the fascia upon the upper part of the muscle; and from the intermuscular septum between the extensors and the peronei. The muscular fibres are continued upon the tendon to the annular ligament, through

Fig. 74.

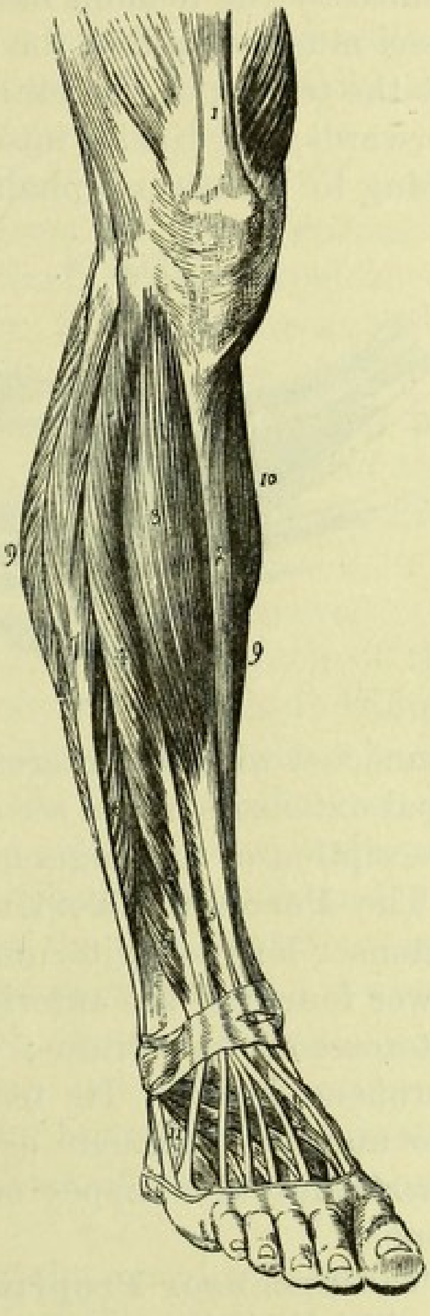


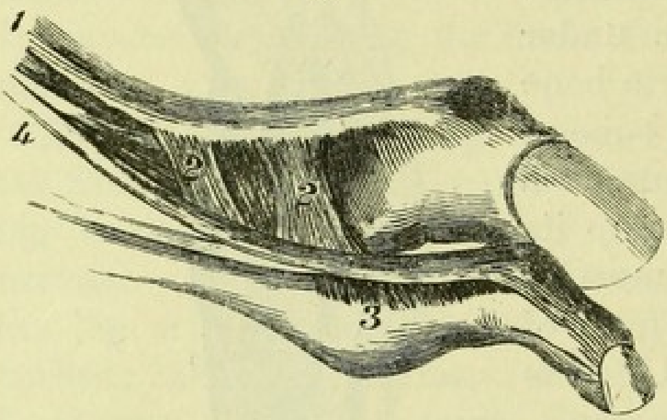
Fig. 74.—Muscles of the front of the leg (from Wilson).

1. Quadriceps extensor inserted into the patella.
2. Subcutaneous surface of the tibia.
3. Tibialis anticus.
4. Extensor longus digitorum.
5. Extensor proprius pollicis.
6. Peroneus tertius.
7. Peroneus longus.
8. Peroneus brevis.

9, 9. Borders of the soleus muscle.
10. Part of the inner belly of the gastrocnemius.
11. Extensor brevis digitorum; the tendon in front of the figure is that of the peroneus tertius; that behind it, the peroneus brevis.

the outer division of which it passes, and at once divides into four tendons for the four smaller toes. The *insertion* of the extensor into the toes is similar to that of the extensor of the fingers, but on a smaller scale. The extensor tendon forms an expansion on the back of the first phalanx of each toe, which is joined by the tendons of the corresponding lumbricales and interossei muscles, and in the case of the second, third, and fourth toes, by the tendon of the extensor brevis digitorum; this is continued forwards, and divides into three parts, the central triangular portion going to the second phalanx and the lateral stronger pieces to the third phalanx. The action of the extensor longus digitorum is principally to flex and abduct the foot, since it only extends the first phalanges of the toes by means of short fibres connecting each tendon with the corresponding bone (Fig. 75, 3). The expansion on the second phalanges is connected with the interossei and lumbricales, which are the principal extensors of the second and third phalanges. (Compare the description of the fingers, p. 53.)

Fig. 75.



The **Peroneus Tertius** (Fig. 74, 6) is often a part of the extensor longus digitorum. It *arises*, below the extensor, from the lower fourth of the anterior surface of the fibula; slightly from the interosseous membrane; and from the septum between it and the peroneus brevis. Its tendon passes through the same division of the annular ligament as the extensor longus digitorum, and is *inserted* into the upper surface of the base of the fifth metatarsal bone.

The **Extensor Proprius Pollicis** (Fig. 74, 5) appears between the tibialis anticus and the extensor digitorum in the lower third of the leg. It *arises* from the middle two-fourths of the anterior surface of the fibula, internally to the extensor longus digitorum; and from the adjacent part of the interosseous membrane. Its

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Fig. 75.—Insertion of extensors of toes (from Duchenne).

1. Extensor proprius pollicis.
2. Fibrous bands passing to first phalanx of great toe.
3. Fibrous bands from—
4. Extensor longus digitorum.

tendon passes beneath the annular ligament and, crossing the anterior tibial artery, is *inserted* into the terminal phalanx of the great toe, being closely connected by short fibrous bands with the first phalanx (Duchenne), which it thus also extends (Fig. 75, 2).

The extensors of the toes also act secondarily as flexors of the foot, *i.e.*, bend it upwards. The peroneus tertius assists in this latter action. The rare form of club-foot 'talipes calcaneus' is produced by the action of these muscles. They are all *supplied* by the anterior tibial nerve.

The **Extensor Brevis Digitorum** (Fig. 74, 11) is the only muscle of the back of the foot. It *arises* from the upper surface of the greater process of the os calcis; from the interosseous calcaneo-astragaloid ligament; and from the lower border of the anterior annular ligament. It ends in four tendons, which pass obliquely across the foot to be *inserted* into the four inner toes, joining the general expansion of the extensor tendons, except on the great toe, where the tendon is inserted separately into the base of the first phalanx after crossing over the dorsal artery of the foot.

The extensor brevis is *supplied* by the anterior tibial nerve.

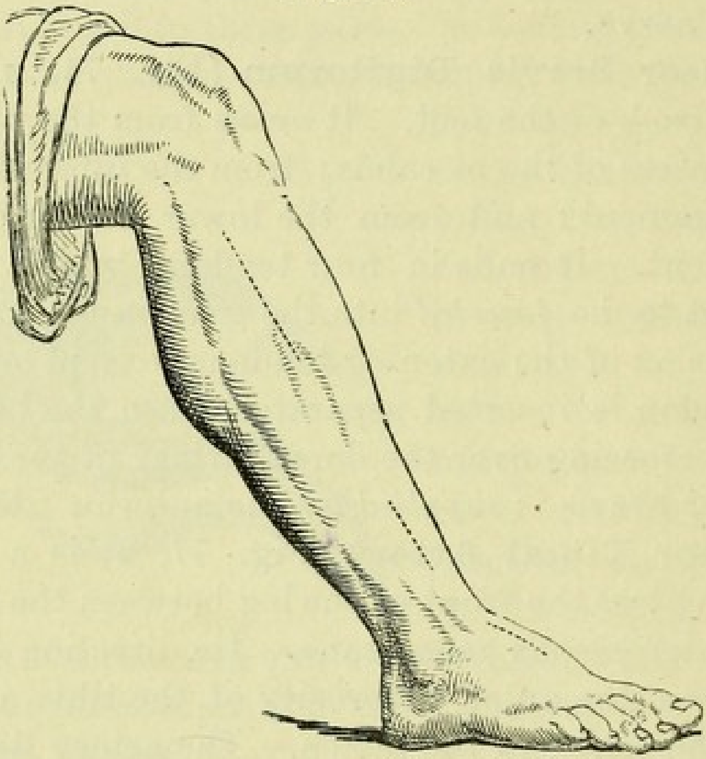
The **Anterior Tibial Artery** (Fig. 77, 2) is a branch of the popliteal, and enters the front of the leg between the tibia and fibula through the interosseous membrane. Its direction is from a point midway between the outer tuberosity of the tibia and the head of the fibula to the centre of the instep. The artery lies at first upon the interosseous membrane between the tibialis anticus and extensor longus digitorum, and then between the tibialis anticus and extensor proprius pollicis; but in the lower part of the leg it winds on to the tibia, and becomes superficial above the ankle-joint between the tendons of the tibialis anticus and extensor proprius pollicis. It then passes beneath the annular ligament and is crossed by the extensor proprius pollicis, after which it changes its name to *dorsal artery of the foot.*

Two *venæ comites* accompany the artery; the anterior tibial nerve lies to its outer side as far as about the middle of the leg, then crosses it, and in most cases again gets to its outer side at the ankle.

Surgery (Fig. 76). The anterior tibial artery may be readily tied above the ankle, by an incision three inches long upon the outer side of the tendon of the tibialis anticus and parallel to it. The artery will be found upon the front of the tibia between the tendons of the tibialis anticus and the extensor proprius pollicis, with the nerve to its outer side.

The artery may also be reached on the dead body in the upper part of its course, but it lies so deeply between the muscles that the operation is seldom, if ever, undertaken on the living subject. An indistinct white line sometimes marks the outer border of the tibialis, but it is well to make the incision a little obliquely and not less than four inches long, beginning about one inch below the head of the fibula, at a point midway between the bone and the outer tuberosity of the tibia. The fascia should be divided in the

Fig. 76.



same direction as the skin, when, if the fore-finger is introduced into the wound, it will probably pass into the cellular interval between the two muscles, there being no intermuscular septum to guide the operator. The tibialis anticus and extensor digitorum must be drawn apart, when the artery will be found upon the interosseous membrane with the nerve to its outer side.

Branches of the anterior tibial artery :—

The *Recurrent branch* arises as soon as the artery reaches the front of the leg, and winds through the fibres of the tibialis anticus to the front of the knee to anastomose with the articular arteries.

Muscular branches to the adjacent muscles arise at various points.

The *Malleolar arteries*, internal and external, the latter being the larger and more constant, pass beneath the tendons to the malleoli, in the neighbourhood of which they are distributed. The external anastomoses with the anterior peroneal artery.

Fig. 76.—Incisions for tying the anterior tibial artery and the dorsal artery of the foot (from Fergusson's "Practical Surgery").

Two other small branches have been described, the *posterior tibial recurrent*, passing to the back of the knee-joint, and the *superior fibular*, passing outwards over the neck of the fibula.

The *Anterior Peroneal* branch of the peroneal artery (*v.* p. 140) appears between the tibia and fibula through an opening in the lower part of the interosseous membrane, running beneath the peroneus tertius to the outer malleolus to supply it, and to anastomose with the external malleolar artery.

The **Dorsalis Pedis Artery** (Fig. 77, 12) is the continuation of the anterior tibial from the annular ligament to the base of the metatarsal bone of the great toe, opposite which it divides into the communicating branch to the sole of the foot and the dorsal artery of the great toe. Its direction is from the centre of the instep to the first interosseous space, and it lies at first superficially between the tendons of the extensor proprius pollicis and the extensor longus digitorum, but is crossed near the point of bifurcation by the innermost tendon of the extensor brevis digitorum. The artery lies upon the bones of the tarsus and their dorsal ligaments, and has the anterior tibial nerve to its outer side. Two *venæ comites* accompany the vessel.

Surgery (Fig. 76). The dorsal artery may be tied in the upper part of its course by an incision on the outer side of, but parallel to, the tendon of the extensor proprius pollicis. It occasionally happens, however, that the artery is displaced to the middle of the foot beneath the tendons of the extensor digitorum.

Branches of the dorsalis pedis artery.

A few small unnamed branches spring from the inner side of the vessel. The *Tarsal artery* arises immediately below the annular ligament, and crosses the foot beneath the extensor brevis digitorum to anastomose with the arteries about the external malleolus.

The *Metatarsal artery* arises lower than the preceding and near the bases of the metatarsal bones. It also runs outwards beneath the extensor brevis digitorum, and gives off three *interosseous* branches to the outer spaces. These run forward upon the interossei muscles, and bifurcate at the roots of the toes to supply the adjacent sides of two toes each, the outer one giving off a branch also to the outer side of the little toe. The anterior and posterior perforating arteries derived from the plantar arch and its digital branches, join these interosseous arteries at their origins and points of bifurcation.

The *Communicating branch* passes between the heads of the first dorsal interosseous muscle to the sole of the foot, where it joins the plantar arch (p. 152).

The *Dorsalis Pollicis* (*vel hallucis*) *artery* runs forward upon the great toe and, after giving a branch to its inner side, bifurcates to supply the adjacent sides of the first and second toes.

The **Anterior Tibial Nerve** (Fig. 77, 4) is a branch of the external popliteal nerve, and reaches the anterior tibial artery by piercing the fibres of the extensor longus digitorum. It lies to the outer side of the artery in the upper part of the leg, but crosses it about the middle, reaching its outer side again at the ankle. Its muscular relations are the same as those of the artery, with which it passes under the annular ligament. In the leg it supplies the four extensor muscles, and as soon as it enters the foot divides into two branches. The outer branch (19) is distributed to the extensor brevis digitorum and the articulations of the foot and ankle joint, having upon it a gangliform enlargement; the inner branch (16)

Fig. 77.

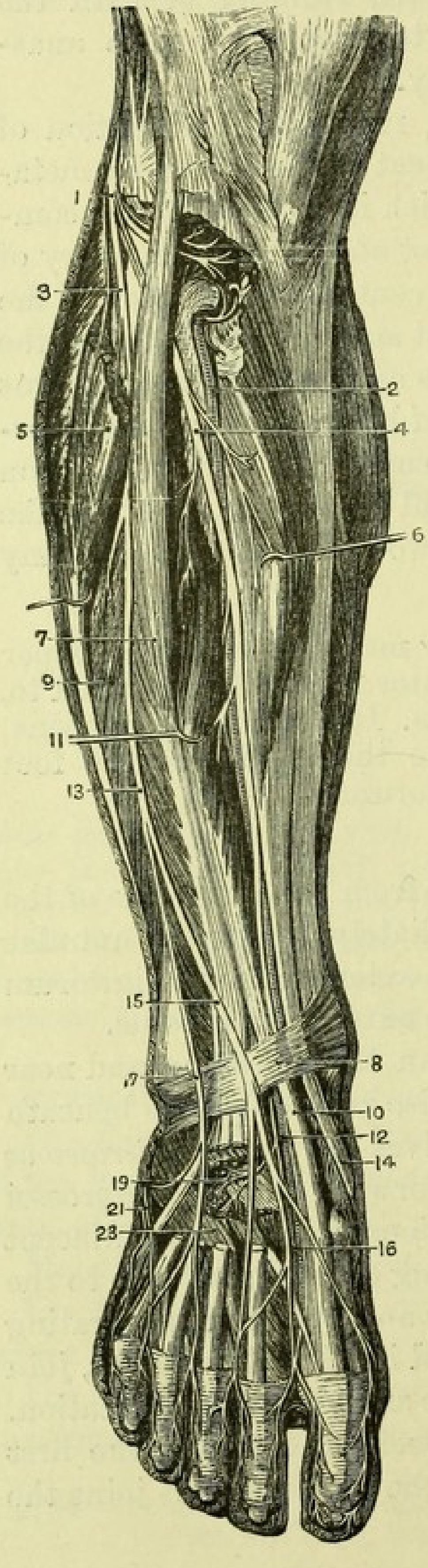


Fig. 77.—Deep dissection of the front of the leg (from Hirschfeld and Leveillé).

1. External popliteal nerve.
2. Anterior tibial artery.
3. Musculo-cutaneous nerve.
4. Anterior tibial nerve.
5. Peroneus longus.
6. Tibialis anticus.
7. Extensor longus digitorum.
8. Anterior annular ligament.
9. Peroneus brevis.
10. Tendon of extensor proprius pollicis.
11. Extensor proprius pollicis.
12. Dorsal artery of foot.
13. Point at which musculo-cutaneous nerve pierces the fascia and divides.
14. Tendon of tibialis anticus.
15. Internal branch of musculo-cutaneous nerve.
16. Cutaneous branch of anterior tibial nerve.
17. External branch of musculo-cutaneous nerve.
19. Deep branch of anterior tibial nerve.
21. External saphenous nerve.
23. Extensor brevis digitorum.

lies to the outer side of the dorsal artery, and becomes cutaneous in the interval between the great toe and next, the adjacent sides of which it supplies.

[The peroneal muscles are to be exposed on the outer side of the leg by removing the fascia covering them, when a strong intermuscular septum will be found on each side attached to the fibula, separating them from the muscles of the front and back of the leg. A portion of the fascia is to be left below the malleolus to form an external annular ligament.]

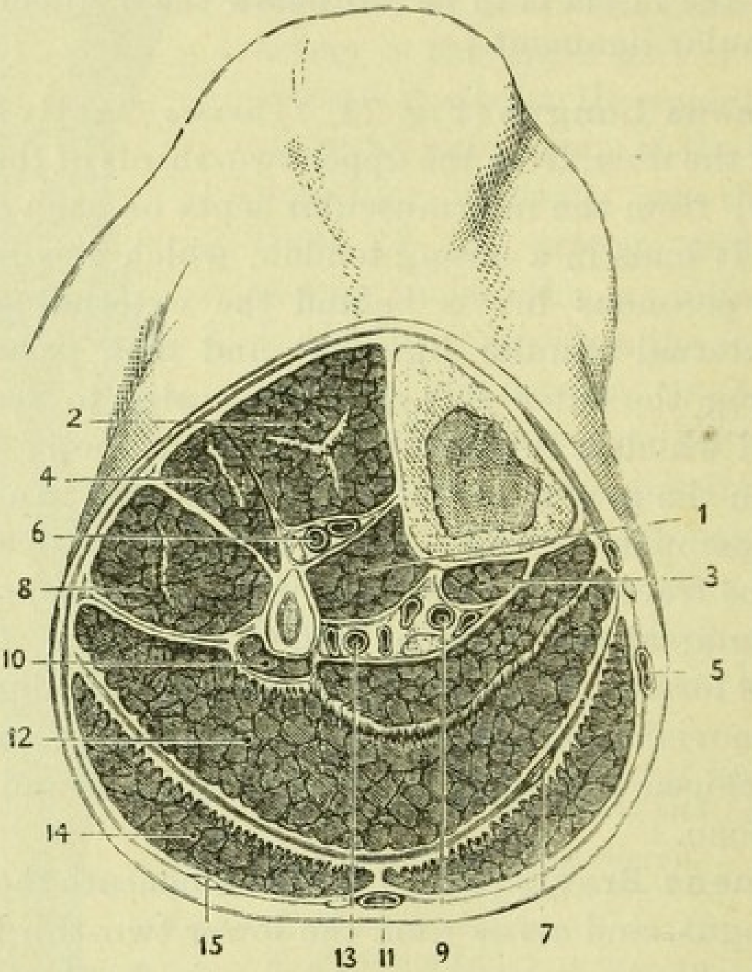
The **Peroneus Longus** (Fig. 74, 7) *arises* slightly from the outer tuberosity of the tibia, from the upper two-thirds of the outer surface of the fibula; from the intermuscular septa on each side, and from the fascia. It ends in a strong tendon, which lies superficially to that of the peroneus brevis behind the external malleolus and under the external annular ligament, and then passes in a sheath of fascia along the outer side of the os calcis to reach the cuboid bone, around which it turns to the sole of the foot. In the sole the tendon lies in the groove of the cuboid bone, and in a fibrous sheath ('sheath of peroneus longus') which is now to be opened, when the tendon can be traced to its *insertion* on the outer side of the base of the first metatarsal and internal cuneiform bones. The sheath of the tendon is formed by fibres of the long plantar ligament, and is lined by a synovial membrane. The tendon has a sesamoid cartilage or bone developed by its fibres where it turns round the border of the cuboid bone.

The **Peroneus Brevis** (Fig. 74, 8) lies beneath the tendon of the peroneus longus, and *arises* from the lower two-thirds of the outer surface of the fibula, its upper part being in front of the lower part of the origin of the peroneus longus; and from the intermuscular septa on each side. It rests upon the lower part of the fibula, and its tendon winds behind the external malleolus, where it is lodged in a groove beneath the tendon of the peroneus longus. It then runs along the outer side of the os calcis in a sheath of fascia in front of the long tendon, and is *inserted* into the posterior extremity of the fifth metatarsal bone.

The peronei act as extensors of the foot, *i.e.*, they point the toes. Both muscles, but especially the peroneus longus, draw up the outer side of the foot, as seen in the form of club-foot called 'talipes valgus.' Both the peronei are *supplied* by the musculo-cutaneous nerve. The synovial membrane under the annular ligament is common to the two peronei, but it divides into two parts as the muscles pass to their insertions.

The **External Popliteal Nerve** (Fig. 77, 1) is to be followed through the fibres of the peroneus longus, to which it was traced in the dissection of the popliteal space. Before entering the muscle the nerve gives off an *external cutaneous* branch to the outer side of the knee-joint, and then winding close to the fibula, gives off a

Fig. 78.



recurrent articular branch, which pierces the extensor longus digitorum to reach the upper part of the tibialis anticus and the front of the knee. It then divides into *anterior tibial* (4), which pierces the extensor longus digitorum, and *musculo-cutaneous* (3), which, after giving branches to the peroneus longus and brevis, appears between

Fig. 78.—A section of the right leg in the upper third (altered from Béraud).

1. Tibialis posticus.
2. Tibialis anticus.
3. Flexor longus digitorum.
4. Extensor longus digitorum.
5. Internal saphenous vein.
6. Anterior tibial vessels and nerve.
7. Tendon of plantaris.
8. Peroneus longus.
9. Posterior tibial vessels and nerve.
10. Flexor longus pollicis.
11. External saphenous vein and nerve.
12. Soleus with fibrous intersection.
13. Peroneal vessels.
14. Gastrocnemius.
15. Communicans peronei nerve.

the peroneus longus and extensor longus digitorum, and finally becomes cutaneous by piercing the fascia in the lower third of the leg.

[The tendons on the back of the foot are to be divided or held aside, and the transversus pedis in the sole is to be removed to permit a clear view of all the interossei.]

Beneath the transversus will be found the *transverse ligament of the metatarsus*, from which its fibres arise, and over which the

Fig. 79.

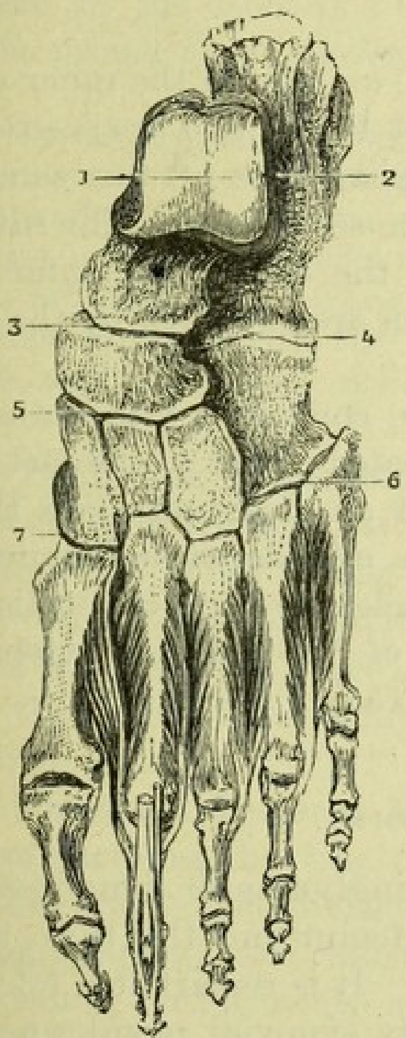
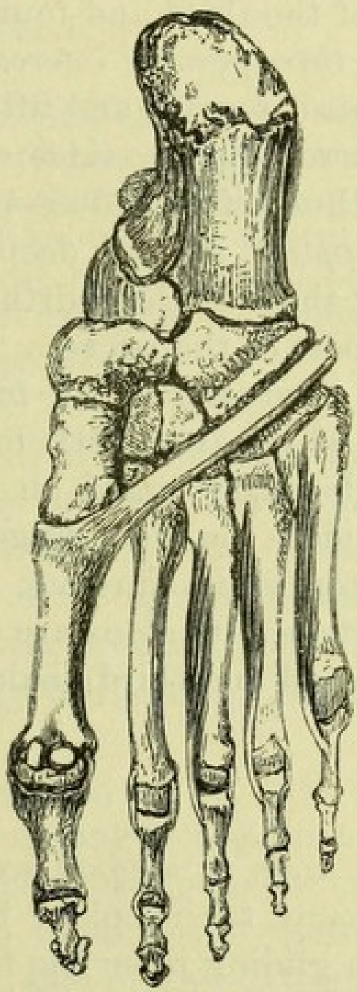


Fig. 80.



digital vessels and nerves pass. It connects the heads of the metatarsal bones together and crosses the tendons of the interossei muscles.

The **Interosseous Muscles** are seven in number, viz. four dorsal and three plantar, the former being strictly between the bones, but

Fig. 79.—The Dorsal Interosseous muscles of the Foot (J. T. Gray). The figures refer to the seven synovial membranes.

Fig. 80.—The Plantar Interosseous muscles (J. T. Gray).

the latter lying rather on their under surfaces. The dorsal are penniform muscles and are readily seen; the plantar are a little obscure, owing to the fibres of the dorsal interossei appearing by their sides.

The *four dorsal interossei* (Fig. 79) *arise* from the adjacent sides of the metatarsal bones in nearly the whole length of their shafts, and are *inserted* into the bases of the first phalanges in such a manner as to abduct from an imaginary line through the second (or long) toe. Thus the 1st is inserted into the *inner* side of the first phalanx of the second toe ; the 2nd into the *outer* side of the first phalanx of the second toe; the 3rd and 4th into the *outer* sides of the third and fourth toes.

The *three plantar interossei* (Fig. 80) *arise* from the inner sides of the third, fourth, and fifth metatarsal bones, and are *inserted* into the corresponding sides of the first phalanges of the same toes. They thus act as adductors towards the second toe. The interossei are *supplied* by the deep branch of the external plantar nerve, except those in the fourth space, which are supplied by the superficial part of the nerve.

The interossei of the foot should be compared with those of the hand, which are a little more complicated owing to the fact of the latter being arranged on each side of an imaginary line through the middle or long finger. Though considered anatomically as adductors and abductors, all the muscles by their connection with the extensor tendons are also flexors of the first and extensors of the second and third phalanges (*v.* p. 156).

The Knee-Joint.

The knee is a good example of ginglymus or hinge-joint, the movement taking place between the femur and the tibia, and the patella gliding upon the former bone. It is remarkable for having interarticular fibro-cartilages, and its synovial membrane is the most extensive in the body.

The knee-joint has *in front* the expansion of the extensor muscles which help to form its capsular ligament, and in front of the patella is a bursa. *Behind* the joint are the popliteal artery, vein, and nerves, with the two heads of the gastrocnemius and the popliteus. To the *inner* side of the joint, but posterior to it, are the tendons of the sartorius, gracilis, semi-tendinosus, and semi-membranosus; and the biceps occupies a similar position on the *outer* side.

The ligaments of the knee may conveniently be divided into extra- and intra-articular.

The **Extra-articular Ligaments** are anterior, posterior, two lateral, and capsular.

The **Anterior Ligament** (Fig. 81, 1) is the *ligamentum patellæ*, which is a broad band reaching from the lower margin of the patella to the tubercle of the tibia, and forming part of the insertion of the quadriceps extensor. The expansions of the vasti on each side form an additional covering to the front of the joint, and become incorporated with its capsule. Between the ligament and the head of the tibia is a bursa, which must not be confounded with the proper *bursa patellæ* in front of the bone.

[To see the remaining external ligaments, the popliteal vessels and nerves and the remains of the gastrocnemius and plantaris must be removed. The tendons of the biceps, semi-membranosus and popliteus are to be traced out fully, and should be carefully preserved, but cut short. The internal lateral ligament will be found to be incorporated with the capsule, the external is beneath the capsule, and is not seen until this has been divided.]

The **Posterior Ligament** (Fig. 82, 8) (ligamentum posticum Winslowii) is a flat band, attached above between the condyles of the femur and below to the back of the head of the tibia; it is closely connected with the tendon of the semi-membranosus, from which a large band of fibres passes obliquely upwards and outwards across the back of the joint superficially to the fibres of the capsular ligament.

The **External Lateral Ligament** (fig. 81, 5; 82, 2) is divided into two portions, the *long* and *short*, the long being the anterior one of the two. The divisions of the tendon of the biceps embrace the long ligament, and must be divided to expose it thoroughly. It is a round cord attached above to the side of the external condyle immediately above the depression for the popliteus, and below to the outer side of the head of the fibula. The tendon of the popliteus and the external inferior articular artery may be traced beneath it. The short ligament, which is derived from the tendon of the gastrocnemius, is placed behind the long, and reaches from the condyle to the head of the fibula, but it is often very indistinct.

The **Internal Lateral Ligament** (Fig. 81, 6; 82, 1) is a broad band closely connected with the capsular ligament. It is attached to the side of the internal condyle, and to the inner side of the head

Fig. 81.

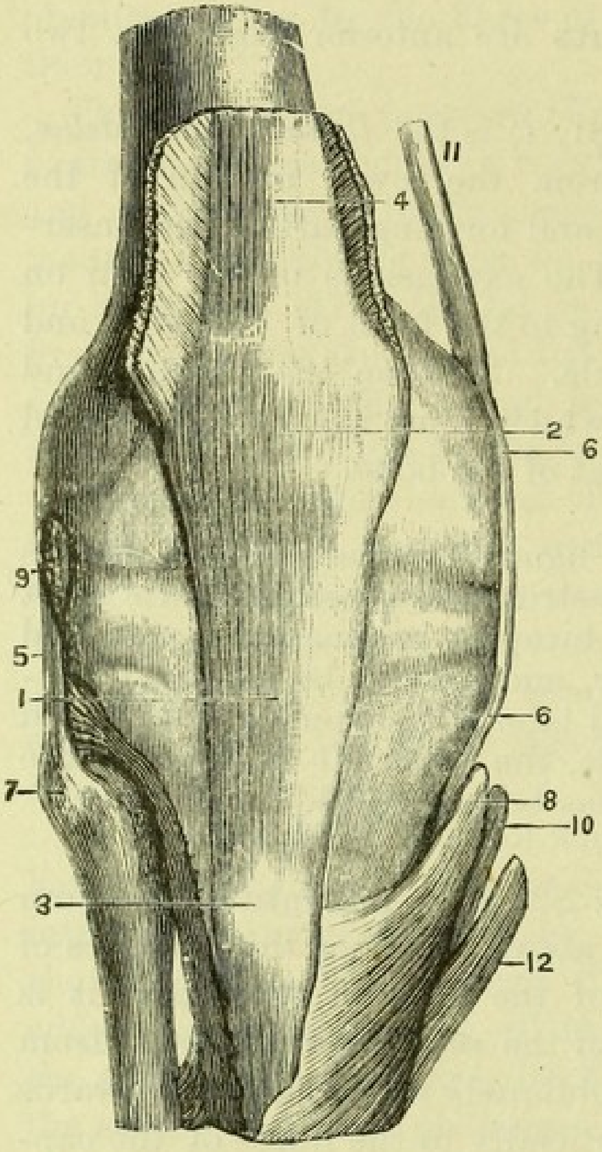


Fig. 82.

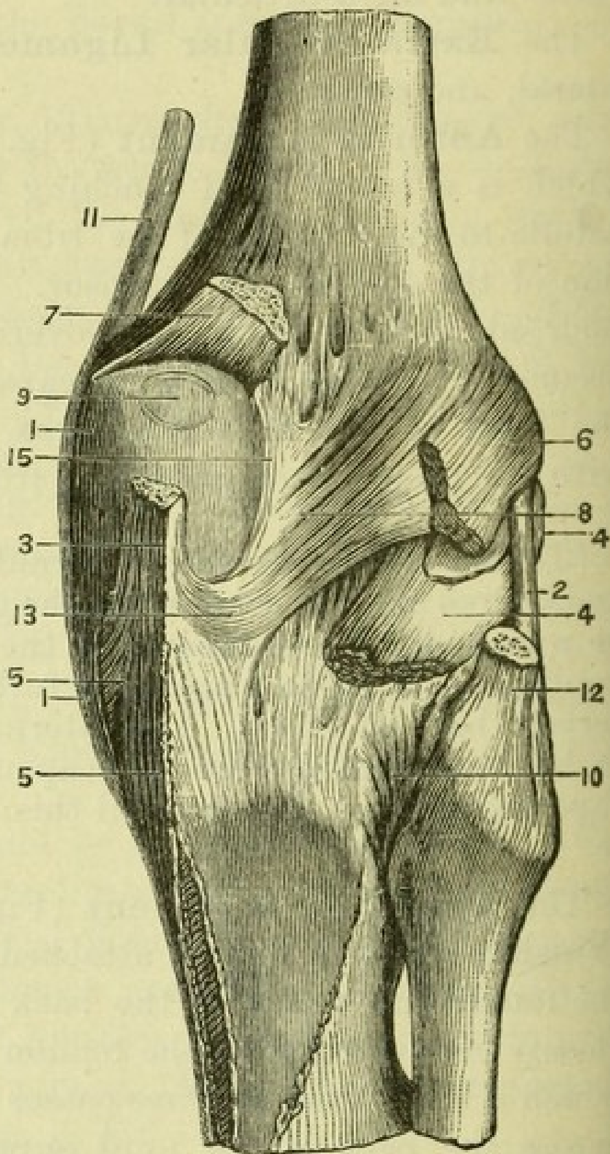


Fig. 81.—Anterior view of the ligaments of the knee-joint (from Sappey).

1. Ligamentum patellæ.
2. Patella covered by ligamentous fibres.
3. Tubercle of tibia.
4. Tendon of rectus.
5. External lateral ligament.
6, 6. Internal lateral ligament.
7. Head of fibula.
8. Insertion of sartorius.
9. Tendon of popliteus.
10. Insertion of gracilis.
11. Tendon of adductor magnus prolonged into internal lateral ligament.
12. Insertion of semitendinosus.

Fig. 82.—Posterior view of the ligaments of the knee-joint (from Sappey).

1, 1. Internal lateral ligament.
2. External lateral ligament.
3. Tendon of semi-membranosus.
4, 4. Popliteus.
5, 5. Prolongations of tendon of semimembranosus.
6. Outer head of gastrocnemius.
7. Inner head of gastrocnemius.
8, 15. Posterior ligament (of Winslow).
9. Opening in capsule.
10. Posterior superior tibio-fibular ligament.
11. Tendon of adductor magnus.
12. Tendon of biceps.
13. Prolongation from tendon of semimembranosus to posterior ligament.

of the tibia, where it covers in the tendon of the semi-membranosus; and is then continued to the upper part of the shaft of the tibia, leaving an interval through which the inferior articular vessels of the knee pass.

The **Capsular Ligament** is a fibrous layer closely connected with the exterior of the synovial membrane and the inter-articular cartilages, being attached to the margin of the articular surface of the tibia below, and above to the femur, as well as the fascia lata and an expansion from the vasti. It blends with the posterior and internal lateral ligaments, and encloses the ligamentum patellæ and the external lateral ligament; it is strengthened by expansions from the several tendons, but is pierced by the tendon of the popliteus.

[The tendon of the rectus is to be divided and drawn down in order to see the extent of the synovial membrane above the patella, since it reaches for a couple of inches above the articular surface of the femur and gives attachment to the *Subcrureus*, a small muscle arising from the lower part of the anterior surface of the femur. The synovial membrane is then to be divided on each side, as near the condyles as possible, and the patella turned down, when the ligamentum mucosum and the ligamenta alaria will be seen.]

The **Ligamentum Mucosum** (Fig. 84, 10) is a process of synovial membrane attached to the notch between the condyles, from which it stretches to a point immediately below the patella.

The **Ligamenta Alaria** (Fig. 84, 9) are two folds of synovial membrane with fringed borders, stretched over the large masses of fat which lie on each side below the patella (infrapatellar), which are seen on each side of the ligamentum mucosum.

[The ligamentum mucosum is to be divided and the patella turned down completely, when the bursa of the ligamentum patellæ can be opened and seen. The capsular and posterior ligaments are to be removed, but the lateral ligaments are to be preserved and the crucial ligaments dissected.]

The **Intra-articular Ligaments** are the two crucial, the coronary and the transverse ligaments. Within the joint also are the two semilunar cartilages.

The **Anterior Crucial Ligament** (Fig. 83, 2) is attached to the external condyle of the femur at its inner and back part, and passes obliquely across the joint to be inserted into the top of the tibia in front of the spine, between the attachments of the internal and external semilunar cartilages, with the latter of which it is closely connected.

The **Posterior Crucial Ligament** (Fig. 83, 3) is broader and stouter than the anterior. It is attached to the internal condyle at

Fig. 83.

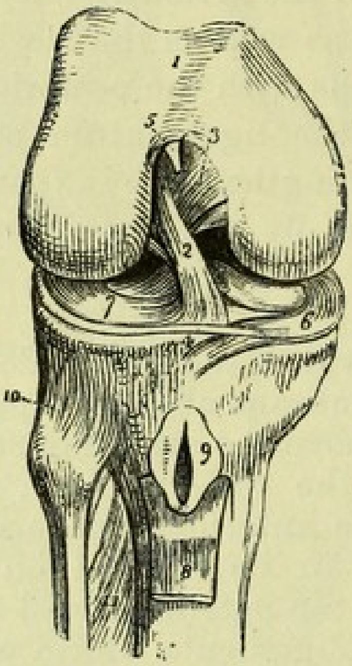


Fig. 84.

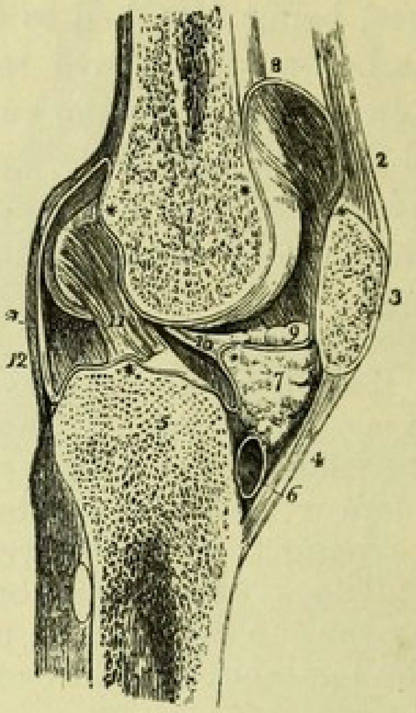


Fig. 83.—The right knee-joint laid open from the front, and dissected to show the internal ligaments (from Wilson).

1. Cartilaginous surface of the lower extremity of the femur.
2. Anterior crucial ligament.
3. Posterior crucial ligament.
4. Transverse ligament.
5. Attachment of the ligamentum mucosum; the rest has been removed.
6. Internal semilunar cartilage.
7. External semilunar cartilage.
8. Part of the ligamentum patellæ turned down.
9. Bursa situated between the ligamentum patellæ and head of the tibia laid open.
10. Anterior superior tibio-fibular ligament.
11. Interosseous membrane.

Fig. 84.—Vertical section of the left knee-joint, showing the reflections of its synovial membrane (from Wilson).

1. The lower part of the femur.
2. Tendon of the quadriceps extensor.
3. Patella.
4. Ligamentum patellæ.
5. The head of the tibia.
6. A bursa situated between the ligamentum patellæ and the head of the tibia.
7. Mass of fat projecting into cavity of the joint below the patella.

* * The synovial membrane.

8. The pouch of synovial membrane which ascends between the tendon of the extensor muscles of the leg and the front of the lower extremity of the femur.
9. One of the alar ligaments; the other has been removed with the opposite section.
10. Ligamentum mucosum left entire; the section being made to its inner side.
11. Anterior crucial ligament.
12. Posterior ligament.

its anterior and outer part, and passes nearly vertically to the posterior margin of the top of the tibia and popliteal notch, being closely connected with the posterior extremity of the internal semilunar cartilage.

The crucial ligaments would alternately check extreme flexion and extension, the anterior ligament becoming tightened when the knee joint is *extended*, and the posterior when the knee is *flexed*. They also limit rotation inwards.

If the lateral ligaments are now divided, it will be found that the femur and tibia become more separated than before, showing that the object of the crucial ligaments is not simply to maintain the articular surfaces in apposition. It will also be seen that whilst rotation of the tibia outwards can now be carried to an extreme degree (so as to bring the crucial ligaments almost parallel), rotation inwards is immediately checked by the crossing of the ligaments, and it is thus that the tendency of the popliteus muscle to rotate the leg inwards is counterbalanced.

The **Transverse Ligament** (Fig. 83, 4) is a small band connecting the anterior extremities of the semilunar cartilages, and often not distinct.

The **Semilunar Cartilages** (Fig. 83) can be partly seen now, but will be fully exposed by dividing the crucial ligaments. They are fibro-cartilages which are thicker at the outer than at the inner margins, and which serve to deepen the condyloid cavities on the top of the tibia, being attached to the margin of the bone by short fibres called the *coronary ligaments*. The extremities of each cartilage are fixed respectively in front of and behind the spine of the tibia, by short strong bands of fibrous tissue.

The **Internal Semilunar Cartilage** (Fig. 83, 6) is oval in form, and embraces the extremities of the external cartilage. Its anterior extremity is attached to the tibia in front of the anterior crucial ligament; its posterior extremity is attached in front of the posterior crucial ligament.

The **External Semilunar Cartilage** (Fig. 83, 7) is nearly circular; its anterior extremity is attached to the tibia immediately in front of the spine, and is connected with the insertion of the anterior crucial ligameut. Its posterior extremity is attached to the back of the spine of the tibia, and is connected with the posterior crucial ligament by a distinct slip.

The tendon of the popliteus is connected with the side of the external cartilage by a distinct slip, and the tendon of the semimembranosus similarly with the internal cartilage.

The **Structures upon the top of the Tibia** from before backwards will be seen to be as follows:—

1, Transverse ligament; 2, Anterior extremity of internal semilunar cartilage; 3, Anterior crucial ligament; 4, Anterior extremity of external semilunar cartilage; 5, Posterior extremity of external semilunar cartilage; 6, Posterior extremity of internal semilunar cartilage; 7, Posterior crucial ligament.

The **Synovial Membrane** (Fig. 84) extends for at least two inches above the articular surface of the femur, forming a pouch beneath the extensor muscles. It is reflected from the articular surface of the femur over the crucial ligaments to the articular surface of the tibia, covering both aspects of the semilunar cartilages, and then lines the capsular ligament. It gives a tube around the tendon of the popliteus where it is within the capsule, and has already been seen to form the ligamentum mucosum and ligamenta alaria.

Tibio-Fibular Articulations.

[The whole of the muscular fibres connected with the bones of the leg and foot must be removed, but the tendinous insertions about the foot should be kept to be examined with the ligaments.]

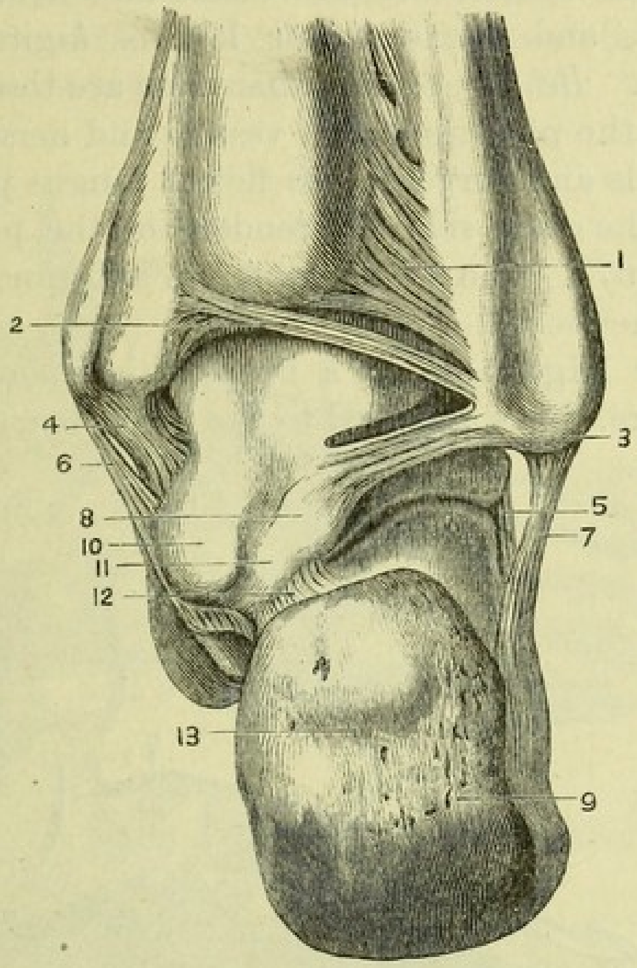
The **Superior** tibio-fibular articulation (Fig. 83) is a simple arthrodial joint, the synovial membrane of which is occasionally continuous with that of the knee. The *anterior* (10) and *posterior* ligaments are short bands connecting the anterior and posterior surfaces of the head of the fibula with the outer tuberosity of the tibia.

The **Middle** tibio-fibular articulation is formed by the *interosseous ligament* or membrane, which is the great bond between the shafts of the bones of the leg, its fibres running downwards from the tibia to the fibula. It is attached to the sharp interosseous borders of both bones in all their lower parts, a hole being made above by the passage of the anterior tibial vessels. The membrane has an opening in it near the lower part, through which the anterior peroneal artery reaches the front of the leg.

Below the interosseous membrane is the *inferior interosseous ligament*, which consists of very short fibres passing between the triangular rough impressions on the adjacent surfaces of the tibia and fibula, immediately above their inferior articulation.

The **Inferior** tibio-fibular articulation (Fig. 87, 1) is a simple arthrodial joint, continuous with the ankle-joint. It has *anterior* and *posterior* (Fig. 85, 1) ligaments between the two bones resembling those above, and in addition, placed below the posterior and distinct

Fig. 85.



from it, a *transverse* (or *inferior*) *ligament* (2), which reaches from the external malleolus to the posterior surface and malleolus of the tibia, forming part of the true ankle-joint.

Fig. 85.—Posterior view of the ankle-joint (from Sappey).

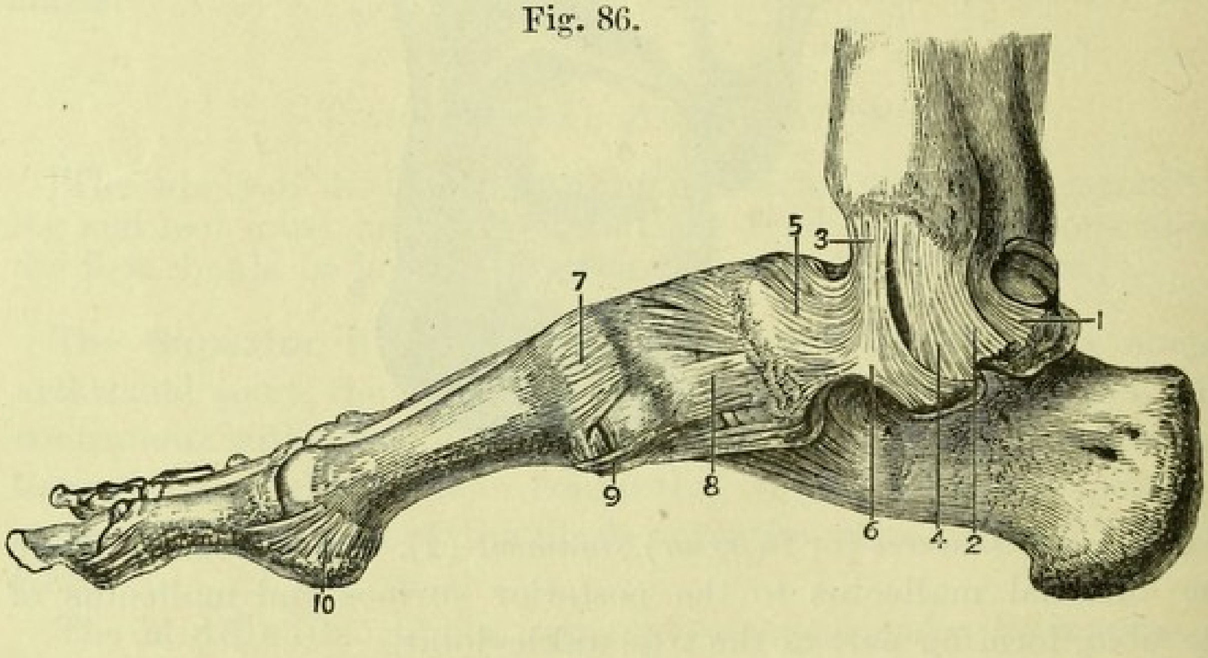
1. Posterior inferior tibio-fibular ligament.
2. Transverse ligament.
3. Posterior fasciculus of the external lateral ligament.
4, 6. Internal lateral ligament.
5. External calcaneo - astragaloid ligament.
7. Middle fasciculus of external lateral ligament.
8. Tubercle on outer side of groove for flexor longus pollicis.
9. Posterior tuberosity of os calcis.
10. Tubercle on inner side of groove for flexor longus pollicis.
11. Groove on astragalus for flexor longus pollicis.
12. Posterior calcaneo - astragaloid ligament.
13. Point of insertion of tendo-achillis.

Ankle-Joint and Articulations of the Foot.

The ankle-joint is a hinge joint capable of limited lateral motion when the toes are pointed. It has *in front* the tendons of the tibialis anticus, the anterior tibial vessels and nerve, the extensor proprius pollicis, and the extensor longus digitorum with the peroneus tertius. *Behind*, to the inner side are the tendons of the tibialis posticus, the posterior tibial vessels and nerve (or it may be the plantar vessels and nerves); the flexor longus pollicis near the middle: and to the outer side, the tendons of the peroneus longus and brevis (Fig. 67). The ankle-joint has anterior, posterior, and two lateral ligaments.

The **Anterior Ligament** is a broad thin membrane which is seldom seen entire. It is attached to the lower margin of the tibia,

Fig. 86.



and to the superior surface of the astragalus, close to its head, and joins the lateral ligament on each side.

The **Posterior Ligament** is not described by many authors, and it is little more than a few fibres stretching over the

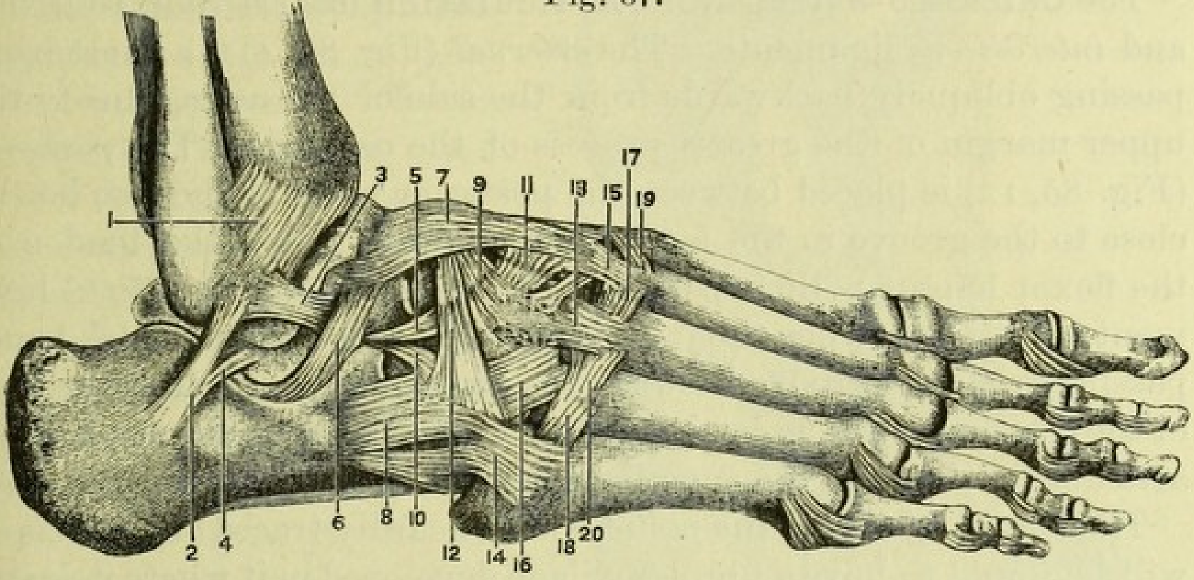
Fig. 86.—Ligaments of the inner side of the ankle and foot (from Sappey).

1, 2, 3, 4. Different parts of internal lateral ligament of ankle.
5, 6. Inferior calcaneo-scaphoid ligament.
7. Internal ligament between internal cuneiform and first metatarsal.
8. Ligament between scaphoid and internal cuneiform.
9. Inferior ligament between internal cuneiform and first metatarsal.
10. Inferior ligament of first metatarso-phalangeal joint.

synovial membrane between the back of the tibia and the astragalus.

The **Internal Lateral Ligament** (Fig. 86, 1, 2, 3, 4) is triangular in shape, and hence has been called *deltoid.* The apex is attached to the extremity of the internal malleolus, and the base to the posterior part of the astragalus, to the lesser process of the os calcis, to the inferior calcaneo-scaphoid ligament, and the tuberosity of the

Fig. 87.



scaphoid bone. A strong *deep portion* passes from the apex of the malleolus to the side of the astragalus.

The **External Lateral Ligament** (Fig. 87) consists of three slips; two horizontal attached to the astragalus, and one, more or less vertical, to the os calcis. The *anterior* slip (3) is attached to the

Fig. 87.—Ligaments of the outer side of the ankle and foot (from Sappey).

1. Anterior inferior tibio-fibular ligament.
2. Middle fasciculus of external lateral ligament of ankle.
3. Anterior fasciculus of external lateral ligament of ankle.
4. External calcaneo - astragaloid ligament.
5. External calcaneo-scaphoid ligament.
6. Interosseous calcaneo-astragaloid ligament.
7. Superior astragalo-scaphoid ligament.
8. External calcaneo-cuboid ligament.
9. Dorsal ligament between scaphoid and external cuneiform.
10. Internal calcaneo-cuboid ligament.
11. Dorsal ligament between external and middle cuneiform.
12. Dorsal ligament between scaphoid and cuboid.
13. Dorsal ligament between external cuneiform and third metatarsal.
14. Dorsal ligament between cuboid and fifth metatarsal.
15. Dorsal ligament between middle cuneiform and second metatarsal.
16. Dorsal ligament between cuboid and third and fourth metatarsals.

17, 18, 19, 20. Dorsal ligaments between bases of metatarsal bones.

front of the external malleolus and to the side of the astragalus in front of the superior articular surface; the *middle* (2) is a round cord which reaches backwards and downwards from the tip of the malleolus to the outer side of the os calcis about its middle; the *posterior* (Fig. 85, 3) is attached to the deep groove behind the articular surface of the external malleolus, and passes horizontally to the posterior surface of the astragalus behind the articulation with the tibia.

The **Calcaneo-astragaloid Articulation** has *external*, *posterior*, and *interosseous* ligaments. The *external* (Fig. 87, 4) is a short band passing obliquely backwards from the side of the astragalus to the upper margin of the greater process of the os calcis. The *posterior* (Fig. 85, 12) is placed between the posterior parts of the two bones, close to the groove in the astragalus through which the tendon of the flexor longus pollicis passes. The *interosseous* (Fig. 87, 6) ligament will be seen when the joint is opened. It is a strong thick band, passing from the groove between the two inferior articular surfaces of the astragalus, to the corresponding groove between the two convex articular surfaces on the superior aspect of the calcaneum (Fig. 89).

The *tendon of the tibialis posticus* is to be fully traced out now, and will be found to have a fibro-cartilage developed in it where it passes under the head of the astragalus, and to be principally attached to the tuberosity of the scaphoid bone and the adjacent internal cuneiform bone, giving slips also to all the adjacent bones of the tarsus (with the exception of the astragalus), and to the second, third, and fourth metatarsal bones. These must be removed to see the true ligaments of the joints.

Ligaments of the Tarsus. On the dorsal aspect of the remaining tarsal bones will be found a number of short bands of fibres, which pass between adjacent bones and have received names as ligaments accordingly.

On the plantar aspect there are similar ligaments, three only of which are worthy of special notice, viz., the long and short calcaneo-cuboid ligaments, and the calcaneo-scaphoid ligament.

The **Long Calcaneo-Cuboid Ligament** (Fig. 88, 9)—*ligamentum longum plantæ*—is a broad ligament which has been already seen in the dissection of the sole of the foot. It is extensively attached to the under surface of the os calcis in front of the tuberosities, and passes forward to be attached to the posterior margin of the peroneal groove in the cuboid bone. Some of the fibres pass on over the tendon of the peroneus (to which they form a sheath), and are attached to the bases of the second, third, and fourth metatarsal bones.

The **Short Calcaneo-Cuboid Ligament** (Fig. 88, 11, 16) lies to the inner side of the long ligament, and is more deeply placed. It reaches from the tubercle on the under surface of the greater process of the os calcis, to the under surface of the cuboid behind the peroneal groove.

The **Calcaneo-scaphoid Ligament** (Fig. 88, 14) is a broad band of yellow elastic ligament, stretching between the lesser process of the calcaneum (*sustentaculum tali*) and the tuberosity of the scaphoid bone. It performs the important function of supporting the head of the astragalus, which rests upon it, and in this is assisted by the tendon of the tibialis posticus, which passes immediately beneath it. The upper surface of the ligament is covered with the synovial membrane of the astragalo-scaphoid articulation.

Fig. 88.

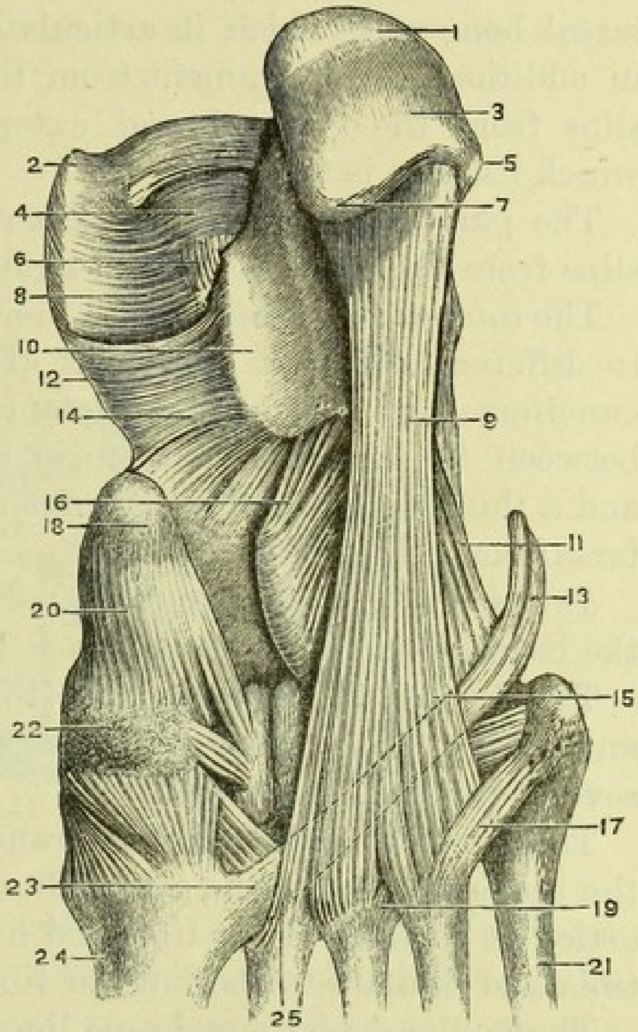


Fig. 88.—Ligaments of the sole of the foot (Sappey).

1. Point of attachment of tendo achillis.
2. Internal malleolus.
3. Posterior tuberosity of os calcis.
4. Posterior part of astragalus.
5. External tubercle on under surface of os calcis.
6. Posterior calcaneo-astragaloid ligament.
7. Internal tubercle on under surface of os calcis.
8 and 12. Internal lateral ligament of ankle.
9. Long plantar ligament.
10. Groove on sustentaculum tali for flexor longus pollicis.
11 and 16. Short plantar ligament.
13 and 23. Tendon of peroneus longus.
14. Inferior calcaneo-scaphoid ligament.
15 and 25. Sheath of peroneus longus.
17. Plantar ligament between fourth and fifth metatarsals.
18. Tubercle of scaphoid.
19. Plantar ligament between third and fourth metatarsals.
20. Plantar ligament between scaphoid and internal cuneiform.
21. Fifth metatarsal.
22. Internal cuneiform bone.
24. First metatarsal bone.

Numerous *interosseous ligaments* bind the bones of the tarsus firmly together, and will be seen when the joints are opened.

The **Metatarsal Bones** (Fig. 88, 19) are connected with the tarsus by strong dorsal, plantar, and interosseous ligaments.

The *dorsal* ligaments are one to each metatarsal bone from the tarsal bone with which it articulates; but the second metatarsal, in addition to its ligament from the middle cuneiform, has extra slips from the internal and external cuneiform bones, between which its base is wedged.

The *plantar* ligaments are less regular, and are united with the slips from the calcaneo-cuboid ligament.

The *interosseous ligaments* are short strong bands, and vary slightly in different subjects. There is always one between the internal cuneiform and the second metatarsal bone; a second may exist between the external cuneiform and the same metatarsal bone; and a third between the external cuneiform and the fourth metatarsal bone (Fig. 89).

Transverse dorsal, plantar, and interosseous ligaments connect the bases of the metatarsal bones.

The **Synovial Membranes** (Fig. 89) of the foot, including the ankle-joint, are seven in number, and will be seen by opening the several joints in succession.

The 1st is the synovial membrane of the ankle (I), reflected over the upper surface of the astragalus, and upon the ligaments to the articular surfaces of the tibia and fibula; it passes also between the tibia and fibula into the inferior tibio-fibular articulation.

The 2nd synovial membrane lines the posterior calcaneo-astragaloid articulation (II).

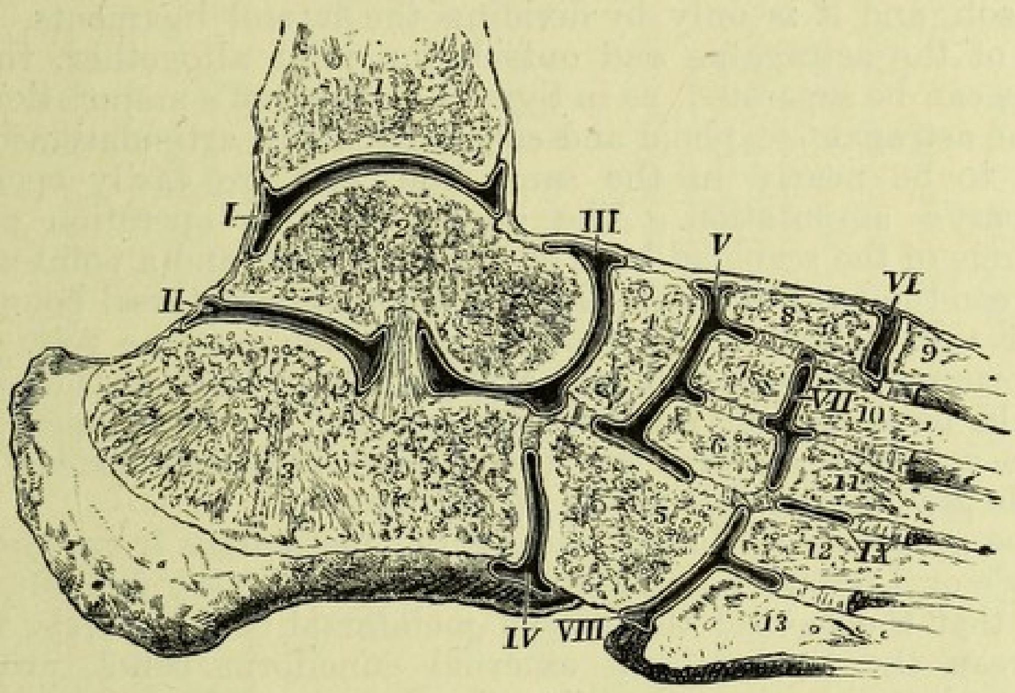
The 3rd synovial membrane covers the head of the astragalus and the concave surface of the scaphoid, being prolonged backwards over the inferior calcaneo-scaphoid ligament into the anterior calcaneo-astragaloid articulation (III).

The strong *interosseous ligament* connecting the under surface of the astragalus and the upper surface of the os calcis will now be seen. It is attached to the deep groove found between the two articulations in each bone. An *interosseous ligament* will also be seen, when the astragalus is displaced, passing as two bands from the upper border of the greater process of the os calcis to the cuboid and scaphoid bones, and hence called the *internal calcaneo-cuboid* and the external *calcaneo-scaphoid* ligaments respectively.

The 4th synovial membrane (IV) is placed between the greater process of the os calcis and the back of the cuboid bone, and when it is opened, the peculiar manner in which the two bones are locked together will be seen.

The 5th synovial membrane (v) is between the scaphoid and the three cuneiform bones, and will be found to pass between the middle and external cuneiform bones to their anterior surfaces, and the bases of the second and third metatarsal bones (VII). It is also

Fig. 89.



prolonged into the articulations between the second, third, and fourth metatarsal bones (IX), and sometimes into that between the external cuneiform and cuboid bones, in which case an interosseous ligament, often existing between the external cuneiform and the fourth metatarsal bone, is wanting.

Interosseous ligaments will be found between the scaphoid and cuboid bones; between the internal and middle cuneiform bones; between the middle and external cuneiform bones; and between the external cuneiform and cuboid bones.

The 6th synovial membrane (VIII) will be found between the

Fig. 89.—Section to show the seven synovial membranes of the foot (from Wilson).

1. Tibia.
2. Astragalus.
3. Calcaneum.
4. Scaphoid.
5. Cuboid.
6. External cuneiform.
7. Middle cuneiform.
8. Internal cuneiform.
9. First metatarsal.
10. Second metatarsal.
11. Third metatarsal.
12. Fourth metatarsal.
13. Fifth metatarsal.

front of the cuboid bone and the bases of the fourth and fifth metatarsal bones, and entering the articulation between them.

The 7th is a separate synovial membrane (VI) for the first metatarsal bone, being placed between it and the internal cuneiform bone.

Surgery.—The shape of the articulations should be particularly noticed with reference to the several amputations about the foot. At the ankle the astragalus is locked between the projecting malleoli, and it is only by dividing the lateral ligaments, by the side of the astragalus and outside the joint altogether, that the bones can be separated, as in Syme's or Pirogoff's amputations.

The astragalo-scaphoid and calcaneo-cuboid articulations will be seen to be nearly in the same line, and are easily opened in Chopart's amputation. The guides for this operation are the tubercle of the scaphoid bone on the inner side, and a point midway between the external malleolus and the fifth metatarsal bone on the outer side, where occasionally a projection may be felt. If, in performing this operation, the articulation in front of the scaphoid should be opened by mistake, the operator would at once see the three articular surfaces for the cuneiform bones instead of the single globular surface of the astragalus.

The operation of disarticulating the metatarsus from the tarsus (Hey's or Lisfranc's amputation) is rendered very difficult by the fact that the base of the second metatarsal bone is firmly wedged between the internal and external cuneiform bones, projecting farther into the tarsus than the other bones, and being also attached to the internal cuneiform by a strong interosseous ligament. In amputating at this point therefore, after opening the articulation of the first and three outer metatarsal bones, it is necessary to thrust the point of the knife between the internal cuneiform and second metatarsal bones to divide this ligament, or there will be danger of dragging away the internal cuneiform bone. The articulations are placed obliquely, that of the fifth being posterior to that of the first metatarsal bone, the bases of these two bones forming the guides to the surgeon.

The articulations between the metatarsal bones and the phalanges, and between the phalanges themselves, are similar to those in the hand but on a smaller scale, and therefore more difficult of dissection. Reference may be made to the hand for their description. (*Vide* p. 85.)

TABLE 2.

MUSCLES OF LOWER EXTREMITY.

Muscle.	Origin.	Insertion.	Nerve.
Tensor vaginæ femoris	Ilium, anterior superior spine and notch	Fascia lata	Superior gluteal.
Sartorius	Ilium, anterior superior spine and notch	Tibia, below inner tuberosity	Anterior crural.
Rectus femoris	Ilium, anterior inferior spine Ilium, depression above acetabulum	Patella	Anterior crural.
Vastus externus	Femur, outer side, linea aspera and septum	Patella and knee-joint	Anterior crural.
Vastus internus	Femur, inner side, linea aspera and septum	Patella and knee-joint	Anterior crural.
Crureus	Femur, anterior surface	Patella	Anterior crural.
Sub-crureus	Femur, lower anterior surface	Synovial pouch of knee	Anterior crural.
Gracilis	Rami of pubes and ischium	Tibia, below inner tuberosity	Obturator.
Pectineus	Pubes and ilio-pectineal line	Femur, half the line from lesser trochanter to linea aspera	Anterior crural, sometimes Obturator.
Adductor longus	Pubes, below crest	Femur, linea aspera	Obturator.
Adductor brevis	Pubes, front of	Femur, linea aspera, and line to lesser trochanter	Obturator.
Adductor magnus	Pubes, ramus, Ischium, ramus and tuberosity	Femur, from linea quadrati to linea aspera and linea aspera to inner condyle	Obturator & Great sciatic.
Obturator externus	Obturator foramen, anterior ½ membrane	Femur, digital fossa	Obturator.
Gluteus maximus	Ilium between crest and curved line; sacrum; coccyx; sacro-sciatic ligament	Femur, from trochanter major to linea aspera; fascia lata	Inferior gluteal (small sciatic).
Gluteus medius	Ilium between superior and middle lines; fascia	Femur, across great trochanter	Superior gluteal.
Gluteus minimus	Ilium between middle and inferior lines	Femur, front of great trochanter	Superior gluteal.
Pyriformis	Sacrum, front of great sciatic notch	Femur, upper border of great trochanter	Sacral plexus.
Obturator internus	Obturator foramen and membrane	Femur, upper border of great trochanter	Branch of sacral plexus
Gemellus superior Gemellus inferior	Ischium, spine Ischium, tuberosity	Tendon of obturator internus	ditto. Nerve to quadratus.
Quadratus femoris	Ischium, tuberosity	Femur, linea quadrati	Branch of sacral plexus
Biceps femoris	Ischium, tuberosity Femur, outer linea aspera and line to external condyle	Fibula, outer side of head	Great sciatic.
Semi-tendinosus	Ischium, tuberosity	Tibia, below inner tuberosity	Great sciatic.
Semi-membranosus	Ischium, tuberosity	Tibia, inner tuberosity; posterior ligament of knee; over popliteus	Great sciatic.
Gastrocnemius	Femur, outer side of outer condyle Femur, above inner condyle	Calcaneum	Internal popliteal.

TABLE 2.—MUSCLES OF LOWER EXTREMITY—*continued.*

Muscle.	Origin.	Insertion.	Nerve.
Plantaris	Femur, above outer condyle	Calcaneum	Internal popliteal.
Soleus	Tibia, oblique line and inner border; Fibula, posterior head and upper $\frac{1}{3}$	Calcaneum	Internal popliteal and posterior tibial.
Popliteus	Femur, depression in outer condyle	Tibia, above oblique line	Internal popliteal.
Flexor longus digitorum	Tibia, below oblique line	Four outer toes, 3rd phalanges (perforans)	Posterior tibial.
Tibialis posticus	Tibia, below oblique line; interosseous membrane; fibula, internal surface	Scaphoid, tuberosity; slips to tarsal and metatarsal bones	Posterior tibial.
Flexor longus pollicis	Fibula, posterior surface; septa	Great toe, terminal phalanx	Posterior tibial.
Tibialis anticus	Tibia, $\frac{2}{3}$ outer surface and tuberosity; $\frac{1}{2}$ interosseous membrane; fascia	Internal cuneiform and 1st metatarsal	Anterior tibial.
Extensor longus digitorum	Fibula, $\frac{3}{4}$ anterior; interosseous membrane; Tibia, outer tuberosity; fascia and septa	Four outer toes	Anterior tibial.
Peroneus tertius	Fibula, $\frac{1}{4}$ anterior; interosseous membr.; septum	5th metatarsal	Anterior tibial.
Extensor proprius pollicis	Fibula, $\frac{2}{4}$ anterior; interosseous membrane	Great toe	Anterior tibial.
Extensor brevis digitorum	Calcaneum, calcaneo-astragaloid ligament and annular ligament	Four inner toes	Anterior tibial.
Peroneus longus	Fibula, $\frac{2}{3}$ outer; septa; fascia	1st metatarsal and internal cuneiform	Musculo-cutaneous.
Peroneus brevis	Fibula, $\frac{2}{3}$ outer; septa	5th metatarsal	Musculo-cutaneous.
Flexor brevis digitorum	Calcaneum; fascia; septa	Four outer toes, 2nd phalanges (perforatus)	Internal plantar.
Abductor pollicis	Calcaneum, inner; fascia; Internal annular ligament	Great toe, 1st phalanx	Internal plantar.
Abductor minimi digiti	Calcaneum, outer; fascia and septum	Little toe, 1st phalanx	External plantar.
Accessorius	Calcaneum (2 heads), long plantar ligament	Tendon of flexor longus digitorum	External plantar.
Lumbricales (4)	Tendons of flexor longus digitorum	Expansion of extensors	2 Internal plantar. 2 External plantar.
Flexor brevis pollicis	Ext. cuneiform; cuboid; tibialis post. tendon	Great toe, 1st phalanx (sesamoids)	Internal plantar.
Adductor pollicis	Bases of metatarsals, 2, 3, 4; peroneal sheath	Great toe, 1st phalanx	Deep external plantar.
Flexor brevis minimi digiti	5th metatarsal	Little toe, 1st phalanx	Deep external plantar.
Transversus pedis	Transverse metatarsal ligament	Great toe, 1st phalanx	Deep external plantar.
Plantar interossei (3)	Metatarsals, 3, 4, 5	Corresponding 1st phalanges	Deep external plantar.
Dorsal interossei (4)	Adjacent sides of metatarsals	2nd toe, 1st phalanx (both sides), 3rd and 4th toes, outer side	Deep external plantar.

PART III.

DISSECTION OF THE ABDOMEN.

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

Surgery.—Before the subject is tied up for the dissection of the perinæum, the student should practise the operation of introducing the catheter.

In the case of the **Male Subject** the operator should stand on the left side of the body, and having oiled a perfectly smooth and clean staff or sound, should grasp the end of the penis with the left hand, and draw it upwards so as to stretch the urethra whilst introducing the instrument. The sound is to be held lightly in the right hand, and is to be passed at first along the fold of the groin, but when it has entered the urethra for a few inches it is to be brought parallel to the median line of the body. The introduction of an instrument is more difficult on the dead than on the living body, owing to the want of the mucous secretion of the urethra and the relaxed condition of the canal; and it is advisable therefore to withdraw the instrument and oil it afresh if any obstruction should occur.

When an obstruction to entering the bladder occurs, the left hand should be placed upon the perinæum at the point to which the staff has reached, and may be made to grasp the urethra and guide the instrument in its right course.

When the point of the staff has passed the bulb, the handle is to be depressed between the thighs, and the point of the instrument will probably enter the bladder. If it is found impossible to depress the handle, the student may be certain that he has failed to pass the triangular ligament, and should be very gentle in his manipulations, or he will very probably perforate the bulb. By a series of very cautious efforts, aided by the left hand on the perinæum, the staff may at last be passed, or if an organic stricture should exist, it will be necessary to use a smaller instrument.

When the handle of the instrument can be depressed between the thighs, the student may judge of its having entered the bladder by the readiness with which it passed, and by the ease with which the end of the staff can be rotated in the bladder. In all cases, however, it is advisable for the student to introduce his left fore-finger into the rectum, in order to ascertain that the instrument is not in a false passage, and also in order to appreciate the thickness of the coats of the bladder, the size of the prostate, and the course the catheter would take on the living body.

In the **Female Subject** it will be advisable to examine the position of the urethra by separating the labia, before attempting to introduce an elastic catheter. It will be seen that the orifice of the urethra is separated from the clitoris by the space known as the vestibule, and that it is close above the entrance to the vagina. To pass the catheter, the student should stand on the right side of the subject, and having passed the left fore-finger between the thighs and labia, should place it at the anterior edge of the orifice of the vagina; the flexible catheter being then passed along the fore-finger can be slightly raised so as to enter the urethra, and will be felt in its passage through that canal by the finger at the orifice of the vagina. It will be well to practise the operation once or twice with the parts exposed to view, and then to repeat it with a cloth thrown over the pubes, as would be done in actual practice.

The Perinæum.

[The perinæum is now to be fully exposed by bringing the buttocks of the subject to the edge of the table, where they are to be raised upon a block. The thighs are then to be flexed upon the abdomen, with the legs bent; and the body is to be secured upon the table with a cord passing beneath it from one knee to the other, a block being placed lengthways between the knees to keep them sufficiently apart. The staff is to be retained in the male urethra, and secured in its place by tying a loop of string round the penis and fastening it to the handle of the staff.]

External Appearances.—*In the male* the skin is of a darker tint than that of the rest of the body, and is more or less covered with hair, which should be removed. In front will be found the *scrotum*, containing the two testes, and obscuring at present the root of the penis and deeper portion of the urethra. Behind the scrotum is the *anus* or orifice of the bowel, and between the two is the true *perinæum*, which will be seen to be marked by a median raphé. Around the anus the skin is thrown into folds, which, if enlarged, form one variety of external piles. By drawing the anus slightly open, a white line will be seen, marking the junction of the skin with the mucous membrane, and corresponding to the separation between the internal and external sphincter muscles (Hilton).

In the female (Fig. 94) the scrotum may be considered to be split in the median line, to form the two *labia majora*, which however consist simply of cellular tissue and fat, and are continuous above with the *mons Veneris*, a thickened portion of the integument over the pubes (only partially seen in this view). The labia are united in front by the *anterior commissure*; they bound the *vulva* and are continued backwards to the anterior boundary of the perinæum, where they are united by the *posterior commissure*. In a female who has not borne children, a small transverse fold of mucous membrane may be seen just within the posterior commissure, which is called the *fourchette*, and between the two is the *fossa navicularis*.

By separating the labia the *clitoris* will be seen at the upper part of the vulva, resembling a diminutive penis in appearance and structure, and having a small and ill-defined *glans* and *prepuce*.

The *nymphæ* or *labia minora* extend obliquely downwards from each side of the clitoris, being connected both with the organ itself and its prepuce, and are lost in the labia majora and wall of the vagina below.

The *vestibule* is a triangular interval, with the apex at the clitoris and the base at the orifice of the vagina, the sides being formed by the nymphæ. An inch below the clitoris is the *meatus urinarius*, which is slightly prominent, and is placed immediately above the orifice of the vagina.

The entrance of the vagina may be more or less occluded by a *hymen*, which is a reduplication of mucous membrane, usually of a crescentic form with the concave border upwards. The *carunculæ myrtiformes* are three or four little projections from the vaginal wall behind the hymen, and are independent of that membrane. On each side of the vagina immediately in front of the hymen, or its remains, are the orifices of the *vulvo-vaginal glands* or glands of Bartholin. The orifices of numerous sebaceous follicles will also be found scattered over the vulva.

The true *perinæum* of the female is between the posterior commissure of the labia and the anal orifice, and is from an inch to an inch and a half long, but becomes considerably elongated during labour. The finger should be introduced into the vagina to ascertain the position and condition of the cervix and os uteri.

Boundaries of the Perinæum.—These are the same in both sexes, and can be best ascertained by placing a pelvis, on which the ligaments are preserved, in the same position as the subject, when the space under examination will be seen to correspond with the inferior aperture of the pelvis. In front is the symphysis pubis, with the divergent rami extending to the tuberosities of the ischia, which form the lateral boundaries. Posteriorly the great sacro-sciatic ligaments extend to the sacrum, but in the recent subject the margins of the glutei maximi overlap these and reach to the coccyx, which is the posterior limit of the space.

The perinæum has been generally considered to resemble the heraldic lozenge, but has more aptly been compared to an inverted ace-of-hearts (Thompson). The inferior aperture of the pelvis is larger in the female than in the male, but considerable variation in the space between the rami of the pubes will be found in different individuals.

The perinæal space may be conveniently divided into halves, by a line passing from the anterior border of one tuberosity of the ischium to the other; the anterior or urethral half contains the urino-genital organs, and the posterior or rectal half the lower extremity of the bowel.

Posterior Space in both Sexes.

[A little cotton-wool is to be introduced into the rectum, and the anus is then to be carefully sewn up, the stitches being placed as near the white line mentioned above as possible. A transverse incision is then to be made in front of the anus, connecting the two tuberosities, and a similar one across the lower extremity of the coccyx. These are to be joined by a vertical median incision, which at the anus splits into two parts to surround that orifice, being carried as near the sutures as possible, and the skin is to be reflected on each side.]

The **Sphincter Ani** (external) (Fig. 90, 16) surrounds the anus and is close beneath the skin. It consists of two symmetrical halves, which are attached to the tip of the coccyx behind, and meet in front of the anus at the 'central point of the perinæum'; some fibres are attached to the integument at both ends of the muscle. The external sphincter controls the lower end of the bowel, and is *supplied* by the inferior hæmorrhoidal nerve and by a branch of the fourth sacral nerve.

The **Central Point of the Perinæum** is the name applied to a tendinous spot in front of the anus, corresponding to the point of meeting of several muscles.

The **Internal Sphincter** cannot be seen at present. It is merely a thickened band of the unstriped circular fibres of the rectum, and differs therefore in structure from the external sphincter, which is a voluntary muscle.

[The edge of the gluteus maximus is now to be defined, since it forms the boundary of the dissection; it will be found extending obliquely upwards and outwards (in this position) from the tip of the coccyx. The fat filling the space between the anus and the edge of the muscle, or the ischio-rectal fossa, is to be carefully removed piecemeal, care being taken to preserve the inferior hæmorrhoidal vessels and nerve which run nearly transversely towards the bowel, and also a little branch of the fourth sacral nerve near the posterior part of the space. Other branches of the pudic vessels and nerve may be seen running forwards towards the scrotum, and if so should be avoided.]

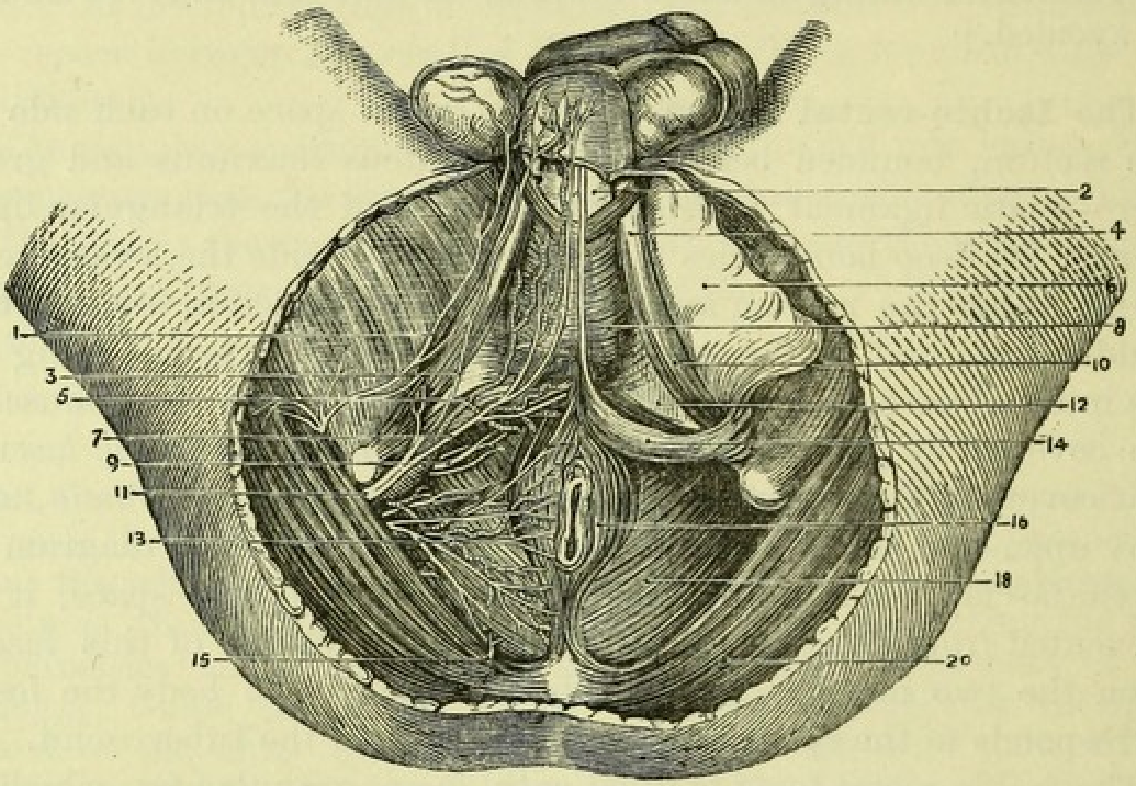
The **Ischio-rectal Fossa** (Fig. 90) is the space on each side of the rectum, bounded behind by the gluteus maximus and great sacro-sciatic ligament, in front by the base of the triangular ligament. Its deep boundaries are, on the *inner* side the levator ani, which slings the rectum and has an oblique direction towards the middle line; and on the *outer* side, the obturator internus lying on the internal surface of the wall of the pelvis. Both these muscles are covered by processes of fascia derived from the pelvic fascia; that covering the obturator being called the *obturator fascia*, and that upon the levator ani being the *anal fascia* (*see* diagram of pelvic fascia). When the finger is pushed into this space, it is prevented from entering the pelvis by the reflection of this fascia upon the two muscles, and on the surface of the body the fossa corresponds to the space between the anus and the tuber ischii.

The ischio-rectal fossa is filled with loose granular fat, which is traversed by the inferior hæmorrhoidal vessels and nerve. On the outer side of the space and more deeply situated than the margin of the pubic arch, the pudic vessels and nerves, which afterwards pass forward through the anterior part of the space, can be felt enclosed in a tube of fascia; and it is here that the artery can be effectually compressed in cases of hæmorrhage after lithotomy. The perineal branches of the pudic artery and nerve leave the main trunks in the anterior part of the ischio-rectal fossa, but they will be better seen afterwards.

Surgery.—The tissues in the ischio-rectal fossa are more or less involved in the several forms of fistula in ano, and the sphincter ani, together with some of the fat and a small branch of artery, will be more or less divided in the ordinary operation for the cure of that affection. In the operation of lateral lithotomy the left ischio-rectal fossa is cut into, and care has to be taken not to injure the rectum on the inner, or the pudic artery on the outer, side of the space.

The **Levator Ani Muscle** (Fig. 90, 18) *arises* within the pelvis, being attached to the back of the os pubis, to the spine of the ischium, and to the pelvic fascia between those points. It is now seen at its *insertion* into the central line of the perinæum, where it meets its fellow of the opposite side both in front of and behind the rectum; it is inserted also into the side of the rectum, and

Fig. 90.



into the anterior surface of the extremity of the coccyx with the opposite muscle.

The levator ani supports the pelvic viscera, and, when in contraction, tends to prevent the expulsion of their contents. It may also be considered as an extraordinary muscle of expiration, since

Fig. 90.—Superficial dissection of male perinæum (drawn by J. T. Gray).

1. Inferior pudendal nerve.
2. Urethra.
3. External or posterior superficial perinæal nerve.
4. Crus penis.
5. Superficial perinæal artery.
6. Deep layer of superficial fascia (reflected).
7. Internal or anterior superficial perinæal nerve.
8. Accelerator urinæ.
9. Muscular branches of pudic nerve.
10. Erector penis.
11. Pudic artery and nerve.
12. Deep perinæal fascia or triangular ligament.
13. Inferior hæmorrhoidal artery and nerve.
14. Reflection of the deep layer of superficial perinæal fascia round transversus perinæi.
15. Branch of fourth sacral nerve.
16. Sphincter ani.
18. Levator ani.
20. Gluteus maximus.

it acts upon the viscera in opposition to the diaphragm. It is *supplied* by the fourth sacral nerve.

The **Inferior Hæmorrhoidal Artery** (Fig. 90, 13) arises from the pudic artery under cover of the ischium, and takes a nearly transverse course inwards to the anus and lower end of the rectum, where it anastomoses with the middle hæmorrhoidal branch of the internal iliac. *Venæ comites* take the same course as the artery, and join the pudic vein.

The **Inferior Hæmorrhoidal Nerve** (Fig. 90, 13) is a branch of the internal pudic nerve, or may arise separately from the lower part of the sacral plexus. In the latter case it takes the same course as the pudic nerve, and is contained in the same sheath of fascia. The nerve takes a nearly transverse course in the perinæum, lying superficially to the inferior hæmorrhoidal vessels, and is distributed to the external sphincter and skin of the anus, giving a branch forward to join the superficial perinæal nerves.

The *Perinæal branch of the Fourth Sacral nerve* is of small size and not readily seen. It appears at the side of the coccyx by piercing the coccygeus muscle, and is distributed to the external sphincter.

A *perforating cutaneous* branch of the sacral plexus, which has passed through the great sacro-sciatic ligament, is usually found winding round the edge of the gluteus maximus, from the ischio-rectal fossa.

Anterior Space in the Male.

[The scrotum being drawn up with hooks, an incision is to be made in the median line, extending from the central point of the perinæum to within three inches of the extremity of the penis. The skin is to be reflected to each side, and the testicles held out of the way with hooks.]

The **Superficial Fascia** of the anterior half of the perinæum is divisible into two layers—superficial and deep.

The *superficial layer* of superficial fascia is continuous with that of the surrounding parts, which it resembles, but is peculiar in the scrotum, where it contains no fat, and has involuntary muscular fibre developed in it, which gives it a pink appearance and constitutes the *dartos*.

The *deep layer* of superficial fascia (Fig. 90, 6) is brought into view by the removal of the superficial layer; but varies considerably in appearance in different subjects, being a distinct membrane in thin subjects, but not easily defined in fat ones. It is continuous with the deep layer of fascia of the groin, and is attached on each side of the front of the rami of the pubes and ischium, nearly to the tuberosity. It then makes a turn around the transversus perinæi muscle on each side, and joins the deep perinæal fascia or triangular ligament. A pouch is thus formed containing the bulb of the urethra with its surrounding muscles, vessels, and nerves, and this is divided into two parts by an incomplete median septum. This pouch is of importance surgically with regard to extravasation of urine. If extravasation should occur from rupture of the bulbous or adjacent portion of the urethra, either from external violence or from the unskilful use of a catheter, or other cause, the urine is effused into this pouch, and, being prevented by the arrangement of the fascia from running back to the anus, and by the attachment of the fascia to the rami of the pubes and ischium from extending laterally on to the thighs, it necessarily distends the pouch and creeps into the scrotum and groin.

[The deep layer of superficial fascia is to be removed, and the superficial perinæal vessels and nerves dissected out; care being taken to preserve the superficial transverse muscle, which runs outwards from the central point of the perinæum.]

The **Superficial Perinæal Artery** (Fig. 90, 5) is a branch of the internal pudic, and arises under cover of the ramus of the ischium near the front of the ischio-rectal fossa to run forwards and inwards. It enters the pouch of fascia by piercing its lower border, and then passes over or under the superficial transversus perinæi muscle, to run forwards and supply the superficial muscles of the perinæum and the integuments of the scrotum.

The **Transverse Perinæal Artery** (Fig. 93, 11) is a branch of the internal pudic, arising immediately in front of, or with, the preceding vessel. It runs towards the median line close to the superficial transverse muscle, and anastomoses with the opposite artery and with the neighbouring branches. *Veins* corresponding to the arteries open into the internal pudic vein.

The **Perinæal Nerve** generally leaves the pudic as a single large trunk in the ischio-rectal fossa, and supplies, besides the two *superficial perinæal* nerves, *muscular* branches to the external sphincter, levator ani, and the muscles in the anterior half of the perinæal space, and a branch may be followed through the accelerator urinæ to the bulb of the urethra (bulbo-urethral nerve of Cruveilhier).

The **Superficial Perinæal Nerves** (Fig. 90) are two in number. The *external* or *posterior* (3) nerve has a short course in the ischio-rectal fossa, where it gives a branch to the anus. It then pierces the reflection of the deep layer of superficial fascia, and gives branches to the scrotum, forming a junction with the inferior pudendal nerve of Soemmering, and usually with the inferior hæmorrhoidal nerve.

The *internal* or *anterior* (7) nerve accompanies the superficial perinæal artery either over or under the transversus perinæi muscle, and is distributed to the scrotum near the median line, where it unites with its fellow of the opposite side, giving also one or two small branches to the levator ani.

The **Inferior Pudendal Nerve** (Fig. 90, 1) (Soemmering) is a branch of the small sciatic nerve, which pierces the deep fascia of the thigh about an inch in front of the tuberosity of the ischium. It varies a good deal in size and distribution, but generally runs inwards and forwards to the scrotum to join the external superficial perinæal nerve.

[The superficial vessels and nerves are to be turned aside, and the muscles dissected out. The accelerator urinæ is in the median line, the erector penis parallel to the ramus of the pubes, and the transversus perinæi crosses between them posteriorly; the muscles thus bounding a triangular space in which a part of the triangular ligament is seen.]

Superficial Muscles of the Perinæum.

The **Accelerator Urinæ** (Fig. 90, 8) (*ejaculator seminis* or *bulbo-cavernosus*) is a single muscle, composed of two symmetrical halves united in the middle line by a delicate fibrous raphé. The fibres *arise* from the central point of the perinæum and from the fibrous raphé in the middle line, and are thus *inserted*;—the posterior fibres, which are nearly transverse in their direction, overlie the bulb and are lost upon the triangular ligament; the middle fibres enclose the urethra and corpus spongiosum; and the anterior fibres pass obliquely outwards and forwards, enclosing the entire circumference of the root of the penis, including the dorsal vessels.

The **Erector Penis** (Fig. 90, 10) covers the crus penis on the ramus of the os pubis. It *arises* from the anterior and inner surface of the tuberosity of the ischium, and also from the ramus of the ischium, and ends in an aponeurosis which is *inserted* into the sides of the crus penis.

The **Transversus Perinæi** (Fig. 90, 14) varies in size and may be divided into two slips. It *arises* from the inner side of the ramus of the ischium, and meets its fellow muscle of the opposite side in the central point of the perinæum, where it is also blended with the fibres of the accelerator urinæ and sphincter ani.

The action of the accelerator is to expel the contents of the urethra by its sudden and spasmodic contraction. It is not put in action during the greater part of the act of micturition; but when the flow of urine has ceased, it serves to eject the small remaining portion, or may be used to arrest the flow of urine suddenly, when its action gives rise to considerable pain. Its action during coition is expressed by the name ejaculator seminis, and its anterior fibres assist materially in producing erection of the penis by compressing the dorsal vein. The erector penis assists somewhat in the production of erection, by compressing the corpus cavernosum.

Surgery.—The triangular space enclosed by the three superficial muscles, and of which the floor is formed by the triangular ligament or deep perinæal fascia, is important surgically as being the point to which the knife reaches in the incision for lateral lithotomy. In the first incision the surgeon cuts freely through the superficial structures, dividing the superficial perinæal and inferior hæmorrhoidal vessels and nerves, and aiming at the lower part of this space, at which point the finger will feel somewhat indistinctly the staff in the urethra. The deeper incision necessarily divides the transverse muscle and artery, together with the lower part of the triangular ligament, and enables the operator to reach the staff in the membranous portion of the urethra.

It should be noticed how the small space between the anus and the bulb of the urethra can be increased by drawing the whole penis upwards; this fact is of importance in relation to median lithotomy, which is performed in this space, and in which operation there is some risk of wounding the bulb. It is obvious that any cutting operation in the median line of the perinæum would be accompanied by but little hæmorrhage, until the vascular structure of the bulb or corpus spongiosum urethræ is reached.

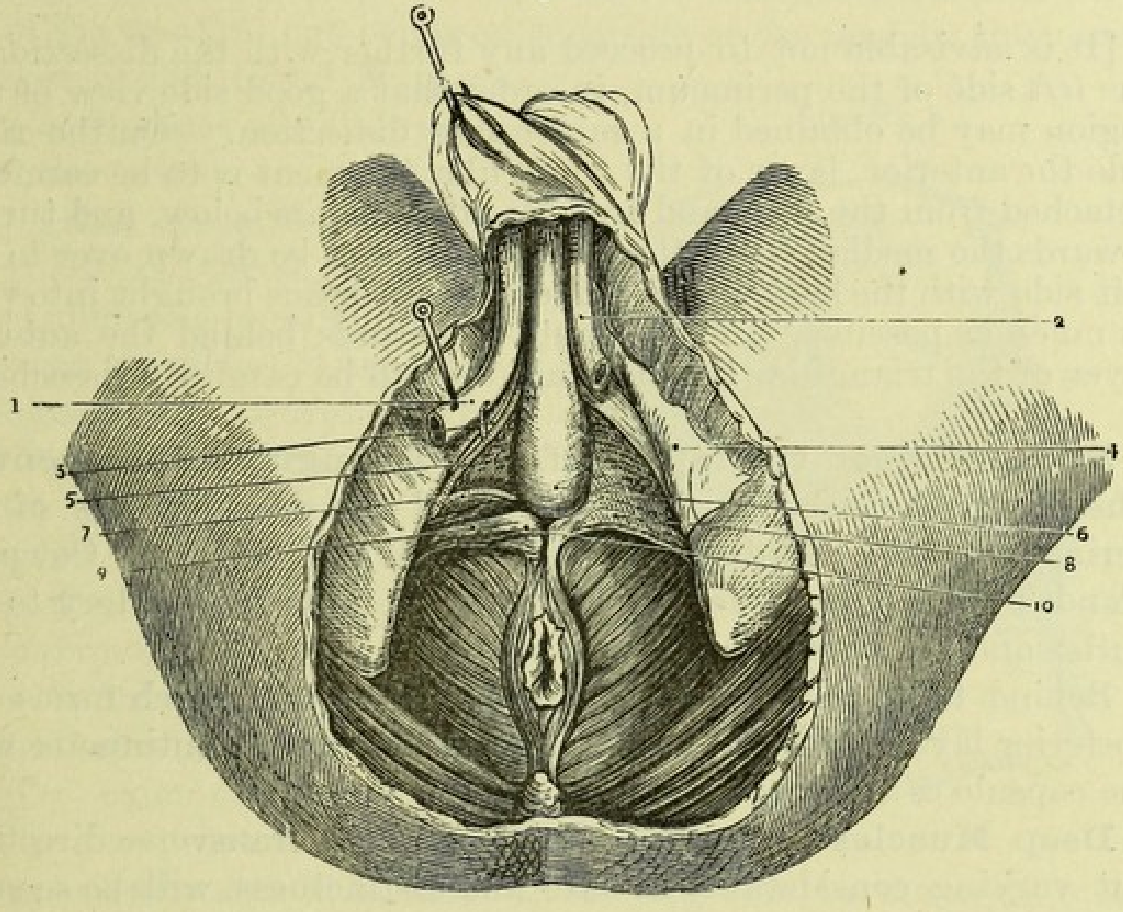
[The accelerator urinæ is to be divided in the middle line, and dissected from the bulb beneath and from the triangular ligament, but its anterior fibres must not be interfered with. The transversus perinæi is to be removed, and the erector penis detached from the bone with the crus penis, which will be seen to be a vascular body attached to the ramus of the pubes for nearly an inch. This is to be drawn forward, a branch of artery going to it being carefully preserved; the triangular ligament will then be exposed. It may be well to leave the crus penis undisturbed on the right side.]

The posterior part of the **Corpus Spongiosum Urethræ** will be seen to be a dark, vascular body, which expands to form the bulb, immediately in front of the triangular ligament.

The **Bulb** (Fig. 91, 6) is slightly expanded from side to side, and consists of two halves united by a delicate septum of fibrous tissue. It is closely connected with the triangular ligament, with which its delicate fibrous covering is continuous.

The **Anterior layer of the Triangular Ligament** of the urethra or **Deep Perineal Fascia** (Fig. 91, 8) is a strong process

Fig. 91.



of fibrous tissue stretching across the pubic arch, being attached to the rami of the pubes and ischium on each side behind the crura penis.

The apex of the ligament is connected with the sub-pubic ligament, and the base has been seen to be continuous with the deep layer of superficial fascia which turns around the transversus

Fig. 91.—Deep dissection of the male perinæum, the anterior triangular ligament being removed on the right side (drawn by J. T. Gray).

1. Right crus penis (cut).
2. Left crus penis (cut).
3. Pudic nerve.
4. Deep layer of superficial fascia (reflected).
5. Pudic artery.
6. Bulb of urethra.
7. Artery of the bulb.
8. Anterior triangular ligament.
9. Compressor urethræ muscle.
10. Position of Cowper's gland (right).

perinæi; but it is also connected with the central point of the perinæum and is continuous with the anal fascia over the levator ani muscle (p. 185).

About an inch below the pubes the urethra perforates the triangular ligament, with which it is inseparably united, and above this point are the openings for the dorsal vessels and nerves of the penis, the vein being in the median line, with the artery and nerve on each side, the last most external.

[It is advisable not to proceed any further with the dissection of the *left* side of the perinæum, in order that a good side view of this region may be obtained in a subsequent dissection. On the right side the anterior layer of the triangular ligament is to be carefully detached from the bone and from its attachments below, and turned towards the median line; the bulb should also be drawn over to the left side with the hooks, so as to increase the space brought into view as much as possible. The minute structures behind the anterior layer of the triangular ligament are then to be carefully dissected.]

Parts between the layers of the Triangular Ligament.—These are, the sub-pubic ligament and the deep muscles of the perinæum; the membranous portion of the urethra; Cowper's glands; portions of the pudic artery and nerve; the artery to the bulb; and the dorsal vein of the penis.

Behind these is a process of the pelvic fascia, which forms the posterior layer of the triangular ligament, and is continuous with the capsule of the prostate.

Deep Muscles.—Muscular fibres having a transverse direction, but varying considerably in size and distinctness, will be seen on the removal of the anterior layer of the triangular ligament. These form the compressor urethræ, but the lower part, when very distinct, may be called the deep transverse muscle.

The **Compressor vel Constrictor Urethræ** (Fig. 92, 7) (Guthrie's muscle) *arises* from the posterior aspect of the ramus of the pubes, and divides into two slips, which run inwards transversely to enclose the membranous portion of the urethra, meeting the opposite muscle in the median raphé, and being expanded upon the whole length of this portion of the canal. Circular muscular fibres surround the membranous urethra beneath the compressor, but these are involuntary, and continuous with the muscular fibres of the prostate (Ellis).

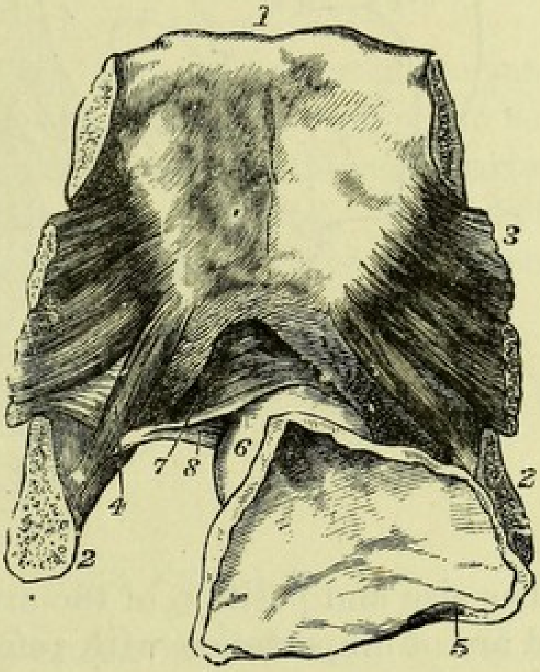
Behind the lower portion of each muscle near the middle line is situate one of Cowper's glands, and the muscle may conceal the artery to the bulb if it should arise lower than usual.

The **Deep Transverse Muscle** is generally merely the lower portion of the preceding muscle, which meets its fellow of the opposite side in the median line below the urethra.

[The muscular fibres are to be divided near the urethra in order to see one of Cowper's glands, and the pudic artery and nerve with their branches are to be followed out.]

Cowper's Glands (Fig. 91, 10) are close to the membranous portion of the urethra, one being on each side of the median line, and are most readily found by tracing to each gland a small branch from the artery to the bulb. Each gland resembles a dried pea in size and shape, and consists of numerous minute lobules. Although the gland is so close to the membranous urethra, the duct opens into the bulbous portion of the canal, being nearly an inch long and perforating the floor of the urethra very obliquely.

Fig. 92.



The membranous portion of the urethra will be more satisfactorily examined afterwards than in the present dissection, but opportunity should be taken to feel the staff in the urethra at this point, since it is here that tube would be opened, on the left side, in the operation of lateral lithotomy, or in the middle line in the median operation.

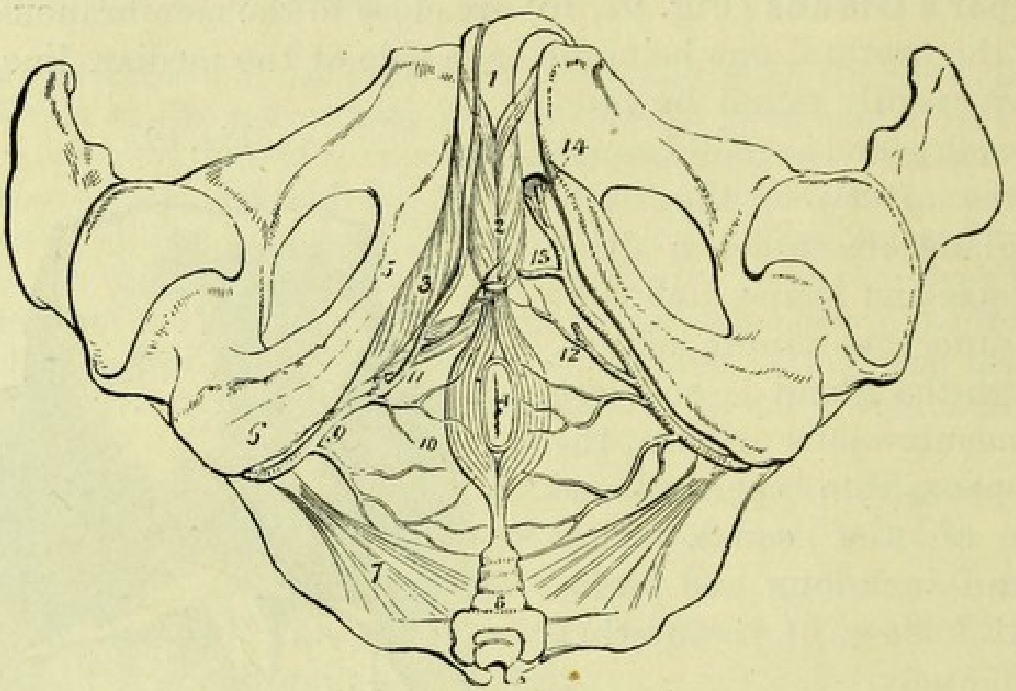
The **Pudic Artery** (Fig. 93, 9) will be found under cover of the pubic arch. It passes forwards between the two layers of the triangular ligament, and, after giving off the artery to the bulb and the artery to the corpus cavernosum, ends in the dorsal artery of the penis.

Fig. 92.—Posterior view of pubes with part of bladder and urethra attached (from Wilson).

1. Body of pubes.
2. Ramus.
3. Obturator internus muscle.
4. Levator ani.
5. Portion of the fundus and neck of bladder laid open.
6. Prostate gland.
7. Transverse fibres of compressor urethræ passing above urethra.
8. Similar fibres passing beneath the canal.

The **Artery to the Bulb** (Fig. 91, 7) is a good sized branch, which is generally in front of the compressor urethræ muscle. It passes transversely inwards to supply the bulb, to reach which it has to pierce the triangular ligament close to the middle line. It generally gives a branch to the Cowper's gland of the same side.

Fig. 93.



The size and position of the artery to the bulb vary considerably, and are of importance with reference to lateral lithotomy. When the origin is as far forwards as represented in Fig. 91 the artery must be free from danger, but if it should arise farther back (and it is occasionally found in the ischio-rectal fossa), it would be liable to be cut, when from its size it might give rise to troublesome and even fatal hæmorrhage.

Fig. 93.—Arteries of the perinæum (from Wilson). On the right side the superficial arteries are seen, on the left the deep.

1. The penis; the crus penis of the left side is cut through.
2. Accelerator urinæ muscle.
3. Erector penis.
4. Anus surrounded by the sphincter ani.
5. Rami of ischium and pubes.
6. Tuberosity of ischium.
7. Lesser sacro-sciatic ligament.
8. Coccyx.
9. Internal pudic artery, crossing the spine of the ischium and entering the perinæum.
10. Inferior hæmorrhoidal branches.
11. Superficial perinæal artery, giving off the transverse artery upon the transversus perinæi muscle.
12. The same artery on the left side cut off.
13. Artery of the bulb.
14. The artery of the corpus cavernosum and the dorsal artery of the penis.

The **Artery to the Corpus Cavernosum** (Fig. 93, 14) is a small branch which enters that vascular body and ramifies in its interior.

The **Dorsal Artery of the Penis** is the termination of the internal pudic. It passes forwards between the bone and the crus penis, and then pierces the suspensory ligament to reach the upper surface of the organ, where it will be subsequently traced.

When the pudic artery is small, the dorsal arteries are derived from the trunks of the internal iliacs, and reach the penis by piercing the triangular ligament on each side of the dorsal vein.

The *Dorsal Vein* of the penis will afterwards be seen piercing the pelvic fascia to join the prostatic plexus of veins.

The *Veins* corresponding to the other branches of the pudic artery take the same course as their arteries, and open into the pudic vein.

The **Pudic Nerve** (Fig. 91, 3) lies externally to the pudic artery, and is only brought into view with some difficulty. It takes the same course as the artery, and ends in the dorsal nerve of the penis, which will be afterwards dissected.

[The flaps of skin should be carefully sewed together before the body is moved from its position.]

Anterior Space in the Female.

[A little cotton-wool is to be inserted in the vagina, and the margins of the labia majora are to be fastened together by a few stitches. An incision is then to be carried transversely above the junction of the labia, from which two vertical incisions, as near the margin of each labium as convenient, are to be prolonged to the central point of the perinæum. The flaps of skin can now be reflected from the middle line, supposing the transverse incision behind the labia to have been already made.]

The **Superficial Fascia** of the anterior half of the female perinæum resembles that of the male, in being divisible into two layers —superficial and deep.

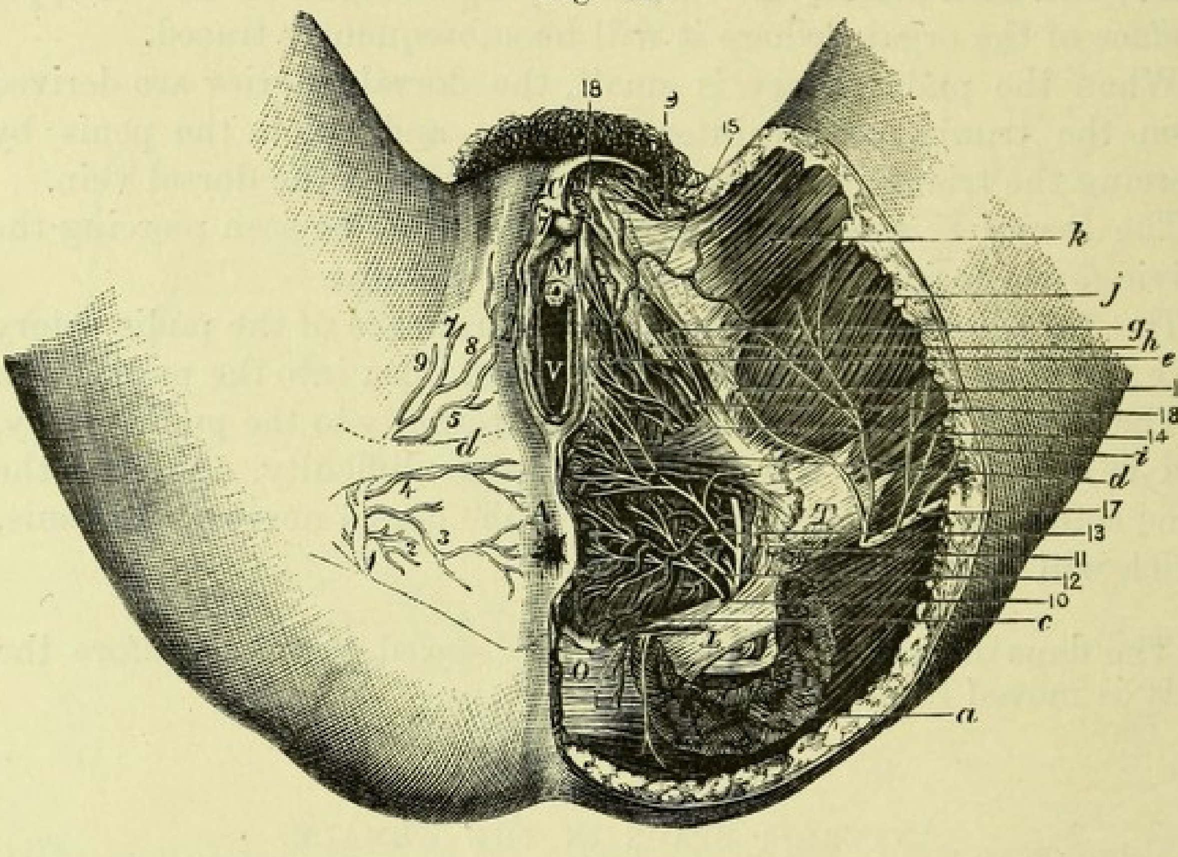
The *superficial layer* of superficial fascia is continuous with the fascia of the body generally, and usually contains much fat, forming the labium.

The *deep layer* of superficial fascia is not so strongly marked as in the male, but has the same connections. It is continuous with the deep fascia of the groin, and is attached on each side to the front of the rami of the pubes and ischium, nearly to the tuberosity.

It then makes a turn around the transversus perinæi muscle on each side, and joins the deep perinæal fascia or triangular ligament.

Owing to the position of the vulva, the deep layer of superficial fascia is divided in the middle line and becomes continuous with

Fig. 94.



the sheath of the vagina; and thus also the pouch between the deep layer of superficial fascia and the triangular ligament (p. 188)

Fig. 94.—The female perinæum (from Savage's 'Illustrations').

1. Pudic artery.
2. Branch to levator ani.
3. Inferior hæmorrhoidal artery.
4. Transverse artery.
5. Great labial (superficial perinæal) artery.
7. Dorsal artery of clitoris.
8. Artery of bulb.
9. Artery to crus clitoridis.
10. Inferior hæmorrhoidal nerve.
11. Pudic nerve.
12. Muscular branch.
13. Internal superficial perinæal nerve.
14. External superficial perinæal nerve.
15. Its junction with—
16. Inferior pudendal nerve.
17. Small sciatic nerve.
18, 18. Dorsal nerve of clitoris.
19. Ilio-inguinal nerve.

A. Anus.
C. Clitoris.
M. Meatus urinarius.
L. Great sacro-sciatic ligament.
V. Vagina.
O. Coccyx.
T. Tuberosity of ischium.
a. Gluteus maximus.
c. Levator ani.
d. Superficial transverse muscle.
e. Compressor bulbi.
g. Erector clitoridis.
h. Triangular ligament (cut).
i. Biceps and semi-tendinosus.
j. Adductor magnus.
k. Gracilis.

is divided in the female into two parts, which have been named *pudendal* or *vulvo-scrotal sacs* of Broca.

[The deep layer of superficial fascia is to be removed, and the superficial perinæal vessels and nerves dissected out, care being taken to preserve the superficial transverse muscle which passes outwards from the central point of the perinæum.]

The **Superficial Perinæal Artery** (artery of the labium) (Fig. 94, 5) is larger than in the male. It is a branch of the internal pudic artery, and arises under cover of the ramus of the ischium to run forwards and inwards. It enters the pouch of fascia by piercing the lower border of the triangular ligament, and then passes over or under the transversus perinæi muscle to supply the superficial muscles of the perinæum and the labium.

The **Transverse Artery** (Fig. 94, 4) is a branch of the internal pudic, arising immediately in front of or with the preceding vessel. It runs towards the median line close to the transverse muscle, and anastomoses with the opposite artery and with the neighbouring branches. *Veins* corresponding to the arteries open into the internal pudic vein.

The **Superficial Perinæal Nerves** (Fig. 94) are two in number, and are branches of the pudic nerve.

The *internal* or *anterior* (13) nerve runs upwards and inwards, entering the pouch of fascia and being distributed to the posterior part of the vulva.

The *external* or *posterior* (14) nerve is larger, and is distributed over the superficial muscles of the perinæum, forming a junction with the inferior pudendal nerve of Soemmering.

The **Inferior Pudendal Nerve** (Soemmering) (Fig. 94, 16) is a branch of the small sciatic nerve, which pierces the deep fascia of the thigh about an inch in front of the tuberosity of the ischium. It is usually of small size in the female, and runs upwards and inwards to join the external superficial perinæal nerve.

[The superficial vessels and nerves are to be turned aside and the muscles dissected out. The muscles are much less distinct than in the male perinæum, and it is impossible to trace all their fibres without maceration and preparation, which it is impracticable for the student to undertake ; he will be able to make out sufficient however to assist materially in following the description.]

The **Perinæal Body** of Savage (Fig. 95, 14) is a structure peculiar to women, consisting of a mass of elastic tissue placed between the orifices of the vagina and rectum, and uniting all the tissues which meet in the central point of the perinæum. Its use appears to be to allow of great stretching, without tearing, during parturition.

The **Superficial Muscles** (Figs. 94 and 95) of the female perinæum closely resemble those of the male, with the exception that the two portions of the central muscle (corresponding to the accelerator urinæ) are separated by the vulva. On each side therefore of the vulva will be found the bulbo-cavernosus; lying on the ramus of the pubes, the erector clitoridis; and, passing from the tuber ischii to the central point of the perinæum, the transversus perinæi.

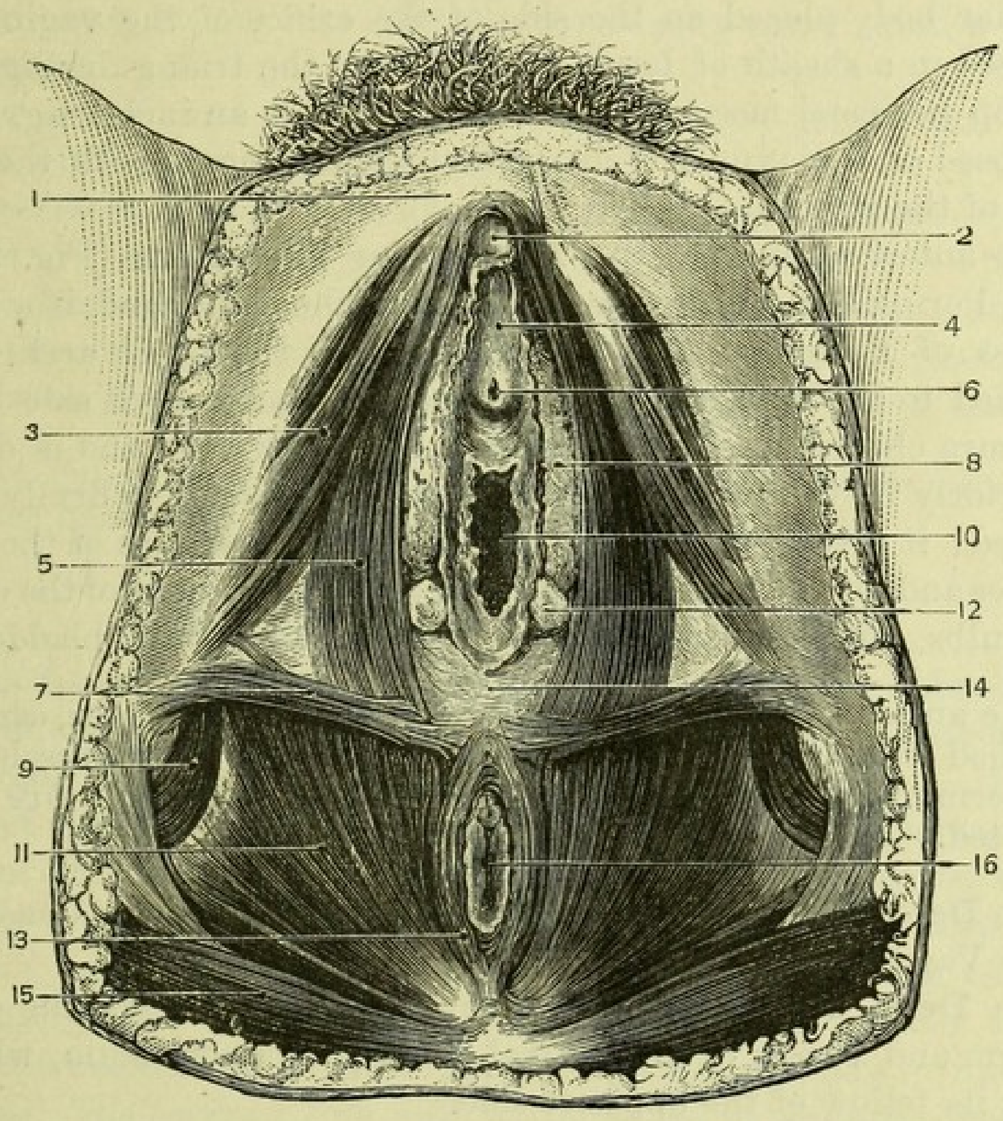
The **Bulbo-Cavernosus** (sphincter vaginæ) (Fig. 95, 5) *arises* from the elastic *perinæal body* between the anus and vagina, two or three of its superficial fibres being prolonged into the sphincter ani; it also arises from the reflection of the deep layer of superficial fascia (ischio-perinæal ligament of Savage) for nearly an inch, and decussates with the inner fibres of the transversus. The fibres of the muscle are divisible into three sets, corresponding to those of the accelerator urinæ of the male. The anterior fibres pass forward on each side of the vulva to meet those of the opposite muscle upon the clitoris, and to be partially *inserted* into the sheath of the clitoris; the middle fibres pass beneath the clitoris and over the great veins upon the urethra, which are analogous to the corpus spongiosum of the male, meeting those of the opposite side; the posterior fibres pass on to the triangular ligament (Savage).

The **Erector Clitoridis** (Fig. 95, 3) resembles the erector penis in the male, and though actually smaller in size, bears a much larger proportion to its organ than that muscle. It *arises* from the front of the tuber ischii, and is *inserted* on the sides of the crus clitoridis.

The **Transversus Perinæi** (Fig. 95, 7) *arises* from the inner side of the ramus of the ischium, and meets its fellow muscle of the opposite side in the central perinæal body, where it is blended with the fibres of the bulbo-cavernosus and sphincter ani, and the deep part of the sphincter vaginæ.

The **Levator Ani** (Fig. 95, 11) is divided by Savage into three parts: 1. The *pubo-coccygeus* is now seen in part, its fibres having the same direction as the sphincter ani. It *arises* from the back of the pubes, and its fibres encircle the rectum between the superficial and deep sphincters, and are *inserted* into the side of the last two bones of the coccyx. 2. The *obturato-coccygeus arises* from the ilio-pubic line of division of the pelvic fascia into obturator and recto-vesical layers (white-line), and is *inserted* into the side of the last two bones of the coccyx. 3. The *ischio-coccygeus* corresponds to the coccygeus muscle as ordinarily described, and extends from the spine of the ischium to the side of the coccyx.

Fig. 95.



[The bulbo-cavernosus muscle is to be divided at its origin and turned up, being dissected from the bulb of the vagina beneath and from the triangular ligament. The transversus perinæi is to be removed, and the erector clitoridis detached from the bone with the

Fig. 95.—The superficial muscles of the female perinæum (from Savage).

1. Pubes.
2. Clitoris.
3. Erector clitoridis.
4. Vestibule.
5. Bulbo-cavernosus muscle.
6. Urethra.
7. Superficial transverse muscle.
8. Bulb of vagina.
9. Obturator internus muscle.
10. Vagina.
11. Levator ani muscle.
12. Gland of Bartholin.
13. Sphincter ani externus.
14. The perinæal body.
15. Gluteus maximus.
16. Anus.

crus clitoridis, which will be seen to be a vascular body attached to the ramus of the pubes for half an inch. This is to be drawn forward, a branch of artery going to it being preserved, and the triangular ligament will be exposed.]

The **Bulb of the Vagina** (Fig. 95, 8) (bulbus vestibuli of Kobelt) corresponds precisely to one half of the bulb of the male. It is a vascular body placed on the side of the orifice of the vagina, and enclosed in a sheath of fascia derived from the triangular ligament or deep perinæal fascia. Each bulb is about an inch long, and is composed of a plexus of veins, which communicate with the great veins of the clitoris.

The anterior layer of the **Triangular Ligament** (Fig. 95) or Deep Perinæal fascia resembles that of the male, and is a strong process of fibrous tissue stretching across the pubic arch, being attached to the rami of the pubes and ischium on each side behind the crura clitoridis. It is perforated by the urethra and is divided posteriorly by the vagina, with the coats of which it is firmly incorporated; it gives passage also to the terminal branches of the pudic arteries and nerves, as in the male, and to the large veins of the clitoris and bulbs, which pass to the plexus on the neck of the bladder.

[The anterior layer of the triangular ligament is to be carefully detached from the bone and removed, when the deep muscles and the terminal branches of the pudic artery and nerve are to be dissected.]

The **Deep Muscles** are the Deep Transverse, and the Constrictor of the Vagina.

The **Deep Transverse Muscle** *arises* from the ramus of the ischium and passes to the central point of the perinæum, where it meets its fellow of the opposite side.

The **Constrictor of the Vagina** consists of a few fibres which *arise* from the central point of the perinæum, and ascend to meet the muscle of the opposite side of the urethra.

Involuntary circular fibres surround the whole length of the female urethra.

The **Glands of Bartholin** (Fig. 95, 12) correspond to Cowper's glands in the male. Each gland is of the size of a small bean, and is situated behind the anterior layer of the triangular ligament opposite the lower border of the bulb. The minute duct of each gland opens on the mucous surface of the vagina, about half an inch from the orifice and in front of the hymen.

Pudic Artery and Nerve (Fig. 94). The terminations of the pudic artery and nerve in the female correspond closely to those of the male, but are much smaller. The artery lies under cover of the ramus of the pubes with the nerve, and gives off an artery to the bulb, to the crus clitoridis, and the dorsal artery of the clitoris.

The *artery of the bulb* (8) runs transversely inwards, and terminates in the bulb of the vagina.

The *artery to the crus clitoridis* (9) is very small, and is lost in that organ.

The *dorsal artery of the clitoris* (7) reaches the dorsum of the organ with the corresponding nerve.

The *Dorsal Vein* of the clitoris is of large size, and passes backwards to open into the great veins around the neck of the bladder.

The *Pudic Nerve* (11) gives off muscular branches (12), and ends in the dorsal nerve of the clitoris (18), which bears a much larger proportion to that organ than the corresponding nerve of the penis.

[The flaps of skin should be carefully fastened together with stitches before the body is moved from its position.]

Dissection of the Abdominal Wall.

The dissection of the Perinæum having been completed, the. student should proceed to examine the abdominal wall, the condition of which will vary considerably in different subjects. In a fat subject the wall of the abdomen will be smooth and uniform, but in a thin muscular subject the prominences of the muscles will be readily recognised. In all bodies the umbilicus will be seen in the median line about midway between the pubes and the ensiform cartilage of the sternum, and it should be noted whether there is any protrusion at this point, constituting an *exomphalos* or umbilical hernia. The median line will be found to be slightly depressed, corresponding, as will be afterwards seen, to the linea alba, and it is here, below the umbilicus, that the operation of paracentesis or tapping the abdomen is performed.

On each side of the median line and parallel to it, is the prominence caused by the rectus abdominis muscle, and occasionally the markings in that muscle known as the *lineæ transversæ* can be seen through the skin. Immediately above the pubes and close to the median line is occasionally seen the prominence of the pyramidalis muscle on each side. The pubic bone will be recognised with the finger, which should be carried outwards to the spine of the pubes, to which Poupart's ligament is attached. The ligament when traced out will be followed along the fold of the groin to the anterior superior spinous process of the ilium, from which the iliac crest passes backwards. On the sides of the lower part of the thorax, the interdigitations of the obliquus externus with the serratus magnus may be seen through the skin, in a well developed subject.

The condition of the abdominal rings and inguinal canal should be carefully examined before the skin is removed. If the spermatic cord be traced up from the testis, it may be felt to disappear through an opening known as the external abdominal ring, and even in a perfectly well formed subject the fore-finger can be passed into the ring with tolerable facility, if pushed up from below, carrying the scrotum before it. In a subject with a tendency to hernia, the finger can be carried along the inguinal canal to the internal abdominal ring, or if a rupture actually exists, may be passed into the abdominal cavity, pushing before it the loose skin. If any tumour of the scrotum should happen to be present, it should be carefully examined and its nature diagnosed, with a view to confirmation by subsequent examination.

In the female, the abdominal ring is usually of small size, and generally too contracted to admit the finger, but may be enlarged by a hernia. The projection above the pubes, which is covered with hair and known as the *mons Veneris*, is due simply to a development of fat in the superficial fascia at this point. The skin of the abdomen of women who have borne children is marked by numerous small white scars, the result of its over-distension during pregnancy.

Percussion and palpation should be carefully practised, in order to make out the limits of the principal organs of the abdomen before the dissection is begun, and the student is referred to Fig. 109, on which the position of the several viscera is shown in health, but from which considerable variations may be expected. The presence of fluid in the peritoneal cavity may be ascertained by the production of fluctuation, between the hands applied on opposite sides of the abdomen.

[In order to dissect the abdominal wall, it is necessary to distend the abdomen fully with air. To do this, a narrow knife should be thrust through the umbilicus into the peritoneal cavity, and a blowpipe should be inserted. A circular incision should previously be made through the skin round the umbilicus, and a piece of whipcord tied round the blowpipe in the groove cut in the skin. When the abdomen has been fully distended, the blowpipe is to be withdrawn, and the opening carefully secured.

One incision is to be carried from the ensiform cartilage to the pubes (avoiding the umbilicus), and another along the crest of the ilium and from the anterior superior spine of the ilium horizontally

Fig. 96.

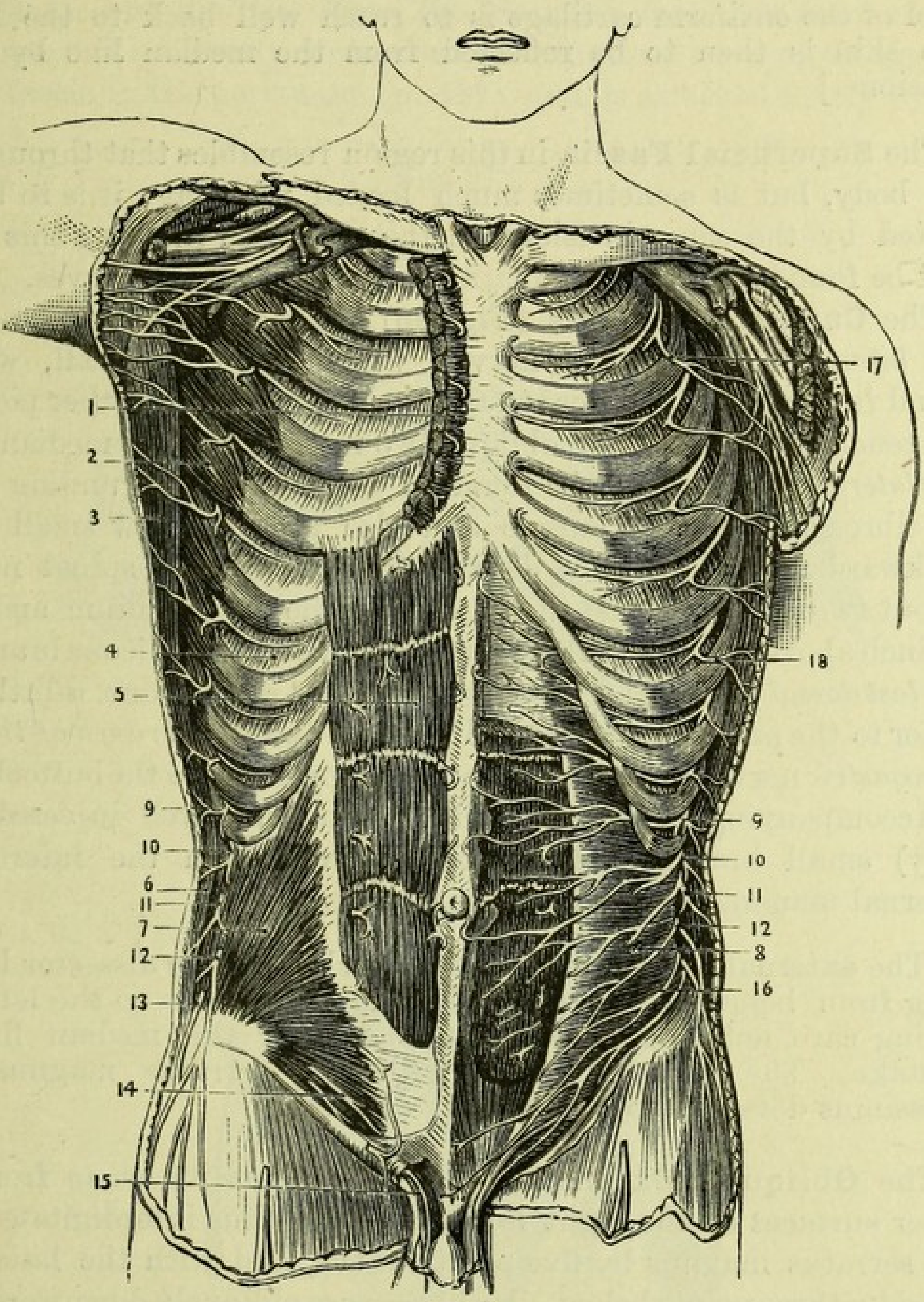


Fig. 96.—The nerves of the abdominal wall (from Hirschfeld and Leveillé).

1. Pectoralis major (cut).
2. Serratus magnus.
3. Latissimus dorsi.
4. Intercostal muscles.
5. Rectus abdominis.
6. Section of obliquus externus.
7. Obliquus internus.
8. Transversalis abdominis.

9, 9. Ninth dorsal nerve.
10, 10. Tenth dorsal nerve.
11, 11. Eleventh dorsal nerve.
12, 12. Twelfth dorsal nerve.

13. Lateral cutaneous branch of first lumbar (ilio-hypogastric).
14. Anterior cutaneous branch of ilio-hypogastric.
15. Anterior cutaneous branch of ilio-inguinal.
16. Ilio-hypogastric and ilio-inguinal nerves.
17. Lateral cutaneous branch of second intercostal nerve.
18. Lateral cutaneous branch of intercostal nerve.

to the middle line joining the first at right angles. A third at the level of the ensiform cartilage is to reach well back to the loins. The skin is then to be reflected from the median line by these incisions.]

The **Superficial Fascia** in this region resembles that throughout the body, but is sometimes much loaded with fat; it is to be reflected by the same incisions as the skin, and in doing this there will be found in it the terminations of the cutaneous nerves.

The **Cutaneous Nerves** (Fig. 96) consist of two sets, anterior and lateral. The *anterior* nerves, which are very small, will be found in two rows, one close to the linea alba, and the other piercing the tendon of the external oblique two inches from the median line; the *lateral* branches will be found of greater length, running along the fibres of the same muscle and also giving a few small twigs backwards. Both sets are derived from the dorsal spinal nerves. About two inches behind the anterior spine of the ilium and half an inch above the crest will be found the lateral cutaneous branch of the *last dorsal* nerve, and close upon the crest of the bone, a little posterior to the preceding nerve, will be seen the *iliac branch of the ilio-hypogastric* nerve (1st lumbar), both of them going to the buttock (13).

Accompanying the nerves will be found (in a well injected body only) small branches of arteries derived from the intercostal, internal mammary, and epigastric arteries.

[The external oblique muscle is to be cleaned, the dissector beginning from below on the right side, and from above on the left, and taking care not to remove its tendon near the median line by mistake. The interdigitations with the serratus magnus and latissimus dorsi are to be carefully defined.]

The **Obliquus Externus** (Fig. 97, 12) has its *origin* from the outer surfaces of the eight lower ribs, and thus interdigitates with the serratus magnus by five points above, and with the latissimus dorsi by three points below. Its fibres pass obliquely downwards and forwards towards the middle line, except the posterior ones, which pass almost vertically to the crest of the ilium.

[In order to see the whole of the insertion of this muscle, it will be necessary to continue the dissection by reflecting the triangle of skin left upon the groin.]

The **Superficial Fascia of the Groin** (Fig. 98) differs from that over the abdomen in being divisible into two layers—superficial and deep.

The *superficial layer of superficial fascia* (*a*) resembles that found elsewhere, but the *deep layer* (*b*) (Scarpa's fascia) is more membranous. It is directly continuous with the deep layer of the superficial fascia in the perinæum (p. 187), and is attached firmly to the

Fig. 97.

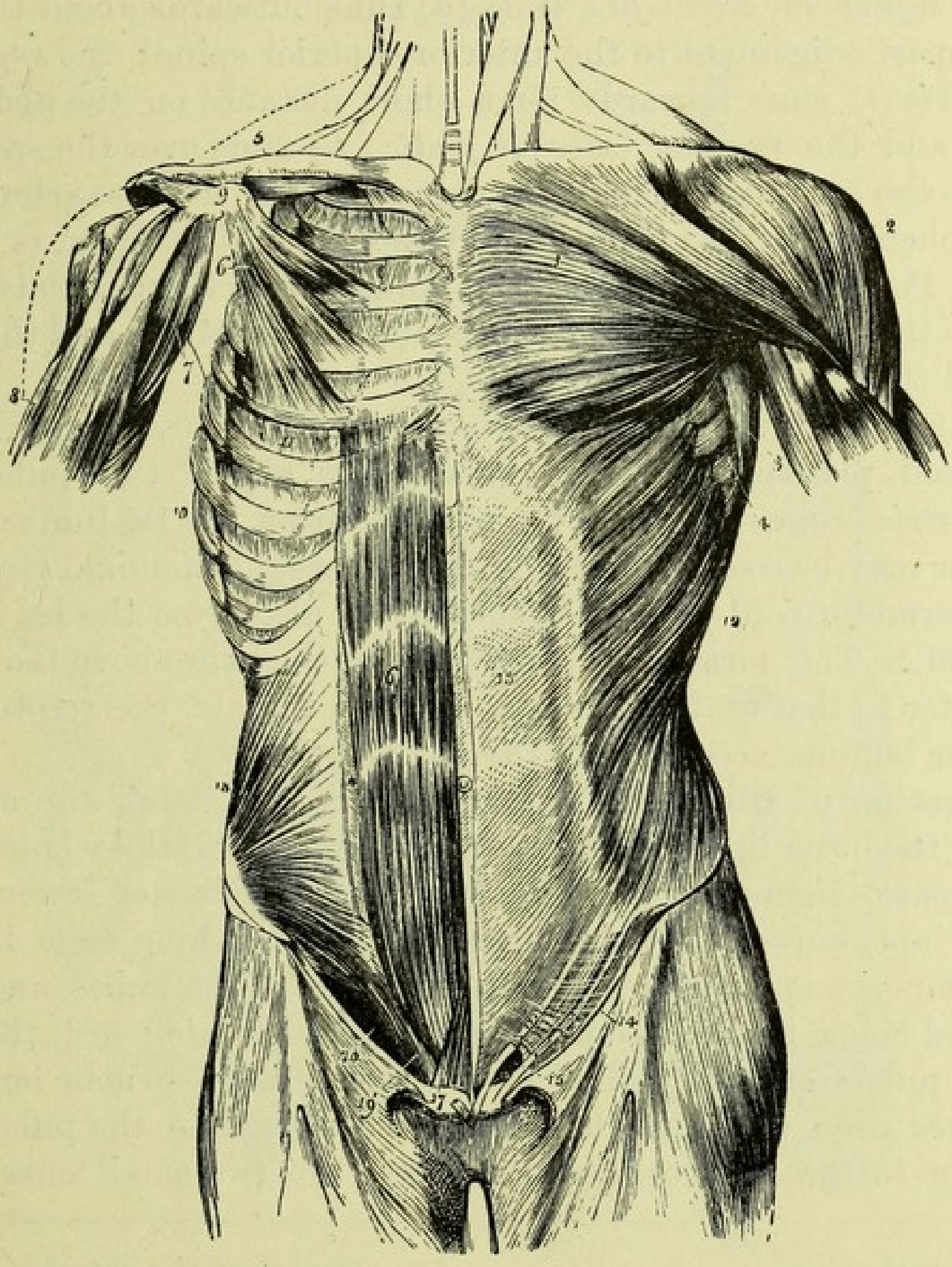


Fig. 97.—Muscles of the anterior aspect of the trunk (from Wilson); on the left side of the body the superficial layer is seen, on the right the deeper layer.

1. Pectoralis major.
2. Deltoid.
3. Anterior border of the latissimus dorsi.
4. Serratus magnus.
5. Subclavius, right side.
6. Pectoralis minor.
7. Coraco-brachialis.
8. Upper part of the biceps, showing its two heads.
9. Coracoid process of the scapula.
10. Serratus magnus, right side.
11. External intercostal muscle of the fifth intercostal space.

fascia lata of the thigh a little below Poupart's ligament, thus preventing any urine which may have been infiltrated into the tissues from passing down the thigh.

Superficial Vessels and Nerves (Fig. 98).—Between the layers of superficial fascia will be found three small branches of the femoral artery, with their accompanying veins.

The *superficial circumflex iliac* (*d*) runs outwards about the level of Poupart's ligament to the anterior superior spine; the *superficial epigastric* (*e*) runs upwards for a short distance on the abdominal wall; and the *superior external pudic* (*f*) runs over the spermatic cord to the scrotum. The veins corresponding to these arteries join the saphenous vein as it opens into the femoral. Upon, or a little below, Poupart's ligament will be found two or three glands, which receive the lymphatics from the penis and scrotum, and the parts around the anus.

The tendon of the obliquus externus being exposed, a nerve will be found piercing it about two inches above the pubes—the *hypogastric branch of the ilio-hypogastric* from the 1st lumbar; and another may be seen issuing from the external abdominal ring upon the spermatic cord—the *ilio-inguinal* (*n*) also from the 1st lumbar (Fig. 96). The former is distributed to the skin above the pubes, the latter to that of the groin, as well as that of the scrotum and penis or labium, according to the sex.

Insertion of Obliquus Externus (Fig. 98).—1st, the anterior half of the outer lip of the crest of the ilium; 2nd, the whole length of Poupart's ligament, which is, in fact, the thickened lower border of the aponeurosis of the external oblique, reaching from the anterior superior spine of the ilium to the spine of the pubes, and being attached below to the iliac portion of the fascia lata; 3rd, the front of the pubes and the pubic crest; and 4th, the whole length of the *linea alba*, *i.e.* from the ensiform cartilage to the pubes. In addition to these larger insertions there are two small ones which

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12. External oblique.
13. Its aponeurosis: the median line to the right of this number is the linea alba; the curved line to its left, the linea semilunaris; the transverse lines above and below the number, the lineæ transversæ.
14. Poupart's ligament.
15. External abdominal ring.
16. Rectus muscle of the right side brought into view by the removal of the anterior segment of its sheath; * posterior segment of its sheath with the divided edge of the anterior segment.
17. Pyramidalis muscle.
18. Internal oblique.
19. Conjoined tendon of the internal oblique and transversalis.
20. The lower curved border of the internal oblique muscle.

cannot be defined in the present stage, viz., into the ilio-pectineal line (forming Gimbernat's ligament), and into the crest of the pubes of the opposite side, forming the triangular fascia.

Immediately above the pubes, the spermatic cord (or the round ligament of the uterus in the female) will be seen to emerge from an opening in the tendon, the outline of which is obscured by the

Fig. 98.

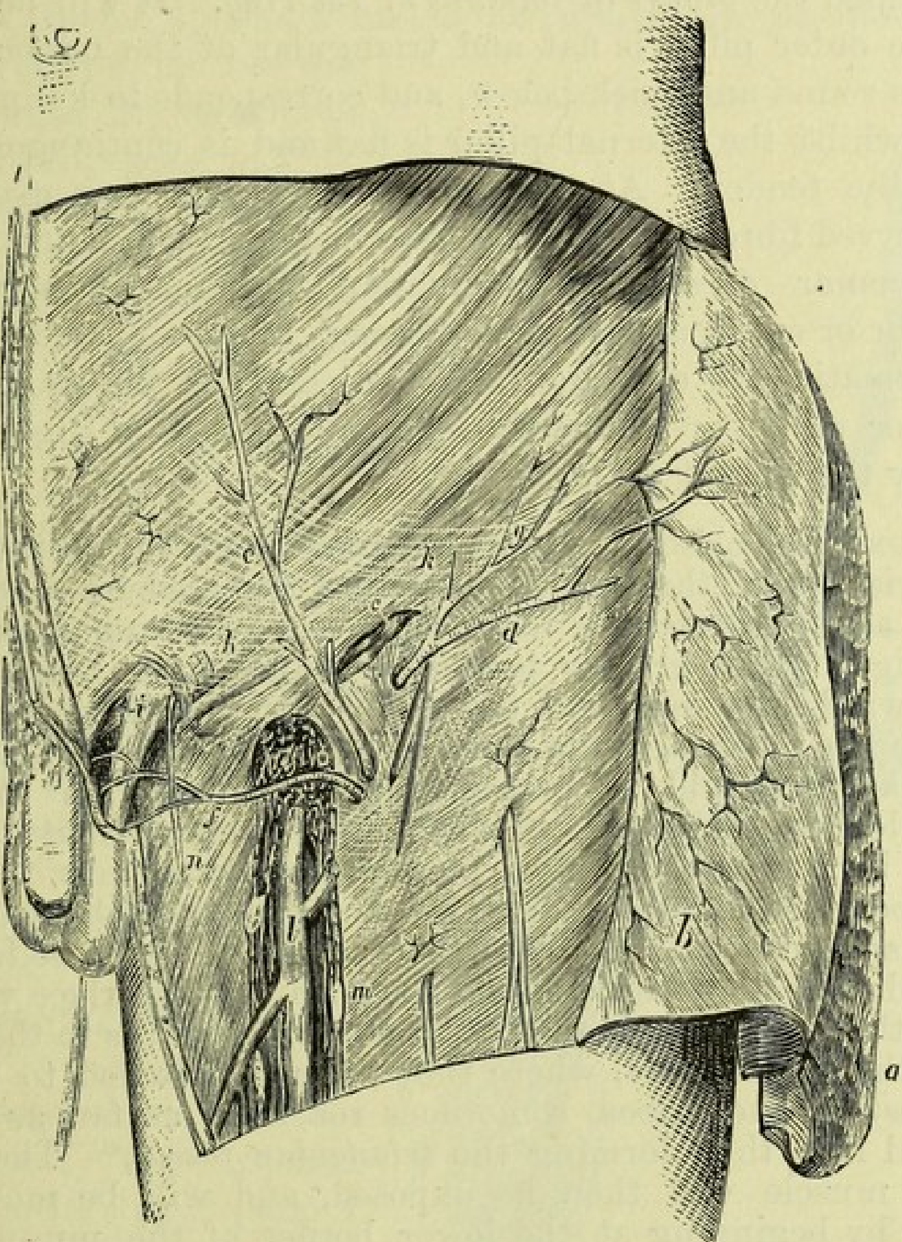


Fig. 98.—Superficial dissection of the inguinal and femoral regions (from Wood 'On Rupture').

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

intercolumnar or *external spermatic fascia*, which must be removed to expose the abdominal ring.

The **External Abdominal Ring** (Fig. 98, *i*) is merely a slit in the external oblique tendon, placed obliquely, immediately above and to the outer side of the spine of the pubes. In the healthy subject it is triangular with the base downwards and inwards, being about an inch in length and half an inch across, and its boundaries have been named the *pillars* or *columns of the ring*. It will be observed that the outer pillar is flat and triangular at the upper part, but becomes round and thick below, and corresponds to Poupart's ligament; whilst the internal pillar is flat and is continuous with the rest of the tendon. At the upper part of the ring may be seen some curved fibres running in a transverse direction and called the *intercolumnar fibres*, the continuation of which forms the intercolumnar or external spermatic fascia. It should be noticed that the spermatic cord does not lie in the centre of the ring, but upon the outer pillar or Poupart's ligament, which is slightly drawn down by the weight of the testis.

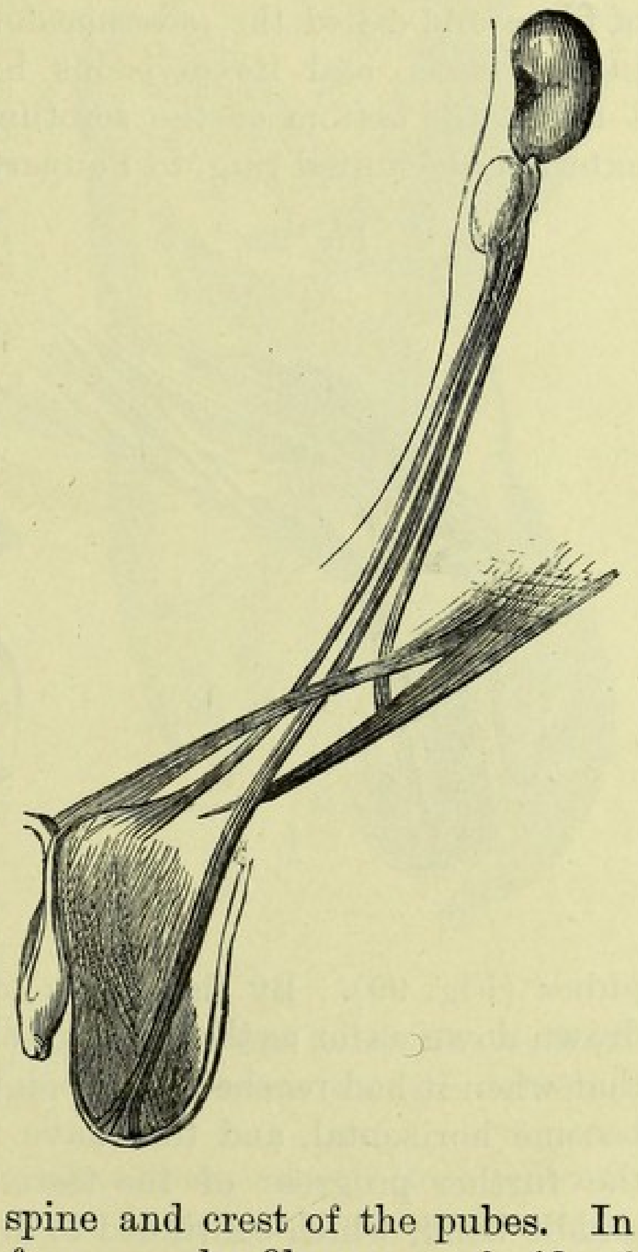
[The external oblique is to be reflected by cutting, both vertically and horizontally, through its muscular fibres where they join the tendon, and by detaching them from the ribs immediately below their origin. The greater part of the muscle can then be turned back towards the loin, and the corresponding tendon may be dissected up as far as possible towards the median line. The handle of the knife should be passed under the triangular portion of tendon left in the groin, after which the tendon may be readily divided by a vertical incision, parallel to and as near the median line as possible, and reflected towards the thigh without endangering the subjacent parts. When this is done, it will be found that the tendinous fibres of one side decussate or interlace with those of the other immediately above the pubes, and cross to the opposite side of the median line, where they become attached to the spine and crest of the pubes, sometimes reaching as far as the ilio-pectineal line, thus forming the *triangular fascia*.* The internal oblique muscle will then be exposed, and will be most readily cleaned by beginning at the lower border of the muscle on the right side, and at the upper border on the left side of the subject. Near Poupart's ligament, a little more of the ilio-hypogastric and ilio-inguinal nerves will be seen.]

The **Obliquus Internus** (Fig. 96, 7).—The fibres of this muscle take the opposite direction to those of the obliquus externus, and

* This tissue, which can be defined in well-developed subjects only, is better named triangular *fascia* than triangular *ligament*, which is apt to be confounded with the deep fascia of the perinæum.

therefore have their origin below and their insertion chiefly above. The *origin* is from the anterior two-thirds of the middle of the crest of the ilium; from the outer half of Poupart's ligament; and slightly from the fascia lumborum. The upper fibres pass to be *inserted* into the cartilages of the last four ribs, where they become continuous with those of the internal intercostal muscles. Below this the muscle is inserted into the cartilages of the 7th and 8th ribs, the xiphoid appendix, and to the linea alba by an aponeurosis, which is split to enclose the rectus and form its sheath, as will be afterwards seen, p. 219; while the lower fibres, becoming gradually more and more horizontal in their course to the middle line, in the end arch downwards to help to form the *conjoined tendon*, and to be *inserted* into the crest of the pubes, and into the ilio-pectineal line behind the attachment of Gimbernat's ligament.

Fig. 99.



In the male subject, some pale muscular fibres will be found to be continuous with the lower border of the internal oblique and to overlie the spermatic cord, forming the *cremaster muscle.*

The **Cremaster** (Fig. 103, *h*), consists of a series of thin muscular loops spread over the spermatic cord. It is attached *externally* to the inner part of Poupart's ligament, where it is continuous with the internal oblique, and *internally* to the spine and crest of the pubes. In addition to the loops, there are a few muscular fibres on each side of the spermatic cord connected with the *cremasteric fascia*. The cremaster is *supplied* by the genital branch of the genito-crural nerve.

Figs. 99, 100, 101.—Diagrams to illustrate the descent of the testis and the formation of the tunica vaginalis (drawn by J. T. Gray).

To explain the formation of this muscle it will be necessary to refer to the early stage of fœtal life, when the testis was situated within the abdomen and immediately below the kidney.

About the seventh month of fœtal life the testis passes through the internal abdominal ring, and by the eighth month reaches the scrotum, a process of peritoneum (*processus vaginalis*) preceding it, and being connected with the testis by the *plica gubernatrix*. The looped fibres of the cremaster would appear to be fibres of the internal oblique drawn down by the testicle in its descent.

According to Curling, a muscular band, consisting of three sets of fibres and called the *gubernaculum testis*, passed from the pubes to the testis, and its divisions had the following attachments – one to the bottom of the scrotum, and one on each side of the external abdominal ring, to Poupart's ligament and the crest of the

Fig. 100.

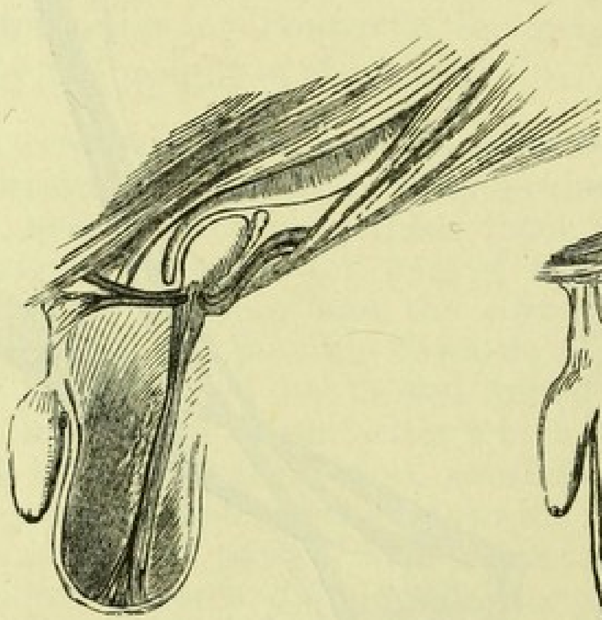
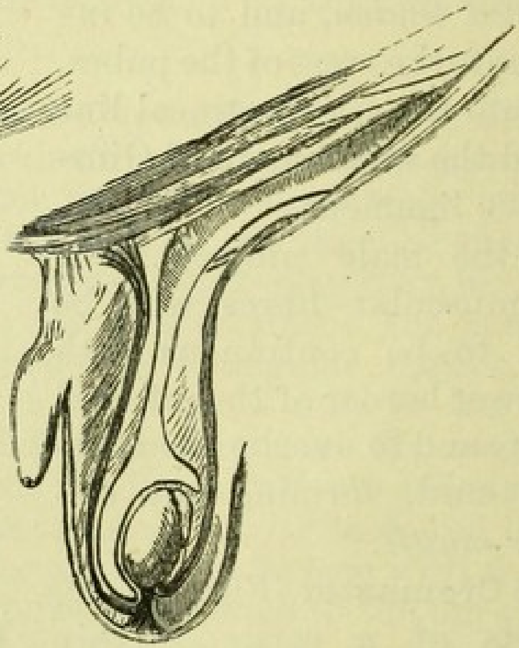


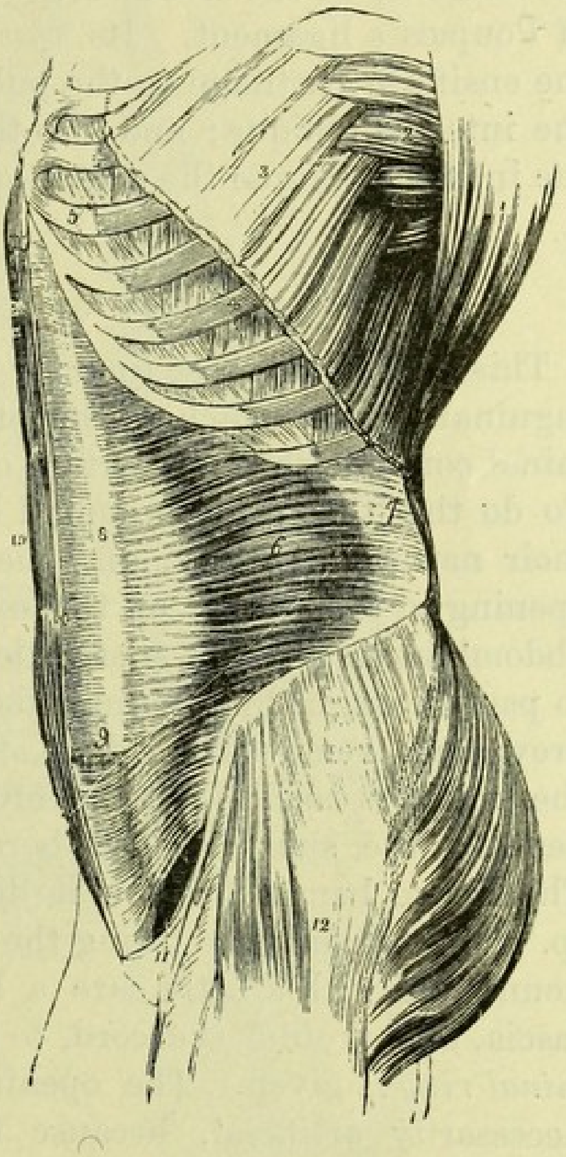
Fig. 101.



pubes (Fig. 99). By the action of these bands the testicle was drawn down as far as the external abdominal ring, but it is obvious that when it had reached this point the lateral bands must have become horizontal, and thus have lost all power of traction; and the further progress of the testis depended therefore upon the middle band, which continued to draw the gland to the bottom of the scrotum (Fig. 100). The effect of this was to stretch the lateral bands attached to the pubes on each side, and thus they formed more or less complete loops upon the cord, and constituted the cremaster muscle, being aided by the lower fibres of the internal oblique, which were drawn down by the testicle in its progress (Fig. 101). It must be added, however, that more recent observations render it more than doubtful if the descent of the testis is actually accomplished by these means.

[The internal oblique is to be divided by a vertical incision from the last rib to the middle of the crest of the ilium, and this is to be carried along the crest and Poupart's ligament to near the lower border of the muscle. The muscular fibres must be carefully divided until a cellular interval is reached, in which, near the crista ilii, will be found the branches of an artery (deep circumflex iliac). The muscle is then to be turned backwards and forwards, care being taken not to injure the exposed nerves or the subjacent transversalis muscle.]

Fig. 102.



The **Nerves** (Fig. 96), five or six in number, are the branches of the lower dorsal nerves, which run horizontally forwards to pierce the rectus muscle and emerge on the front of the abdomen. At this stage they may be seen giving off their *lateral cutaneous* branches, which pierce the obliquus internus at once. Close above the crista ilii may be found the branches of the first lumbar nerve (16) (ilio-hypogastric and ilio-inguinal), running downwards to the pubes.

The **Transversalis Muscle** (Fig. 102, 6) has its *origin*—1, from the inner surfaces of the cartilages of the lower six ribs, where it

Fig. 102.—Lateral view of the transversalis abdominis muscle (from Wilson).

1. Latissimus dorsi.
2. Serratus magnus.
3. Upper part of the external oblique.
4. Two of the external intercostal muscles.
5. Two of the internal intercostals.
6. Transversalis.
7. Its posterior aponeurosis.
8. Its anterior aponeurosis passing behind the sheath of the rectus.
9. Lower part of the left rectus with the aponeurosis of the internal oblique and transversalis passing in front.
10. Right rectus muscle.
11. Poupart's ligament.
12. Tensor vaginæ femoris and gluteus medius invested by fascia lata.

interdigitates with the diaphragm; 2, by a strong aponeurosis, which posteriorly is divided into three parts, attached respectively to the anterior surfaces of the transverse processes, to the tips of the transverse processes, and to the spinous processes of all the lumbar vertebræ (together forming what is commonly called the *fascia lumborum*) (Fig. 111); 3, from the anterior two-thirds of the inner lip of the crest of the ilium, and 4, from the outer third of Poupart's ligament. Its *insertion* is into the middle line from the ensiform cartilage to the pubes, being inseparably united with the internal oblique; and into the ilio-pectineal line, forming with the internal oblique the *conjoined tendon.*

Anatomy of Inguinal Hernia.

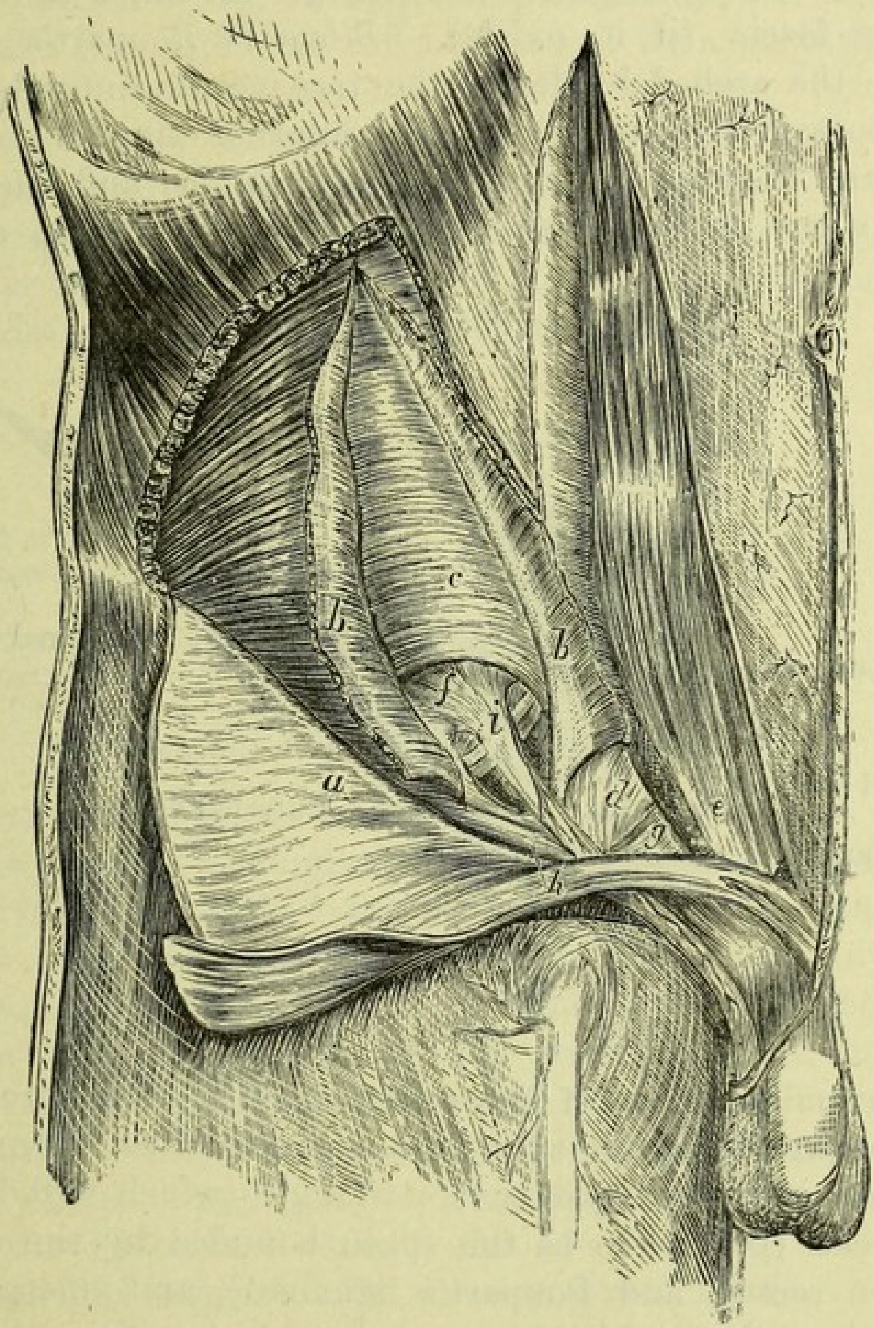
This will be the best time for examining the parts concerned in inguinal hernia, which is the protrusion of some part of the abdominal contents through certain openings in the region of the groin. To do this the muscles should be restored as nearly as possible to their natural positions, and the student will then see again the opening in the tendon of the external oblique called the external abdominal ring. The spermatic cord with its vessels will be seen to pass through this opening (the intercolumnar fascia having been previously removed), and on tracing up the cord by turning the muscles aside in their order, it will be found to disappear beneath the sharp arched border of the transversalis muscle. The tissue beneath which it disappears is the *facia transversalis* (p. 220), a membrane lining the abdomen externally to the peritoneum, and with a little care a hole may be demonstrated in this fascia, and around the cord, to which the name of *internal abdominal ring* is given. The opening of the internal ring is however necessarily artificial, because the fascia transversalis was prolonged upon the cord when the testis was drawn out of the abdomen; this prolongation thus taking the shape of a funnel, and being hence called the *infundibular fascia.** (Fig. 103, *i.*)

The **Internal Abdominal Ring** (Fig. 104), is an opening in the fascia transversalis, placed midway between the symphysis pubis and the anterior superior iliac spine, and about half an inch above Poupart's ligament, immediately externally to the deep epigastric vessels. The fascia is distinctly thickened at the lower and outer parts of the ring.

* The infundibular fascia has also been called the internal spermatic fascia.

The **Inguinal Canal** (Fig. 103) is the space between the external and internal abdominal rings, an inch and a half in length, and is occupied by the spermatic cord. The simplest way therefore to

Fig. 103.



study the boundaries of the canal will be to take them in their relation to the cord which lies in it (Fig. 104).

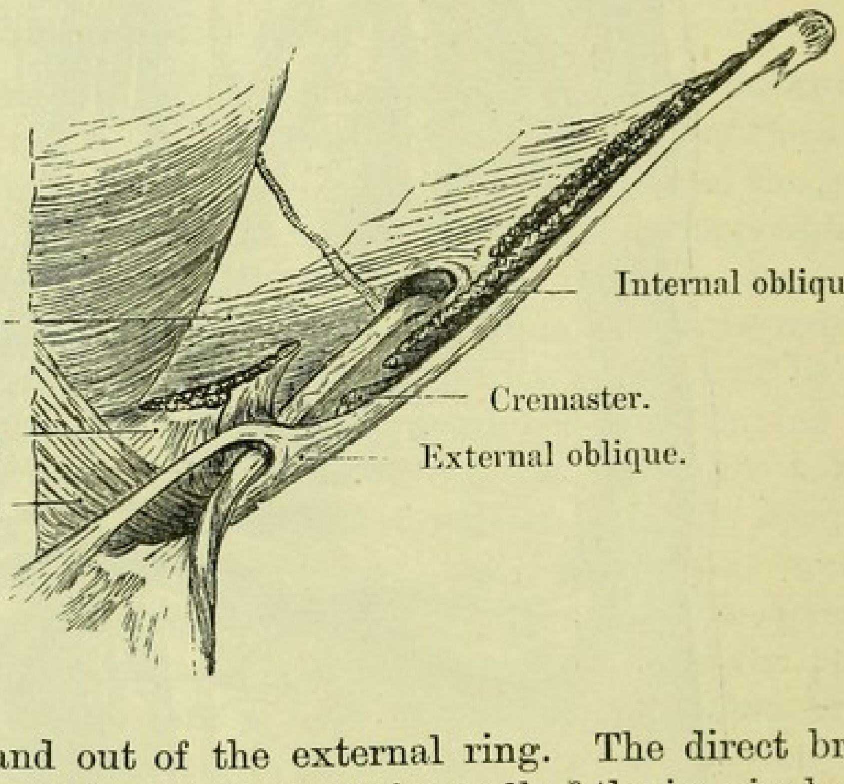
Fig. 103.—Dissection of the inguinal canal (from Wood 'On Rupture').

a. External oblique (turned down).
b, *b*. Internal oblique.
c. Transversalis.
d. Conjoined tendon.
e. Rectus abdominis with sheath opened.
f. Fascia transversalis.
g. Triangular fascia.
h. Cremaster.
i. Infundibular fascia.

In front of the inguinal canal are 1, (in its whole length) the tendon of the external oblique; 2, (in its outer third) the lowest part of the muscular fibres of the internal oblique; and 3, a small portion of the cremaster. *Behind* are—beginning nearest the internal ring—1, the fascia transversalis (for the whole length of the canal); 2, the conjoined tendon (in its inner third); 3, the triangular fascia (if it exists). *Below* is Poupart's ligament. *Above* are the arched border of the transversalis muscle, and the interval between that muscle and the internal oblique.

Inguinal Hernia is of two kinds, *oblique* and *direct*. The oblique passes through the internal abdominal ring, along the

Fig. 104.



inguinal canal and out of the external ring. The direct breaks through or pushes before it the posterior wall of the inguinal canal at its lower part in Hesselbach's triangle (which will be subsequently seen (p. 221) to be the space bounded by the epigastric artery, the rectus, and Poupart's ligament), and emerges at the external ring, thus taking a more *direct* course than the *oblique* variety.

The *coverings* of each hernia will be best seen by tracing them from within outwards; thus oblique hernia would have (1) peritoneal sac; (2) in coming through the internal ring it would have the fascia transversalis, or infundibular fascia; (3) in passing

Fig. 104.—Diagram of the inguinal canal, showing its anterior and posterior boundaries (drawn by J. T. Gray).

beneath the internal oblique it would have the cremaster muscle, the fibres of which are united by cellular tissue and are sometimes known as the cremasteric fascia; in emerging from the external ring it would have (4) the intercolumnar or spermatic fascia, and (5) the superficial fascia and skin.

A direct hernia would have (1) the peritoneum, and (2) the fascia transversalis (for both line the abdomen); then pushing into the inguinal canal it would have a covering (3) from the conjoined tendon; and lastly emerging from the external ring, it would have (4) the intercolumnar or spermatic fascia, and (5) the superficial fascia and skin. Thus the number of coverings of both varieties is the same, the difference consisting in the substitution of the conjoined tendon for the cremaster muscle.

Coverings of Inguinal Hernia.

Oblique.	*Direct.*
Peritoneum or sac.	Peritoneum or sac.
Fascia transversalis (or infundibular fascia.	Fascia transversalis.
Cremaster muscle (or fascia).	Conjoined tendon.
Intercolumnar or spermatic fascia.	Intercolumnar or spermatic fascia.
Superficial fascia.	Superficial fascia.
Skin.	Skin.

By dividing the fascia transversalis immediately to the inner side of the internal abdominal ring, there will be found an artery called the deep epigastric, lying between the two rings and running in a line from the middle of Poupart's ligament towards the umbilicus; and the varieties of inguinal hernia have been named *external* or *internal* according to their relation to this vessel. It is obvious that a hernia, passing through the internal ring must be *external* to this artery, and hence oblique hernia and external hernia are synonymous terms. In the same way, direct hernia protrudes through the abdominal wall to the *inner* side of the epigastric artery, and thus internal is the same as direct hernia.

The anatomy of the parts concerned in hernia being fully comprehended, it will be readily seen that the direction in which force is to be applied to return the protruded bowel into the abdomen—commonly called the *taxis*—must differ in the two cases; and the student should notice the effect which the position of the body and limbs has upon the tissues near the groin. Thus, with the body and legs extended at full length, the lower part of the abdomen is rendered tense; whilst if the thigh is flexed upon the pelvis and adducted, and the body bowed forward, the structures become relaxed, and would more readily admit of the return of the protruded bowel.

Varieties of Hernia.—There are two varieties of oblique inguinal hernia, termed *congenital hernia* and *infantile* or *encysted hernia*, the anatomy of which requires explanation.

To understand these fully it will be necessary to refer for a moment to the descent of the testis (p. 210). When the testicle is in the abdomen it has the peritoneum attached to its surface, and during its descent into the scrotum it accordingly drags a fold of peritoneum down with it, so that at first a tube extends along the whole length of the inguinal canal (Fig. 101). By a natural

Fig. 105.

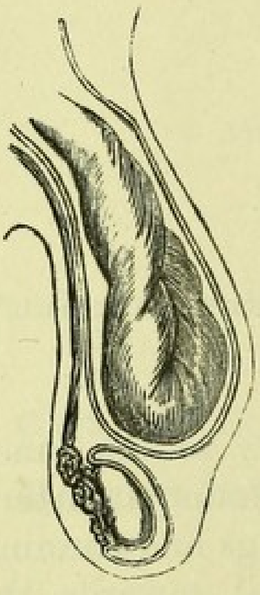


Fig. 106.

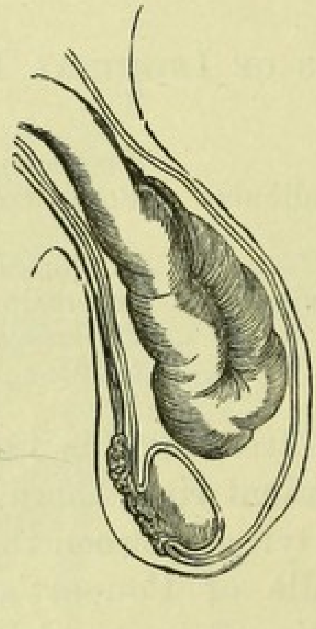
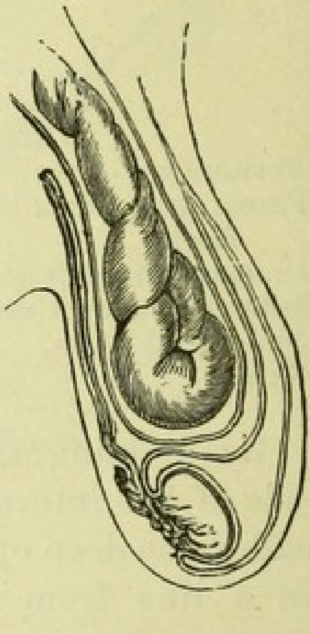


Fig. 107.



process during the later months of fœtal life, however, an obliteration of the portion of tube within the canal takes place, and thus a small sac is formed around the testis which is called the *tunica vaginalis*, while a mere dimple is left in the peritoneum at the internal ring. Thus when in the ordinary condition of the parts a hernia descends, its sac is above and quite distinct from the tunica vaginalis (Fig. 105).

Occasionally, however, this obliteration does not take place, and the tunica vaginalis remains continuous with the peritoneum. In

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Fig. 105.—Diagram of a common scrotal hernia, showing the relation of the sac to the tunica vaginalis testis (J. T. Gray).

Fig. 106.—Diagram of a congenital hernia, the sac being continuous with the tunica vaginalis testis (J. T. Gray).

Fig. 107.—Diagram of an infantile hernia, showing the tunica vaginalis prolonged in front of the sac (J. T. Gray).

that case the hernia descends at once into the tunica vaginalis and lies over the testis, and being the consequence of a congenital defect it is termed *congenital hernia* (Fig. 106).

In what is termed *congenital hydrocele* the anatomical arrangement is the same, and the fluid runs from the peritoneal cavity into the scrotum and back again, according to the position of the patient.

Infantile or *encysted hernia* exists when only a partial obliteration of the peritoneal tube has taken place, and the tunica vaginalis is left larger than usual and prolonged into the inguinal canal to a slight extent. Thus when a hernia descends, it pushes down behind this portion of the tunica vaginalis, and there are therefore three layers of serous membrane in front of that covering the intestine, two being formed by the tunica vaginalis and one by the peritoneal sac (Fig. 107).

There are two varieties of direct inguinal hernia which depend upon the subdivision of Hesselbach's triangle into two pouches by the obliterated hypogastric artery (p. 221). The commoner form passes straight through or protrudes the conjoined tendon, as described above; the rarer issues externally to the obliterated hypogastric artery and the conjoined tendon, and thus occupies a great part of the inguinal canal, but although simulating an ordinary oblique hernia the epigastric artery is external to its neck. It has been called the *superior internal*, or the *internal oblique* hernia.

Surgery.—*Operation for Strangulated Hernia.*—In this operation the object is to reach and divide any tissue which presses upon the bowel and prevents its return within the abdomen. An incision is made over the external ring, and the surgeon dissects carefully down through the several layers (which are never distinctly separable in practice) until he reaches the peritoneal sac, which is recognised by its bluish appearance. Passing the forefinger carefully around this he feels for the stricture, which may possibly be at the external ring (where it is easily divided), or more probably within the inguinal canal. Having discovered the stricture, he next passes the hernia-knife along the finger, and, using it or a director as a guide, insinuates the knife, held flat, beneath the stricture, and divides it by bringing the edge of the knife upwards and pressing it against the tissues with the finger.

The direction in which the superficial incision is made is of little consequence, but in the deep incision the rule is to cut directly *upwards*, so as to be parallel to the epigastric artery ; for since a mistake in the diagnosis between an external and an internal hernia may occur, owing to the parts becoming distorted and the abdominal rings drawn together in old-standing herniæ, it is well to be careful lest the artery should be divided.

Radical Cure of Hernia.—Various operations for the radical cure of hernia have been employed of late, the principle of all being to draw together more or less completely the walls of the inguinal canal, with or without removal of the peritoneal sac. The operation can be done either by a free incision, exposing the external ring, the pillars of which are then stitched together, or by the subcutaneous application of a ligature through a small incision, as recommended by Wood. In this, the left forefinger being passed beneath the margin of the conjoined tendon, a needle is thrust through the tendon and afterwards through the internal and external pillars of the ring, and these three points are drawn together, thus occluding the canal.

The **Spermatic Cord** may now be examined, and will be found to consist of the *vas deferens* or duct of the testicle, together with the spermatic artery and its complicated plexus of veins, bound together with loose areolar tissue and covered more or less by the cremaster muscle. In a well-injected subject a small branch may be traced from the epigastric artery to the cord, which is the *cremasteric* branch; and the genital branch of the genito-crural nerve may be found in the cremaster muscle, which it supplies. The position of the vas deferens at the back of the cord should be noticed, and may always be recognised by its feeling like a piece of whipcord. Upon the vas may be found a small branch of the vesical artery—the *deferential* branch.

Tunica Vaginalis Testis (Fig. 105).—By drawing the testicle out of the scrotum and making an incision over the anterior part of it, the *tunica vaginalis* will be opened, and will be seen to consist of two parts, the tunica vaginalis *propria* upon the testis, and the *reflexa* or part around. The tunica vaginalis propria converts the subjacent tunica albuginea into a fibro-serous membrane, a structure similar to that which constitutes the pericardium and the dura-mater.

The **Penis** should now be examined, and the student may advantageously practise the operation of circumcision. It should be noticed that the skin assumes the character of mucous membrane at the margin of the fore-skin or *prepuce*, and that it retains this appearance as it covers the *glans penis*. The true mucous membrane, however, does not extend beyond the orifice of the urethra. Below the orifice of the urethra will be found the fold called the *frœnum præputii*, and around the base of the glans penis is a circular ridge, the *corona glandis*, upon which open a number of sebaceous glands, the *glandulæ odoriferæ*, that secrete the *smegma præputii*. An incision is to be carried along the upper surface of the penis, when there will be found in the middle line the single *dorsal vein*, with the *dorsal artery* and *nerve* on each side of it, the nerve being most external. The artery and nerve are the terminations of the pudic artery and nerve, and the vein passes through the triangular ligament to open into the prostatic plexus.

The *Suspensory Ligament* of the penis is a triangular piece of strong fibrous tissue, attached to the front of the symphysis pubis and to the upper surface of the penis, where it is divided into two layers to give passage to the dorsal vessels and nerves.

[Returning to the abdominal wall the dissector will find the rectus muscle close to the median line and still enclosed in its sheath, through which it is indistinctly visible. The line between the recti is known as the *linea alba*, that at the outer border of each muscle as the *linea semilunaris*, and the transverse markings, three or four in number, are the *lineæ transversæ*.]

The **Sheath of the Rectus** (Fig. 103) having been opened by a vertical incision, will be found to be formed by the tendon of the internal oblique, which splits at the linea semilunaris to enclose it. Thus in front of the muscle there is the tendon of the obliquus externus and one-half of the tendon of the obliquus internus, whilst behind is the other half of the tendon of the obliquus internus and the tendon of the transversalis. This arrangement does not hold good throughout, for upon lifting up the lower part of the rectus it will be found that a little below the umbilicus (seldom so low as midway between the umbilicus and pubes) the sheath is wanting behind, *i.e.* the aponeurosis does not split, but passes entirely in front, and below this level there is nothing between the muscle and the peritoneum but the fascia transversalis.

The point where the sheath ceases to pass behind the rectus is marked by a sharp curved margin (fold of Douglas), over which the epigastric vessels will be seen to pass, and which will be afterwards seen from behind (Fig. 108, *c*).

[In many subjects immediately above the pubes, in front of the rectus and enclosed in its sheath, will be found a little muscular slip, the pyramidalis. Both muscles are to be cleaned in the direction of their fibres.]

The **Pyramidalis** (Fig. 97, 17) *arises* from the crest of the pubes close to the median line, and passes up for about two inches to be *inserted* into the linea alba.

The **Rectus Abdominis** (Fig. 97, 16) *arises* by two heads, one from the crest and the other from the symphysis pubis. It expands into a broad thin muscle, and is *inserted* into the ensiform cartilage and into the cartilages of the last three true ribs (5th, 6th and 7th).

The lineæ transversæ are tendinous intersections corresponding to abdominal ribs; one is placed nearly opposite the umbilicus, a second at the level of the ensiform cartilage, and a third between them. A fourth is occasionally found between the umbilicus and the pubes.

The **Epigastric Artery** (Fig. 103) is to be traced into the rectus muscle, which it will be found to enter at the part where the sheath is deficient, passing over the fold of Douglas. The muscle should be divided and carefully dissected off the artery, which may be traced up to the sternum, where it anastomoses with the internal mammary artery. This is a most important anastomosis, forming a direct communication between the subclavian and the external iliac arteries, which comes into play after ligature of the external or common iliacs, or obstruction of the descending aorta.

The nerves piercing the rectus are the terminations of the lower intercostal nerves, which pass through it and the sheath to reach the skin (Fig. 96).

The **Fascia Transversalis** is the membrane lining the transversalis muscle, and is continuous with the *fascia iliaca* covering the iliacus muscle. It varies in appearance, being usually thin and transparent, but in fat subjects becoming thickened and united with the sub-peritoneal layer of adipose tissue. Midway between the anterior superior iliac spines and the symphysis pubis, and half an inch above Poupart's ligament in the fascia tranversalis, is the *internal abdominal ring*, through which the spermatic cord of the male and the round ligament of the female reach the groin, receiving in their passage a covering from the fascia transversalis (infundibular fascia). Beneath the middle of Poupart's ligament the fascia transversalis passes upon the external iliac vessels, to join the iliac fascia in forming the sheath of the femoral vessels (p. 94), and a few thickened fibres lying beneath Poupart's ligament form the *deep crural arch*.

Action of the Abdominal Muscles.—The abdominal muscles, when put in action, compress the viscera, and thus act as muscles of *expiration*, and in direct opposition to the diaphragm. The attachment of the muscles to the lower ribs enables them at the same time to depress the wall of the thorax, thus assisting the internal intercostal muscles. The abdominal muscles are called into play chiefly in violent expiratory efforts, such as coughing, sneezing, etc., and have a most important action upon the viscera during the acts of micturition, defæcation, vomiting, and parturition. The rectus abdominis has the power of approximating the pelvis and thorax, as seen in rising from the supine position without the aid of the hands, or in climbing. When spasmodically contracted in tetanus, it produces the bowed condition of the trunk known as *emprosthotonos*.

The abdominal muscles are *supplied* by the lower six intercostal nerves, and by the ilio-hypogastric and ilio-inguinal branches of the first lumbar nerve (Fig. 96).

[The abdominal wall having been finished on both sides, the dissectors should cut through the remains of the abdominal muscles in two or three places until the peritoneum is exposed, but without injuring the latter, in order to study the appearance of the membrane which forms the sac of a hernia. They should then open the abdomen and dissect the viscera together.]

Cavity of the Abdomen.

[The abdomen is to be opened by a transverse incision at the level of the umbilicus, and another cut is to be carried from the umbilicus to the sternum, a little to the left of the median line.]

By holding up the lower portion of the abdominal wall before dividing it in the median line, and viewing it from behind, the dissectors will perceive through the peritoneum five cords taking a course towards the umbilicus (Fig. 108). The central cord is the obliterated urachus (*m*), those on each side of it are the obliterated hypogastric arteries (*i*), and the outside ones are the two epigastric arteries (*b*) seen through the wall. The peritoneum is raised into distinct folds by the obliterated hypogastric arteries, and externally to the epigastric artery on each side may be seen a small dimple in the membrane, marking the position of the internal abdominal ring. The term "Hesselbach's triangle" (*d*) has been applied to the triangular space bounded by the border of the rectus internally, the epigastric artery externally, and Poupart's ligament below, and it is through this that direct inguinal hernia forces its way. It is, as was pointed out above (p. 217), subdivided into two parts by the obliterated hypogastric artery, which, like the epigastric artery is often supported by a distinct fold of peritoneum. The fold of Douglas (*c*), or sharp lower margin of the posterior sheath of the rectus, will be readily perceived through the peritoneum.

[By dividing the lower portion of the abdominal wall in the median line, it can be reflected on each side, and the abdominal contents will be exposed.]

Abdominal Cavity (Fig. 109).—The parts first seen on opening the abdomen are the stomach and right lobe of the liver, with a small portion of the left lobe and the gall-bladder if distended,

Fig. 108.

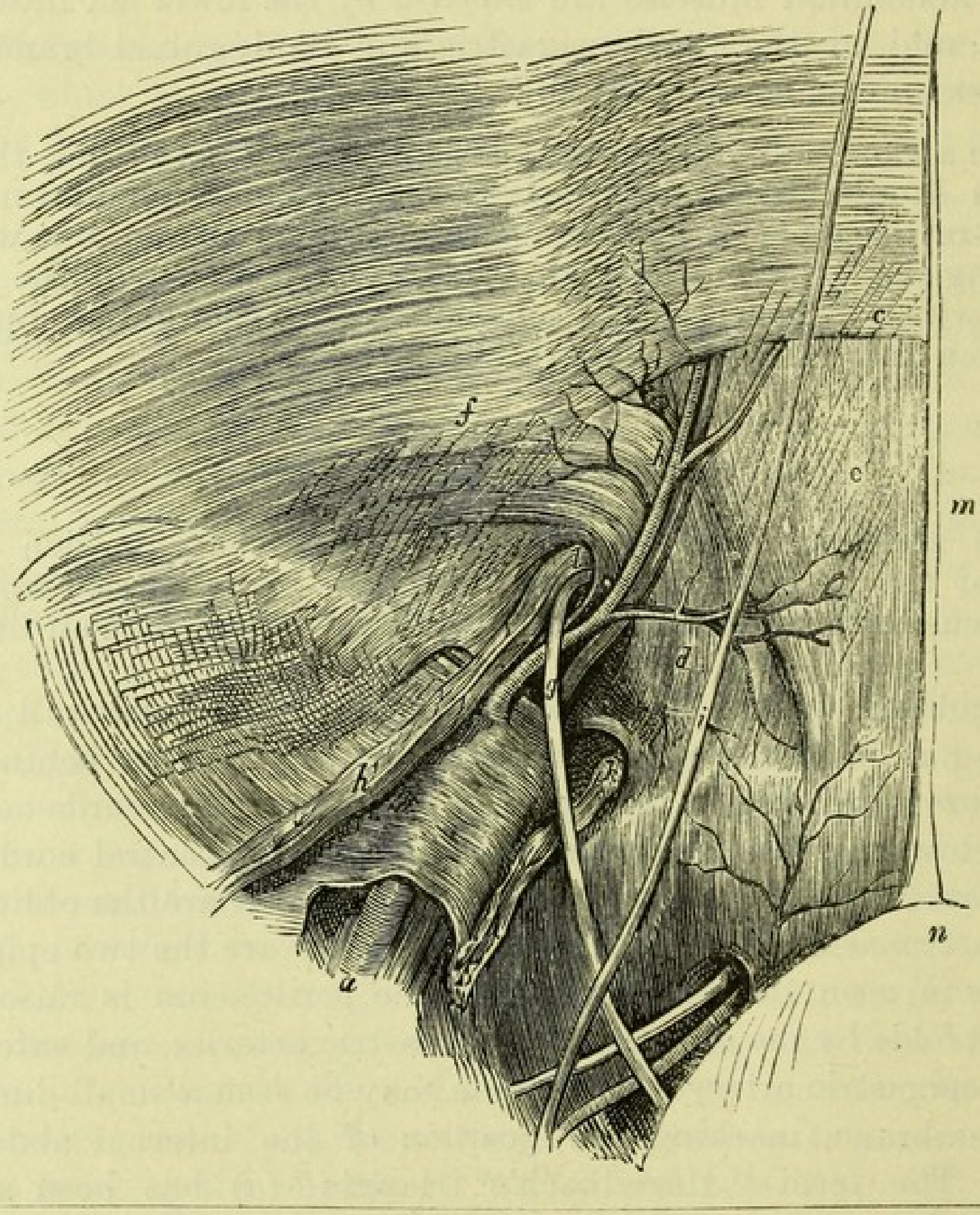
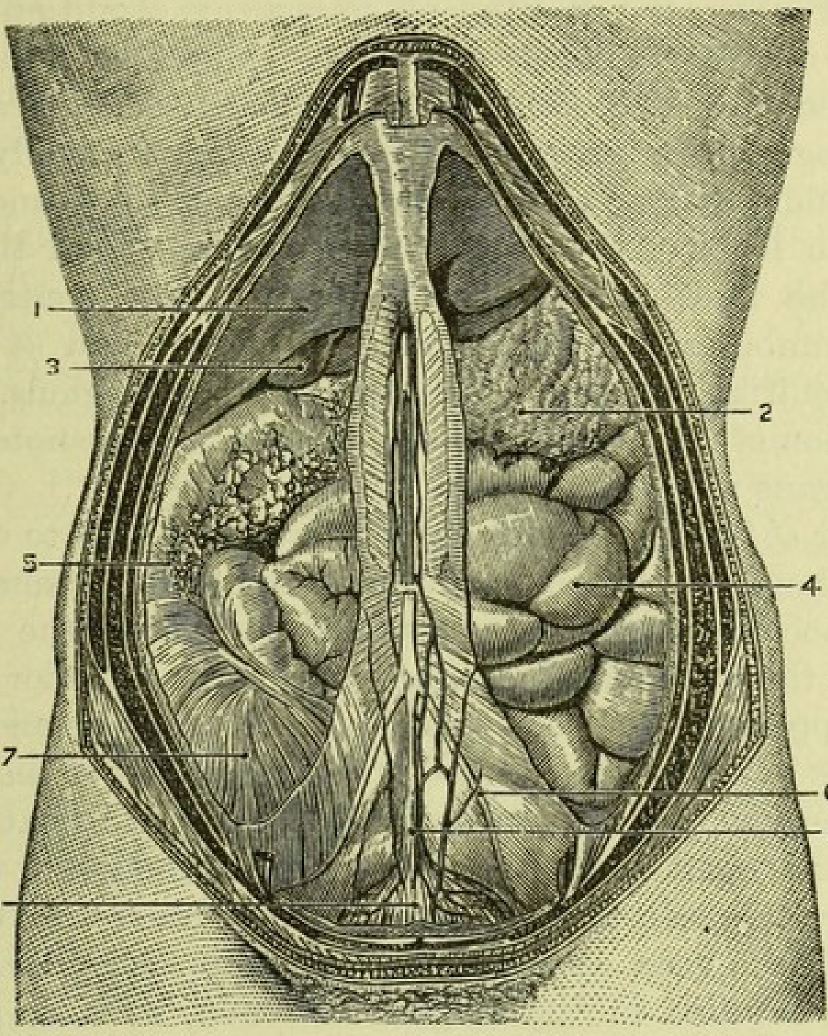


Fig. 108.—Dissection of the lower part of the abdominal wall from within, the peritoneum having been removed (from Wood 'On Rupture').

a. External iliac artery.
b. Epigastric artery.
c. Border of the posterior part of the sheath of the rectus (fold of Douglas).
d. Conjoined tendon in the triangle of Hesselbach.
e. Posterior surface of rectus.
f. Fascia transversalis.
g. Vas deferens.
h. Spermatic vessels.
i. Obliterated hypogastric artery.
k. Lymphatics in crural ring.
l. Internal abdominal ring.
m. Urachus.
n. Bladder.

whilst the great omentum passing down from the stomach conceals the rest of the intestines. Should, however, the great omentum be turned up, as often happens, the mass of the small intestines

Fig. 109.



REGIONS OF THE ABDOMEN.

Right Hypochondriac.	Epigastric.	Left Hypochondriac.
Right Lumbar.	Umbilical.	Left Lumbar.
Right Iliac.	Hypogastric.	Left Iliac.

Fig. 109.—The abdominal viscera *in situ*, the front of the abdominal wall except a narrow mesial portion of peritoneum having been removed (from Béraud).

1. Liver.
2. Transverse colon and great omentum (the latter tucked up).
3. Gall bladder.
4. Coils of small intestine.
5. Ascending colon.
6. Obliterated hypogastric artery.
7. Cæcum.
8. Urachus.
9. Bladder.

will be visible, and immediately below the stomach the transverse colon. The ascending and descending colon will be more or less visible on each side, according to the amount of their distension. A very much distended bladder, or the pregnant uterus, would be visible at once, and the amount of liver and stomach which appears will depend upon the healthy or unhealthy condition of those organs, and upon their not having been displaced by tight-lacing.

For convenience of description the abdomen is divided into the following regions, by imaginary lines passing vertically upwards from the middle of Poupart's ligament on each side; and horizontally, at the level of the ninth costal cartilages and the highest points of the iliac crests, respectively. In the centre are the epigastric, umbilical, and hypogastric regions; and at each side the hypochondriac, lumbar, and iliac or inguinal regions.

The position of the several viscera should now be noted and the different organs identified.

Beginning at the upper part, the *liver* will be found to occupy the right hypochondriac, the epigastric, and sometimes a small part of the left hypochondriac regions; passing to it from the umbilicus will be seen the obliterated umbilical vein. Its anterior margin is sharp; its upper surface corresponds to the diaphragm and abdominal wall; its lower surface touches the pyloric end of the stomach, the commencement of the duodenum, the hepatic flexure of the colon and the right kidney; and its posterior surface or border will be afterwards seen to be adapted to the crura of the diaphragm, and to touch the vena cava and the left suprarenal capsule. The *stomach* will be seen in the epigastric region, with its greater or left end reaching into the left hypochondrium. By drawing this end out from beneath the ribs, the spleen will be found attached to it, and will also frequently be found to be bound firmly to the diaphragm by old inflammatory adhesions. Tracing the stomach to the right side it will be found to reach almost to the gall-bladder and to terminate in the small intestine (duodenum), and the point of demarcation between the organs is marked by a thickened band of fibres, the pylorus. In front of the stomach are the diaphragm, the abdominal wall, and the liver; behind it will afterwards be seen the pancreas, the crura of the diaphragm, the aorta and vena cava, and the left kidney. The *duodenum* can be traced for a short distance only at present. By drawing up the great omentum the transverse colon will be exposed crossing the umbilical region, and continuous on the right side with the ascending colon, and on the left with the descending colon, which should be traced out. Occupying chiefly the hypogastric, but extending into several other regions, are the coils of the small intestine, two-fifths of which constitute the *jejunum*, and the remainder the *ileum*; this may be seen to end in the large intestine in the right iliac fossa, where the commencement of the colon (*caput cœcum coli*, or *cœcum*) will be recognised by its little appendage, the *appendix vermiformis*. In the left iliac region will be seen the tortuous portion of the large intestine, called the *sigmoid flexure*, which may be traced to its termination in the *rectum* at the brim of the true pelvis.

TABLE OF ABDOMINAL CONTENTS.

Right Hypochondriac Region.	*Epigastric Region.*	*Left Hypochondriac Region.*
Right lobe of liver and hepatic flexure of colon, right supra-renal capsule, and part of right kidney.	Stomach (centre and both orifices), left lobe and part of right lobe of liver, gall bladder and 1st and 2nd parts of duodenum; cœliac axis, abdominal aorta, vena cava, semi-lunar ganglia, receptaculum chyli, and vena azygos; pancreas, upper or inner part of spleen, parts of kidneys, and supra-renal capsules.	Stomach (cardiac end), spleen and tail of pancreas, splenic flexure of colon, left supra-renal capsule, and part of left kidney, sometimes also a part of liver.
Right Lumbar Region.	*Umbilical Region.*	*Left Lumbar Region.*
Ascending colon, small intestine, part of right kidney.	Great omentum, transverse colon, 3rd portion of duodenum, parts of both kidneys, and small intestine.	Descending colon, small intestine, left kidney.
Right Iliac Region.	*Hypogastric Region.*	*Left Iliac Region.*
Cæcum coli, vermiform appendix and part of ileum.	Small intestines, apex of bladder in distension and in children. Pregnant uterus.	Sigmoid flexure and small intestines.

The above table of necessity includes organs whose positions cannot be seen at present, and will be subsequently studied.

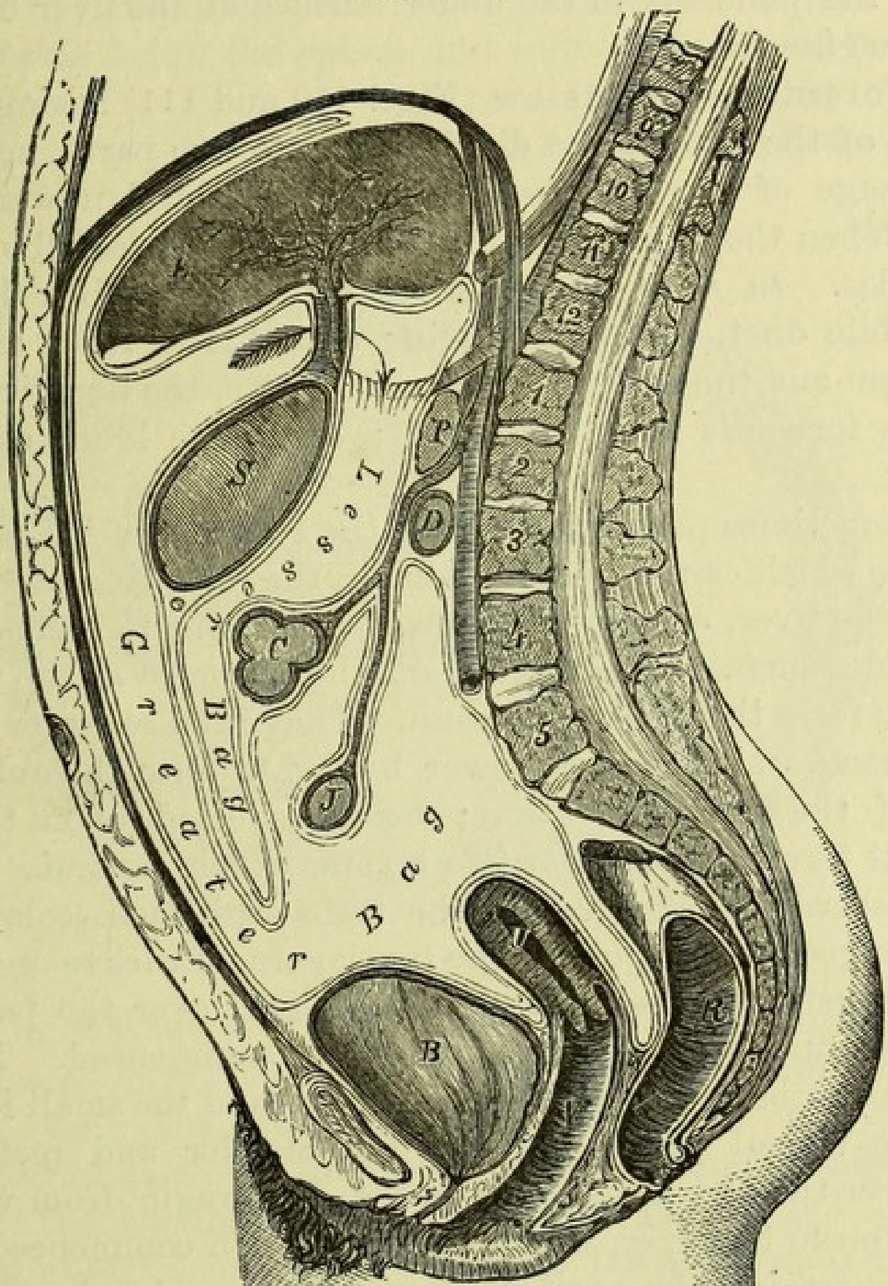
It will be well for the student to notice the distinctive appearances of the several parts of the intestinal canal, and particularly the differences between the large and small intestines. The condition of the intestines will vary so much according to the mode of death, that mere size is no criterion, the small intestines being occasionally distended to a much greater size than the large; but attention to the following points will prevent all possibility of error. The cylinder of the small intestine is uniform throughout, and the surface is perfectly smooth; the large intestine on the contrary will be found to be pouched or slightly constricted at short intervals throughout, except the rectum. Moreover it will be seen to be marked by distinct bands of longitudinal muscular fibres, three in number, and in most subjects small pieces of fat (*appendices epiploicæ*) will be found attached along the free border. In the healthy condition the large intestine is about as large again as the small intestine.

The **Peritoneum** (Fig. 110).—The serous membrane covering the intestines is now to be traced, in doing which the student must bear in mind that he has already opened the cavity of the peritoneum, which was previously a shut sac. The best way to learn the peritoneum is to trace it as simply as possible at first, and afterwards to study any complications.

Beginning at the umbilicus the membrane will be seen to line the abdominal wall, and so to reach the diaphragm; from this it is reflected on the upper surface of the liver, round its anterior margin, and on the under surface of the organ as far back as the transverse fissure. It then passes down to the stomach, forming the anterior layer of the *gastro-hepatic* or *lesser omentum*, covers the anterior surface of the stomach, and is prolonged downwards over the intestines to form the anterior layer of the *great omentum* or *epiploon*. By turning up the great omentum, the peritoneum will be seen to be reflected upon itself to form the posterior layer of the great omentum, which is continued upwards until it meets with the transverse colon, behind which it is prolonged to the spine, forming the under layer of the *transverse meso-colon*. It is now carried over the mesenteric vessels to the small intestine and back to the spine, thus forming the two layers of the *mesentery;* and it can then be seen to pass over the abdominal aorta into the pelvis, where it invests the rectum (*meso-rectum*) and passes from that intestine to the bladder, forming in the male the *recto-vesical pouch.* In the female the peritoneum is reflected from the rectum to the upper part of the vagina, forming the *recto-vaginal pouch* (*cul-de-sac of Douglas*), then over the uterus and between the uterus and bladder, forming the *utero-vesical pouch.* It is lastly carried over the bladder to the lower part of the abdominal wall and so to the umbilicus.

What is called the *greater bag* of the peritoneum has now been traced, but there is another pouch called the *lesser bag* placed behind it in part, and continuous with it through a hole or tube, the *foramen of Winslow.* This will be found by passing the finger carefully round the right border of the lesser omentum, immediately below the liver, when its point may be seen through the semi-transparent *double* fold of the lesser omentum. To see the cavity of the lesser bag, an incision must be carefully made through the double anterior layer of the great omentum, when, if the parts are healthy, the bag will be readily opened and the finger passed through the foramen of Winslow will be clearly seen.

Fig. 110.



Tracing it from the foramen, the membrane of the lesser bag will be found to form the posterior layer of the lesser omentum, then

Fig. 110.—Diagram of vertical section of the peritoneum (drawn by J. T. Gray).

The continuation of the greater with the lesser bag through the foramen of Winslow is marked by an arrow.

L. Liver.	J. Jejunum.	B. Bladder.
S. Stomach.	P. Pancreas.	U. Uterus.
C. Colon.	D. Duodenum.	R. Rectum.

to cover the posterior surface of the stomach, and to be prolonged downwards to form the two internal layers of the great omentum; after which it covers the upper part of the transverse colon and forms the upper layer of the transverse meso-colon. It then passes up over the pancreas to the under surface of the liver behind the transverse fissure.

The **Foramen of Winslow** (Figs. 110 and 111) is simply a constriction of the peritoneum dividing it into two parts, produced by the passage of the hepatic artery forwards and upwards to the liver. When the finger is in the foramen it will feel the following boundaries. *In front*, the lesser omentum containing the hepatic artery, bile duct, and portal vein; *behind*, the right crus of the diaphragm and the inferior vena cava ; *below*, the hepatic artery (as it passes forwards from the aorta) ; *above*, the lobus caudatus of the liver.

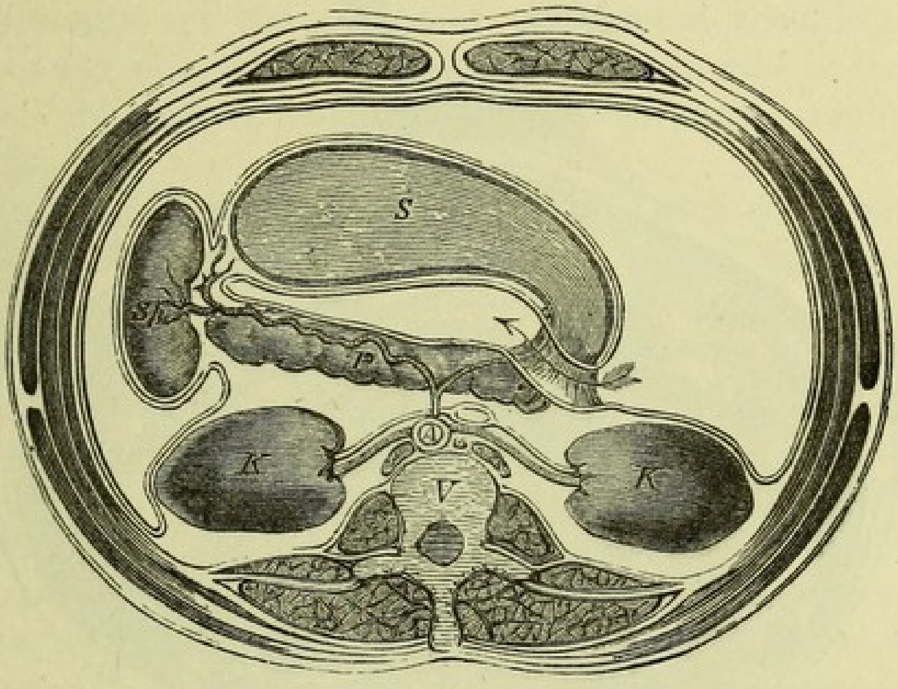
It is sometimes preferred to trace the two sacs of the peritoneum together, which can be readily done in the following way. Beginning at the liver, one layer covers the front and the other the back of the under surface of the organ, and the two meet at the transverse fissure to form the lesser omentum. They then separate to enclose the stomach, uniting at its lower border to form the anterior two layers of the great omentum; being reflected upon themselves they next form the posterior two layers, which separate to enclose the transverse colon, forming the transverse meso-colon as they are prolonged to the spine. The two layers now leave one another, and the upper one (lesser bag) is prolonged over the pancreas to the under surface of the liver, where it commenced. The under layer (greater bag) forms the mesentery around the small intestines; the recto-vesical pouch between the bladder and rectum; and passes over the abdominal wall to the diaphragm, from which it is reflected on to the liver, where the description commenced.

Besides tracing the peritoneum vertically as has been shown, it should be traced horizontally as follows. Below the level of the transverse colon the circle will be found to be exceedingly simple. Beginning at the median line of the abdominal wall, the peritoneum may be traced to the right iliac region, where it will be found to surround the cæcum and to cover the front of the ascending colon (forming the *meso-cæcum* and the *ascending meso-colon*); it then forms the *mesentery*, a fold by which the small intestine is attached to the spine, any portion of which will serve to show it; and lastly, covering the anterior surface of the descending colon and the sigmoid flexure (*descending meso-colon* and *sigmoid meso-colon*) it is brought round again to the abdominal wall. The ascending colon is not unfrequently, especially in children, completely surrounded by peritoneum.

A fold attaching the top of the descending colon to the under surface of the diaphragm (*costo-colic*, Jenner) should be noticed, since it passes below the spleen and influences the movements of that organ.

Above the colon the arrangement is a little complicated by the

Fig. 111.



existence of the two sacs, the continuity of which, however, may thus be traced (Fig. 111). Beginning at the median line of the abdominal wall, the peritoneum may be traced into the right hypochondrium and over the right kidney; it then passes through the loop of the hepatic artery (foramen Winslowii), and across the body in front of the pancreas almost as far as the spleen, then to the posterior surface of the stomach and back to the foramen again, where it forms the posterior layer of the lesser omentum. Reflected at this point upon itself, the membrane will be seen to form the anterior layer of the lesser omentum and to be continued over the

Fig. 111.—Transverse section of the abdomen at the level of the foramen of Winslow (drawn by J. T. Gray).

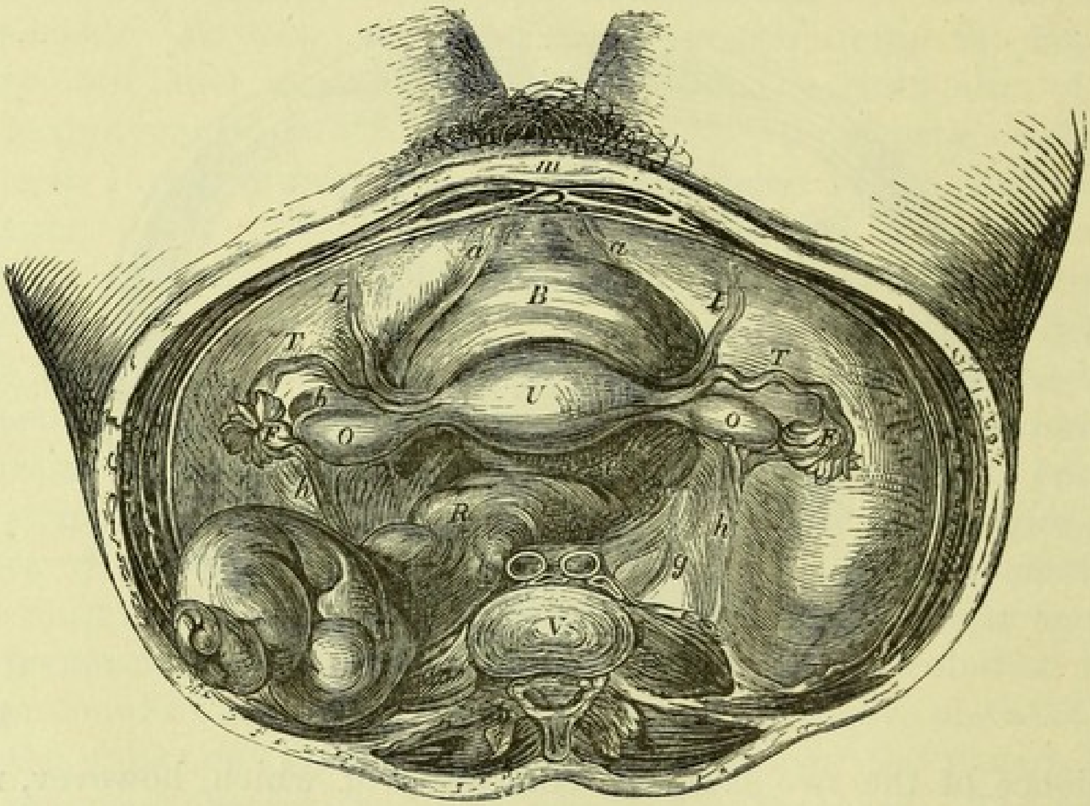
The arrow passes from the greater bag to the lesser bag of the peritoneum through the foramen of Winslow, which is seen in section.

S. Stomach. Sp. Spleen. V. Vertebra.
P. Pancreas. K. Kidney. A. Aorta.

front of the stomach; thence (forming the *gastro-splenic omentum*) to the spleen, which it encloses, and so to the left hypochondrium and round the abdominal wall. The continuity of the greater with the lesser bag is thus evident, and the foramen of Winslow is seen to be merely the narrowed tube of communication between the two cavities.

Besides the folds of peritoneum which have been named in

Fig. 112.



tracing the membrane, these are others which form certain ligaments of the liver and bladder, and of the uterus in the female.

Passing from the umbilicus to the Liver the obliterated umbilical vein or *round ligament* is seen, and around it is reflected a double fold of peritoneum, the *suspensory* or *falciform ligament* of the liver. This is prolonged on each side over the diaphragm and on to the upper surface of the liver, where it forms the upper layer of the

Fig. 112.—Female pelvic organs, seen from above (from Savage).

a, a. Obliterated hypogastric arteries.
b. Broad ligament of uterus.
e. Posterior ligament of uterus.
g. Ureter.
h. Ovarian vessels.
m. Linea alba and section of urachus.
B. Bladder.
L. Round ligament of uterus.
F. Fimbriated extremity of Fallopian Tube.
T. Fallopian Tube.
O. Ovary.
R. Rectum.
U. Uterus.
V. Fifth lumbar vertebra.

coronary ligament; the under layer being formed partly by the lesser bag of the peritoneum, and the triangular surface of the liver between the two being attached by firm areolar tissue to the diaphragm. The doubled edges of the upper layer of the coronary ligament on each side are called the right and left *lateral ligaments.*

The *false ligaments* of the Bladder are formed by the peritoneum; they are five in number, two posterior, two lateral, and one superior. The *posterior* false ligaments are the margins of the recto-vesical pouch, and are formed by the membrane being reflected over the obliterated hypogastric arteries. The *lateral* false ligaments are the pieces of peritoneum reaching from the bladder to the sides of the pelvis, and the *superior* is that passing over the obliterated hypogastric arteries and urachus to the umbilicus.

In the female (Fig. 112), the pelvis is divided transversely by a fold of peritoneum reaching from each side of the uterus to the side of the pelvis, and called the *broad ligament* of the uterus; in this will be found the ovary, the Fallopian tube, and the round ligament. It is by the open mouth of the Fallopian tube that the peritoneum has a communication with the mucous membrane of the uterus. The Uterus and Vagina intervene between the rectum and bladder of the female, and the peritoneum is prolonged from the rectum to the posterior wall of the vagina, and then over the uterus to the bladder, thus forming the *recto-vaginal* and *utero-vesical* pouches, the margins of which are the *anterior* and *posterior ligaments* of the uterus.

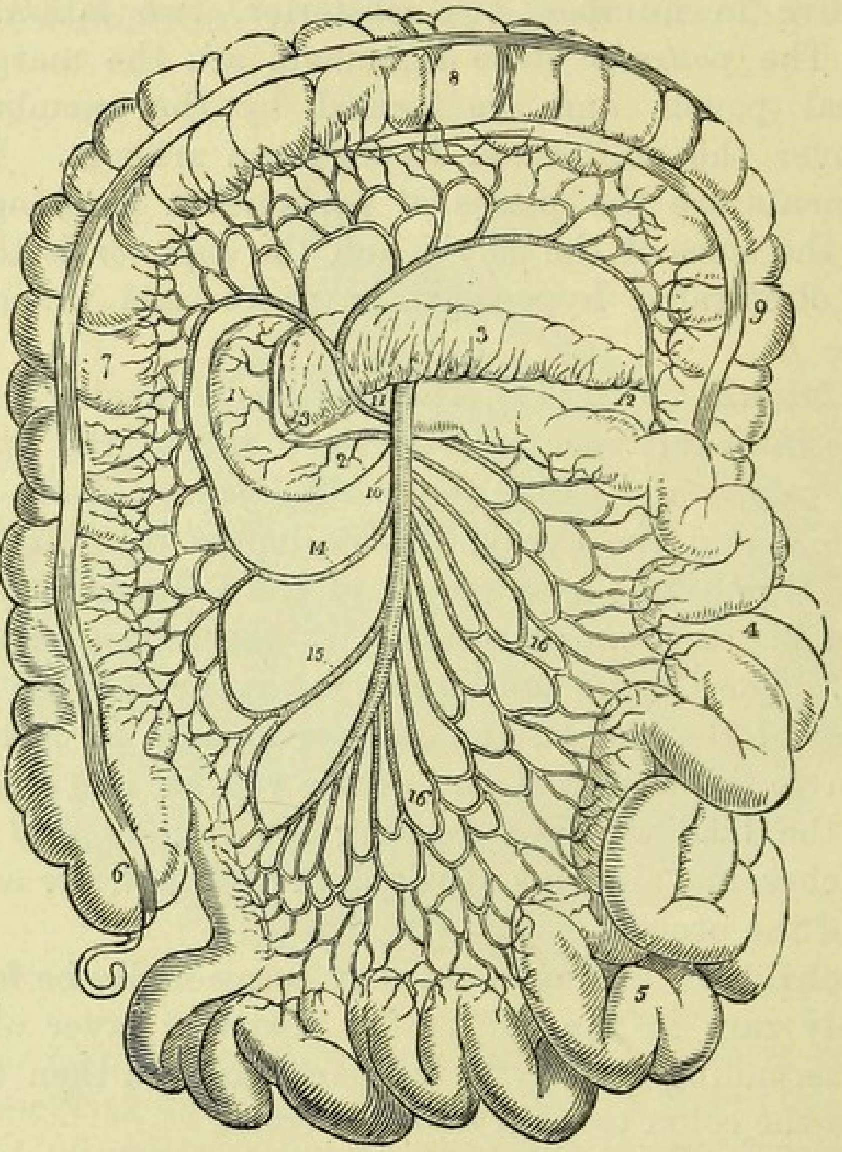
In the child an arrangement may occasionally be found which is extremely rare in the adult—the posterior layer of the great omentum ascending directly to the pancreas, and then being again reflected to the colon to form its meso-colon.

Mesenteric Vessels.

[In order to dissect the mesenteric arteries, the great omentum and transverse colon must be turned up over the cartilages of the ribs and the small intestines be drawn down. Beginning at the upper end of the jejunum (*i.e.*, at the point where the small intestine can first be distinctly seen), the dissector should remove the whole of the anterior layer of the mesentery as far as the edge of the bowel, where it is to be cut off. This must be continued along the whole length of the small intestine, and the mesentery will be found to pass obliquely downwards from left to right. After the vessels contained in the mesentery are cleaned, the under layer of the ascending and transverse meso-colon must be removed in the same way to expose the vessels going to the large intestine.]

The **Superior Mesenteric Artery** (Fig. 113, 10) is the vessel which supplies the small and half the large intestines. A branch

Fig. 113.



of the abdominal aorta, it comes off immediately behind the pancreas, and passes forward between it and the duodenum, giving

Fig. 113.—Course and distribution of the superior mesenteric artery (from Wilson).

1. Descending portion of the duodenum.
2. Transverse portion.
3. Pancreas.
4. Jejunum.
5. Ileum.
6. Cæcum and appendix vermiformis.
7. Ascending colon.
8. Transverse colon.
9. Descending colon.
10. Superior mesenteric artery.
11. Colica media.
12. Its anastomosis with the colica sinistra.
13. Pancreatico-duodenalis inferior
14. Colica dextra.
15. Ileo-colica.
16, 16. Vasa intestini tenuis.

off the *inferior pancreatico-duodenal* branch (13), which takes a curved course to the right, and between the head of the pancreas and the duodenum, to anastomose with the *superior pancreatico-*

Fig. 114.

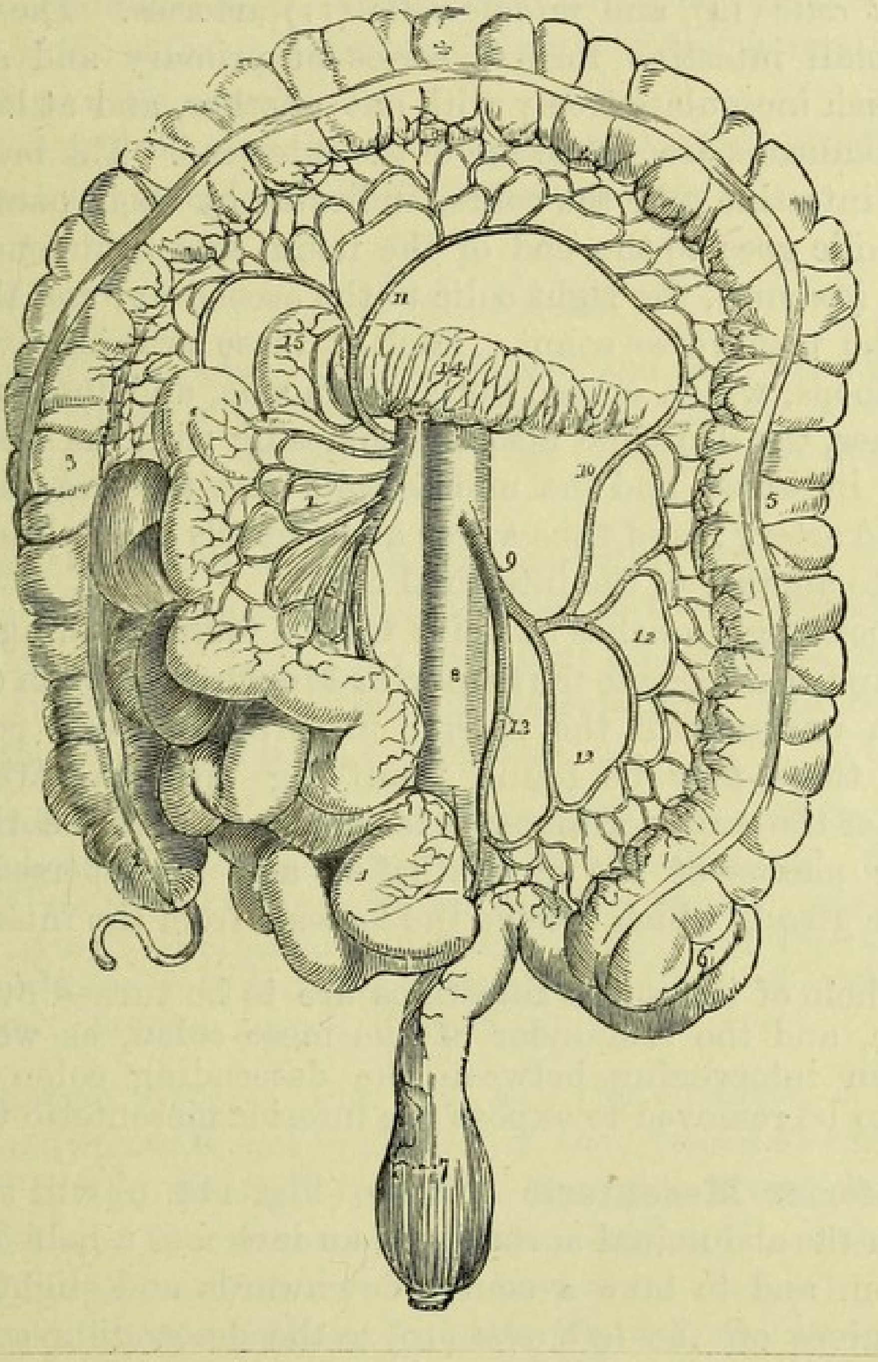


Fig. 114.—Branches of the inferior mesenteric artery (from Wilson).

1, 1. The superior mesenteric and small intestines turned over to the right side.
2. Cæcum and appendix cæci.
3. Ascending colon.
4. Transverse colon turned upwards.
5. Descending colon.
6. Sigmoid flexure.
7. Rectum.
8. Abdominal aorta.
9. Inferior mesenteric artery.
10. Colica sinistra inosculating with—
11. Colica media.
12, 12. Sigmoid branches.
13. Superior hæmorrhoidal artery.
14. Pancreas.
15. Descending portion of the duodenum.

duodenal artery. The trunk of the superior mesenteric artery will be seen to take a slightly curved direction from left to right, and from its convexity or left side are given the branches to the small intestine (16) (*vasa intestini tenuis*), while from its concavity or right side are given three branches to the large intestine, *ileo-colic* (15), *right colic* (14), and *middle colic* (11) arteries. The branches to the small intestine form a series of primary and secondary loops, which inosculate freely with one another, and at last ramify in the submucous areolar tissue of the intestine. The branches to the large intestine take the course indicated by their names; thus the ileo-colic goes to the end of the ileum and commencement of the colon (cæcum), the right colic to the ascending, and the middle colic to the transverse colon. Each of these arteries divides into primary loops, which spread out on each side, and inosculate with one another, the ileo-colic also anastomosing with the branches to the small intestine, and the middle colic with those of the inferior mesenteric artery; and thus a free anastomosis is established from one part to another of the intestinal canal.

Corresponding branches of veins will be found running with the arteries, and opening into the **Superior Mesenteric Vein** (Fig. 117, 5), which unites with the splenic to form the vena portæ. In addition, there may be found ramifying upon the arteries the branches of the superior mesenteric plexus of nerves derived from the solar plexus of the sympathetic; and interspersed are the lymphatic glands which receive the lacteals from the intestines.

[The whole of the small intestines are to be turned over to the right side, and the remainder of the meso-colon, as well as the peritoneum intervening between the descending colon and the spine, is to be removed to expose the inferior mesenteric vessels.]

The **Inferior Mesenteric Artery** (Fig. 114, 9) will be seen to arise from the abdominal aorta about an inch and a half above the bifurcation, and to take a course downwards and slightly to the left. It gives off the *left colic* (10) to the descending colon; the *sigmoid* (12) (three or four) to the sigmoid flexure; and lastly, the *superior hæmorrhoidal artery* (13), which descends into the pelvis to supply the rectum. These arteries form loops and anastomose freely with one another, and moreover, the left colic inosculates with the middle colic of the superior mesenteric, and the superior hæmorrhoidal with the middle hæmorrhoidal of the internal iliac artery.

The **Inferior Mesenteric Vein** (Fig. 117, 4) will be seen to have tributaries corresponding to the branches of the artery; amongst these is the superior hæmorrhoidal which anastomoses with the middle hæmorrhoidal (6), a tributary of the internal iliac vein. The inferior mesenteric vein passes upwards beneath the pancreas to join the splenic vein, and so into the vena portæ, thus forming a communication between the two great venous systems. Branches of the inferior mesenteric plexus of the sympathetic may be traced upon the vessels.

It may be noticed that the mesenteric veins never present dilatations, which is owing to their having no valves.

The Cœliac Axis.

[The intestines are now to be replaced, and the liver fastened up to the ribs, either with hooks or, better, by a few stitches: the stomach being then drawn down, the lesser omentum is to be carefully removed.]

Between the layers of the lesser omentum near its free border will be found three important structures, in the following relation to one another (Fig. 116). To the right and most in front is the bile-duct (7), to the left is the hepatic artery (5), and behind and between the two is the large vena portæ (9).

[Behind the lesser omentum in the middle line will be found the short trunk of the **Cœliac Axis** and its branches, viz., the gastric (coronaria ventriculi), the hepatic, and the splenic arteries. The branches are to be cleaned as far as exposed, but the cœliac axis itself should be left for the present, for fear of injuring the sympathetic plexuses surrounding it.]

The **Gastric Artery** (Fig. 115, 12), the smallest of the three, runs at first upwards and to the left, it then passes along the lesser curvature of the stomach from left to right, giving branches to both surfaces of that organ and to the œsophagus; it anastomoses at the pylorus with the pyloric branch of the hepatic artery. Branches of the sympathetic (gastric plexus) may be traced upon it. Its accompanying *vein* opens into the vena portæ.

The opportunity may be taken to notice the distribution of the pneumo-gastric nerve to the stomach. The left pneumo-gastric gives numerous branches to the front of the stomach, and the right to the back of the viscus, and these can be generally seen through the peritoneal coat without further dissection.

The **Hepatic Artery** (Fig. 115, 1) passes upwards and to the right side (thus forming the inferior and anterior boundaries of the foramen of Winslow), and will be seen to divide into the right and left hepatic branches, which enter the transverse fissure of the

Fig. 115.

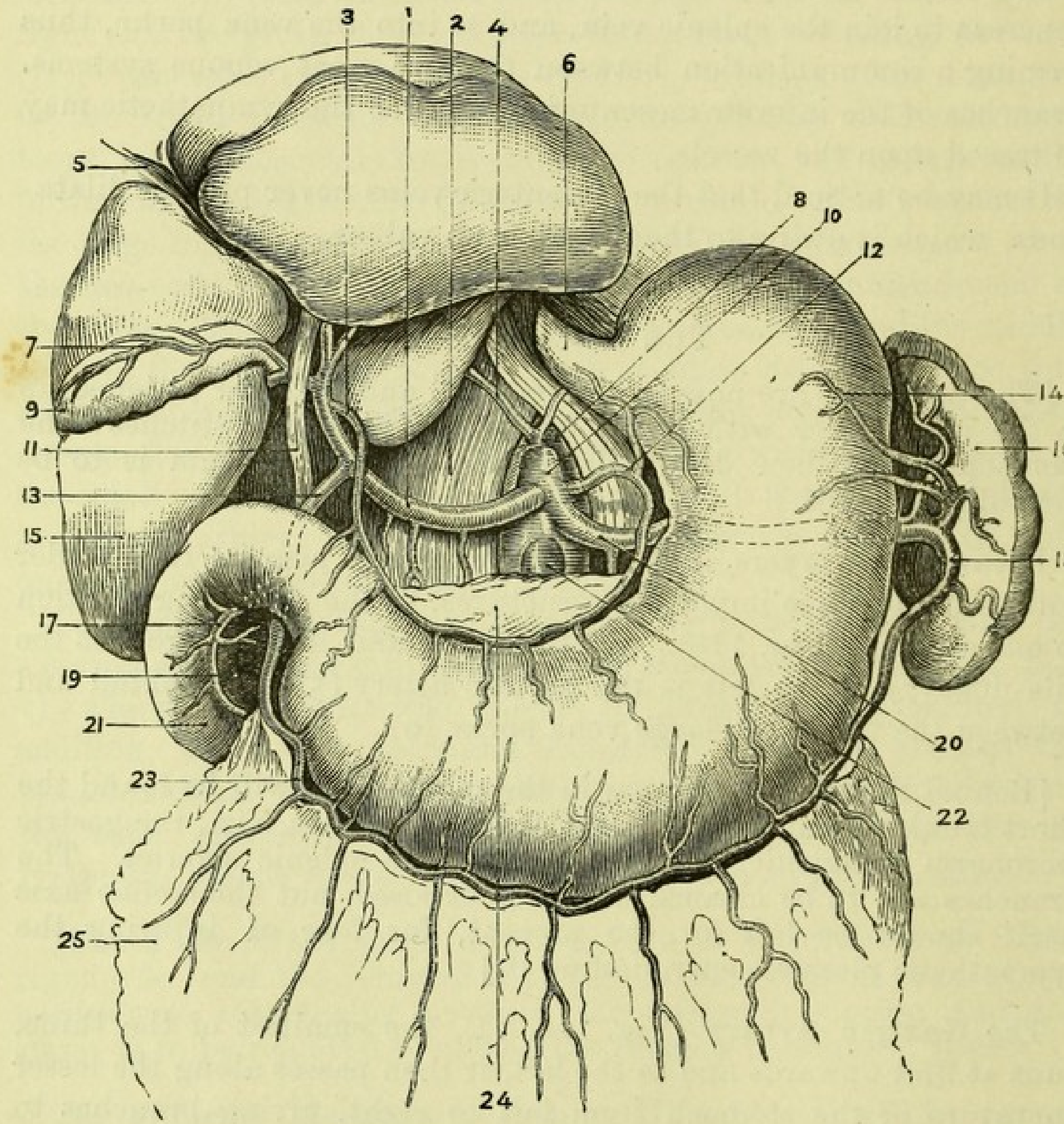


Fig. 115.—Branches of the cœliac axis (from Henle).

1. Hepatic artery.
2. Diaphragm.
3. Superior pyloric artery.
4. Right phrenic artery.
5. Round ligament of liver.
6. Œsophagus.
7. Cystic artery.
8. Abdominal aorta.
9. Gall-bladder.
10. Cœliac axis.
11. Ductus communis choledochus.
12. Gastric artery.
13. Gastro-duodenal artery.
14. Vasa brevia of splenic artery.
15. Liver.
16. Spleen.
17. Pancreatico-duodenalis (superior).
18. Gastro-epiploica sinistra.
19. Head of pancreas.
20. Splenic artery.
21. Duodenum.
22. Superior mesenteric artery.
23. Gastro-epiploica dextra.
24. Pancreas (drawn down).
25. Great omentum.

liver. The artery gives off first the *pyloric* branch (3), which has been seen to anastomose at the upper border of the pyloric end of the stomach with the gastric, and secondly a trunk which immediately disappears behind the duodenum and is called the *gastro-duodenal* (13). From the right hepatic branch the small *cystic* (7) artery is given off, which is distributed to the gall-bladder by two branches, one passing between it and the liver and the other along its free surface.

The **Splenic Artery** (Fig. 115, 20) can now be seen only in part, taking a tortuous course behind the stomach and along the upper border of the pancreas to the spleen.

[To continue the dissection it will be necessary to remove the intestines which have been examined, by putting a couple of ligatures upon the upper part of the jejunum, and also upon the upper part of the rectum, and dividing the intestine between the two ligatures at each point. By cutting the superior mesenteric artery the small intestine will be at once set free, but the large intestine must be carefully removed by dividing the meso-colon close to the intestine throughout, and lastly by cutting the inferior mesenteric artery. The gastro-duodenal and splenic arteries and their branches are then to be cleaned.]

The **Gastro-duodenal Artery** (Fig. 115, 13) can be traced out by turning up the stomach. After passing behind the duodenum, it divides into the right gastro-epiploic and the superior pancreatico-duodenal arteries.

The *Gastro-epiploica dextra* (23) runs from right to left along the great curvature of the stomach between the folds of the great omentum, supplying branches to both surfaces of the stomach as well as to the omentum; it anastomoses with the gastro-epiploica sinistra of the splenic artery.

The *Pancreatico-duodenalis superior* (17) will be found between the duodenum and the head of the pancreas, the latter of which it surrounds, and both of which it supplies; it anastomoses with the small branch from the commencement of the superior mesenteric artery called the *pancreatico-duodenalis inferior* (Fig. 113, 13), and gives branches to both pancreas and duodenum.

The **Splenic Artery** (Fig. 115, 20) can now be seen in the whole of its course to the spleen, near which it breaks up into four or five branches entering the hilum or fissure on the concave surface of that organ. As it passes along the upper border of the pancreas it gives off small branches to it (*pancreaticæ parvæ*), and one (*pancreatica magna*) which runs along the whole length of the gland, with the duct. It also gives small branches (*vasa brevia*) (14) to the great end of the stomach, and one of larger size (*gastro-epiploica sinistra*) (18), which runs along the great curvature to anastomose with the gastro-epiploica dextra of the hepatic, supplying branches to both surfaces of the stomach and to the omentum. Upon the hepatic and splenic arteries are corresponding plexuses of the sympathetic.

The **Splenic Vein** (Fig. 117, 2) is placed below its artery, and lies behind the pancreas. It receives tributaries corresponding to the branches of the artery, and also, about opposite the middle of the pancreas, the inferior mesenteric vein. It is joined by the superior mesenteric vein behind the head of the pancreas, the two forming the vena portæ.

[The pancreas and duodenum should now be thoroughly defined, and the bile duct and the pancreatic duct traced to their entrance into the intestine. If desired, the stomach may be removed by tying and cutting it near the pylorus, and at the œsophagus.]

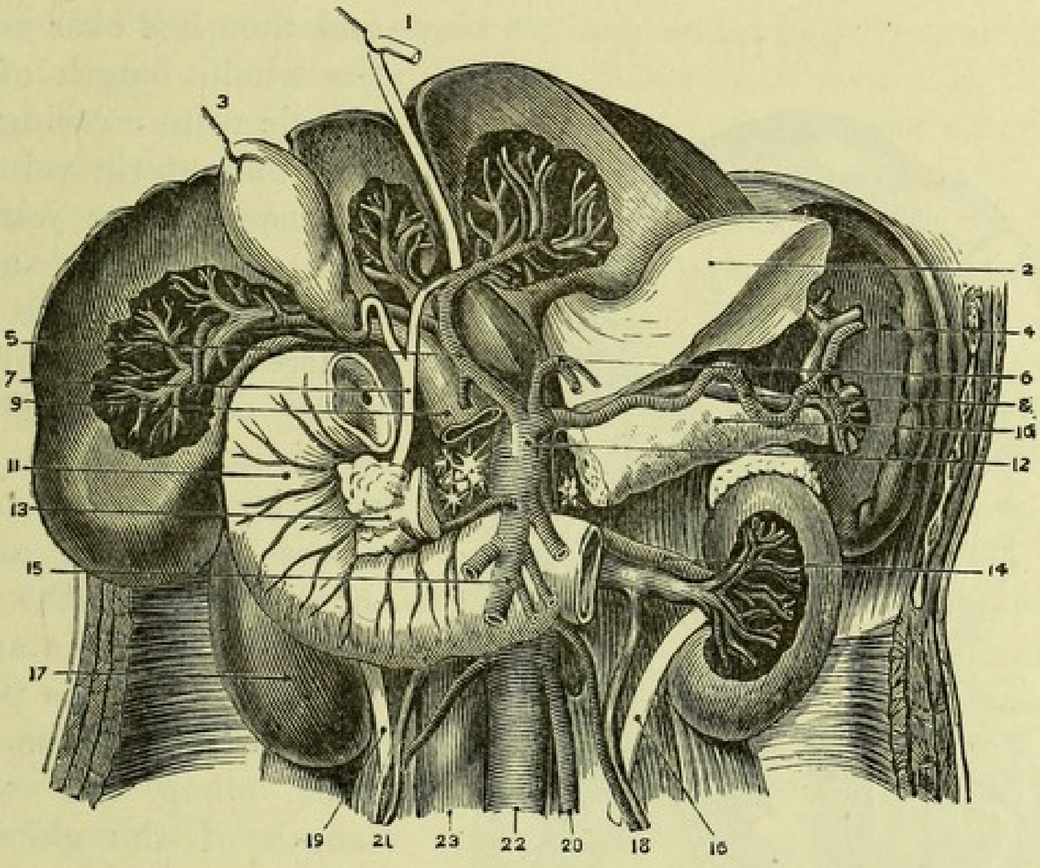
The **Duodenum** (Fig. 116, 11) is from eight to ten inches long (twelve finger-breadths), and makes a peculiar bend upon itself before it passes beneath the mesenteric artery, to become the jejunum; the first two portions being in the epigastric, and the third in the umbilical region.

The *first* or *ascending portion* reaches from the pylorus to the under surface of the right lobe of the liver, where it is in close proximity to the gall-bladder. It is covered both in front and behind by a prolongation from the lesser omentum, and is therefore movable with the stomach. Behind it are the vena portæ, the common bile duct, and the gastro-duodenal artery.

The *second* or *descending portion* is covered in front by that part of the peritoneum which forms the commencement of the transverse meso-colon. It is thus bound down to the surface of the right kidney, in front of which it descends for about three inches behind the transverse colon. It lies close to the outer side of the head of the pancreas, with the pancreatico-duodenal arteries intervening, and into its posterior surface the biliary and pancreatic ducts open.

The *third* or *transverse portion* is fixed to the abdominal wall at the line of attachment of the meso-colon, and therefore has no proper peritoneal covering. It is crossed by the superior mesenteric artery and vein, and lying upon the vena cava, and upon the aorta, which is placed between the crura of the diaphragm, it gradually ascends from the level of the third to that of the second lumbar vertebra, at the left side of which it becomes the jejunum. Immediately above it are the head and the body of the pancreas, with the pancreatico-duodenal arteries. This is the most fixed portion

Fig. 116.



of the small intestine, and, owing to the weight of the remainder of the bowel, it is at the junction of the duodenum with the jejunum that laceration most commonly occurs in cases of abdominal injury.

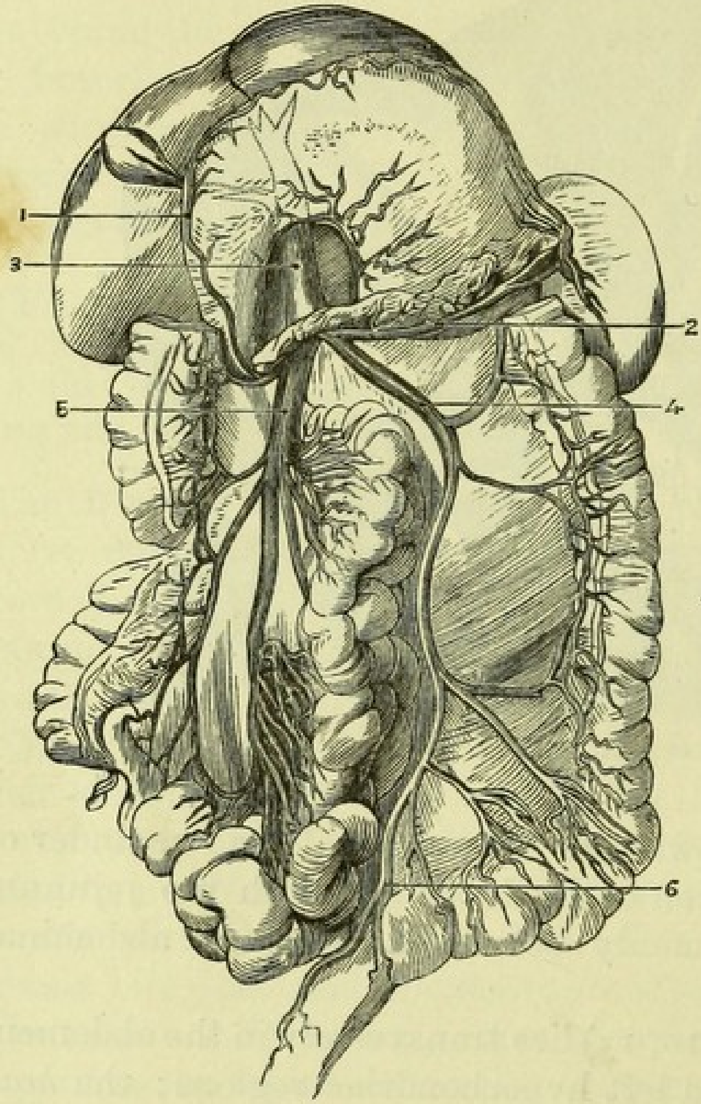
The **Pancreas** (Fig. 116, 10, 13) lies transversely in the abdomen, occupying the epigastric and left hypochondriac regions; the *head*

Fig. 116.—Duodenum (altered from Hirschfeld and Leveillé).

1. Round ligament of liver.
2. Great end of stomach (cut).
3. Gall-bladder.
4. Spleen.
5. Hepatic artery.
6. Coronary artery.
7. Common bile duct.
8. Splenic artery and vein.
9. Vena portæ.
10. Tail of pancreas.
11. Duodenum.
12. Cœliac axis; on each side of the aorta at this point are the semilunar ganglia.
13. Head of pancreas.
14. Left renal vessels.
15. Superior mesenteric artery.
16. Left ureter.
17. Right kidney.
18. Left spermatic vessels.
19. Right ureter.
20. Inferior mesenteric artery.
21. Right spermatic vessels.
22. Aorta.
23. Vena cava.

being embraced by the duodenum, the *body*, which is concave posteriorly, crossing the aorta opposite the 1st lumbar vertebra, and the *tail* touching the spleen, the front of the left kidney and supra-renal capsule, and the left renal vessels. It is covered by the lesser bag of the peritoneum, and from right to left it crosses the vena portæ, the vena cava, and the aorta between the crura of the diaphragm; and then lies over nearly the whole length of the splenic vein, crossing the two mesenteric veins as they ascend to join it. The cœliac axis arises immediately above the pancreas, and the splenic artery occupies a groove in its upper border. The superior mesenteric artery arises behind it, and a small portion of the head winds round this artery so as to touch its posterior surface. The duct runs along the whole length of the gland to join the common bile duct, which lies in the groove between the duodenum and pancreas; and the united ducts open very obliquely into the back of the second part of the duodenum.

Fig. 117.



The **Bile Duct** (Fig. 116, 7) should be traced up to the liver, where it will be found to commence in the right and left *hepatic ducts*, which emerge from the transverse fissure; these unite to form the *common hepatic duct*, which is joined at an acute angle by the duct of the gall-bladder (*cystic*), thus forming the common bile duct or *ductus communis choledochus*. The bile duct lies between

Fig. 117.—The portal vein and its tributaries (from Henle).

1. Gastro-duodenal vein.
2. Splenic vein.
3. Portal vein.
4. Inferior mesenteric vein.
5. Superior mesenteric vein.
6. Superior hæmorrhoidal vein.

the layers of the lesser omentum to the right of the hepatic artery and portal vein, and passes behind the first portion of the duodenum to join the pancreatic duct, and open into the duodenum as described above.

The **Vena Portæ** (Fig. 117, 2) is formed to the right of the median line by the junction of the splenic and superior mesenteric veins behind the pancreas, about an inch and a half from its right extremity, and immediately in front of the vena cava. It is four inches long, and ascends between the layers of the lesser omentum to the transverse fissure of the liver, between, but posterior to, the bile duct and the hepatic artery. It receives the small gastric and cystic veins, and is remarkable for having no valves.

The **Spleen** (Fig. 116, 4) occupies the back of the left hypochondrium, its longer axis being oblique and corresponding to the 9th, 10th, and 11th ribs in the lower part of the axilla, and is attached to the greater end of the stomach by the gastro-splenic omentum, which is reflected from it to the diaphragm. Its outer surface is in contact with the diaphragm, the inner is divided into two parts, of which the posterior is applied to the left kidney and supra-renal capsule, and the anterior is in contact with the stomach, the tail of the pancreas, and the splenic flexure of the colon. It lies against the left supra-renal capsule and the diaphragm, and the tail of the pancreas touches its lower margin. The splenic vessels will be seen to enter the *hilum* or slit on its concave surface.

Deep Dissection of the Abdomen.

[The stomach, duodenum, pancreas, and spleen should now be taken away by dividing the œsophagus, bile duct, and vessels, and the liver should then be carefully removed in order to see the arrangement of the coronary ligament. The round and falciform ligaments should first be cut and the liver pulled down; by carrying the knife along the attachment to the diaphragm, the upper layer of the coronary ligament will then be divided, as well as the lateral ligaments on each side, which are formed from it. The vena cava and a part of the liver uncovered by peritoneum will now be exposed, the latter being attached to the diaphragm by areolar tissue, and when this is carefully divided, the right supra-renal capsule and the top of the right kidney will be brought into view. The vena cava must be cut through at the upper and again at the lower margin of the liver, when it will only be necessary to divide the under layer of the coronary ligament (derived chiefly from the lesser bag of the peritoneum) to remove the organ.

The viscera should all be placed in a covered pan, for examination during the time that the subject is turned.

The Diaphragm is to be cleaned by stripping off the peritoneum, as far as possible in the direction of the muscular fibres; and at the same time the inner surface of the flap of abdominal muscles still attached should be cleaned, in order to follow out the fibres of the transversalis. Care must be taken not to puncture the diaphragm, and to leave the branches of artery and nerve ramifying on its surface. The crura or muscular slips on each side of the aorta must be carefully cleaned, and two tendinous arches over the psoas and quadratus lumborum muscles defined, for which purpose it will be well to detach one kidney and turn it over to the opposite side temporarily.]

The **Diaphragm** (Fig. 118) is arched, being concave towards the abdomen (particularly on the right side); this concavity is exaggerated after death, owing to the fact that *expiration* is the last act of life. It rises to the level of the fifth costal cartilage on the right and the sixth on the left side, but during extreme expiration reaches higher, during extreme inspiration lower, than this level. It *arises* from the back of the ensiform cartilage and from the inner surfaces of the six lower ribs, where it interdigitates with the transversalis abdominis; also from the internal and external arcuate ligaments, of which the internal one passes from the body to the transverse process of the first lumbar vertebra, and the external one from the same transverse process to the last rib; they cross the psoas and quadratus lumborum muscles respectively.

The *ligamentum arcuatum externum* is only the artificially isolated border of the fascia covering the quadratus lumborum, which is the anterior lamella of the fascia lumborum derived from the posterior tendon of the transversalis abdominis muscle (Fig. 111).

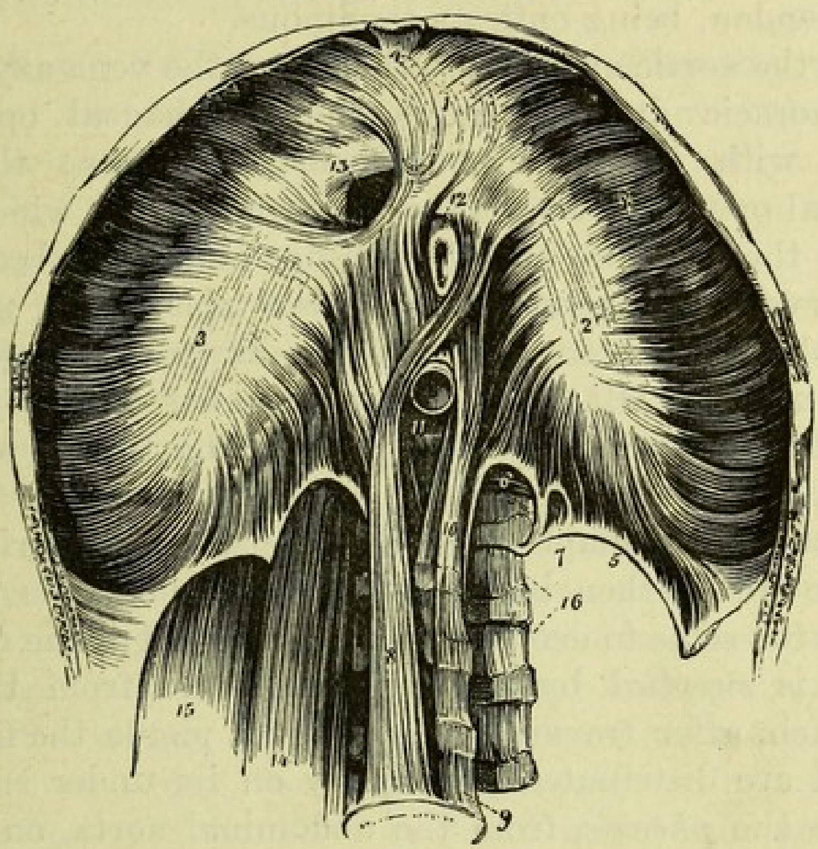
The *ligamentum arcuatum internum* is formed solely by the posterior tendinous fibres of the crus of the diaphragm, and to it the fascia of the psoas is attached.

The *crura* or pillars of the diaphragm *arise* from the front of the bodies of the upper lumbar vertebræ; the right crus is the larger, and reaches as low as the third vertebra and the intervertebral substance below it, but the left reaches only the second lumbar vertebra.

All the fibres of the diaphragm are *inserted* into the central tendon, called from its shape the *cordiform* or *trefoil tendon*, but the inner fibres of the crura decussate with one another and form a figure-of-8 before they pass into the tendon, thus surrounding first the aorta and then the œsophagus.

Openings.—There are three large openings in the diaphragm, viz., the Aortic, the Œsophageal, and the Vena Caval openings,

Fig. 118.



and two or three small orifices in the crura for the splanchnic nerves and vena azygos minor, and also for the vena azygos major, if it does not pass through the aortic opening.

The *Aortic* and *Œsophageal* openings are in the loops formed by the crura. The anterior or œsophageal opening, which is also slightly to the left side, is entirely muscular; but that for the

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Fig. 118.—Under or abdominal surface of the diaphragm (from Wilson).

1. The central leaflet of the tendinous centre.
2. The left or smallest leaflet.
3. The right leaflet.
4. Fasciculus from the ensiform cartilage.
5. Ligamentum arcuatum externum of the left side.
6. Ligamentum arcuatum internum.
7. A small arched opening occasionally found, through which the least splanchnic nerve passes.
8. Right crus.
9. Fourth lumbar vertebra.
10. Left crus.
11. Aortic opening.
12. Œsophageal opening.
13. Opening for the inferior vena cava.
14. Psoas magnus passing beneath the ligamentum arcuatum internum.
15. Quadratus lumborum passing beneath the ligamentum arcuatum externum.

aorta will be found upon dissection to be tendinous, and to be formed by the internal tendinous fibres of the two crura. The aortic opening is strictly speaking *behind* the diaphragm, being bounded posteriorly by the vertebral column.

The opening for the *Vena Cava* is more or less quadrilateral (*foramen quadratum*), and is situated in the right division of the cordiform tendon, being entirely tendinous.

Through the aortic orifice pass the aorta, the vena azygos major, and the thoracic duct; through the œsophageal opening, the œsophagus with the two pneumogastric nerves; through the quadrilateral opening passes the vena cava inferior, which is firmly attached to the margins of the opening, and also a branch of the phrenic nerve. The greater and lesser splanchnic nerves pass through a slit in each crus, and the vena azygos minor (if it exists) passes through the left crus. The gangliated cord of the sympathetic is continued into the abdomen from the thorax beneath the ligamentum arcuatum internum.

The position of the diaphragm alters considerably during inspiration, for the muscle then becomes flattened, and slopes downwards and backwards so as to deepen the posterior part of the chest. The diaphragm is *supplied* by the phrenic nerves from the cervical plexus, which, after traversing the thorax, pierce the fibres of the muscle and are distributed principally on its under surface. Its arteries are the *phrenic*, from the abdominal aorta, on the under surface, and the *musculo-phrenic* and *comes nervi phrenici* from the internal mammary, which anastomose with some of the intercostal arteries. The branches of the internal mammary will be seen when the upper surface of the diaphragm is dissected with the Thorax.

[The vessels and muscles of the abdominal cavity are now to be cleaned. Around the aorta and its branches will be found a quantity of tough tissue, which is the sympathetic nerve giving off plexuses to the several vessels. The greater part of this may be removed, but the great splanchnic nerves should be traced from the points where they pierce the crura of the diaphragm to their terminations in the semilunar ganglia. These are large masses of a pinkish colour, situated on each side of the aorta close to the diaphragm; the right lies beneath the vena cava, it will therefore be necessary to turn down this vessel for a short distance in order to expose it; the ganglia closely resemble lymphatic glands in appearance, and are connected by numerous nerves surrounding the cœliac axis which constitute the solar plexus, and must be cleaned. The gangliated cord of the sympathetic on each side of the vertebræ is to be preserved. The vena cava inferior (a piece of which it will be remembered has been removed with the liver) is to be cleaned, and care must be taken not to cut off the right spermatic vein on its anterior surface. The vein may be secured in its proper position with a pin if necessary. The kidneys and supra-renal capsules are to be dissected out and the vessels going to each defined, and the spermatic vessels should be traced out.]

Sympathetic Nerve.—On each side of the aorta and close to the crura of the diaphragm will be seen an irregular mass of a somewhat crescentic form, called the semi-lunar ganglion (Fig. 116, 12), and into it the great splanchnic nerve from the thoracic ganglia may be traced.

The *Solar plexus* is formed by fibres crossing from one semi-lunar ganglion to the other, around the cœliac axis and superior mesenteric artery between the supra-renal capsules, and receives a branch from the right pneumogastric. Its continuation, the aortic plexus, will have been more or less seen in cleaning the aorta, and so also the secondary plexuses derived from it and distributed upon the several branches, viz., the phrenic plexus, gastric plexus, hepatic plexus, splenic plexus, superior mesenteric plexus, supra-renal plexus, renal plexus, spermatic plexus, and inferior mesenteric plexus. In addition to the great splanchnic nerve, the lesser splanchnic nerve may, in a favourable subject, be traced into the cœliac plexus, and the third or least splanchnic nerve into the renal plexus.

The **Abdominal Aorta** (Fig. 119) is the direct continuation of the thoracic aorta, and reaches from the last dorsal vertebra to the left side of the fourth lumbar vertebra, where it divides into the two common iliacs. It was covered originally and quite superficially by the stomach, transverse colon, and small intestines; and in more immediate contact with it were found (from above downwards) the pancreas and splenic vein, below the cœliac axis and superficially to the origin of the superior mesenteric artery; the duodenum and the left renal vein, immediately below the superior mesenteric artery. Immediately below the renal vein the spermatic arteries lie in front of the aorta for a short distance, and lower down is the inferior mesenteric artery, from which the peritoneum was reflected over the aorta to the bifurcation.

The artery lies against the bodies of the vertebræ and the anterior common ligament, and crosses the left lumbar veins. To its right is the vena cava, in close connection below but separated at the upper part by the right crus of the diaphragm; and deeply placed between the upper part of the aorta and the right crus is the receptaculum chyli, with the thoracic duct and the vena azygos major. To its left is the left gangliated cord of the sympathetic. Its point of bifurcation, though often in the middle line, is usually a little below and to the left of the umbilicus, above which it may be readily compressed.

Surgery (Fig. 120).—The abdominal aorta has been tied immediately above the bifurcation for iliac aneurism, but without success. It may be reached by a median incision prolonged above and below the umbilicus, by which Sir Astley Cooper originally tied it, the peritoneum being necessarily opened in front, and again at the point of ligature; or by an incision at the side, similar to that for ligature of the common iliac artery but larger, by which the peritoneum is turned forward and left unopened. Mr. Lane has proposed to apply the ligature above, instead of below, the origin of the inferior mesenteric artery, in order to preserve the anastomoses of that vessel.

The **Branches** of the abdominal aorta are—1. Phrenic or diaphragmatic. 2. Cœliac axis (dividing into gastric, hepatic, and splenic). 3. Superior mesenteric. 4. Supra-renal or capsular. 5. Renal. 6. Spermatic (ovarian in female). 7. Inferior mesenteric. 8. Middle sacral. 9. Lumbar arteries. 10. Common iliacs.

The **Phrenic** arteries (Fig. 119, 2) are two small branches, which arise close below the diaphragm and ramify on its under surface, where they form a circle and anastomose with one another, with the superior phrenic and musculo-phrenic of the internal mammary artery, and with the lower intercostals. Each supplies also a branch to the supra-renal capsule, and small twigs are given by the left to the œsophagus, and by the right to the vena cava. The *veins* open into the vena cava.

The **Cœliac Axis** (Fig. 119, 4) is only half an inch in length, and divides at once into the gastric, hepatic, and splenic arteries (*v.* p. 235).

The gastric and splenic *veins* open into the vena portæ, but the hepatic veins, which receive the blood from the vena portæ as well as from the hepatic artery in the liver, open into the vena cava.

The **Superior Mesenteric** artery (Fig. 119, 6) supplies all the small and half the large intestine (*v.* p. 232). Its *vein* opens into the vena portæ.

The **Supra-renal** arteries (Fig. 119, 7), pass, one on each side, transversely to the supra-renal capsules, the right going beneath the vena cava. In addition to this artery (middle capsular), the capsule is supplied by a branch from the phrenic (superior) and

Fig. 119.

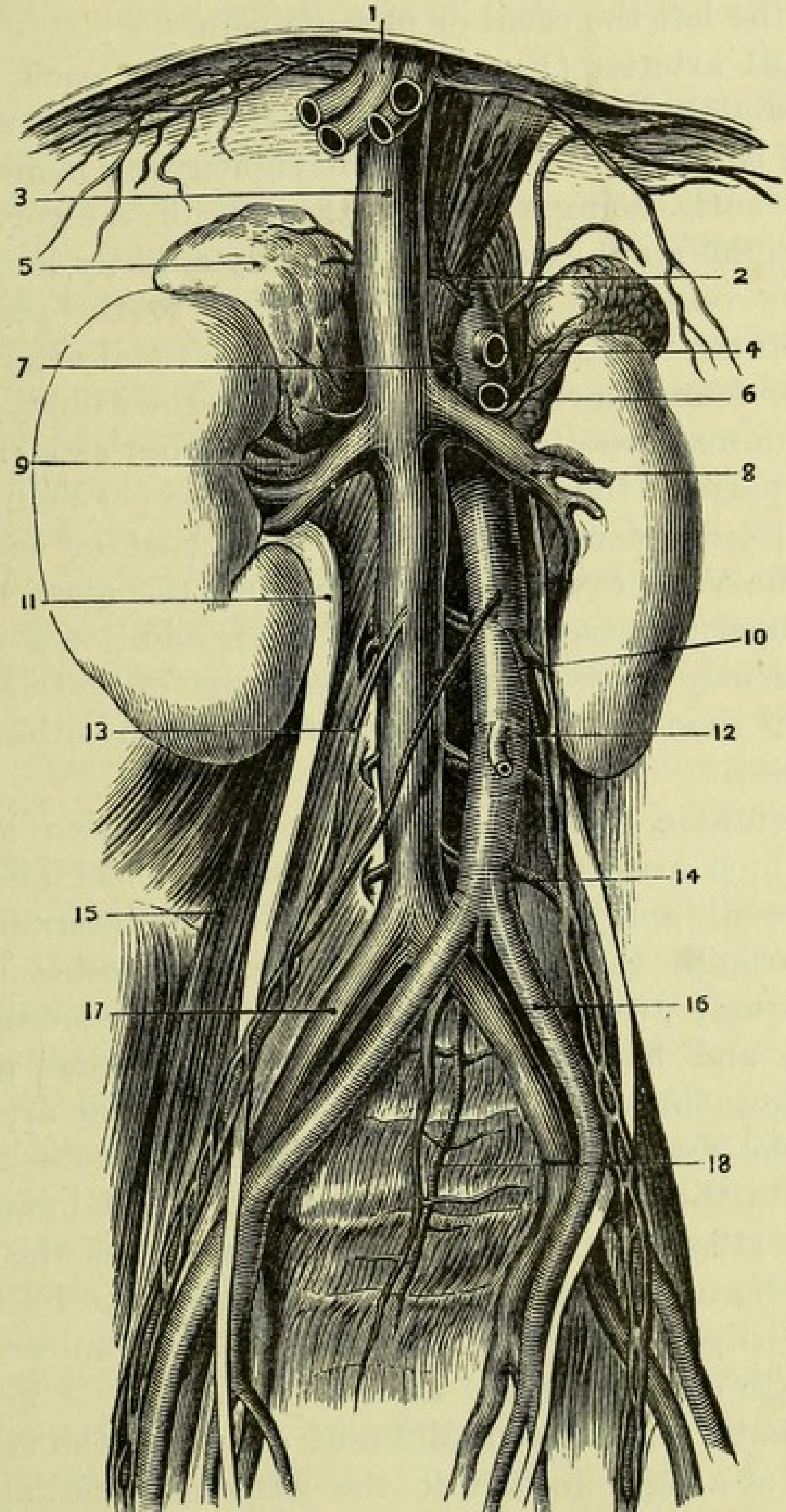


Fig. 119.—Abdominal aorta and vena cava (from Henle).

1. Hepatic veins (cut).
2. Phrenic arteries.
3. Vena cava.
4. Cœliac axis (cut).
5. Supra-renal capsule.
6. Superior mesenteric artery (cut).
7. Supra-renal artery.
8. Renal vein.
9. Renal artery.
10. Left spermatic vessels.
11. Right ureter.
12. Inferior mesenteric artery.
13. Right spermatic vein.
14. A lumbar artery.
15. Psoas magnus.
16. Common iliac artery.
17. Common iliac vein.
18. Middle sacral artery.

one from the renal artery (inferior). The right *vein* enters the vena cava, the left the renal or phrenic vein.

The **Renal** arteries (Fig. 119, 9), arising on each side of the aorta immediately below the capsular arteries, pass transversely to the concave border of the kidney, the right going beneath the vena cava. The aorta being a little to the left of the vertebræ at this point, the right renal artery is necessarily slightly longer than the left, and the veins are the reverse, owing to the position of the vena cava on the right of the column. The renal artery breaks up into three or four branches just as it enters the kidney, and one or more of them may pass in front of the vein, but as a rule the relation of the parts at the hilum of the kidney is (1) Vein, (2) Artery, (3) Ureter, from before backwards. The renal or emulgent *veins* open into the vena cava, the left crossing the aorta immediately below the superior mesenteric artery. An additional renal artery not unfrequently arises from the lower part of the aorta, or from the common iliac artery, and occasionally more than one such vessel is present.

The **Spermatic** arteries (Fig. 119, 10) are two long slender branches, which arise from the front of the aorta about an inch below the renal, and pass downwards to the internal abdominal ring and through the inguinal canal to the testes. The right crosses obliquely over the vena cava (though sometimes passing beneath it), and both rest upon the external iliac arteries near Poupart's ligament, and are close to the epigastric arteries at the ring. In the female the spermatic arteries become the *ovarian*, and pass into the pelvis to ramify in the broad ligament of the uterus (Fig. 112, *h*). One small twig accompanies the round ligament to the inguinal canal, another runs along the Fallopian tube, and a third supplies part of the uterus, anastomosing with the uterine branch of the internal iliac.

The spermatic *veins* take a different course on the two sides, the left opening at a right angle into the left renal vein, and the right opening directly into the vena cava; which arrangement is said to account in part for the more frequent occurrence of 'varicocele' on the left side. Dr. J. H. Brinton, of Philadelphia, has demonstrated the existence of a valve at the caval orifice of the right vein, but not at the entrance of that of the left side into the renal.

The great length of the spermatic arteries is accounted for by the fact that the testicles were originally in the abdomen, opposite the point where the arteries arise, and that as they descended the vessels necessarily became elongated.

The **Inferior Mesenteric** artery (Fig. 119, 12) supplies the lower half of the large intestine (*v.* p. 234), and its *vein* opens into the splenic vein.

The **Middle Sacral** (Fig. 119, 18) is a small branch arising at the bifurcation of the aorta, and passing down into the pelvis along the middle of the sacrum. It anastomoses with the lateral sacral branches of the internal iliac arteries, and its corresponding *vein* opens into the left common iliac vein.

The **Lumbar** arteries (Fig. 119, 14), four or five in number, arise in a double row from the back of the aorta, and pass transversely, close upon the vertebræ, beneath the gangliated cords of the sympathetic, and on the right side beneath the vena cava. Only small portions of these arteries can be seen at present, but when followed out each will be found to divide into an anterior and posterior branch. Of these the anterior runs between the abdominal muscles, and the posterior passes between the transverse processes to the muscles of the back, giving also a branch into the vertebral canal through the intervertebral foramen, which supplies the membranes of the cord and ends in the body of the vertebra. The lumbar *veins* open into the vena cava.

The **Common Iliac Arteries** (Fig. 119, 16) are the direct continuations of the abdominal aorta, and extend from the left side of the fourth lumbar vertebra to the lumbo-sacral articulation, where each divides into the external and internal iliac arteries. The right common iliac is a little longer than the left, and the relations differ on the two sides, owing, principally, to the fact that the two common iliac *veins* unite to form the vena cava on the right side of the vertebral column. Both arteries rest on the vertebral column, being covered in front by the peritoneum, and are usually crossed by the ureters, near their termination, but the *left* is crossed in addition by the rectum and inferior mesenteric vessels. The *left* artery lies against the psoas magnus, but the *right* artery lies upon its own vein at the lower part and crosses the vein of the opposite side above. The *left* common iliac vein will be seen to lie to the inner side of its own artery, and then to pass beneath the right artery to reach the vena cava, whilst the *right* vein is at first behind and then to the outer side of the right artery until it unites with the left. Thus both the veins lie to the right of their respective arteries, and the commencement of the vena cava is immediately to the right of, or sometimes even slightly behind, the right common iliac.

The only branches from the trunks of the arteries are small twigs to the iliacus muscles and to the ureter; the *common iliac veins* receive the lateral sacral and ilio-lumbar veins, and the middle sacral vein enters the left common iliac.

The **Vena Cava Inferior** (Fig. 119, 3) lies to the right of the aorta, and in close relation to it except at the upper part. It is formed by the junction of the two common iliac veins on the right of the fifth lumbar vertebra, and lies on the right of the vertebral column as high as the liver; there it passes forwards to enter the posterior border of that gland, through which it reaches the quadrilateral opening in the diaphragm. The lumbar and the right renal arteries, and the sympathetic ganglia, lie behind the vena cava; in front of it are the peritoneum, the duodenum, pancreas and liver, the foramen of Winslow, the right spermatic artery, and the portal vein. It receives the lumbar, right spermatic, renal, right supra-renal, and phrenic veins, and as it passes through the liver the large hepatic veins open into it; and thus the whole of the blood of the abdomen and lower extremities is returned to the heart.

The **External Iliac Artery** (Fig. 153, 16) reaches from the point of bifurcation of the common iliac to Poupart's ligament, where it becomes the femoral, its direction corresponding with a line drawn from the umbilicus to a point midway between the symphysis pubis and the anterior superior iliac spine. It passes along the brim of the true pelvis, and is bound down to the psoas muscle on the outer side by a process of fascia, which includes both it and the vein, and must be removed in order to expose them. The crural branch of the genito-crural nerve lies close to the outer side of the artery, and the genital branch of the same nerve, as well as the spermatic vessels, lie upon it near Poupart's ligament. Occasionally the ureter crosses the upper part of the artery. The *vein* lies to the inner side of the artery in the whole of its course upon the left side, but is beneath its upper part on the right side. An inch above Poupart's ligament one of the branches of the vein (circumflex iliac) will be seen to cross the artery, and close to the ligament the *vas deferens* hooks round the epigastric artery, and descends into the pelvis to the inner side of the external iliac artery.

Branches.—The deep epigastric and the deep circumflex iliac arteries are given off just above Poupart's ligament.

The *Epigastric* artery passes upwards immediately outside the peritoneum, and enters the rectus muscle at its posterior aspect, to which it has been already traced (p. 220). The branches of the epigastric are *pubic* to the back of the pubes, *cremasteric* to the cord, and *muscular*. An abnormal branch of large size is frequently found coming off from the epigastric close to its origin, and descending into the pelvis; this is the obturator artery, and its important relations to femoral hernia have been already described (p. 97). The *epigastric vein* joins the external iliac vein.

The *Circumflex Iliac* artery takes a course outwards along Poupart's ligament, and is at first immediately outside the peritoneum. It soon, however, pierces the transversalis, and a branch of it serves as the guide to the interval between that muscle and the internal oblique. The artery runs along the crest of the ilium between the muscles, and anastomoses with the ilio-lumbar branch of the internal iliac and with the last lumbar artery. The *vein* has been seen to cross the external iliac artery an inch above Poupart's ligament, to open into the external iliac vein.

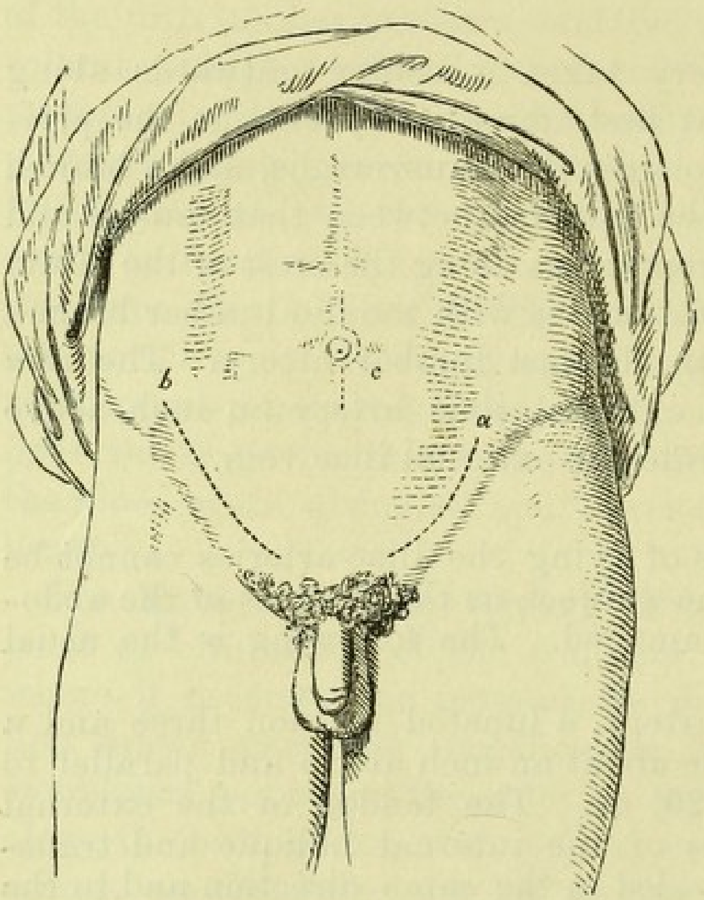
Surgery.—The operations of tying the iliac arteries cannot be conveniently practised on the subject, as the muscles of the abdomen would be necessarily damaged. The following is the usual mode of proceeding:—

To tie the External Iliac artery, a lunated incision three and a half inches long is to be made about an inch above and parallel to Poupart's ligament (Fig. 120, *a*). The tendon of the external oblique and the fleshy fibres of the internal oblique and transversalis muscles are to be divided in the same direction and to the same extent, and it is usual to divide the transversalis on a director, to avoid the possibility of injuring the peritoneum. Care must also be taken not to divide the epigastric artery. The fascia transversalis, now exposed, is to be divided on a director and the peritoneum is then to be carefully stripped up from the iliac fossa and turned forward with the viscera, the ureter and spermatic vessels generally adhering to the membrane and being therefore drawn out of the way. The finger can now reach the inner border of the psoas, at which the artery can be felt, but the sheath must be carefully opened before the needle can be passed between the vein and the artery. The vessel should be tied as nearly as possible midway between the origins of the internal iliac and epigastric arteries.

The Internal and Common Iliac arteries may be tied through a similar incision prolonged to a length of about five inches (Fig. 120, *b*), or by one of similar length placed so that its centre is opposite the anterior superior iliac spine. The steps of the proceeding are the same as those for tying the external iliac, but the operations are more arduous, owing to the greater depth of the arteries and the consequent difficulty in reaching them.

When the external iliac artery is tied, the circulation in the lower limb is carried on principally by the internal iliac, the branches of which (gluteal, sciatic, and obturator) anastomose freely with branches of the profunda femoris. In addition, the anastomoses between the epigastric and the internal mammary branch of the subclavian, and between the circumflex iliac and the lumbar arteries, become greatly developed.

Fig. 120.



If the internal iliac were tied, a return current would be established from the profunda femoris to the branches before mentioned, whilst the visceral branches would be supplied by free anastomoses from the vessels of the opposite side. When the common iliac is tied, the circulation in the limb depends mainly upon the internal mammary and epigastric, aided by blood brought circuitously from the opposite internal iliac to that of the same side, and thence to the profunda femoris. The middle sacral artery would also form a direct communication between the aorta and the lateral sacral branch of the internal iliac.

The **Kidney** (Fig. 116, 14) may be roughly said to lie between the last rib and the crest of the ilium. The lower end, however, does not reach to within an inch or more of the iliac crest, while the upper generally reaches as high as the eleventh rib, and therefore lies on a small portion of the diaphragm and on the quadratus lumborum and psoas muscles, but the right kidney is always a little lower than the left. The upper extremities of both organs are nearer the spine than the lower, and upon them are fixed the

Fig. 120.—(From Fergusson's 'Practical Surgery.')

a. Line of incision for tying the external iliac artery.
b. Line of incision for tying the common iliac artery.
c. Sir Astley Cooper's incision for tying the abdominal aorta.

supra-renal capsules. It will be remembered that in front of the kidney was the peritoneum, with the vertical part of the duodenum, the ascending colon, and the under surface of the liver on the right; and the stomach, the lower part of the spleen, the tail of the pancreas, and the descending colon on the left side. The outer border of the kidney is convex, the inner or *hilum* concave, and the vessels entering or leaving it at this border are the renal vein, renal artery, and ureter, which lie in that relation to one another from before backwards.

The *Ureter* (Fig. 119, 11) should be traced out, and will be seen to be from fourteen to sixteen inches long, to lie over the psoas muscle, to pass beneath the spermatic vessels, and, having crossed the common or external iliac artery, to disappear in the pelvis, where it will be afterwards traced to the bladder.

The **Supra-renal Capsule** (Fig. 119, 5) is a small triangular yellow body, somewhat resembling a cocked-hat, placed immediately above each kidney and lying against the crus of the diaphragm. The vessels to it should be traced out, and one kidney and capsule are then to be removed and put aside with the viscera for after-examination.

[The kidney being removed or turned out of the way, the fasciæ covering the psoas, quadratus lumborum, and iliacus are to be defined, and afterwards those muscles are to be cleaned, all nerves passing out of them being carefully preserved.]

Fascia of the quadratus lumborum.—The anterior lamella of the fascia lumborum, which forms part of the origin of the transversalis abdominis muscle, (*v.* p. 212), will be found to lie in front of the quadratus muscle and to pass inwards to the tips of the transverse processes; what has been described as the ligamentum arcuatum externum of the diaphragm being merely the border of this, artificially isolated.

The *fascia over the psoas* is a distinct structure, although connected externally with the fascia of the quadratus. It is continuous with the iliac fascia below, and passes upwards over the psoas to be attached to the lower edge of the ligamentum arcuatum internum of the diaphragm, and to the sides of the bodies of the vertebræ from which the muscle takes its origin. It is owing to this fascia that "psoas abscess," the result of diseased spine, is conducted along the psoas muscle to the inner side of the thigh.

The *Iliac Fascia* covers the iliacus internus muscle and is continuous with the fascia over the psoas magnus, being strengthened at the lower part by an expansion from the psoas parvus, when that muscle is present. The iliac fascia should be traced to Poupart's ligament, beneath which it passes to unite with the fascia transversalis in forming the sheath of the femoral vessels (*v.* p. 94).

The **Psoas Magnus** muscle (Fig. 121, 6) *arises* from the sides of the bodies and roots of the transverse processes of the last dorsal and all the lumbar vertebræ, and from their intervertebral substances. A series of tendinous arches from which muscular fibres arise, connected with the intervertebral substance and upper border of each vertebra, will be seen to spring across the hollow in the side of the body to become attached to the lower border of the same vertebra and to the next intervertebral substance; and thus the lumbar vessels which occupy these hollows are protected from pressure. The muscle passes along the border of the true pelvis in close relation to the iliac vessels, and disappears beneath Poupart's ligament to be *inserted* by a tendon into the back of the lesser trochanter of the femur.

The **Psoas Parvus** (Fig. 121, 4) is a small muscle occasionally found upon the front of the psoas magnus. It *arises* from the bodies of the last dorsal and first lumbar vertebræ, and ends in a long tendon which is *inserted* into the ilio-pectineal eminence and part of the ilio-pectineal line, giving an expansion to the iliac fascia.

The **Iliacus Internus** (Fig. 121, 8) lies in the iliac fossa, from the greater part of which it *arises*, as well as from the ilio-lumbar ligament and the ala of the sacrum. A few fibres also are attached to the capsular ligament of the hip-joint. The fleshy fibres of the iliacus are united with the tendon of the psoas at its *insertion* into the femur.

The psoas and the iliacus are flexors of the thigh, but taking their fixed point below are flexors of the trunk upon the thigh. This is seen in dislocation of the femur downwards into the thyroid foramen, when the body is always bowed forwards owing to the tension of these muscles. The psoas is *supplied* by the lumbar nerves, the iliacus by the anterior crural nerve.

The **Quadratus Lumborum** (Fig. 121, 5) is the short muscle filling the space between the last rib and the crista ilii. It has its origin below, from the posterior portion of the inner lip of the crest of the ilium and from the adjacent ilio-lumbar ligament; and ascends to be *inserted* into the lower border of the last rib, and by three or four slips into the tips of the transverse processes of the lumbar vertebræ. It is sometimes described as consisting of two distinct parts. The quadratus draws down and fixes the last rib, and draws the lumbar spine towards the iliac crest, or, if both muscles act together, it steadies the lumbar spine; it is *supplied* by the posterior branches of the lumbar nerves.

Twelfth dorsal nerve (Fig. 121, 3).—Crossing the quadratus. and immediately below the ligamentum arcuatum externum, will be found a large nerve, the twelfth dorsal, which will be seen to disappear through the transversalis muscle, and must not be confounded with the branches of the lumbar plexus.

The **Lumbar Plexus** (Fig. 121).—At the outer border of the psoas, and about midway between the last rib and the crest of the ilium will be found two small nerves (often united), crossing the quadratus obliquely and piercing the abdominal muscles immediately above the crest, and generally close together. These are the *ilio-hypogastric* (7) and *ilio-inguinal* (9) nerves, and their size varies considerably in different subjects, one being often larger than the other, or there being one trunk only which subdivides in the abdominal wall. The after-course of the nerves has been given in the dissection of the abdominal wall, the ilio-hypogastric being distributed to the skin of the lower part of the abdomen, and by its dorsal branch to the buttock, and the ilio-inguinal emerging from the external abdominal ring to supply the scrotum.

The *Genito-crural nerve* (11) appears on the front of the psoas at its upper part, and is of small size. It descends on the muscle, and divides into a *genital* (29) branch, which accompanies the spermatic cord through the inguinal canal to the cremaster, and a *crural* (27) branch, which runs under Poupart's ligament to the outer side of the external iliac artery, and is lost in the skin of the thigh.

The *External Cutaneous nerve* (15) appears at the outer border of the psoas just below the level of the crista ilii. It crosses the iliacus obliquely to the anterior superior spinous process, close to which it passes under Poupart's ligament to the outer side of the thigh. (This frequently comes from the anterior crural nerve, and is then nearly transverse in its direction.)

The *Anterior Crural* (23) is the large nerve close to the outer border of the psoas at its lower part, and lies deeply between that muscle and the iliacus. It passes under Poupart's ligament into the thigh, but in the abdomen gives branches to the iliacus internus muscle.

The *Obturator nerve* (25) will be better dissected with the pelvis, but if desired may be seen passing below the brim of the true pelvis, to disappear through the upper part of the thyroid foramen.

An *Accessory Obturator* nerve is occasionally found arising with the obturator nerve. The accessory nerve is usually very small,

Fig. 121.

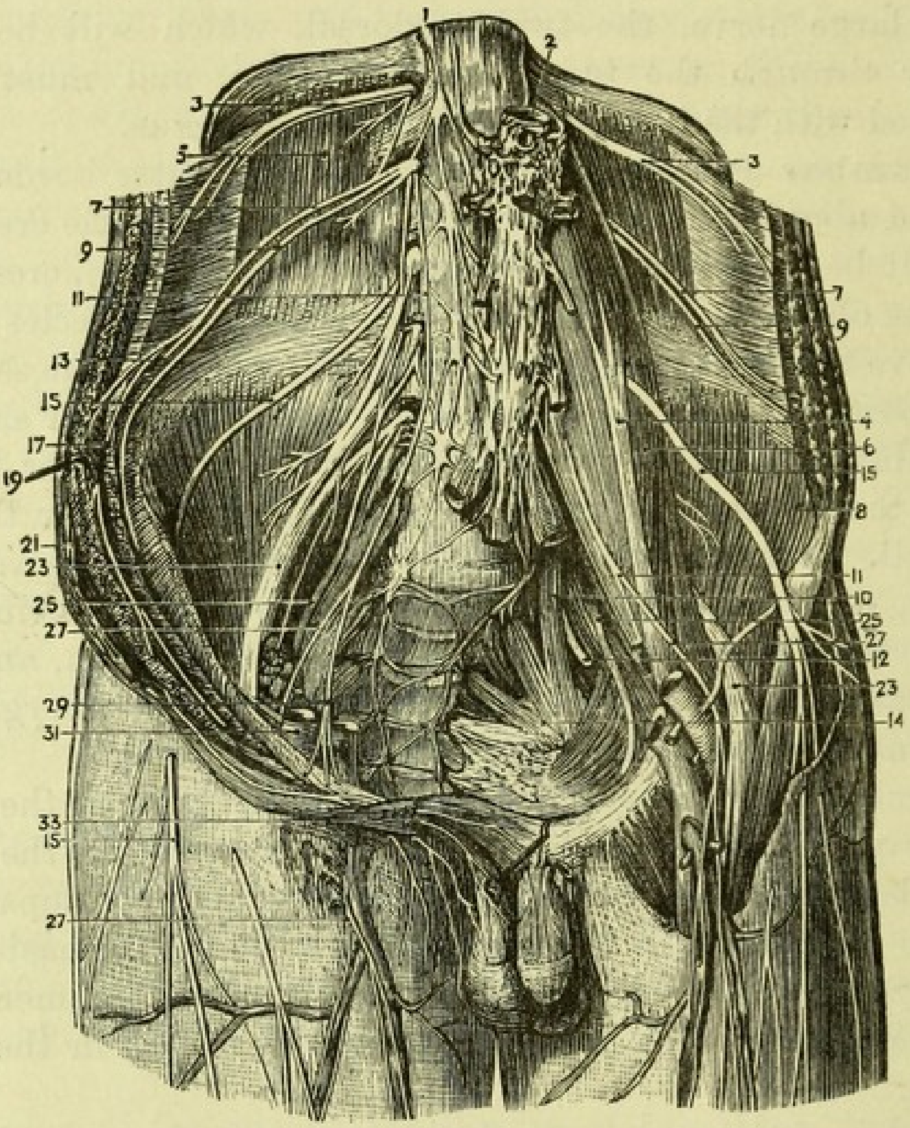


Fig. 121.—Lumbar plexus (from Hirschfeld and Leveillé).

1. Right gangliated cord of sympathetic.
2. Abdominal aorta.
3, 3. Last dorsal nerves.
4. Psoas parvus.
5. Quadratus lumborum.
6. Psoas magnus.
7, 7. Ilio-hypogastric nerves.
8. Iliacus internus.
9, 9. Ilio-inguinal nerves.
10. Lumbo-sacral nerve.
11, 11. Genito-crural nerves.
12. Gluteal branch of ilio-hypogastric nerve.
13. Iliac branch of ilio-hypogastric nerve.
14. Sacral plexus.
15, 15, 15. External cutaneous nerves.
17. Transversalis abdominis.
19. Obliquus internus.
21. Obliquus externus.
23, 23. Anterior crural nerves.
25, 25. Obturator nerves.
27, 27. Crural branch of genito-crural nerve.
29. Genital branch of genito-crural nerve.
31. External iliac artery.
33. External abdominal ring.

and passes over the brim of the pelvis beneath the psoas, joining the obturator nerve on the inner side of the thigh, and supplying twigs to the pectineus and the hip joint.

[The psoas should be carefully removed piecemeal on one side, in order to dissect the lumbar nerves to their origins, and to trace out the plexus completely. The gangliated cord of the sympathetic can now be fully seen, and should be cleaned.]

The *Lumbar plexus* will now be seen to be formed by the 1st, 2nd, 3rd, and part of the 4th lumbar nerves, with a branch from the 12th dorsal; the remainder of the 4th joining with the 5th to form the lumbo-sacral cord. The several nervous trunks are united more or less definitely by connecting branches, and from them the nerves are given off, thus :—from the 1st the ilio-hypogastric and the ilio-inguinal nerves; from the 1st and 2nd the genito-crural nerve; from the 2nd and 3rd the external cutaneous nerve; from the 2nd, 3rd, and 4th the anterior crural nerve; from the 3rd and 4th the obturator nerve. Thus it will be seen that the origins of the nerves are very simple, a nerve being added or subtracted in regular sequence, as follows :—

Lumbar nerves	1 . . .	Ilio-hypogastric and ilio-inguinal.
	1 2 . .	Genito-crural.
	2 3 .	External cutaneous.
	2 3 4	Anterior crural.
	3 4	Obturator.

Sympathetic Nerve.—The *Gangliated Cord of the Sympathetic* (Fig. 121, I) will be found on each side of the spinal column, and behind the vena cava upon the right side. A ganglion is situated opposite each vertebra, and branches of communication may be traced from each, which may be divided into (1) those communicating with the ganglia above and below; (2) those communicating with the spinal nerves, which are often two in number, and join the nerves above and below each ganglion; (3) branches to the plexuses upon the neighbouring arteries supplying the viscera and the vertebræ and ligaments.

Some *lymphatic glands* (*lumbar*) may also be found by the side of the aorta at the lower part, which receive the lymphatics from the testis, and are therefore affected in malignant diseases of that organ.

The **Vena Azygos Major** may be seen lying close to the right side of the aorta, and communicating with one or more of the lumbar veins. It passes through the aortic opening.

The **Vena Azygos Minor** (if it exists) may be seen to commence in the left lumbar veins, and to pass through the left crus of the diaphragm.

Receptaculum Chyli.—By detaching the right crus of the diaphragm from the vertebræ, and if necessary, removing a piece of the aorta opposite the upper lumbar vertebræ, the *receptaculum chyli*, an irregular tube about two inches long, will be seen lying to the right side of the aorta, opposite the first, second, or third lumbar vertebræ. It receives the lymphatics and lacteals of the abdomen, and is continued upwards as the thoracic duct.

The subject will now be turned for the dissection of the back, and the dissectors of the abdomen should occupy the time with the examination of the viscera.

Viscera of the Abdomen.

[The stomach and intestines should be cleaned by allowing a stream of water to pass through them; and the stomach, as well as a piece of small and large intestine, should be distended with air by means of a blow-pipe, so as to permit of dissection of their coats.]

The **Stomach** (Fig. 122) presents a lesser and a greater curvature at its upper and lower borders, and a greater and lesser end. The great end is the dilatation on the left side of the body near the entrance of the œsophagus, and is called the cardiac or splenic end, or is sometimes known as the fundus. The small or pyloric end presents a small dilatation, called the antrum of the pylorus, and terminates in the duodenum, the junction of the two viscera being marked by a thickened band of fibres, which can both be seen and felt, and is called the *pylorus*.

The coats of the stomach are four—serous, muscular, areolar, and mucous.

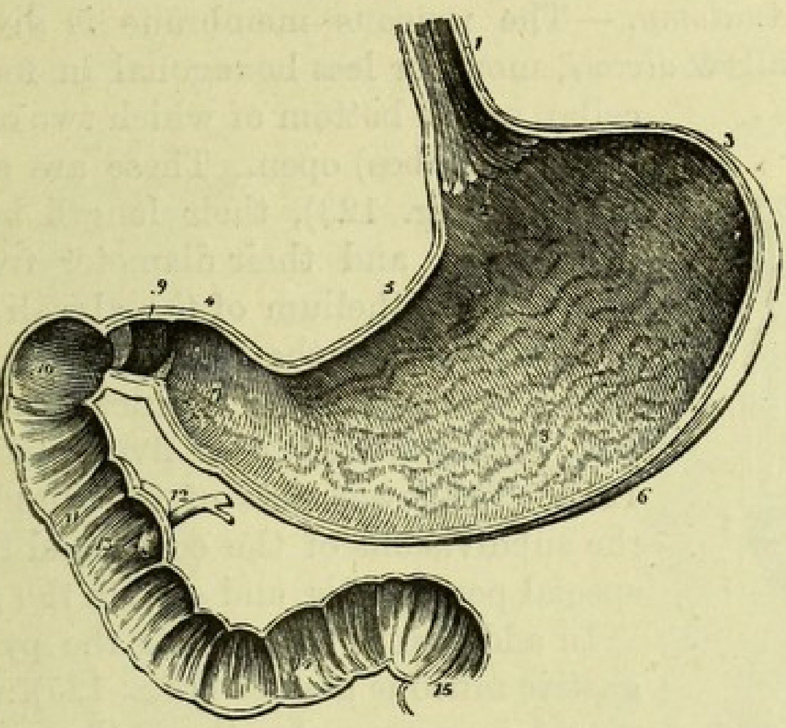
The *serous coat* is continuous with the lesser omentum above, and with the great omentum below; that in front of the stomach being derived from the greater bag, and that behind from the lesser bag of the peritoneum. Along the lesser and greater curvatures the two layers of peritoneum are separated by the gastric, the pyloric, and the gastro-epiploic vessels.

The *muscular coat* consists of three sets of unstriped fibres, longitudinal, circular and oblique. The longitudinal fibres are continuous with those of the œsophagus, and, running principally along the lesser curvature, are continued into the duodenum. The circular fibres, which are next in order, enclose the entire viscus, and are collected together at the small end to form the pylorus.

The oblique fibres are most internal, and are continuous with the circular fibres of the œsophagus; they are distributed principally over the great end of the stomach.

The *areolar* or *sub-mucous coat* consists of areolar tissue, in which

Fig. 122.



the blood-vessels ramify, and between this and the mucous coat is a fine layer of involuntary muscle, the *muscularis mucosæ.*

On laying open the stomach along its lesser curvature, the *mucous membrane* will be seen to be arranged in longitudinal folds or ridges called *rugæ*, which disappear when the viscus is distended, and are more evident in the child than in the adult. By inverting the pyloric end the *pylorus* or *pyloric valve* will be seen, a ring of the mucous membrane being projected by a set of strong

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Fig. 122.—Vertical and longitudinal section of the stomach and duodenum (from Wilson).

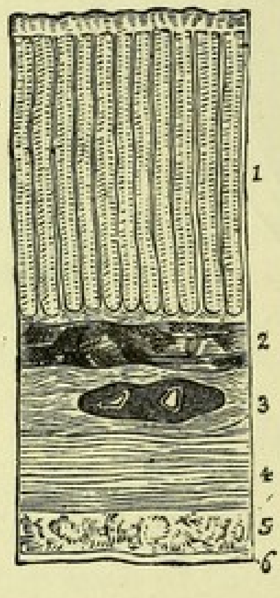
1. Œsophagus.
2. Cardiac orifice of the stomach.
3. Great end of the stomach.
4. Lesser or pyloric end.
5. Lesser curve.
6. Greater curve.
7. The antrum of the pylorus.
8. Longitudinal rugæ of the mucous membrane.
9. Pylorus.
10. Ascending portion of the duodenum.
11. Descending portion.
12. Pancreatic duct and ductus communis choledochus close to their termination.
13. Papilla upon which the ducts open.
14. Transverse portion of duodenum.
15. Commencement of jejunum. In the interior of the duodenum and jejunum the valvulæ conniventes are seen.

circular fibres, surrounding the intestine and acting as a sphincter muscle.

The mucous membrane is thick and soft, and of a pink colour when recent; it is thickest near the pylorus and thinnest at the greater end, which is the spot therefore where perforation from post-mortem digestion usually takes place.

Minute Anatomy.—The mucous membrane is divided into a series of shallow *alveoli*, more or less hexagonal in form (stomach cells), at the bottom of which two or more *tubuli* (stomach tubes) open. These are arranged side by side (Fig. 123), their length being from $\frac{1}{60}$ to $\frac{1}{20}$ inch, and their diameter from $\frac{1}{500}$ to $\frac{1}{360}$ inch; the epithelium of the alveoli is columnar.

Fig. 123.



In addition to the simple tubes, there are in man a few compound tubules near the cardiac end, having from two to five subdivisions (Fig. 124). The lower ends of the simple tubes and the subdivisions of the compound tubes contain special peptic cells, and secrete the gastric juice.

In addition to these, near the pylorus are the gastric mucous glands (Fig. 125), mostly compound in man. In these the columnar epithelium of the alveoli is prolonged into the tubes nearly to the blind extremities, which are filled with granules. Lenticular glands or lymphoid follicles are scattered over the surface of the gastric mucous membrane.

The **Small Intestines** extend from the pylorus to the ileo-cœcal valve, averaging twenty feet in length, and have certain general characteristics in common; thus, they are of a uniform calibre throughout, and their external surface is smooth and regular. They have four coats, viz. peritoneal, muscular (longitudinal and circular), areolar, and mucous. The peritoneal coat is not found throughout; thus, the first part of the duodenum is completely invested except where the vessels enter, the second part only in

Fig. 123.—Perpendicular section of the stomach in the pyloric region: showing its coats and the gastric glands; from the pig (from Wilson, after Kölliker).

1. Gastric glands.
2. Muscular layer of the mucous membrane.
3. Submucous coat, in which a vessel has been divided.
4. Transverse fibres of the muscular coat.
5. Longitudinal fibres of the muscular coat.
6. Serous coat.

front, and the third part not at all; the jejunum and ileum are completely covered by peritoneum. The longitudinal muscular fibres are external, and the circular internal,* and they are both complete and continuous layers, the internal being considerably the thicker of the two. There is also a fine muscular layer (*muscularis mucosæ*) between the areolar and mucous layers, as in the

Fig. 124.

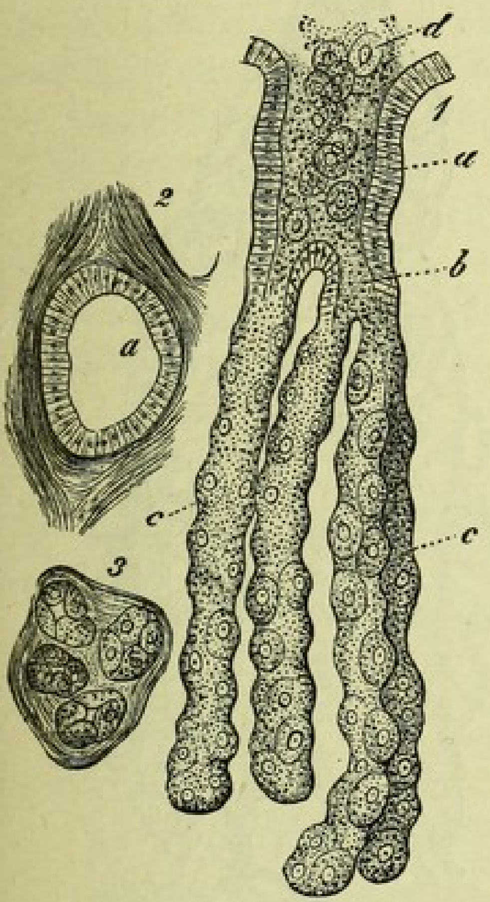
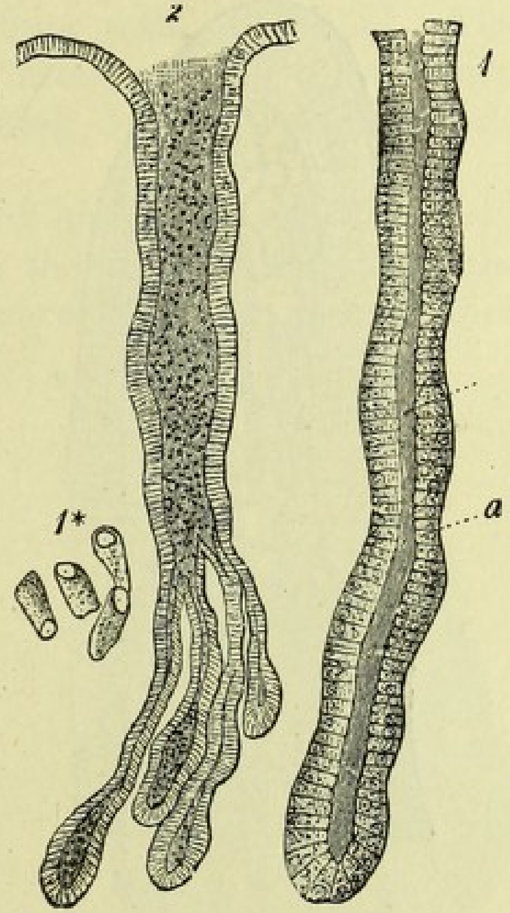


Fig. 125.



stomach. The mucous membrane has the following characteristics throughout—valvulæ conniventes, villi, Lieberkühn's follicles, solitary glands, and a columnar epithelium; but the duodenum and ileum have certain special structures in addition.

Fig. 124.—A compound peptic gland of a dog (from Frey).

a. Stomach-cell.
b. Sub-division into
c, c. Tubuli.
d. Contents of cell.
2. Transverse section of stomach cell *a*.
3. Transverse section of tubuli.

Fig. 125.—Gastric mucous glands (from Frey).

1. A single mucous gland lined by columnar cells *a*.
1* Columnar epithelium.
2. A compound mucous gland.

* An artificial aid to the remembrance of this fact is afforded by noting that lOngitudinal = Outer, and cIrcular = Inner layer.

The **Duodenum** (Fig. 122) should be laid open along its free border, in order to see the opening of the bile and pancreatic ducts, which is marked by a papilla situated at the back of the vertical portion of the intestine, and about or below its middle (13). A probe should be passed into the orifice and along the pancreatic duct.

Fig. 126.

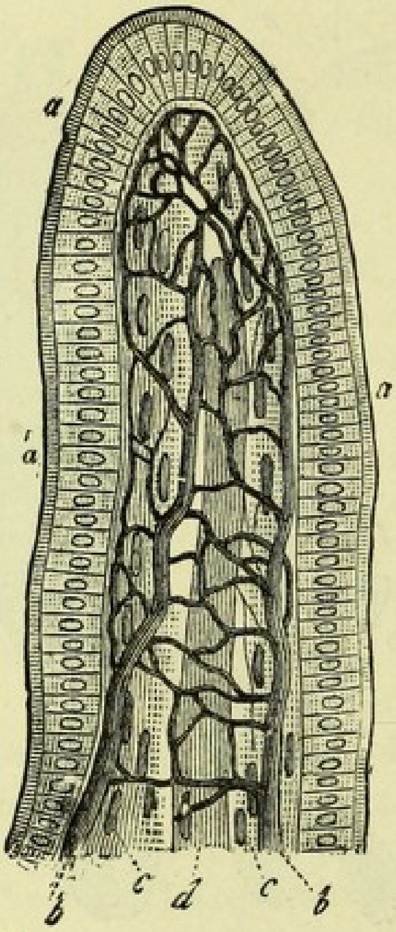
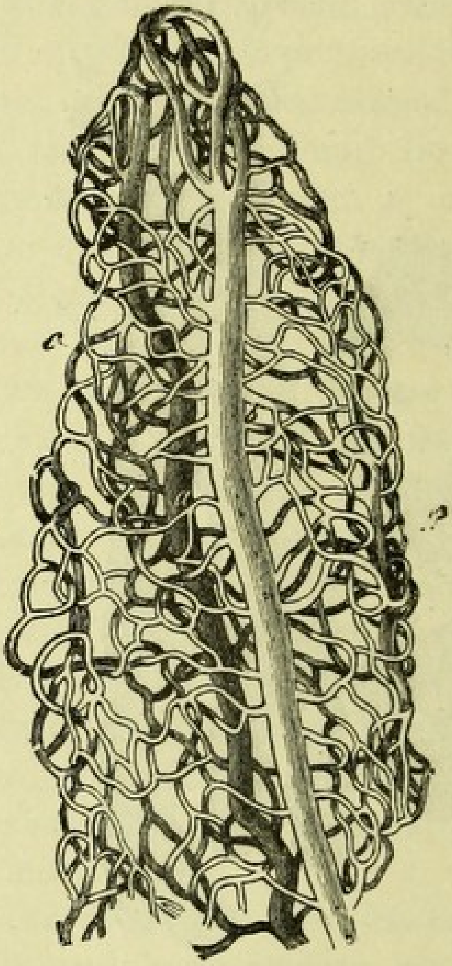


Fig. 127.



The duodenum is from eight to ten inches long, and has a special structure (Brunner's glands) in addition to the ordinary characteristics of the small intestine.

Valvulæ conniventes (or valves of Kerkring) are transverse folds of mucous membrane, which will be seen to commence a little beyond the pylorus, and to increase in size at the lower part of the duodenum.

Fig. 126.—An intestinal villus (from Frey).

a. Columnar epithelium.
b. Capillary plexus.
c. Muscular fibres.
d. Axial chyle radicle.

Fig. 127.—Vascular network of a villus (from Frey).

a. Venous branch. *b.* Arterial branch. *c.* Capillary plexus.

Villi (Fig. 130, 1) are the minute projections from the surface of the mucous membrane, which give it a velvety appearance, and may be best seen by floating a piece of intestine in water. Each villus is a prolongation of the mucous membrane, formed of lymphoid tissue and covered with columnar epithelium. It contains in its centre a single or double lacteal, surrounded by a delicate layer of involuntary muscle prolonged from the *muscularis mucosæ ;* externally to which is a capillary plexus, with the basement-membrane on which the epithelium rests (Fig. 126). The capillary plexus is supplied by a small artery passing up one side of the villus, and ends in a vein running down the opposite side (Fig. 127).

Lieberkühn's follicles (Fig. 130, 2) are minute tubes, which are placed between the villi, and resemble the mucous glands of the stomach ; they dip into the submucous areolar tissue, and are lined with columnar epithelium.

Fig. 128.

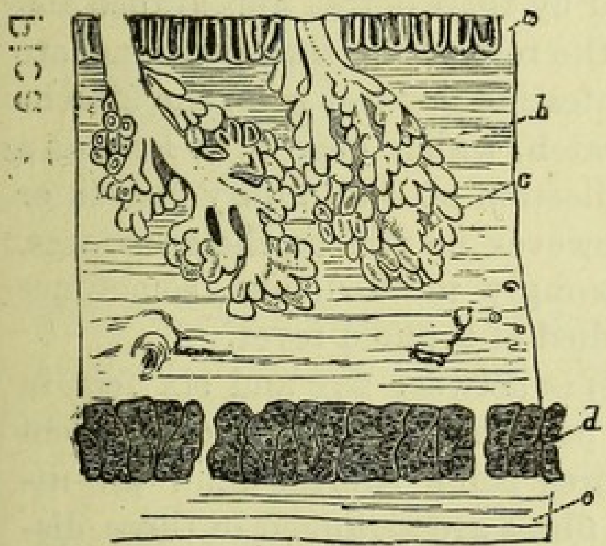
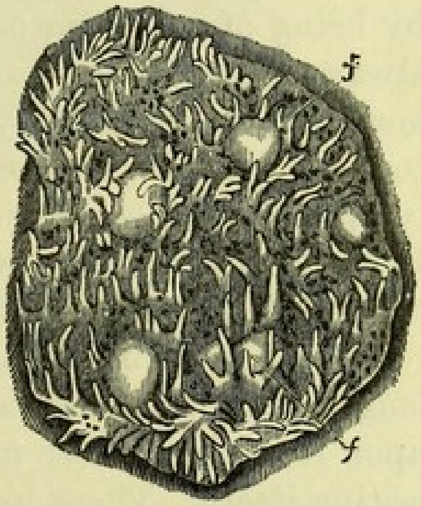


Fig. 129.



Solitary glands, or lymphoid follicles (Fig. 129), are minute white round bodies, consisting of closed vesicles containing milky fluid and covered with villi.

Brunner's glands (Fig. 128), peculiar to the upper part of the duodenum, are small lobulated glands situated in the submucous

Fig. 128.—Vertical section of mucous membrane of duodenum, showing Brunner's glands (from Wilson, after Ecker).

a. Follicles of Lieberkühn.
b. Submucous tissue.
c. Brunner's glands.
d. Circular muscular fibres.
e. Longitudinal muscular fibres.

Fig. 129.—Surface of small intestine showing solitary glands *f*, *f* and villi.

areolar tissue and having small ducts which open into the intestine. To see these it is necessary to pin out a piece of duodenum with the mucous membrane downwards, and then carefully to dissect away the muscular coat.

[The jejunum and ileum (except a few inches to be left attached to the cœcum) should be laid open along the line of attachment of the mesentery, so as to avoid damaging Peyer's patches, which are on the free border.]

The **Jejunum** includes about two-fifths of the remaining small intestine, and is remarkable for the large size of the valvulæ conniventes and the number of solitary glands, but has no special characteristic.

In the **Ileum**, the valvulæ conniventes will be found to diminish rapidly in size, and to be wanting at the lower part.

Peyer's patches (*glandulæ agminatæ*) (Fig. 130, 4) are the special characteristic of this part of the intestine; they are from twenty to thirty in number, but vary much in size and are occasionally invisible. They will be recognised by their dotted appearance and by being of a lighter colour than the rest of the intestine, and are always found on the part of the intestine farthest from the attachment of the mesentery. Each patch, which may be as long as a couple of inches, is formed of a collection of the solitary glands or lymphoid follicles, which have however no villi on their surfaces. Peyer's glands will be found strongly marked, and sometimes ulcerated, in subjects which have died of typhoid fever.

The **Large Intestine** (Fig. 114) is between five and six feet in length, and is remarkable for the pouched appearance consequent upon its longitudinal muscular fibres being shorter than the intestine itself. These longitudinal fibres are arranged in three distinct bands, two of which can be seen through the peritoneum, and the third between the layers of the meso-colon. (In the rectum, which is not pouched, and the vermiform appendix, these fibres spread over the whole gut, as in the small intestine.) The *appendices epiploicæ* are small processes containing fat, attached along the free border of the intestine, which will be found to vary considerably in size in different subjects.

The **Cœcum** (Fig. 131, 1) (caput cœcum coli) is distinguished by its rounded shape and by the opening of the ileum into it. It has attached to its lower and back part the *appendix vermiformis*, which is a little tubular prolongation terminating in a blind extremity.

[The cœcum with a few inches of small and large intestine should be detached, and the large intestine turned inside out to see the ileo-cœcal valve. After this has been done and the intestine re-inverted, the cut ends may be tied and the piece inflated and dried, that the valve may be again examined in the dry condition.]

Fig. 130.

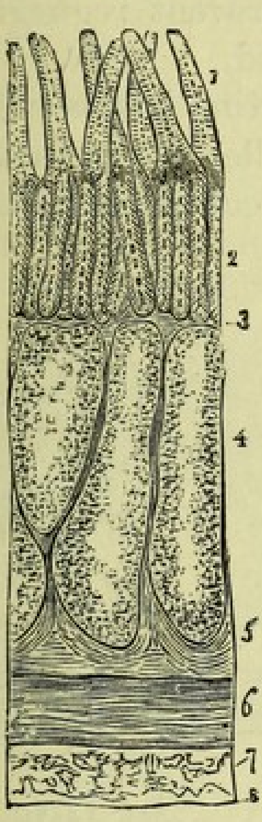
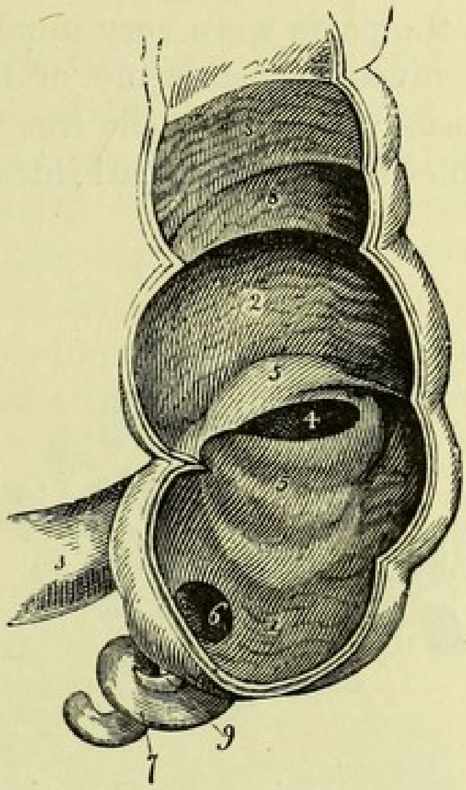


Fig. 131.



The *Ileo-cœcal valve* (Fig. 131, 5) is formed by a prolongation of a piece of ileum through the wall of the cœcum, to which it is firmly attached; and, being stretched from side to side, the small

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Fig. 130.—Section of the lower part of ileum of the calf, through a Peyer's gland (from Wilson, after Kölliker).

1. Villi.
2. Tubular glands or Lieberkühn's follicles.
3. Muscular stratum of the mucous membrane.
4. Sacculi of Peyer's gland.
5. Deep portion of the submucous coat.
6. Circular layer of the muscular coat.
7. Longitudinal layer of the muscular coat.
8. Serous coat.

Fig. 131.—The cœcum laid open, showing the entrance of the ileum and the ileo-cœcal valve (from Wilson).

1. Cœcum.
2. Commencement of colon.
3. Ileum.
4. Aperture of entrance of the ileum into the large intestine.
5, 5. Ileo-cœcal valve.
6. Aperture of appendix vermiformis cœci.
7. Appendix vermiformis.
8, 8. Sacculi of the colon.
9. Mesentery of appendix vermiformis.

intestine forms two folds which project into the cœcum and form the valve. The upper fold, which is horizontal in direction, is sometimes known as the *ileo-colic*, and the lower or more vertical one as the *ileo-cœcal* fold.* The ridges on each side, formed by the prolongation of the two folds, are called the *frœna* or *retinacula.* It is obvious that these folds permit the ready passage of fluid from the small into the large intestine, but would prevent regurgitation unless the parts were very much over-distended.

The mucous membrane of the large intestine has *no* villi, for they cease abruptly at the free margin of the ileo-cœcal valve, but resembles that of the small intestine in having columnar epithelium

Fig. 132.

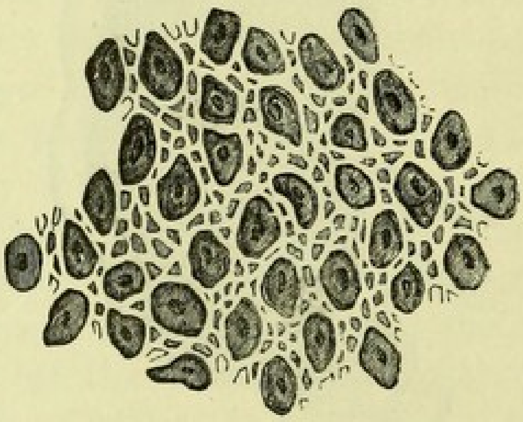
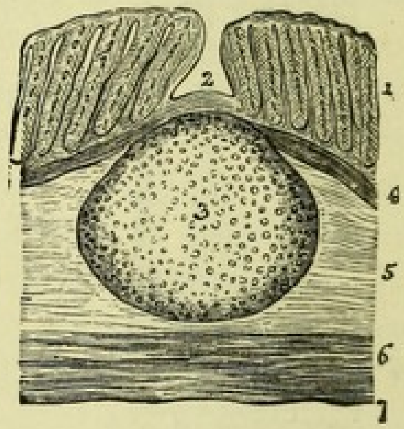


Fig. 133.



and a muscular layer. Tubular glands resembling the follicles of Lieberkühn, and solitary glands or closed follicles, embedded in the submucous tissue and having over them small depressions on the mucous surface, are found throughout the large intestine (Figs. 132 and 133).

The **Pancreas** (Fig. 116) should be cleaned, but left attached to the duodenum. It is about seven inches long, and the larger end, where it touches the bowel, is called the head, the central portion the body, and the small extremity the tail. Its average weight is

Fig. 132.—Portion of the mucous membrane of the large intestine, magnified 75 times (from Wilson).

Fig. 133.—Solitary gland from the colon of a child, as shown in a section of the intestine (from Wilson, after Kölliker).

1. Tubular glands.
2. Depression on the surface of the membrane corresponding with the central prominence of the gland.
3. The gland.
4. Muscular layer of the mucous coat.
5. Submucous coat.
6. Muscular coat.
7. Serous coat.

* Artificial memory, S H I P—Superior Horizontal, Inferior Perpendicular.

three ounces. The pancreas is a compound racemose gland, and consists of lobules of a yellowish colour held together by loose fibrous tissue, a small duct passing from each lobule into the main trunk. A probe being passed from the duodenum into the duct (canal of Wirsung), it should be dissected out, and will be found to pass along the whole length of the gland, and nearer the posterior than the anterior surface, a large accessory duct passing from the head.

The pancreatic duct lies close to the bile duct, and the two pierce the duodenal wall together, opening usually by a common orifice. Occasionally there is a separate duct from the head of the pancreas opening into the duodenum by itself. The pancreas derives its blood from the splenic and from the superior and inferior pancreatico-duodenal arteries; its nerves from the solar plexus.

The **Spleen** (Fig. 116, 4) is purple in colour and somewhat oval in form, and has a convex outer and a concave inner surface, with

Fig. 134.

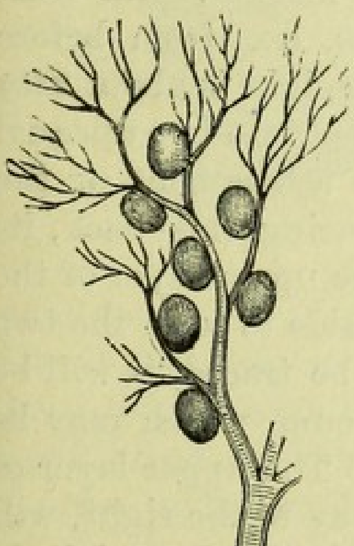


Fig. 135.

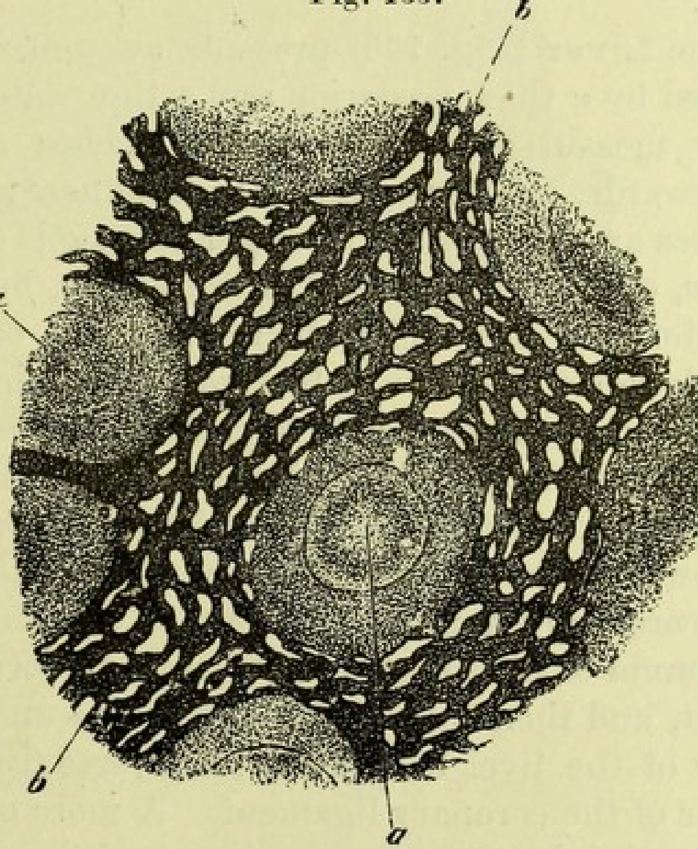


Fig. 134.—Arterial twig of the splenic artery, showing the connection of the splenic corpuscles with the small vessels. From the spleen of the dog (from Wilson, after Kölliker).

Fig. 135.—Section of the spleen of rabbit (from Frey).

a. Malpighian corpuscle.
b. Sustentacular matter of pulp, with the interspaces filled with venous blood.

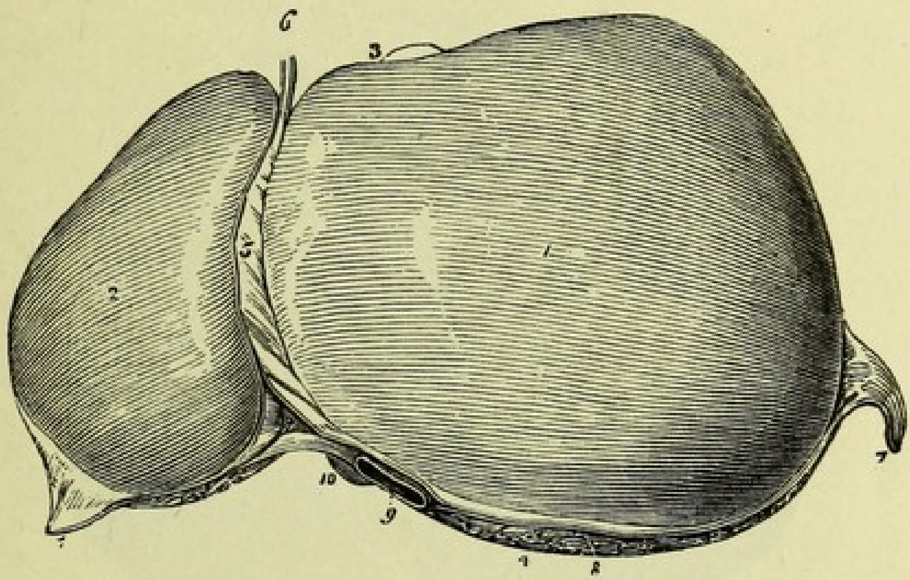
an anterior border which is sharp and slightly notched, and a posterior border which is thicker. The concave surface is divided into two parts by a ridge and a vertical fissure, the *hilum*, into which the splenic vessels should be traced. Beneath the peritoneal coat which invests the organ will be found a fibrous coat, which is also continued into the splenic substance, forming the *trabeculæ* or meshes in which the splenic *pulp* is contained. In this pulp, which consists of a reticulum of branched connective-tissue corpuscles (Quain), are found the *Malpighian corpuscles* which are special to the spleen, and are small vesicular bodies containing white semi-fluid matter, attached to the minute divisions of the splenic artery (Fig. 134). They are composed of lymphoid tissue derived from a transformation of the external or areolar coat of the small arteries, and average $\frac{1}{70}$ inch in diameter. The arteries end in capillaries, which lose themselves in the connective tissue of the pulp, in the interstices of which the blood flows. The veins anastomose freely in and upon the trabeculæ, and open into the splenic vein (Fig. 135).

The **Liver** (Fig. 136) presents an upper and an under surface united by a thick posterior and a thin anterior margin. Its ordinary measurements are, twelve inches across, six from before backwards, and three inches in thickness; its weight is about fifty ounces avoirdupois. The upper surface is divided into two unequal parts, of which the right is the larger, by the attachment of the falciform or suspensory ligament; and on tracing this back, its two layers will be found to diverge, forming the upper layer of the coronary ligament, which is prolonged at each side to form the two lateral ligaments. If the left lateral ligament be traced, it will be found to consist of a double fold of the peritoneum, which may be followed to the under surface of the left lobe. The upper layer of the coronary ligament, if traced in the same way to the right, will be found to be reflected upon itself to form the right lateral ligament, and then will be followed to the under surface of the right lobe of the liver behind the transverse fissure, to form the under layer of the coronary ligament. A more or less triangular interval is thus left between the two layers of the coronary ligament, where the liver is attached to the diaphragm by cellular tissue, and has the right suprarenal capsule and top of the right kidney in close relation with it, and through which the vena cava passes to the diaphragm. In this manner four ligaments of the liver are formed by peritoneum, the fifth or round ligament being the obliterated umbilical vein.

The **under surface** of the liver (Fig. 137) presents five *fissures* and five *lobes* for examination.

Fissures.—The *longitudinal fissure* divides the under surface into right and left lobes, and is occupied by the round ligament or umbilical vein (1). Its continuation behind the transverse fissure is the *fissure for the ductus venosus* (8), and contains that obliterated vessel. The *transverse fissure* (*porta*) is at right angles to the longitudinal; to it the small omentum is attached, and it gives passage to the hepatic duct (4), hepatic artery (3), and portal vein (5), which lie in that order from before backwards.* Parallel to the longitudinal fissure is the *fissure for the gall-bladder* (2), which last

Fig. 136.



should be distended with air by a blowpipe placed in the duct. Placed obliquely at the posterior margin of the liver and behind the gall-bladder is the short groove or *fissure for the vena cava* (7), a portion of which vessel has been left *in situ*.

Lobes.—The whole of the liver substance on the right of the longitudinal fissure is strictly the *right lobe* (R), but certain parts

Fig. 136.—Upper surface of the liver (from Wilson).

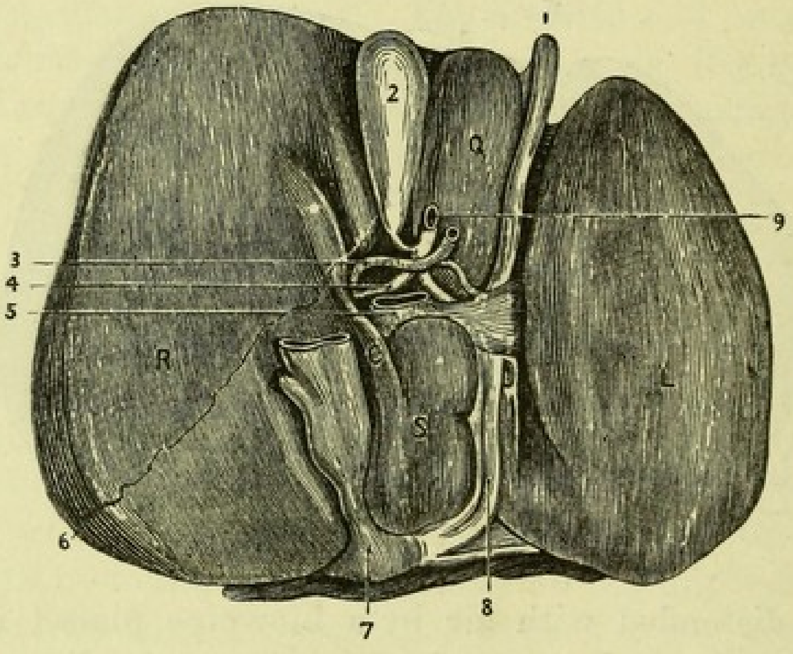
1. Right lobe.
2. Left lobe.
3. Fundus of the gall-bladder seen projecting beyond the anterior border of the right lobe.
4. Posterior or rounded border.
5. Falciform or suspensory ligament.
6. Round ligament.
7, 7. The two lateral ligaments.
8. The space left uncovered by the peritoneum and surrounded by the coronary ligament.
9. Inferior vena cava.
10. Point of the lobus Spigelii.

* It will be observed that the order of vessels entering the liver is the reverse of those entering the kidney, *q. v.* p. 248.

of it have received special names, viz., lobus quadratus, lobus Spigelii and lobus caudatus. The right lobe has two shallow depressions on its under surface, the anterior one being where the ascending colon touches the liver, and the posterior one corresponding to the anterior surface of the right kidney, over which it lies in the erect posture.

The *Lobus quadratus* (Q) is the square lobe bounded by the longitudinal and transverse fissures and the gall-bladder; it is in relation with the pyloric end of the stomach and the first part of the duodenum. The *Lobus Spigelii* (S) is the projecting portion behind the transverse fissure, and between the fissures for the vena

Fig. 137.



cava and the ductus venosus. The *Lobus caudatus* (C) is the small "*tail*" of liver substance which connects the lobus Spigelii with the right lobe. The *left lobe* (L), which is in contact with the stomach, is on the opposite side of the longitudinal fissure, across which there is often a bridge of liver substance (pons hepatis).

The vessels entering the transverse fissure should be defined, and the fibrous tissue around them (capsule of Glisson) removed. The

---

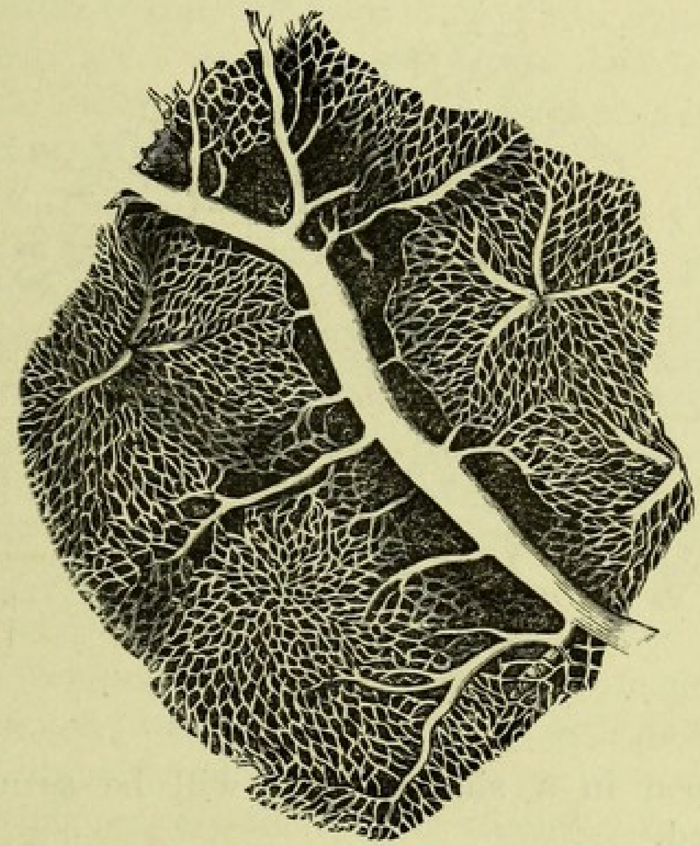
Fig. 137.—Under surface of the liver (from Bonamy).

R. Right lobe.
L. Left lobe.
Q. Lobus quadratus.
S. Lobus Spigelii.
C. Lobus caudatus.
1. Umbilical vein in longitudinal fissure.
2. Gall-bladder in its fissure.
3. Hepatic artery in transverse fissure.
4. Hepatic duct in transverse fissure.
5. Portal vein in transverse fissure.
6. Line of reflection of peritoneum.
7. Vena cava.
8. Obliterated ductus venosus.
9. Ductus communis choledochus.

right and *left hepatic ducts* (4) will be found to emerge from the corresponding lobes and to unite in the *common hepatic duct*, which is about two inches long; this is afterwards joined by the *cystic duct* from the gall-bladder, to form the *common bile duct* (ductus communis choledochus) (9), which is nearly three inches long, and should be traced into the duodenum.

The *gall-bladder* (2) is a pear-shaped bag attached by cellular tissue to the liver, and covered superficially by the peritoneum. When distended, its large end or *fundus* projects beyond the

Fig. 138.



anterior border of the liver; the neck is curved upon itself twice and ends in the cystic duct, which is about an inch and a half long and joins the hepatic duct. The mucous membrane presents numerous ridges separating alveoli of irregular shape. The epithelium is columnar.

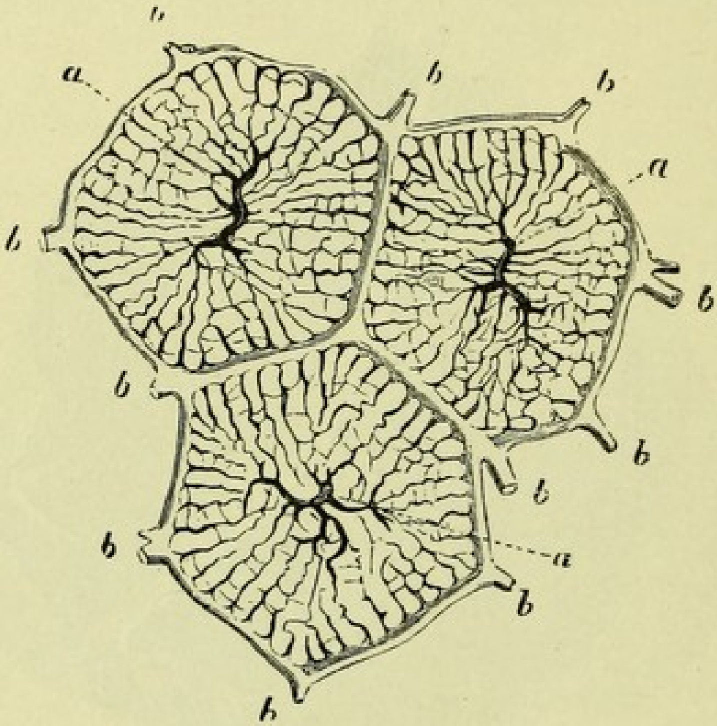
The hepatic artery and the portal vein each divide into right and left branches, and from the right artery the cystic branch should be traced to the gall-bladder.

Fig. 138.—Rabbit's liver injected, showing a portal vein, with interlobular branches and plexus. Intralobular vein commencing in the centre of a lobule (from Frey).

The piece of the vena cava removed with the liver is to be laid open, when the large hepatic veins, two or three in number, will be seen opening into it.

In order to learn the arrangement of the vessels in the liver, the vena portæ should be carefully laid open for some distance with a pair of scissors. Through the thin wall of the vein a branch of injected hepatic artery will then be seen, and accompanying it is a branch of hepatic duct, the three vessels thus lying side by side in what is known as a *portal canal.* One of the hepatic veins

Fig. 139.



being laid open in a similar way, will be seen to be totally unaccompanied.

An incision into any part of the liver will show on its cut surfaces a number of openings, some wide open,—the hepatic veins; others more or less collapsed, and having by their sides the sections of a small injected artery and duct. These last are the portal veins lying in the portal canals, and they collapse on account of the loose attachment of the fibrous tissue around them.

Minute Anatomy (Fig. 139).—The blood from the chylopoietic viscera is brought to the liver by the vena portæ, and from it the bile is secreted. The divisions of the vein have been seen to pass

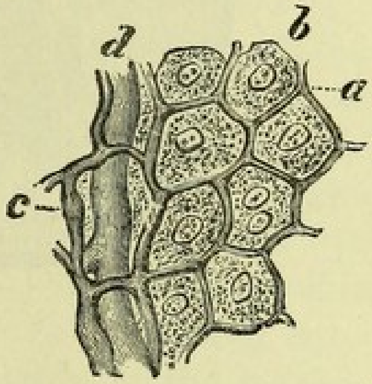
Fig. 139.—Diagram of the circulation in the lobules of the liver (after Kiernan).

a, a. Intralobular veins. *b, b.* Interlobular veins.

through the portal canals, in which they receive the vaginal and capsular branches from the fibrous tissue of the organ, and subsequently divide until their branches run *between* the minute lobules or acini, and are therefore called *interlobular veins* (*b*). The lobules are surrounded by these interlobular veins, from which the lobular plexus of capillaries is derived, converging to the centre of each lobule and pouring its blood into the *intralobular vein* (*a*). Each intralobular vein passes out of the lobule at right angles to the portal vessels, and unites with other intralobular veins to form the *sublobular* veins; these open into the *venæ cavæ hepaticæ* or *hepatic veins*, which have been traced into the vena cava. The appearance of a piece of minutely injected liver is shown in Fig. 138.

The commencement of each primary *hepatic duct* is in the centre of each minute lobule, being continuous, according to Beale, with the basement membrane upon which the hepatic cells are placed. But according to other observers, the ducts commence in intercellular passages or biliary capillaries, with proper walls (Fig. 140). The minute ducts run towards the circumference of the lobule, and the radicles of adjacent lobules unite, the resulting ducts running along the portal canals by the side of the portal vein, to emerge eventually at the transverse fissure.

Fig. 140.



The *Hepatic artery* is principally for the nourishment of the tissue of the organ, and has little if anything to do with its function. It gives off *vaginal* branches which run in the portal canals, and *capsular* branches which supply the fibrous tissue on the surface, the blood being eventually returned into branches of the portal vein. The *interlobular* branches accompany the interlobular veins, and their blood enters the plexus within the lobules from which the bile is secreted.

The **Kidney** (Fig. 119) is convex on its anterior and flattened on its posterior surface, and its upper extremity is somewhat larger than the lower. Its outer border is convex and regular, while the internal is notched at the point where the vessels enter. An average kidney measures about four inches in length, two-and-a-half in

Fig. 140.—Lobule of liver, showing relation of biliary ducts and hepatic cells (from Wilson, after Frey).

a. Minute biliary ducts (capillaries). *c*. Biliary ducts.
b. Hepatic cells. *d*. Blood-vessels.

breadth, and rather over an inch in thickness. Its weight in the male is about $4\frac{1}{2}$ ounces, and rather less in the female. The renal artery enters, and the renal vein and ureter emerge at a slit on the

Fig. 141.

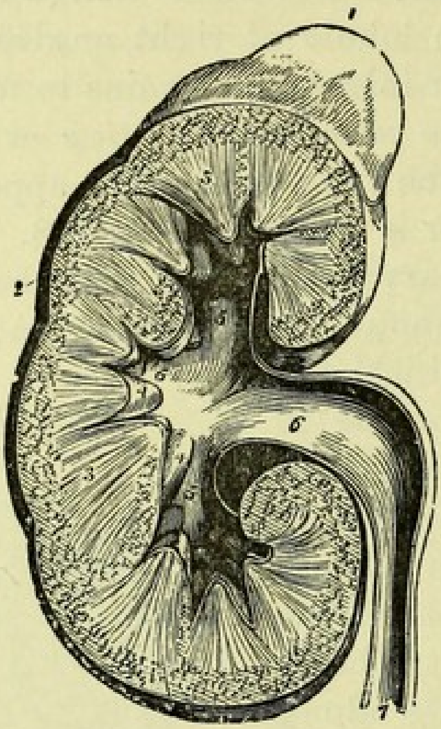
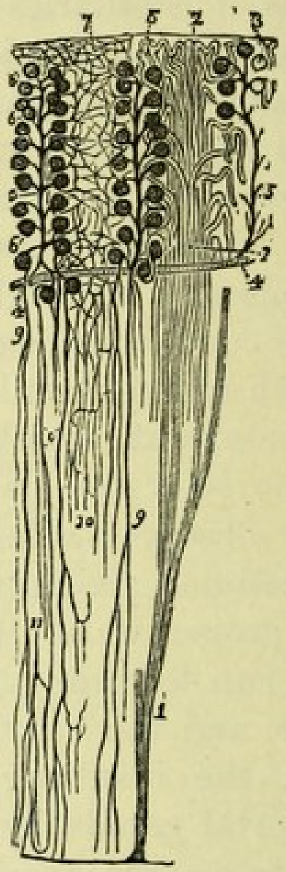


Fig. 142.



inner border called the *hilum*, and the *trunks* of the vessels have the following relations from before backwards, viz., vein, artery, and ureter (compare vessels entering transverse fissure of liver in the

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Fig. 141.—Section of the kidney, surmounted by the suprarenal capsule (from Wilson).

1. Suprarenal capsule.
2. Cortical portion of the kidney.
3, 3. Tubular portion, consisting of cones.
4, 4. Two of the papillæ projecting into their corresponding calices.
5, 5, 5. The three infundibula; the middle 5 is situated in the mouth of a calyx.
6. Pelvis.
7. Ureter.

Fig. 142.—Plan of the structure of the kidney (from Wilson, after Kölliker).

1, 1. Tubulus rectus, dividing into branches as it ascends.
2, 2. Pyramid of Ferrein; with the tubuli contorti.
3. Origin of two tubules from their respective Malpighian bodies.
4, 4. Branch of an artery.
5, 5. Three interlobular arteries giving off afferent twigs to the Malpighian bodies, 6, 6.
7. Capillary plexus formed by the efferent vessels, of which one is seen at 8.
9, 9. Arteriolæ rectæ.
10. Capillary plexus of the tubular structure of the pyramid.
11. One of the venulæ rectæ.

reverse order, p. 270). Very generally, however, one of the branches of the renal artery will enter the hilum in front of the vein. The hilum is prolonged around the pelvis, the space being occupied by fat, and called the *sinus* of the kidney.

The ureter, if traced upwards, will be found to expand, forming the *pelvis* of the kidney, and it should be noticed that the pelvis has a direction downwards; so that by referring to this, to the position of the vessels, and to the flattening of the posterior surface, the side to which the kidney belongs can be readily ascertained. The kidney is enclosed in a tough fibrous capsule, which may be peeled off to see the kidney substance. To see the internal structure of the organ, it should be opened through the convex border by a vertical incision, which is to be carried into the pelvis.

The *Pelvis* (Fig. 141, 6) will be found to be subdivided at the upper, middle, and lower part of the kidney into three, or sometimes two tubular portions, which are called the *Infundibula* (5), and are again subdivided into more numerous short dilated branches called the *Calices.* Projecting into the calices are small nodules of kidney substance termed the *papillæ* or *mamillæ* (4), which will be seen to be the apices of certain triangular dark-coloured bodies called the *pyramids* of Malpighi or *cones* (3). These pyramids, which are arranged more or less regularly side by side, constitute what is called the *tubular* or *medullary* substance of the kidney, the lighter granular portion at the margin of the section being the *cortical* substance (2).

The renal artery breaks up into four or five branches, which again subdivide and pass between the pyramids to the cortical substance, forming arches between the cortical and medullary portion. From these the *interlobular* arteries arise, which pass between the subdivisions of the cortical substance or *pyramids of Ferrein*, and give off the *afferent* arteries to the *Malpighian bodies* or *glomeruli* (Fig. 142). Each of these consists of a capillary plexus with an arterial twig (or afferent vessel) entering, and a venous radicle (or efferent vessel) leaving it, and these bodies are arranged along the arteries "like bunches of currants." Each Malpighian body or plexus is enclosed in a *capsule*, which is continuous with a minute *uriniferous tube* (Fig. 143). The tube is convoluted in the cortical substance, and a secondary *intertubular plexus* is formed upon it by the venous radicle, after it has emerged from the Malpighian tuft. The tube then becomes suddenly smaller, and passes for a variable distance into the pyramid, again curving upon itself to reach the cortical portion, where the diameter increases, and the tube opens into the straight or collecting tubes of the pyramids. These small tubes are known as the looped tubes of Henle (Fig. 145). The uriniferous tubes of the pyramids converge at their apices, where they empty themselves into the calices; from these the urine passes into the infundibula, and thence into the pelvis and ureter.

The relation of the epithelium to the blood-vessels of the Malpighian body is uncertain. The capsule is lined with pavement

Fig. 143.

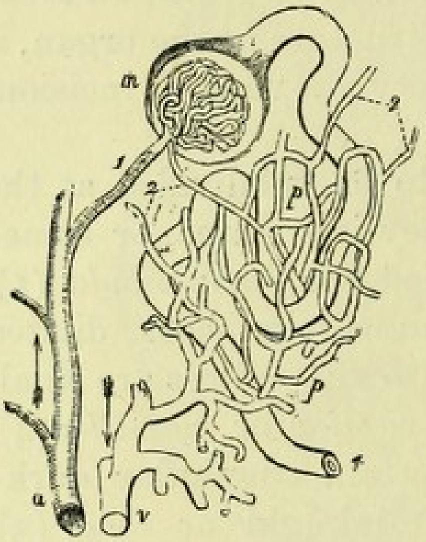
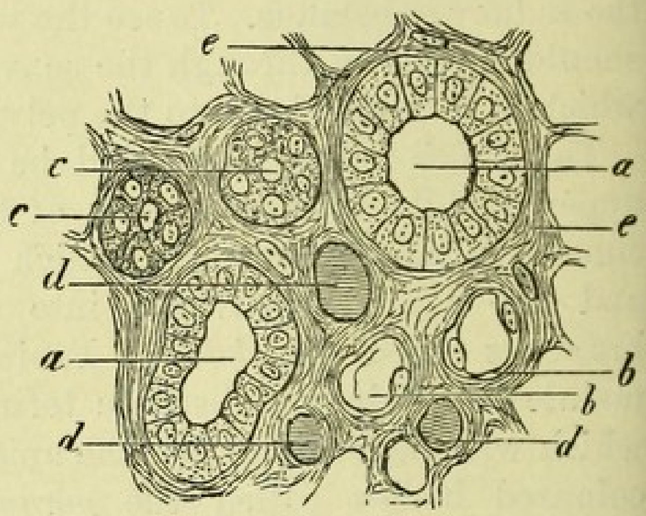


Fig. 144.



epithelium, and this is probably continued over the blood-vessels, but cannot be demonstrated in the adult. The convoluted tubes are lined with similar flattened epithelium, but the looped tubes, as they increase in diameter, are filled with granular epithelium. The large collecting tubes have a distinct columnar epithelium (Fig. 144).

Between the straight tubuli of the medullary portion are numerous straight arteries, which are recurrent branches from

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Fig. 143.—Plan of the renal circulation (from Wilson, after Bowman).

a. Branch of the renal artery giving off several Malpighian twigs.

1. An efferent twig to the capillary tuft contained in the Malpighian body, *m*; from the Malpighian capsule the uriniferous tube is seen taking its tortuous course to *t*.

2, 2. Efferent vessels; that which proceeds from the Malpighian body is smaller than the corresponding artery.

p, *p*. The capillary plexus ramifying on the uriniferous tube. This plexus receives its blood from the efferent vessels, 2, 2, and transmits it to the branch of the renal vein, *v*.

Fig. 144.—Section through a renal pyramid (from Frey).

a. Collecting tube with columnar epithelium.

b. Convoluted tube with flat cells.

c. Looped tube with granular contents.

d. Section of blood-vessel.

e. Fibrous sustentacular tissue.

the arches between the cortical and medullary substances, and these are joined by the straight efferent vessels of some of the deeper glomeruli. The renal artery also supplies the fibrous capsule of the kidney with branches, which anastomose with the lumbar arteries from the aorta.

The interlobular veins, after receiving the blood from the secondary plexus on the tubes, accompany the interlobular arteries and unite in arches at the base of the pyramids, between which the *straight* veins pass to emerge at the hilum and form the renal or *emulgent* vein. On the surface of the kidney may be seen small venous radicles forming, from their arrangement, what are known as the *Stellate* veins. They receive blood from the capsule of the kidney, and pass in to join the venous arches.

Fig. 145.

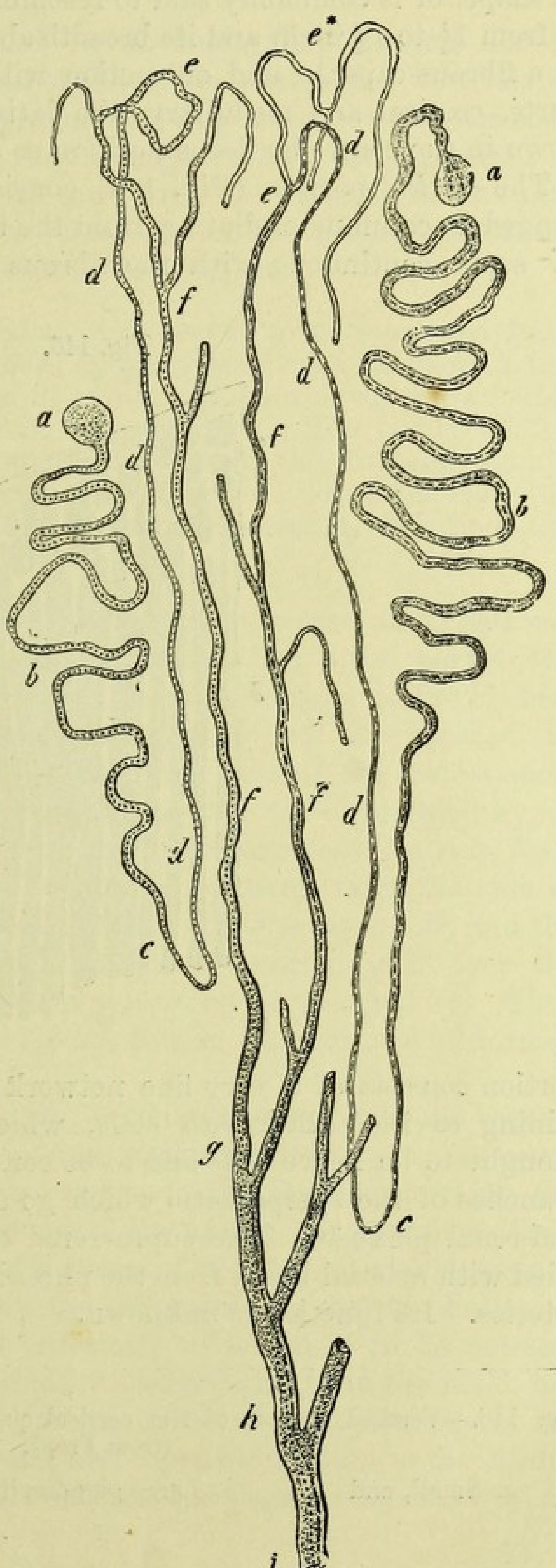


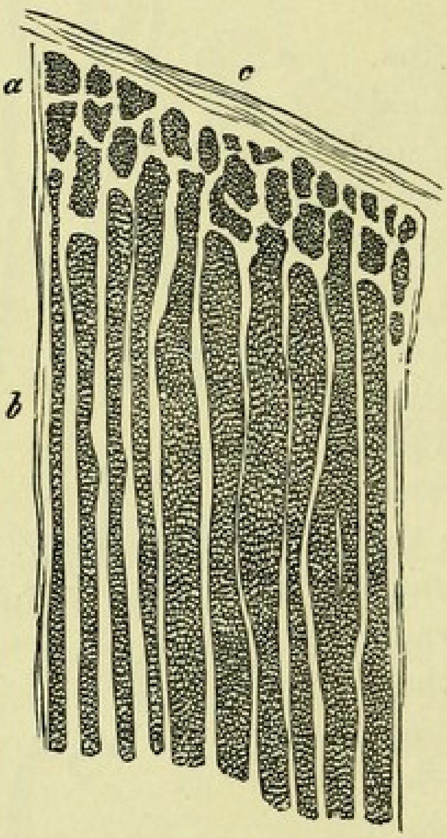
Fig. 145.—Diagram showing the course of the uriniferous tubes (from Frey).

a. Bowman's capsule.
b. Convoluted uriniferous tube.
c, *d.* Looped tubes.
e, *f.* Collecting tubes joining in.
g, *h.* Uriniferous tube.
i. Papilla.

The **Supra-Renal Capsule** (Fig. 141, 1) is irregularly triangular in shape, or is commonly said to resemble a cocked-hat. Its height is from $1\frac{1}{4}$ to $1\frac{3}{4}$ inch, and its breadth about $1\frac{1}{4}$ inch. It is enclosed in a fibrous capsule, and on section will be seen to consist of two parts, cortical and medullary, the latter being generally broken down in the centre by decomposition so as to form a cavity.

The *cortical* portion (Fig. 146) consists of polyhedral cells arranged in columns, radiating from the centre, and held in position by septa continuous with the fibrous envelope. The *medullary*

Fig. 146.



portion consists of a very fine network of connective tissue, containing cavities filled with cells, which are by some observers thought to be nerve cells and to be continuous with the numerous branches of the sympathetic which go to the organ from the solar and renal plexuses. The supra-renal capsule is abundantly supplied with arterial blood from the phrenic, aorta, renal, and lumbar arteries. Its function is unknown.

Fig. 146.—Vertical section of the cortical portion of a supra-renal capsule (from Frey).

a. Small, and *b.* Large gland cylinders. *c.* Capsule.

The Pelvis.

The subject being replaced on its back, the dissectors should proceed with the examination of the pelvis, unless they were unable to finish the aorta, lumbar plexus, and iliac arteries before the body was turned, in which case they must revert to the dissection of them at once (*v.* p. 245). In any case the dissector is strongly advised to read through the dissection of the deep parts of the abdomen again, before proceeding any further.

[The pelvis with two lumbar vertebræ is to be separated from the trunk with the saw, when, by placing it on a table with the sacrum towards himself, the dissector will be able to get a better view of the contents than he has yet done. The cavity of the pelvis should be carefully sponged out, and the dissector should let a stream of water run through the rectum. The bladder should be emptied of any urine it may contain by pressure with the hand, and be moderately distended with air.]

The **Peritoneum** (Fig. 150) should be examined first, and will be found to pass over the rectum, binding the upper part to the front of the sacrum (*meso-rectum*); from the rectum to the bladder forming the *recto-vesical pouch*, and thence over the back of the bladder to the abdominal wall. On each side of the recto-vesical pouch the reflections of the peritoneum over the obliterated hypogastric arteries and the ureters are called the *posterior false ligaments* of the bladder. The peritoneum passing from the side of the bladder to the pelvis forms the *lateral false ligaments*, and the portion reaching to the back of the abdominal wall over the urachus is called the *superior false ligament* of the bladder. Thus the false ligaments of the bladder, five in number, are all formed by peritoneum.

In the **Female** (Fig. 112) the peritoneum passes from the rectum to the posterior wall of the vagina, forming the *recto-vaginal pouch* (Douglas), and then over the uterus to the bladder, forming the *utero-vesical pouch*. On each side of the uterus it is stretched across the pelvis, forming the *broad ligament* of the uterus, which contains the round ligament in front, the ovary behind, and the Fallopian tube above, the fimbriated extremity of which is to be noticed. The false ligaments of the bladder are the same as in the male, but are less distinctly marked; the reflections of peritoneum from the bladder to the uterus in front, and from the rectum to the uterus behind, have been named the *anterior* and *posterior ligaments of the uterus*

[The peritoneum is to be stripped off the upper part and sides of the bladder, but the recto-vesical pouch is not to be interfered with at present. By scraping away a little fat with the handle of the knife the pelvic fascia will be brought into view, but to examine it thoroughly the following dissection is to be made, in order to obtain a view from the outside. One dissector holding the pelvis firmly, the other is to clear away the remains of the adductor muscles on the left side of the pubes so as to expose the obturator externus muscle, which must then be carefully removed. Beneath the muscle will be found the branches of the *obturator artery*, forming a circle around the foramen and lying upon the obturator membrane or ligament, which gives passage to both obturator artery and nerve at its upper part. On removing the obturator ligament, the fibres of the obturator internus muscle will be brought into view. With the saw a horizontal cut is now to be made from the upper margin of the obturator foramen into the cotyloid cavity, and a similar one at the lower margin of the obturator foramen, the extremities of the two cuts being about an inch apart in the bottom of the cavity. These are to be joined by a vertical cut with the chisel, and the piece of bone having been loosened with that instrument, can be removed with the bone-forceps. With the chisel and bone-forceps the margins of the obturator foramen may then be cut away so as to leave only a ring of bone. The obturator internus being now fully exposed, should be carefully detached from the adjacent structures, and may then be readily removed by grasping the tendon with the bone-forceps and drawing the whole muscle out through the lesser sacro-sciatic foramen. The outer surface of the pelvic fascia will then be exposed.]

The **Pelvic Fascia** consists of several more or less distinct structures, which are however in many places continuous with one another.

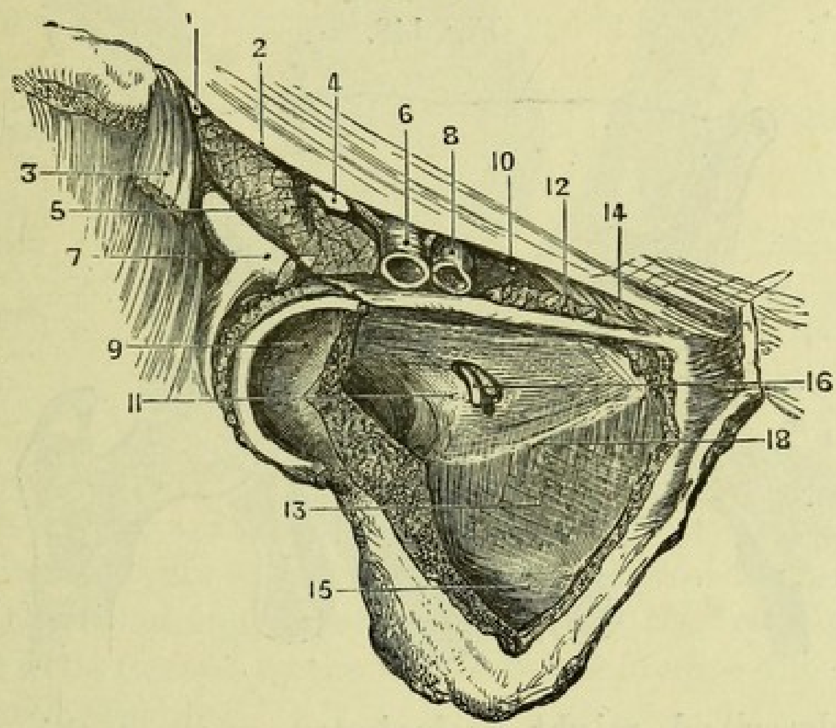
1. The *obturator fascia* (pelvic fascia proper), the outer surface of which has been exposed in the dissection described above, is the special fascia of the obturator internus muscle, to the inner surface of which it is applied, and round the margins of which it is fixed, viz., to the back of the pubes in front, to the upper border of the true pelvis above, to the margin of the great sciatic notch behind, and to the ischial tuberosity and the great sacro-sciatic ligament and arch of the pubes below.

2. The *fascia over the pyriformis* covers the muscle of that name as well as the sacral plexus, intervening between the nerves forming it and the larger branches of the internal iliac artery. It is continuous with the posterior part of the obturator fascia.

3. The *recto-vesical fascia* forms an oblique septum across the

pelvis, and is concave upwards. It is fixed in front to the back of the pubes above the origin of the levatores ani, and dips down between these muscles as far as the apex of the prostate, thus forming two rounded folds, the *anterior true* (*pubo-prostatic*) *ligaments of the bladder*. Laterally it blends with the obturator fascia along what is known as the *white line;* this extends from the back of the pubes to the ischial spine, and may be seen by looking into

Fig. 147.



the pelvis from above. From the under surface of this white line the levator ani arises. Near the front, the recto-vesical fascia is attached to the sides of the bladder, and at this part it is thickened, forming the *lateral true ligaments* of this viscus. Posteriorly, the recto-vesical fascia blends with the lower part of the fascia over the pyriformis. It supplies a sheath to each of the structures piercing it, viz., one to the prostate, which at the apex of this gland is continuous with the posterior layer of the triangular

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Fig. 147.—Pelvic fascia seen from the outside (drawn by J. T. Gray).

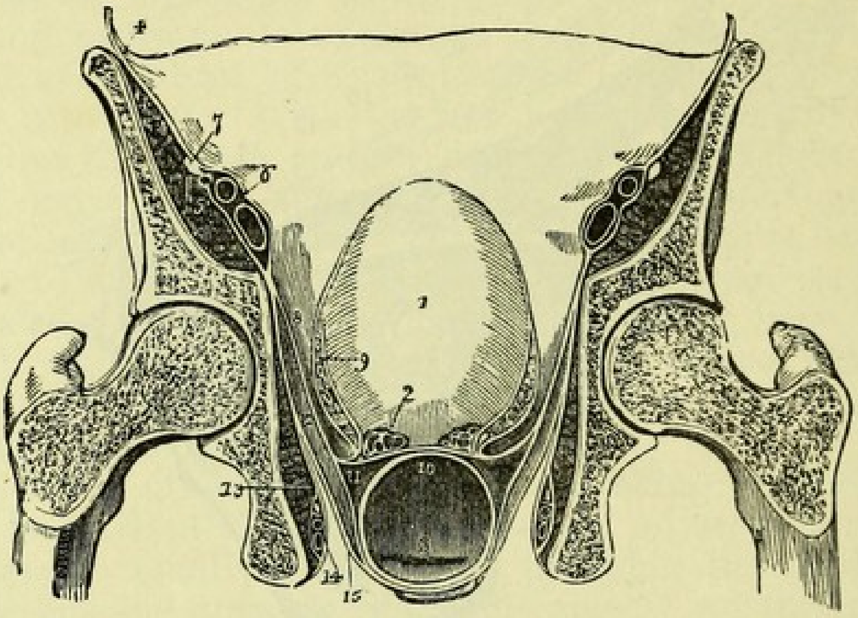
1. External cutaneous nerve.
2. Poupart's ligament.
3. Sartorius.
4. Anterior crural nerve.
5. Psoas and iliacus muscles.
6. Femoral artery.
7. Origins of rectus femoris.
8. Femoral vein.
9. Acetabulum, partly removed.
10. Crural ring.
11. Pelvic fascia.
12. Pectineus muscle.
13. Obturator fascia.
14. Gimbernat's ligament.
15. Pudic vessels and nerve in sheath of fascia.
16. Obturator vessels and nerve.
18. Fascial origin of levator ani (white line).

ligament; and one to the lower part of the rectum, while between the two it gives an imperfect covering to the vesiculæ seminales. In the female the vagina also receives a sheath from it. The levator ani is closely applied to the outer surface of the recto-vesical fascia.

4. The *anal fascia* is a thin membrane covering the outer surface of the levator ani, and derived from the obturator fascia.

The *posterior layer of the triangular ligament*, which has been

Fig. 148.



previously described, might be included amongst this system of fasciæ; for it occupies the pubic arch, and blends at its attachment to the bones with the obturator fascia, while at the apex of the prostate it is continuous with the recto-vesical fascia.

The ischio-rectal fossa is included between the recto-vesical

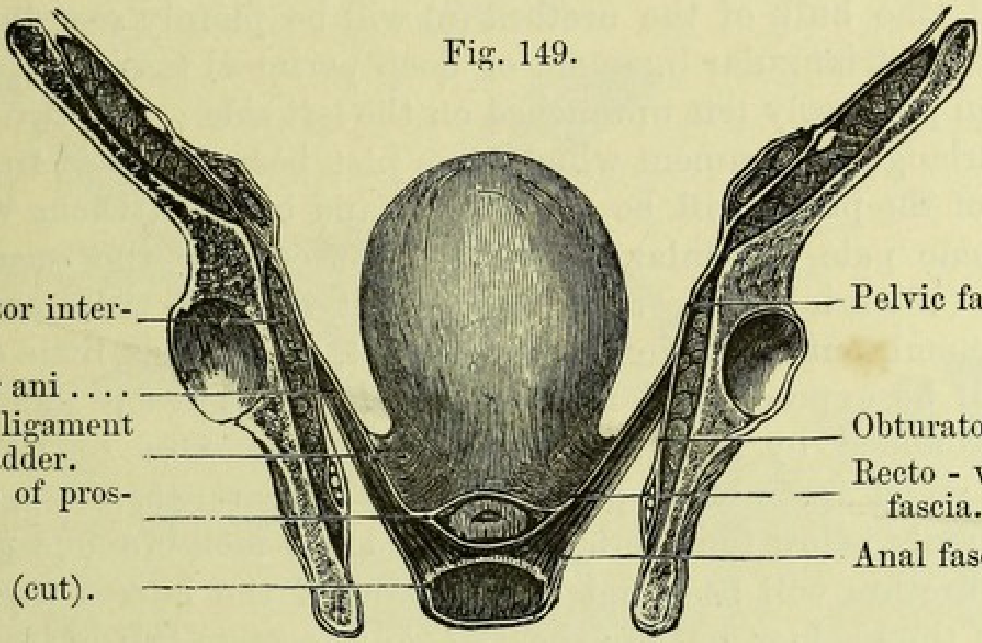
Fig. 148.—Transverse section of the pelvis, seen from behind, showing the distribution of the pelvic fascia (from Wilson).

1. Bladder.
2. Vesicula seminalis of left side, divided.
3. Rectum.
4. Iliac fascia, covering in the iliacus and psoas (5); and forming a sheath for the external iliac vessels (6).
7. Anterior crural nerve excluded from the sheath.
8. Pelvic fascia, splitting into the recto-vesical and obturator layers.
9. Recto-vesical layer, forming the lateral ligament of the bladder of one side, and a sheath to the vesical plexus of veins.
10. A layer of fascia passing between the bladder and rectum.
11. A layer passing round the rectum.
12. Levator ani.
13. Obturator internus, covered in by the obturator fascia, which also forms a sheath for the internal pudic vessels and nerve (14).
15. Anal fascia investing the under surface of the levator ani.

Figs. 14 and 15 are placed in the ischio-rectal fossa.

fascia and the part of the obturator fascia below the white line, which is sometimes described as the line of splitting of the pelvic fascia. The recto-vesical fascia and the levatores ani form together a strong layer for the support of the abdominal viscera.

Fig. 149.



Thus, the levator ani muscle is seen to be enclosed by the recto-vesical and anal layers of fascia; the ischic-rectal fossa to be lined by the obturator and anal layers; and four of the true ligaments of the bladder to be formed by the recto-vesical layer,—the fifth being the obliterated urachus.

[On the left side, the obturator fascia and the triangular ligament are to be separated from their bony attachments, and the ischial spine is to be cut off with bone forceps.

The innominate bone is then to be sawn through in front, externally to the symphysis, the cut passing through the horizontal and descending rami of the pubes, and behind through the sacro-iliac synchondrosis. The external branches of the internal iliac vessels being then divided, the innominate bone may be taken away. The student can now see more clearly the attachment of the white line to the ischial spine, and, after clearing away the remains of the obturator fascia and the levator ani, he should pass a sound through the urethra into the bladder, which is to be moderately distended with air, stuff the rectum (and vagina, if the subject be a female one) and the recto-vesical pouch with tow, and then take away the remains of the recto-vesical fascia; cleaning at the same time the viscera and the branches of vessels going to

Fig. 149.—Section of pelvis to show the pelvic fascia from the front (drawn by J. T. Gray).

them as far as possible. The rectum may conveniently be secured by a string to the top of the sacrum or the lumbar vertebra.]

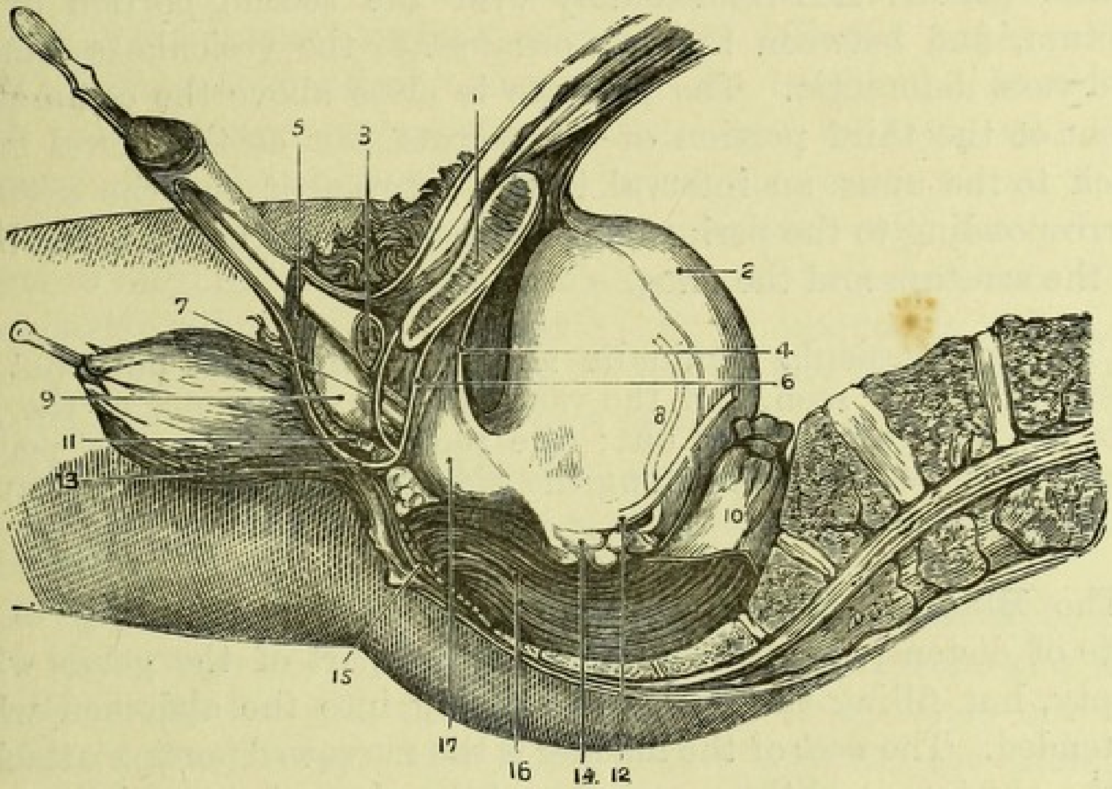
Side View of the Pelvis (Fig. 150).—Beginning in front, and supposing the dissection of the perinæum to have been made as directed, the bulb of the urethra (9) will be plainly seen lying in front of the triangular ligament or deep perinæal fascia (7), which has been purposely left untouched on the left side. The two layers of the triangular ligament which have just been detached from the ramus of the pubes will be recognised, and between them will be seen some pale muscular fibres, the cut edge of the *compressor urethræ* (Guthrie). The staff may be felt through these as it lies in the membranous portion of the urethra, which by a little dissection will be exposed, and may be seen in a favourable subject to be surrounded by circular muscular fibres. One of Cowper's glands, which resembles a pea in size and appearance, may be found immediately below the urethra. Behind the membranous portion of the urethra will be found the remains of the lateral true ligament of the bladder and the sheath of the prostate (6), derived from the recto-vesical fascia.

The **Membranous portion of the Urethra** is a very important part, and should be specially noticed in the present view. It is seen to extend from the posterior layer of the triangular ligament to the deep perinæal fascia or anterior layer of the triangular ligament. It is nearly an inch in length and is almost horizontal in its position, but the posterior extremity is rather further from the symphysis than the anterior, the latter being about one inch from that bone. This is the portion of the urethra opened by the deep incision in lithotomy, and it should be noticed how much its position will vary according to the movements of the staff,—whether that instrument be hooked under the pubes or depressed towards the rectum.

The sheaths derived from the recto-vesical fascia should be traced on to the prostate, bladder, and rectum, and these organs are to be cleaned, and their relations to one another noticed.

The **Rectum** (Fig. 150, 10) is about eight inches long, and extends from the left sacro-iliac synchondrosis to the anus, above lying a little to the left of the median line of the pelvis; but lower down reaching the middle line of the sacrum, and occasionally passing slightly on to the right side for a short distance. It is divided into three portions, a superior, which reaches the middle of the third piece of the sacrum, a middle, which is three inches long and reaches the tip of the coccyx, and an inferior portion, which is an inch and a half in length and curves slightly backwards to the anus; the upper two parts of the intestine being closely attached to the front of the sacrum and coccyx, while the

Fig. 150.



third part passes through the levator ani and sphincter muscles to the anus, immediately in front of the tip of the coccyx.

The peritoneum surrounds the first vertical portion and binds it to the sacrum, forming the meso-rectum; the membrane only covers the front of the upper part of the second portion, as it forms

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Fig. 150.—Section of pelvis to the left of the median line at the pubes, and through the middle line of the sacrum (drawn by J. T. Gray).

1. Section of left pubic bone.
2. Peritoneum on bladder.
3. Left crus penis (cut).
4. Recto-vesical fascia forming anterior ligaments of bladder.
5. Part of accelerator urinæ.
6. Posterior layer of triangular ligament, or pelvic fascia, continuous with the capsule of the prostate.
7. Anterior layer of triangular ligament, or deep perinæal fascia.

Between 6 and 7 are seen the following:—membranous urethra, deep muscles of urethra (insertion), and Cowper's gland of the left side.

8. Vas deferens.
9. Bulb of urethra.
10. Rectum.
11. Cut edges of accelerator urinæ and transversus perinæi.
12. Left ureter.
13. Reflection of deep layer of superficial fascia round tranversus perinæi.
14. Left vesicula seminalis.
15. Cut edge of levator ani.
16. Rectum.
17. Prostate.

the recto-vesical pouch; and has no connection with the third part at all. (Thus the relations of the rectum nearly correspond to those of the duodenum, as respects the peritoneum, *v.* p. 238.)

The first part of the rectum has in front of it the recto-vesical pouch of peritoneum and the bladder in the male.

The bladder lies immediately over the second portion of the rectum, and between the two organs are the vesiculæ seminales and vasa deferentia. The prostate is close above the commencement of the third portion of the rectum, but as the bowel turns back to the anus, an interval is left between it and the urethra, corresponding to the perinæum proper or surface between the back of the scrotum and the anus.

[The left vesicula seminalis should be dissected out that its position may be seen, and the vas deferens and ureter of the left side are also to be traced out; the recto-vesical pouch of peritoneum is to be laid open along the side, so that its extent may be fully appreciated.]

The **Bladder** (Fig. 156) varies in position according to its state of distension, being in the anterior part of the pelvis when empty, but filling the pelvis and rising into the abdomen when distended. The *neck* of the bladder is the narrowed portion attached to the prostate, and the remainder of the viscus is termed the *body*. In the vertical position of the subject, the part which is in contact with the pubes is the lower wall (3), and it is almost horizontal in position, the neck of the bladder being really the lowest part. The upper part of the body (2) is completely covered by peritoneum, and is in contact with small intestine as well as with the rectum in the male, and with the uterus in the female. The *apex* or *summit* (1) looks forwards, and to it the obliterated urachus (5) is attached. The *base* or *fundus* of the bladder (4) looks backwards and slightly downwards in the erect position of the body, and is seen to rest on the second portion of the rectum, with the vesiculæ seminales and vasa deferentia intervening. The sides of the bladder are crossed by the obliterated hypogastric arteries, which pass to the abdominal wall near the urachus, and limit the line of reflection of the peritoneum. They are in contact with the wall of the pelvis and are crossed posteriorly by the vasa deferentia.

The peritoneum is reflected from the second portion of the rectum on to the fundus of the bladder, at the level of the entrance of the ureters, and is then continued over the upper surface and parts of the sides of the bladder until it is reflected over the urachus to the abdominal wall, leaving the rest of the organ uncovered (Fig. 150, 2).

It should be noticed how much the extent of bladder uncovered by peritoneum, both above and below, depends upon the distension of the viscus; since, in the contracted state the inferior, often known as the anterior surface, is in contact with the pubes, whilst in the distended condition it rises above the bone and is in contact with the posterior surface of the abdominal muscles, and thus tapping above the pubes without injury to the serous membrane is possible. The depth of the recto-vesical pouch will similarly be found to vary, the peritoneum reaching nearer to the prostate when the bladder is empty than when it is full; consequently the operation of tapping by the rectum can be only safely undertaken when the bladder is distended. Cripps gives the average distance of the recto-vesical pouch from the anus as $2\frac{1}{2}$ inches when both rectum and bladder are empty, and $3\frac{1}{2}$ inches when the bladder is distended.

The left **Ureter** (Fig. 150, 12) descending from the kidney is contained in the posterior false ligament of the bladder, and now can be traced beneath the peritoneum to its entrance into the fundus of the bladder, at a point nearly opposite the posterior extremity of the vesicula seminalis.

The left **Vas Deferens** (Fig. 150, 8) can be traced from the testicle, and has been seen to turn down into the pelvis to the inner side of the external iliac artery, after leaving the inguinal canal. It is now seen to wind over the posterior part of the side of the bladder, crossing the obliterated hypogastric artery on its outer side, and to be continued beneath the peritoneum to the fundus of the bladder, where it hooks round the ureter to become internal to it; the vas will be afterwards traced to the prostate.

The **Prostate Gland** (Fig. 150, 17) is now seen, as the part lies on the table, in front of the bladder; but when the body is erect it is situated below the neck of the bladder, which terminates at the enlarged *base* of the gland. The *apex* touches the triangular ligament (Fig. 156, 14). The posterior part is in contact with the commencement of the third part of the rectum, and the anterior surface touches the pubes, the sides being covered by the anterior portions of the levatores ani. It is enclosed by a process of recto-vesical fascia forming the *capsule* of the gland, within which is the special fibrous capsule, and between the two is the large prostatic plexus of veins. In old age the prostate is frequently enlarged, in which case it presses upon the rectum as well as upon the urethra; the latter passes through its substance nearer the upper than the lower surface.

[A transverse cut is now to be made at the bottom of the recto-vesical pouch, which will allow the bladder to be drawn forward, when a little dissection will expose that part of the surface of the viscus uncovered by peritoneum which lies over the rectum.]

The portion of the base of the bladder uncovered by peritoneum (*trigonum vesicæ*) is triangular in shape, and is bounded on the sides by the *vasa deferentia* and *vesiculæ seminales*; the base of the triangle is formed by the reflection of peritoneum at the line of the entrance of the ureters, and the apex is at the back of the prostate. It is here that the bladder is opened when punctured from the rectum.

A process of the recto-vesical layer of pelvic fascia can now be traced between the rectum and bladder (p. 282), giving a covering to those organs, to the prostate, and to the vesiculæ seminales.

The **Vesiculæ Seminales** (Fig. 150, 14) are two convoluted sacs, placed between the fundus of the bladder and the rectum, and converging to enter the base of the prostate close to the median line. They are somewhat expanded at their posterior extremities, which are about two inches apart and reach nearly to the recto-vesical pouch. They have the vasa deferentia lying close to their inner sides, and together they form the sides of the triangle mentioned above.

The *vasa deferentia* become somewhat enlarged as they pass beneath the bladder; they lie close to the inner sides of the vesiculæ, and the duct of each vesicula joins the corresponding vas deferens at the prostate, thus forming the *common ejaculatory duct* (Fig. 156, 12).

In the Female (Fig. 151), the short urethra will be seen to pass obliquely downwards from the bladder; and immediately below and behind it is the vagina passing up to the uterus, which must be held in position by a string passed through its fundus. The rectum occupies the same position as in the male, but is rather larger; and the peritoneum will be seen to pass from it to the posterior surface of the upper part of the vagina, thus forming the recto-vaginal pouch, being then reflected over the uterus to form the utero-vesical pouch between it and the bladder.

The recto-vesical fascia gives coverings to the rectum and vagina, which should be defined, and the latter canal may be laid open along the side to study the position of the *os uteri*, when the uterus is in its proper position and when displaced.

The **Bladder** (Fig. 151, 4) closely resembles that viscus in the male, but is rather larger, and its fundus is in contact with the vagina instead of with the rectum and prostate.

The **Urethra** (Fig. 151, 6) in the female is about an inch and a half long, placed immediately beneath and behind the pubes, and

Fig. 151.

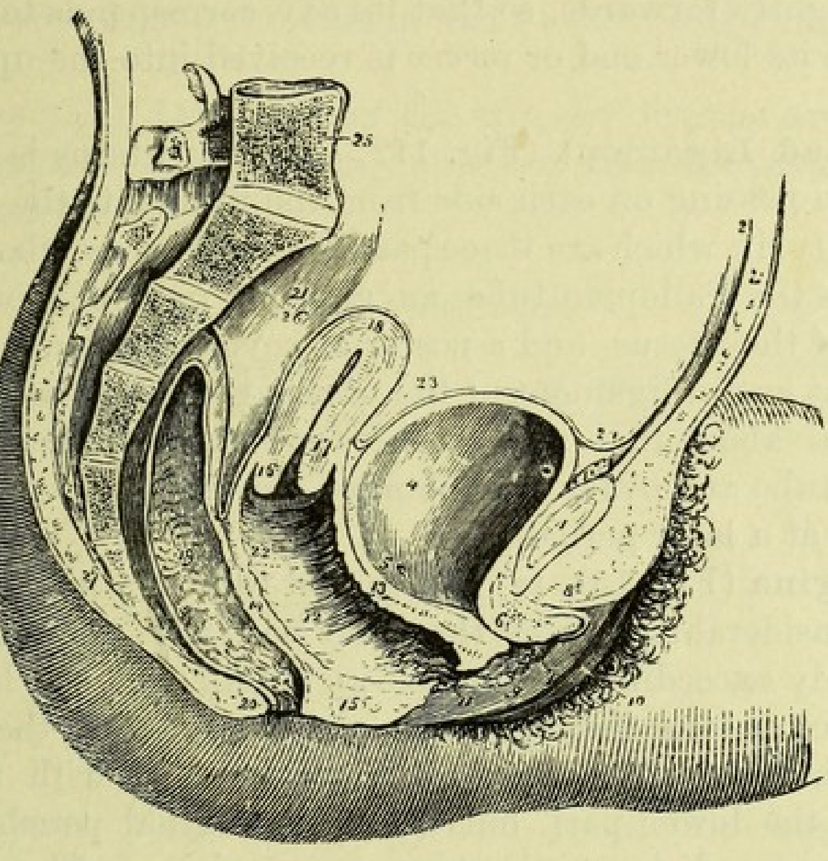


Fig. 151.—Side view of the viscera of the female pelvis (from Wilson).

1. Symphysis pubis.
2. Abdominal parietes.
3. Collection of fat, forming the prominence of the mons Veneris.
4. Urinary bladder.
5. Entrance of left ureter.
6. Canal of the urethra.
7. Meatus urinarius.
8. Clitoris, with its preputium, divided through the middle.
9. Left nympha.
10. Left labium majus.
11. Meatus of the vagina narrowed by the contraction of its sphincter.
12, 22. Canal of the vagina, on which are the transverse rugæ.
13. Thick wall of separation between the base of the bladder and the vagina.
14. Wall of separation between vagina and rectum.
15. Perinæum.
16. Os uteri.
17. Cervix uteri.
18. Fundus uteri.
19. Rectum.
20. Anus.
21. Upper part of rectum, invested by peritoneum.
23. Utero-vesical fold of peritoneum. The recto-vaginal fold is seen between the rectum and posterior wall of the vagina.
24. Superior false ligament of the bladder.
25. Last lumbar vertebra.
26. Sacrum.
27. Coccyx.

curved downwards and slightly forwards from the bladder. It may be said to correspond to the prostatic and membranous urethra of the male.

The **Uterus** (Fig. 151, 18) is situated behind the bladder, and, if in its proper position and healthy, its upper end or *fundus* should not reach above a line drawn from the upper edge of the pubic symphysis to the lumbo-sacral articulation (Savage). The uterus is tilted slightly forwards, so that its axis corresponds to that of the pelvis, and its lower end or *cervix* is received into the upper end of the vagina.

The **Broad Ligament** (Fig. 112, *b*) of the uterus is the fold of peritoneum passing on each side from the fundus to the sides of the pelvic cavity, in which are three partial subdivisions, viz., a superior in which is the Fallopian tube, an anterior in which is the round ligament of the uterus, and a posterior covering the ovary.

The right round ligament of the uterus is now to be traced from the internal abdominal ring to the fundus of the uterus, but the Fallopian tube and ovary may be more conveniently examined with the uterus at a later period.

The **Vagina** (Fig. 151, 12) is a curved tube of which the anterior wall is considerably shorter than the posterior, the former in the virgin rarely exceeding two inches in length, but the latter being nearly twice as long (Savage). It is in contact with the bladder in front, with the levatores ani at the sides, and with the rectum behind at the lower part, but the recto-vaginal pouch of peritoneum intervenes between the two organs above. The neck of the uterus projects backwards into the upper extremity of the vagina, and its lower extremity passes through the levator ani muscle, and is surrounded by the sphincter vaginæ.

[The viscera of the pelvis being drawn down to the left, the internal iliac vessels and sacral plexus of the right side can be examined; the position of many of them on the left side having been previously, as far as possible, ascertained. Opportunity may be taken to trace branches of the sympathetic nerve to the sides of the pelvic organs.]

The **Internal Iliac Artery** (Fig. 152, 4) is a branch of the common iliac, from which it comes off at the lumbo-sacral articulation, and immediately passes into the pelvis. It is usually about an inch to an inch and a half long, and is smaller than the external iliac. In the fœtus it is proportionally much larger, and the *hypogastric artery*, the direct continuation of the internal iliac in size and direction, passed forwards over the bladder to the umbilicus, but is now converted into a fibrous cord, which however is pervious for a short distance, and thus gives branches to the bladder. The internal iliac is crossed by the ureter, and closely covered by the peritoneum in front; behind it are the internal iliac vein, the sacrum and the lumbo-sacral cord. At the upper border of the great sacro-sciatic notch it divides into *anterior* and *posterior* trunks, which give branches to the viscera and to the inside and outside of the pelvis.

Branches (Fig. 152).—From the anterior division are given off three visceral and three parietal branches; from the posterior trunk three parietal branches.

Anterior Division.

Visceral branches.	Superior vesical. Inferior vesical. Middle hæmorrhoidal.	Parietal branches.	Obturator. Pudic. Sciatic.
	Uterine, Vaginal — additional in female.		

Posterior Division.

Parietal branches.	Gluteal. Ilio-lumbar. Lateral sacral.

1. The *Superior Vesical* (7) arteries are small branches from the unobliterated portion of the hypogastric artery, which are distributed to the upper part of the bladder. A middle vesical branch is sometimes derived from one of these, and from another or from the inferior vesical is derived the *artery of the vas deferens*, which accompanies the duct to the testicle and anastomoses with the spermatic artery.

2. The *Inferior vesical* and 3, *Middle hæmorrhoidal* (16) arteries generally come off together, and are distributed to the under surface of the bladder, of the prostate and vesiculæ seminales, and to the adjacent portion of the rectum. The middle hæmorrhoidal artery anastomoses with the superior hæmorrhoidal branch of the inferior mesenteric above, and with the inferior hæmorrhoidal branch of the pudic artery below. The arteries on the bladder anastomose freely with one another, and with those on the opposite side.

4. The *Uterine* (8) and *Vaginal* arteries supply those organs, the uterine passing to the cervix and then giving branches to the body the uterus.

5. The *Obturator* (9) artery passes directly forwards, below the level of the nerve, to the obturator foramen, through the upper part

Fig. 152.

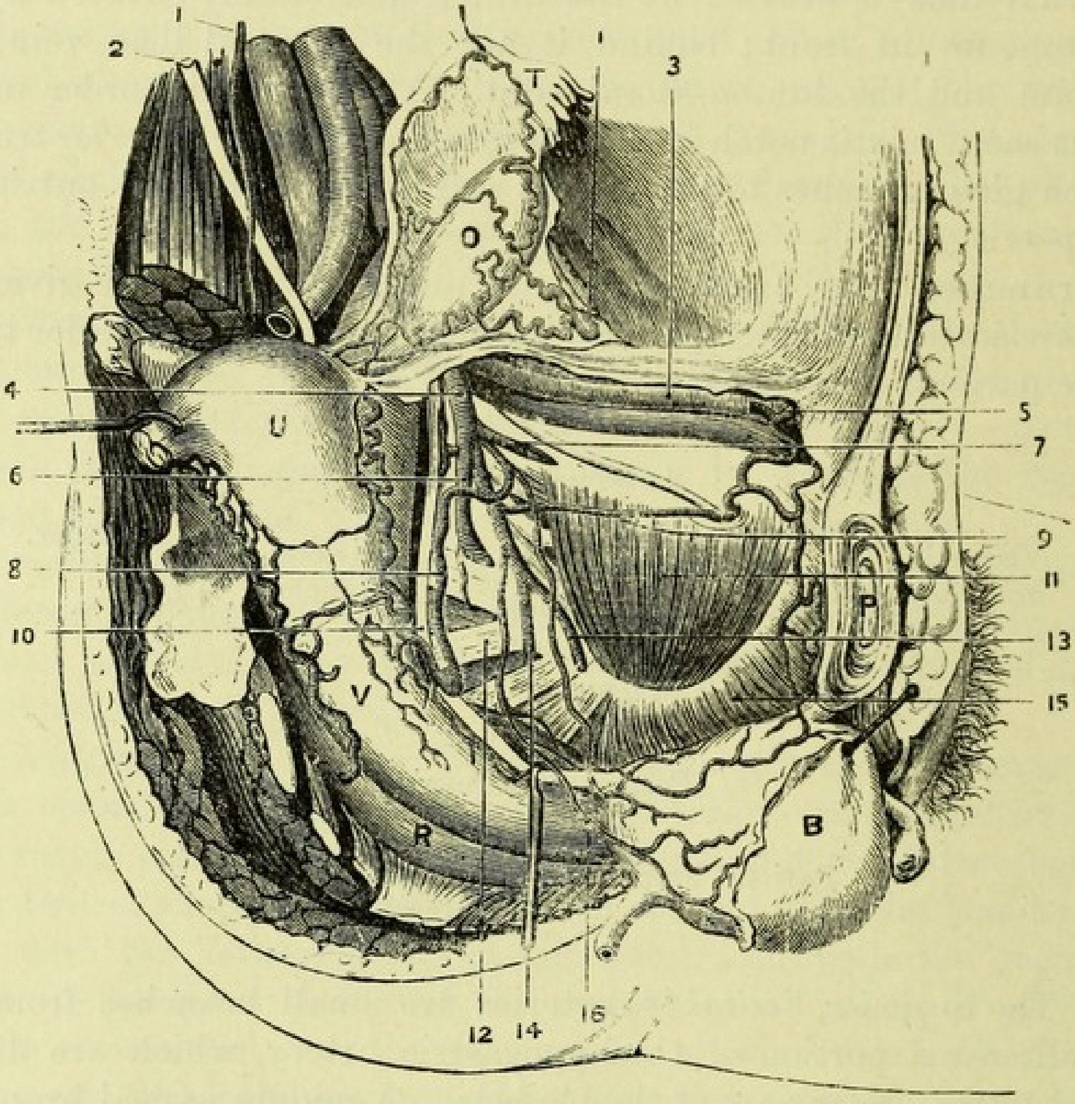


Fig. 152.—Side view of female pelvis with internal iliac artery (altered from Savage).

1, 1. Spermatic or ovarian artery.
2. Right ureter (cut).
3. External iliac vessels.
4. Internal iliac artery.
5. Epigastric artery giving off an obturator branch.
6. Posterior trunk of internal iliac dividing into gluteal, ilio-lumbar, and lateral sacral branches.
7. Anterior trunk of internal iliac artery giving off superior vesical and uterine arteries, and ending in the obliterated hypogastric (cut).
8. Uterine artery anastomosing with the ovarian in the broad ligament, and giving off a vaginal branch.
9. Obturator artery.
10. Left ureter.
11. Obturator internus.
12. Sacral plexus.
13. Pudic artery.
14. Sciatic artery.
15. Levator ani.
16. Inferior vesical and middle hæmorrhoidal arteries.

B. Bladder.
U. Uterus.
O. Ovary.
T. Fallopian Tube.
V. Vagina.
R. Rectum.
P. Pubes.
S. Sacrum.

of which it disappears with the nerve, after giving off a small *pubic* branch to the back of the bone, and also an *iliac* branch to the iliacus internus and ilium. The distribution of the obturator artery outside the pelvis has been already seen on the right side (p. 280), but may now be followed out on the left side.

When the obturator arises from the epigastric artery, there is generally a small branch running in the proper position with the obturator nerve (*v.* p. 251).

6. The *Pudic* (13) and 7, the *Sciatic* (14) arteries can only be seen for a short distance within the pelvis, as they lie on the pyriformis before passing through the lower part of the greater sacro-sciatic foramen below that muscle. The pudic is generally smaller than the sciatic, and a little in front of it, but the size and relative positions of the vessels vary. Supposing the perinæum and the buttock to have been dissected, the opportunity may be taken to trace the sciatic artery through the great sacro-sciatic foramen to its distribution outside the pelvis, and to follow the pudic in its course around the spine of the ischium, and through the lesser foramen to the perinæum, where it will be seen running close to the margin of the pubes (Fig. 153, 19).

The three parietal branches from the posterior division of the internal iliac artery (Fig. 153) are, the gluteal, the ilio-lumbar, and the lateral sacral arteries.

1. The *Gluteal* artery is a thick trunk, disappearing at once through the upper part of the great sacro-sciatic foramen, between the lumbo-sacral cord and the first sacral nerve, and above the pyriformis. It supplies *muscular* branches and a *nutritious* artery to the innominate bone, and is distributed to the buttock (p. 119).

2. The *Ilio-lumbar* artery (10) passes into the iliac fossa beneath the psoas and iliacus muscles; and then divides into 1, a *lumbar* branch which anastomoses with the last lumbar artery, and supplies a spinal branch, and 2, an *iliac* branch which supplies the iliacus and the bone, anastomosing with the obturator, circumflex iliac, and lumbar arteries.

3. The *Lateral sacral* artery (13, 15) (often double) descends on the front of the sacrum, internally to the sacral foramina, to the coccyx, where it anastomoses with the artery of the opposite side and with the sacra media from the aorta. In its course it gives branches which enter the sacral foramina, and reach the muscles and skin on the back of the sacrum, while others supply the pyriformis muscles and coccygeus, as well as the sacral nerves.

The *Veins* corresponding to the branches of the internal iliac artery open into the internal iliac vein, with the exception of the ilio-lumbar and occasionally the lateral sacral veins, which join the common iliac veins. The internal iliac vein passes beneath its artery to the common iliac vein, which on the left side also receives the middle sacral vein.

Fig. 153.

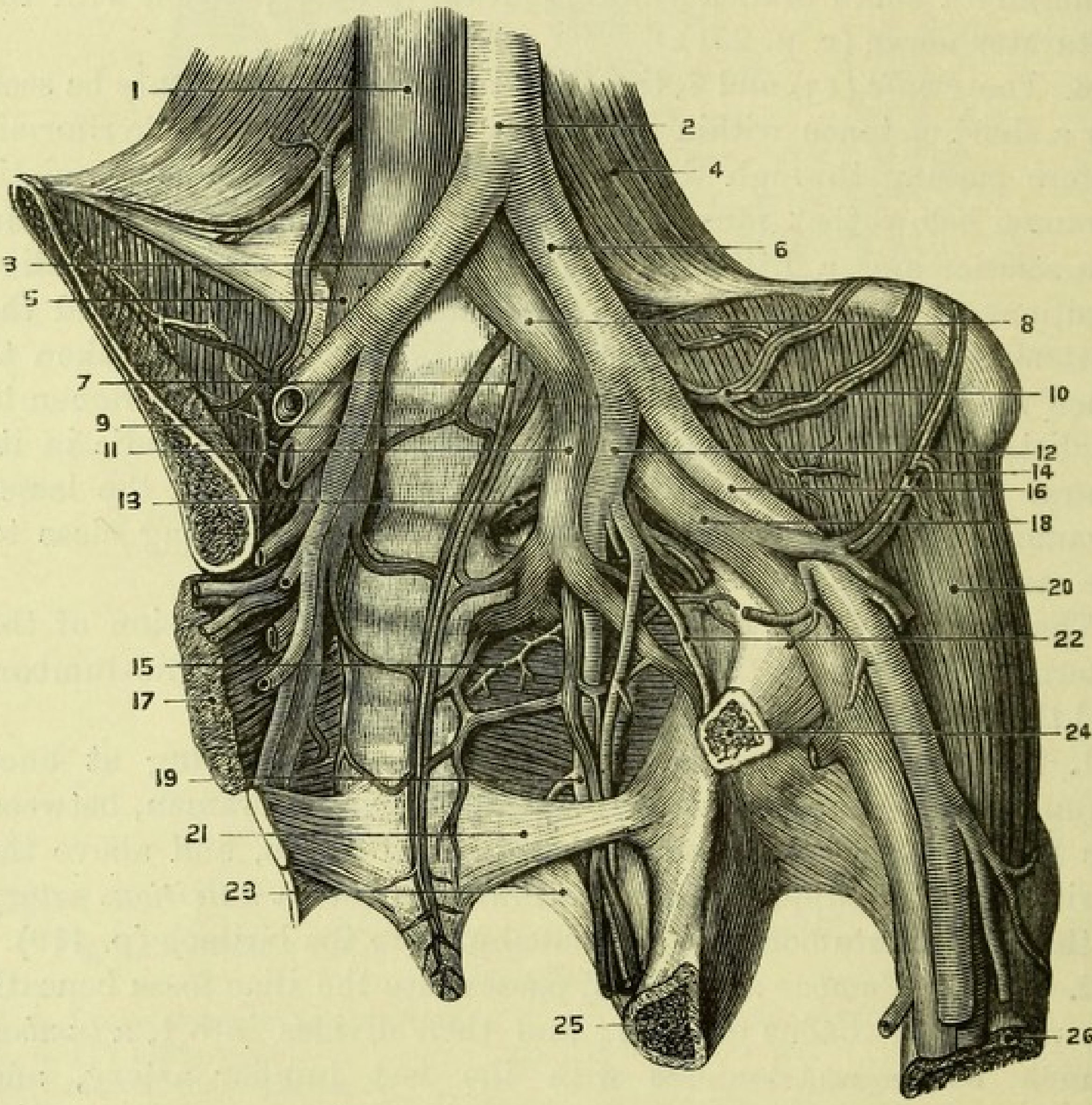


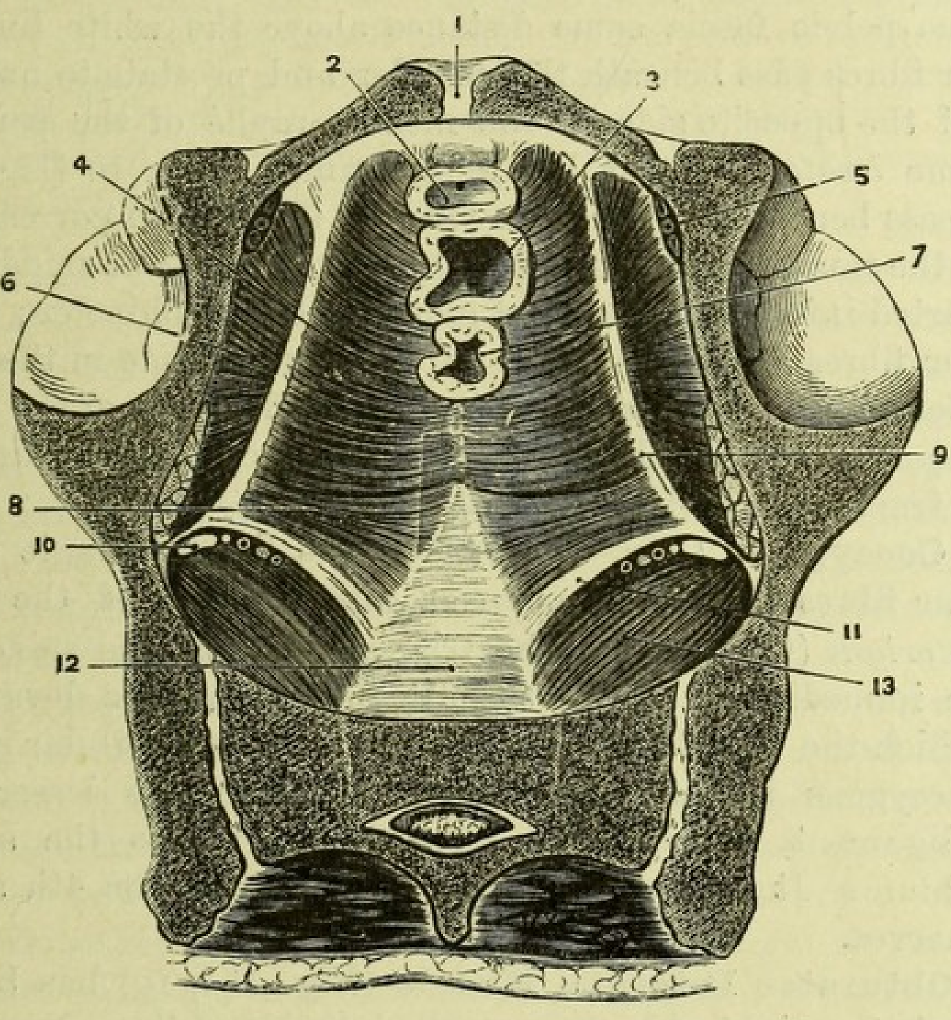
Fig. 153.—The iliac arteries and veins (from Bonamy and Beau).

1. Vena cava.
2. Aorta.
3. Right common iliac artery.
4. Quadratus lumborum.
5. Right common iliac vein.
6. Left common iliac artery.
7. Middle sacral artery.
8. Left common iliac vein.
9. Middle sacral vein.
10. Ilio-lumbar artery.
11. Left internal iliac vein.
12. Left internal iliac artery.
13. Lateral sacral artery.
14. Circumflex iliac artery.
15. Lateral sacral artery.
16. Left external iliac artery.
17. Pyriformis.
18. Left external iliac vein.
19. Pudic vessels.
20. Ilio-psoas.
21. Small sacro-sciatic ligament.
22. Obturator artery.
23. Great sacro-sciatic ligament.
24. Horizontal ramus of pubes.
25. Ischium.
26. Femur.

[The bladder and rectum are now to be drawn out of the pelvis as much as possible, to do which it will be necessary to divide the ligaments of the bladder and the recto-vesical layer of pelvic fascia; this will bring into view the structures which close the lower aperture or outlet of the pelvis.]

The **Floor of the Pelvis** (Fig. 154) is formed by the following structures. In front the levatores ani of the two sides blend in the

Fig. 154.



middle line, supporting and being closely connected with the pelvic viscera. Immediately behind these, and separated from them only by a very narrow space of cellular tissue, are the two coccygei muscles, beneath which the two smaller sacro-sciatic ligaments,

Fig. 154.—Floor of female pelvis (from Savage).

1. Symphysis pubis.
2. Section of bladder.
3. Section of vagina.
4. Levator ani muscle.
5. Obturator vessels.
6. Obturator internus muscle.
7. Section of rectum.
8. Coccygeus muscle.
9. 'White line' of pelvic fascia.
10. Sciatic and pudic vessels and nerves.
11. Lesser sacro-sciatic ligament.
12. Front of sacrum.
13. Pyriformis muscle.

which bound the great sacro-sciatic foramen. This foramen is closed by the pyriformis muscle, above which the gluteal, and below which the sciatic and pudic vessels and nerves leave the pelvis.

The **Levator Ani Muscle** (Fig. 155, 23) takes its *origin* from the back of the pubes and from the front of the spine of the ischium; between those points its fibres are usually attached to the *white line* of the pelvic fascia, seen in the dissection of the fascia from without (Fig. 147), but occasionally the fibres arise from the pelvic fascia some distance above the white line. The anterior fibres pass beneath the bladder and prostate to unite with those of the opposite side in the median raphé of the perinæum, the name *levator prostatæ* being sometimes given to those fibres which pass beneath the prostate [in the female the corresponding part of the muscle is connected with the vagina]; the middle fibres are inserted into the rectum and blend with the sphincter; and the posterior fibres unite with those of the opposite side in the median raphé behind the anus, and are attached to the apex of the coccyx. It is *supplied* by branches from the 4th sacral nerve, and by a branch from the anterior perinæal nerve.

The **Coccygeus** (Fig. 155, 34) is the little triangle of pale muscular fibres having its *insertion* into the side of the coccyx, and its *origin* (the apex of the triangle) is from the spine of the ischium immediately behind the attachment of the levator ani, from which the muscle is separated by a narrow cellular interval. The coccygeus is intimately connected with the lesser sacro-sciatic ligament, which passes from the sacrum to the spine of the ischium. It is *supplied* by a branch from the 4th and 5th sacral nerves.

The **Obturator Internus Muscle** (Fig. 155, 19) has been destroyed on the right side, but on the left side of the pelvis may be seen both above and below the level of the fascial origin of the levator ani. It *arises* from the posterior aspect of the rami of the pubes and ischium immediately in front of the thyroid foramen; from the inner surface of the obturator ligament; and from the surface of bone behind the foramen as far as the great sacro-sciatic notch. The fibres end in a tendon, which turns at a right angle round the margin of the lesser sacro-sciatic foramen, to be *inserted* on the fore part of the inner surface of the great trochanter of the femur, its deep surface being subdivided into four or five small tendons as it winds over the edge of the sacro-sciatic notch, which is encrusted with cartilage and lubricated by a bursa. It is *supplied* by a special nerve derived from the junction of the lumbo-sacral with the first sacral nerve.

[The pelvic viscera are now to be removed by carefully detaching the urethra and bladder from the pubes, dividing the levator ani, and severing the slight connections between the rectum and coccyx. The whole of the urinary and genital organs should be carefully preserved for after-examination. The sacral nerves can now be dissected on the right side of the pelvis, and in order to see them clearly it will be well to remove the remaining branches of the internal iliac artery. All the branches of the sacral nerves should be preserved, and care should be taken not to remove the gangliated cord and hypogastric plexus of the sympathetic. The upper sacral nerves will be readily seen emerging from the foramina, but the fifth sacral and the coccygeal nerves will be found piercing the coccygeus muscle close to the side of the coccyx.]

The **Sacral Plexus** (Fig. 155) is formed by the upper three and part of the fourth sacral nerves, and the lumbo-sacral cord derived from the fourth and fifth lumbar nerves, which is seen descending into the pelvis. The several nerves as they leave the sacral foramina receive branches from the gangliated cord of the sympathetic, which is internal to them, and then, lying on the pyriformis muscle, they unite to form one large flat band, which is the plexus. This passes through the great sacro-sciatic foramen immediately above the lesser sacro-sciatic ligament, and by looking at the outside of the pelvis, the dissector will be able to see the three nerves into which it divides, viz., Great Sciatic, Small Sciatic, and Internal Pudic; and to trace the pudic nerve around the spine of the ischium and through the lesser sacro-sciatic foramen to the perinæum.

Branches within the Pelvis.—A couple of branches are given to the *pyriformis*, either from the plexus or from the sacral nerves before they unite. The nerve to the *obturator internus* (26) arises at the point of union of the lumbo-sacral with the first sacral nerve, and, lying on the anterior surface of the plexus, passes with the pudic nerve through the sacro-sciatic foramina to the inner surface of the muscle, supplying in its course the gemellus superior. The nerve to the *quadratus* from the lower part of the plexus, or sometimes from the great sciatic nerve, passes out beneath that nerve close upon the hip-joint, and supplies the quadratus and the gemellus inferior (p. 122).

At the upper margin of the great sacro-sciatic foramen will be seen the *superior gluteal nerve* (15), derived from the lumbo-sacral cord and one or two of the upper sacral nerves; it passes out above the pyriformis with the gluteal artery.

Below the plexus are the branches of the other sacral nerves. These last can seldom be made out well, since the nerves them-

Fig. 155.

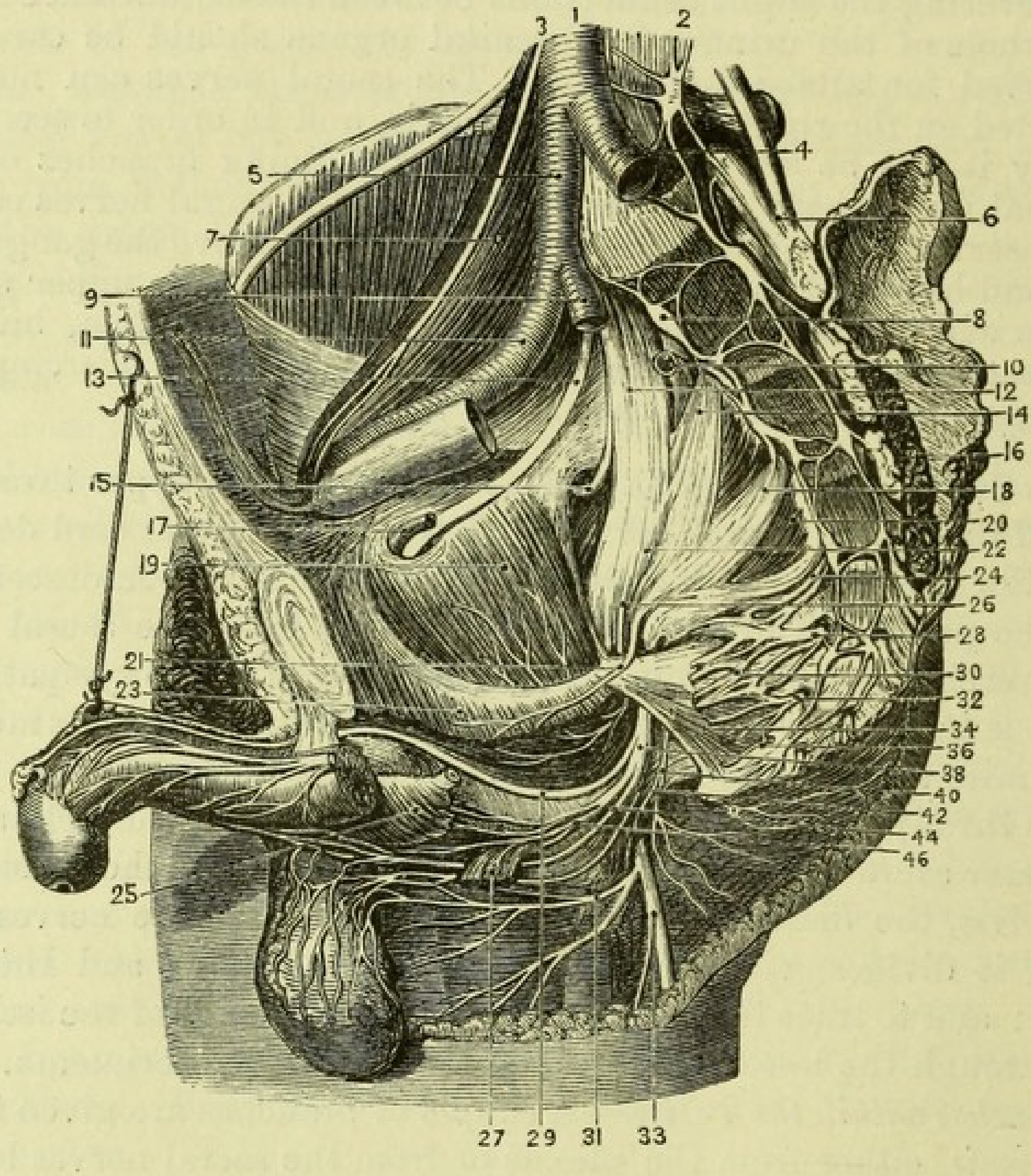


Fig. 155.—Side view of the nerves of the pelvis, the viscera having been removed (from Hirschfeld and Leveillé).

1. Abdominal aorta.
2. Gangliated cord of sympathetic (left side).
3. Genito-crural nerve.
4. Left common iliac artery.
5. Right common iliac artery.
6. Left lumbo-sacral cord.
7. Psoas muscle.
8. Gangliated cord of sympathetic (right side).
9. Internal iliac artery (cut).
10. Gluteal artery (cut).
11. Right external iliac artery.
12. Right lumbo-sacral nerve.
13. Obturator nerve.
14. First sacral nerve.
15. Gluteal nerve.
16. Pyriformis of left side (cut).
17. Obturator artery.
18. Second sacral nerve.
19. Obturator internus.
20. Pyriformis of right side.
21. Nerve to levator ani.
22. Sacral plexus.
23. Levator ani (cut).
24. Third sacral nerve.
25. Bulb of urethra covered by accelerator urinæ.

selves are very small, and a quantity of fibrous tissue is mixed with them.

From the 4*th Sacral nerve* a branch may be traced to its junction with the 5th nerve, and from the 4th also are derived *visceral branches* to the bladder and rectum, which communicate with the sympathetic, and *muscular branches* to the levator ani and coccygeus; as well as the *hæmorrhoidal branch* which passes through the levator ani or between this muscle and the coccygeus to the perinæum, to supply the external sphincter.

The 5*th Sacral nerve* communicates with the 4th and the coccygeal nerve, and terminates by piercing the coccygeus muscle, which it supplies, to reach the skin over the back of the coccyx.

The *Coccygeal nerve* (6th) also emerges from the lower end of the sacral canal, and pierces the coccygeus muscle to end on the back of the coccyx.

The **Gangliated Cord of the Sympathetic** (Fig. 155, 8) may be traced on each side of the sacrum internally to the foramina, and has upon it four or five ganglia; the two cords unite on the coccyx in the *ganglion impar*. Communicating branches are given to the sacral nerves and to the hypogastric plexus.

The *Hypogastric plexus* is placed on the front of the sacrum, and is continuous with the sympathetic plexus upon the aorta. It is continued forward upon the two internal iliac arteries to form the *pelvic plexuses*, which are placed on each side of the bladder and rectum.

In addition, there are upon the several hollow viscera plexuses from the sympathetic, parts of which are visible in the various stages of the dissection. They are derived from the pelvic plexuses, and are distributed over the branches of arteries supplied to the several viscera, receiving corresponding names.

The **Pyriformis Muscle** (Fig. 155, 20), if not sufficiently well seen, may be more fully exposed by drawing the sacral plexus out of the sacro-sciatic foramen. It *arises* from the front of the sacrum between the 1st, 2nd, 3rd, and 4th sacral foramina, from the great

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26. Nerve to obturator internus.
27. Transversus perinæi.
28. Fourth sacral nerve.
29. Dorsal nerve of penis.
30. Visceral branches (cut).
31. Inferior pudendal nerve.
32. Fifth sacral nerve.
33. Small sciatic nerve.
34. Coccygeus muscle.
36. Sixth or coccygeal nerve.
38. Internal pudic nerve.
40. Inferior hæmorrhoidal nerve.
42. Posterior superficial perinæal nerve.
44. Anterior superficial perinæal nerve.
46. Deep perinæal nerves to bulb and muscles.

sacro-sciatic ligament and the margin of the great sacro-sciatic foramen, and leaves the pelvis through the great sacro-sciatic foramen, having the gluteal vessels and nerve at its upper, and the sciatic and pudic vessels and nerves at its lower border. It is *inserted* into the upper border of the great trochanter of the femur, and is *supplied* by branches from the upper sacral nerves.

Pelvic Viscera in the Male.

[The bladder with the urethra and the rectum having been removed as directed, should be laid on the table with the rectum uppermost, and that viscus should be filled with cotton-wool and cleaned, and its muscular fibres exposed.]

The **Rectum** (Fig. 156, 8) is about eight inches long and is generally largest just above the anus, which will be seen to be surrounded by the sphincter muscle. The arrangement of the peritoneum upon the rectum has been already described (p. 285), and the longitudinal muscular fibres will be now seen to differ from those of the rest of the large intestine, in being spread all around it instead of being collected in three bands. The internal or circular muscular fibres become thickened near the anus to form the internal sphincter muscle, which is best seen when the bowel is opened. The numerous arteries entering the rectum are derived from three sources—the superior hæmorrhoidal artery from the inferior mesenteric, which may be traced to within three inches of the anus; the middle hæmorrhoidal from the internal iliac; and the inferior hæmorrhoidal from the internal pudic. The veins open both into the *vena portæ* and the internal iliac vein.

The intestine being opened along its unattached border, the mucous membrane will be seen to be smooth, except near the anus, where it is thrown into longitudinal folds by the sphincter. Here also it frequently happens that hæmorrhoids exist. Three or four transverse ridges of mucous membrane (valves or folds of Houston) will be found from three to six inches above the anus, which occasionally cause difficulty in the introduction of a bougie or rectum tube.

[The rectum is now to be carefully dissected from the bladder, which is to be moderately distended with air, and the under surface of the penis and bladder being then placed before the student, he is to dissect out thoroughly the whole of the parts exposed.]

The **Penis** (Fig. 156) is now seen to be composed of the two *corpora cavernosa*, which occupy the upper surface, and the *corpus* *spongiosum urethræ* (21), which is situated between them on the under surface. The latter is prolonged in front to form the *glans penis* (20), while behind it terminates in the dilated part called the *bulb* (18), from which any remains of the accelerator

Fig. 156.

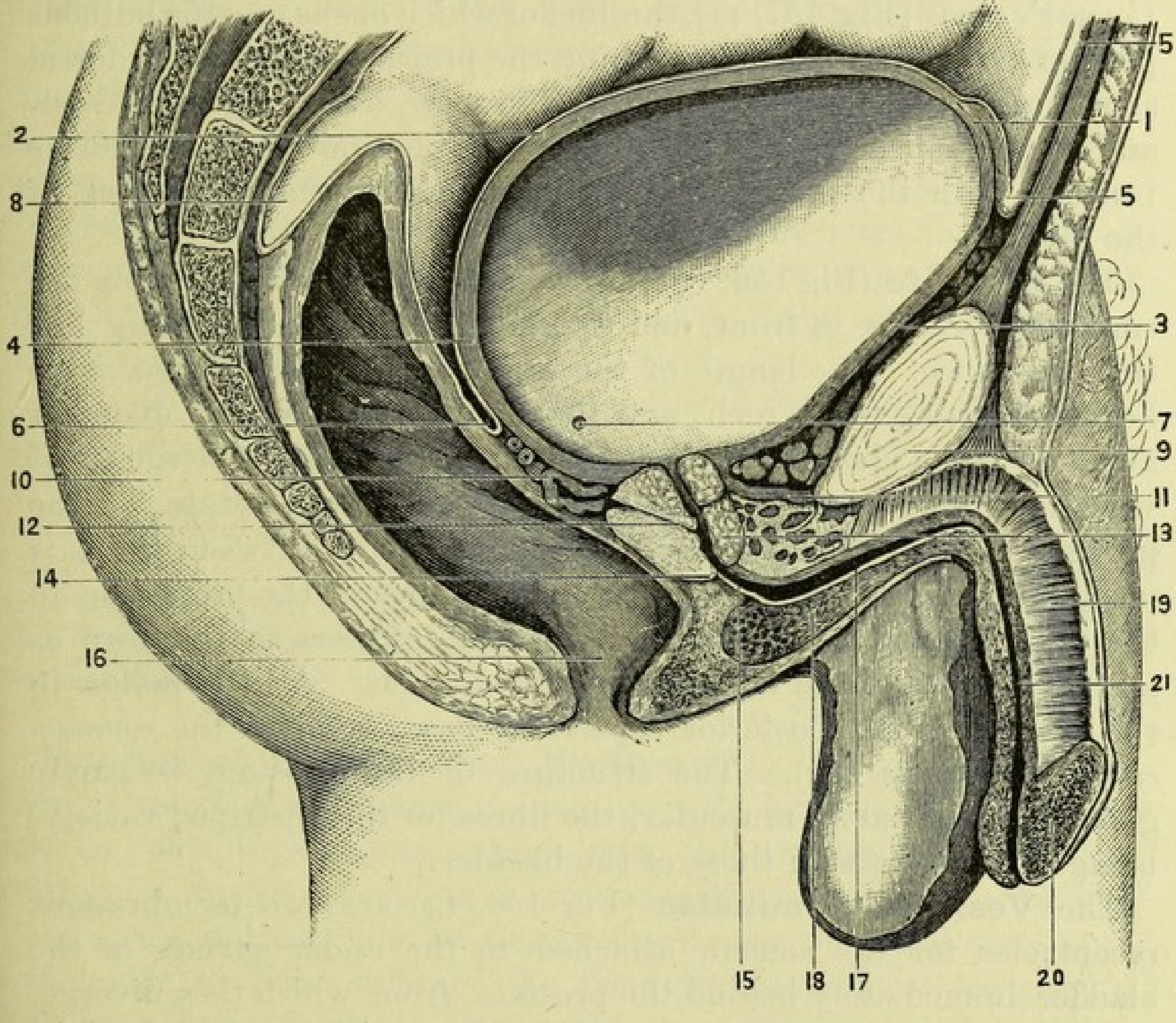


Fig. 156.—Sagittal section through the middle line of the pelvis and the pelvic viscera (from Sappey).

1. Apex of the bladder.
2. Upper surface of the bladder.
3. Lower surface of the bladder.
4. Fundus of the bladder.
5. Urachus making a turn upon itself.
6. End of recto-vesical pouch.
7. Entrance of ureter.
8. Rectum, points to the lower limit of the meso-rectum.
9. Symphysis pubis.
10. End of vas deferens and inner part of left vesicula seminalis, indicating the base of the prostate.
11. Anterior true ligament of bladder.
12. Common ejaculatory duct.
13. Prostatic part of the urethra.
14. Apex of the prostate.
15. Membranous part of the urethra.
16. Anus.
17. Bulbous part of the urethra.
18. Bulb.
19. Septum pectiniforme.
20. Glans penis.
21. Spongy part of urethra.

urinæ muscle should be removed. Behind the bulb is the slender *membranous portion* (15) of the urethra, which terminates at the *prostate* (13), the under surface of which is now exposed with the *vesiculæ seminales* (10), *vasa deferentia*, and base of the bladder. On each side of the membranous portion of the urethra may be found, by careful dissection, a little yellow body of the size of a pea, *Cowper's gland* (Fig. 157, 11), the duct of which opens into the bulbous portion of the urethra. By turning the preparation over, the dorsal aspect of the penis will be brought into view, and the dorsal vessels and nerves will be seen. The dorsal vein may now be traced to its junction with the plexus of veins around the prostate and neck of the bladder.

The **Prostate** (Fig 156, 13) is shaped like a chestnut, having the small end or apex in front, and weighs in the adult something less than an ounce. The length of the organ from base to apex is in health from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch, and the greatest transverse diameter about $1\frac{3}{4}$ inch (Thompson); but these measurements undergo great variation in old persons, the subjects of "enlarged prostate." The prostate consists of two lateral lobes, the division between which is marked by a slight groove on the under surface, the projection in the floor of the urethra described by some authors as the third or middle lobe being the result of morbid changes. A little hollow in the centre of the posterior aspect, or base, receives the *common ejaculatory ducts* (12). The structure of the prostate is partly glandular and partly muscular, the fibres (of the unstriped variety) being continuous with those of the bladder.

The **Vesiculæ Seminales** (Fig 150, 14) are two membranous receptacles for the semen, attached to the under surface of the bladder immediately behind the prostate, from which they diverge. Each vesicle consists of a convoluted tube, which becomes straight at the base of the prostate, and joins the corresponding *vas deferens* to form the *common ejaculatory duct*, which will be afterwards seen opening into the urethra.

The **Bladder** (Fig. 156).—The *peritoneal coat* of the bladder has been already dissected (p. 286).

The *muscular coat* consists of three layers, external or longitudinal, middle or circular, and internal (submucous of Ellis), also longitudinal.

The *external layer*, sometimes known as the *detrusor urinæ*, is attached to the anterior true ligaments of the bladder at the back of the pubes. It is continued over the bladder and joins the posterior part of the prostate.

The *middle layer* consists of circular fibres, which form the *sphincter vesicæ* around the neck of the bladder, and are then continued over the prostate. They become more or less oblique in their distribution over the bladder.

The *internal layer* is continuous with the longitudinal fibres of the urethra, and is joined by the fibres of the ureters, which meet in the middle line and are also spread over the trigonum (Ellis).

Sir Charles Bell described special muscular bands continued from the ureters to the back of the prostate, the existence of which as separate structures is doubtful. According to Dr. Pettigrew, whose beautiful preparations are in the museum of the College of Surgeons of England, the arrangement of the muscular fibres of the bladder is reducible to a series of figure-of-8 loops, the so-called circular fibres depending upon compression of the two halves of the figure,—thus 8 becomes **8**.

Beneath the muscular is the *fibrous coat* of the bladder, composed of loose connective tissue.

[The bladder is to be opened along its upper surface by a longitudinal cut, which is to be continued with a strong pair of scissors through the upper surface of the prostate and the whole length of the urethra, in the latter portion being a little to one side of the middle line.]

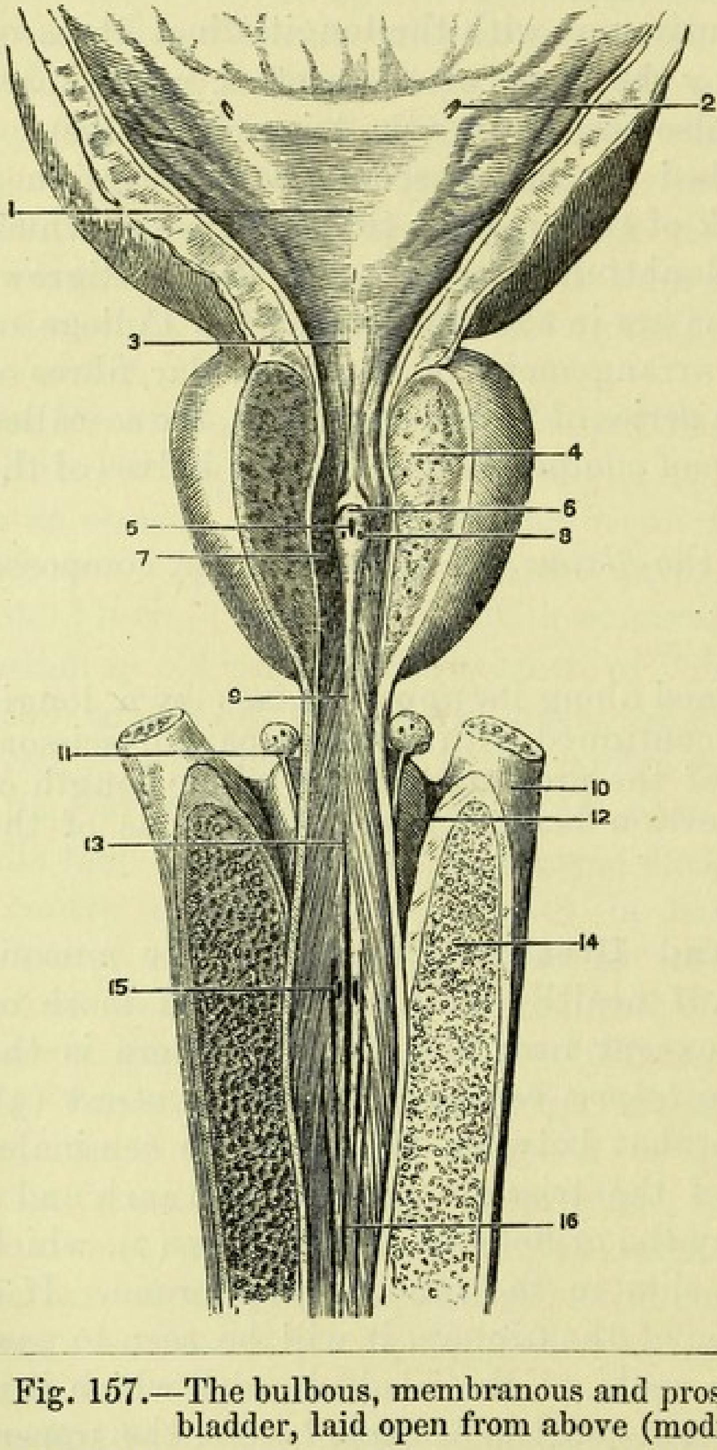
Interior of Bladder and Urethra (Fig. 157).—The mucous membrane of the bladder, if healthy, will be pale and more or less in folds throughout, except near the urethra, where is the triangular space called the *trigone vesicale* or *trigonum vesicæ* (3). This space corresponds to that between the vesiculæ seminales externally, and the sides of the triangle are about an inch and a half long, being bounded by the orifices of the ureters (2), which will be recognised as little slits in the mucous membrane. If a probe be introduced into one of the ureters, it will be seen to pass very obliquely through the coats of the bladder, with which it is firmly united. The epithelium consists of three layers, the uppermost being flattened, the middle pyriform, with the large end uppermost and the small end prolonged between the small rounded cells of the deepest layer.

The *Uvula vesicæ* (3) is a small elevation of the mucous membrane at the orifice of the urethra, which is not often seen.

The **Urethra** (Fig. 156) averages eight inches in length, and is divided into the prostatic, membranous, bulbous, and spongy portions.

The *Prostatic portion* (Fig. 157) lies in the prostate and is about an inch and a quarter long. On each side of it will be seen the cut substance of the prostate, which consists partly of glandular and partly of muscular tissue. At the bottom of the prostatic portion of the urethra is a ridge called the *veru montanum* or *caput gallinaginis* (6), dividing the canal into two hollows called the *prostatic sinuses* (8), into which the prostatic ducts open. On the veru montanum and near its posterior part will be found the *sinus pocularis* (5), a little blind pouch directed backwards, just within which are placed the orifices of the common ejaculatory duct (7).*

Fig. 157.



* The position of the sinus pocularis is given differently by various authors; thus Quain, Gray and Wilson place it on the anterior, and Cruveilhier and Ellis on the posterior, part of the veru montanum. The discrepancy arises from slight variations in the shape and extent of the ridge.

Fig. 157.—The bulbous, membranous and prostatic urethra, with part of the bladder, laid open from above (modified from Wilson).

1. Trigonum vesicæ.
2. Opening of ureter.
3. Uvula vesicæ, indicating the apex of the trigone.
4. Lateral lobe of prostate.
5. Opening of sinus pocularis.
6. Veru montanum.
7. Aperture of ejaculatory duct.
8. Prostatic sinus and openings of prostatic ducts.
9. Membranous part of the urethra.
10. Crus penis.
11. Cowper's gland and commencement of its duct.
12. Upper surface of the bulb.
13. Commencement of bulbous portion of urethra.
14. Section of crus penis.
15. Entrance of duct of Cowper's gland.
16. Spongy part of the urethra.

The *Membranous portion* (9) is the shortest and narrowest division of the urethra, and being placed between the two layers of the triangular ligament which meet below, its upper wall is somewhat longer than its floor, the former measuring about $\frac{3}{4}$ inch and the latter $\frac{1}{2}$ inch (Thompson). The wall of this portion is thin and membranous, but it will be seen to be enclosed by circular involuntary fibres continuous with the circular fibres of the bladder and prostate. The mucous membrane is smooth, and presents no orifices; it is frequently stained of a red colour.

The *Bulbous portion* (13) is the part corresponding to the bulb externally, and is about an inch long, but there is no line of demarcation between it and the spongy portion. The canal is dilated at this spot, and in the floor of it are the two minute orifices of the ducts of Cowper's glands (15), which run obliquely through the wall of the urethra for some distance. The cut edge of the bulb will be seen to be continuous with the corpus spongiosum, which surrounds the spongy or anterior portion of the urethra, and expands again to form the *glans penis*.

The *Spongy portion* (16) is the longest part of the canal, and averages five inches in length. Its calibre is somewhat smaller than that of the bulbous portion, but it expands in the glans penis to form the *fossa navicularis*, again becoming contracted at the *meatus* or orifice, at which point the urethra is as small as in the membranous portion, and occasionally smaller. Along the floor of the spongy portion are numerous mucous follicles or *lacunæ*, the orifices of which are directed towards the meatus; a few similar follicles are situated on the upper surface of the urethra, one of which opposite the fossa navicularis is the *lacuna magna*. This can seldom be made out when the urethra is opened from above, as here directed.

The mucous membrane is smooth and pale in health, but the student should notice carefully any traces of stricture, which will probably be found, if present, in the bulbous portion. The epithelium of the posterior part of the urethra is columnar, but it becomes tesselated near the glans penis.

Beneath the mucous membrane of the urethra there is a layer of longitudinal involuntary muscular fibre, continuous with the submucous layer of the bladder (Ellis), and intermixed with fibrous tissue. According to Hancock, circular muscular fibres also invest the whole length of the urethra at the same level.

The **Corpora Cavernosa Penis** are now seen to be two vascular bodies enclosed in fibrous capsules, which unite to form a median septum between them, known as the *septum pectiniforme* (Fig. 156, 19, Fig. 158, 5) from the comb-like appearance produced by apertures in it. The elastic capsule consists of two layers of fibres, longitudinal and circular, from which *trabeculæ* or thread-like processes are distributed through the vascular tissue of the organ. The attachment of the corpora cavernosa or crura penis has been seen in the dissection of the perinæum.

A transverse section of the penis (Fig. 158) shows the reticulated structure of the corpora cavernosa and of the corpus spongiosum,

Fig. 158.

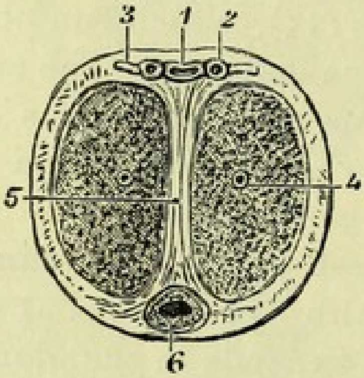
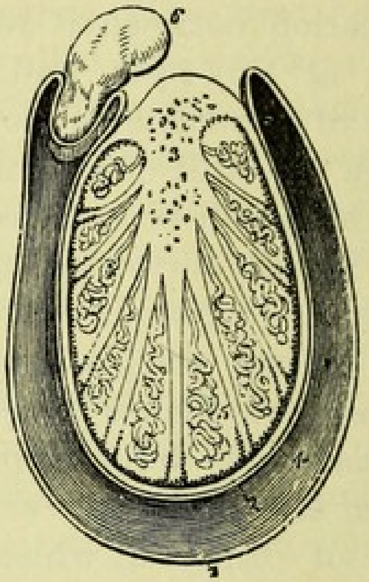


Fig. 159.



which suroundsr the urethra. The dorsal vein (1), with a dorsal artery (2) and nerve (3) on each side of it, lie along the upper surface of the corpora cavernosa. The artery of the corpus cavernosum (4) is in the substance of the corpus cavernosum.

The **Testicle** (Fig. 159) has already been seen in its position in the scrotum, and its structure should now be investigated as

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Fig. 158.—Transverse section of the penis.

1. Dorsal vein.
2. Dorsal artery.
3. Dorsal nerve.
4. Artery of corpus cavernosum.
5. Septum pectiniforme.
6. Urethra, surrounded by corpus spongiosum.

Fig. 159.—Transverse section of the testicle (from Wilson).

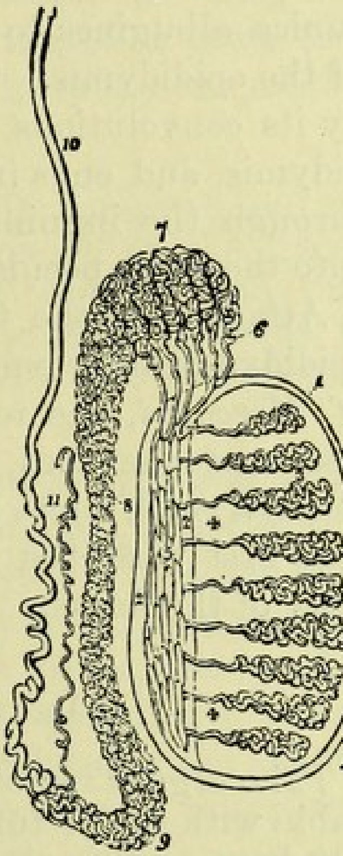
1. Cavity of the tunica vaginalis.
2. Tunica albuginea.
3. Mediastinum testis giving off numerous septa. The cut extremities of the vessels below the figure belong to the rete testis; and those above to the arteries and veins of the organ.
4. Tunica vasculosa, or pia mater testis.
5. One of the lobules, consisting of the convolutions of the tubuli seminiferi, and terminating by a single duct, the vas rectum.
6. Section of the epididymis.

far as possible, but cannot be thoroughly seen without mercurial injection.

The testis consists of two parts, an anterior or larger portion, the *body* of the testis, and the accessory and more slender posterior part, the *epididymis*, which is to the outer side of the body, and from the lower end of which the *vas deferens* or duct arises.

The testicle has three tunics or coverings. The *tunica vaginalis* (1) is a serous covering derived originally from the peritoneum, and described as consisting of two portions, the *tunica vaginalis propria*, which covers the organ, and the *tunica vaginalis reflexa* or reflected portion. The *tunica albuginea* (2) is a fibrous covering enclosing the body of the testis, and sending into its centre a vertical process called the *mediastinum* (3) or corpus Highmorianum. From this secondary processes or *septa* are derived, which separate the *lobules* of the testicle. The tunica albuginea is inseparably connected with the tunica vaginalis, thus forming a fibro-serous membrane. The *tunica vasculosa* (4) is beneath the tunica albuginea, and contains the ramifications of the blood-vessels, which cannot be seen except when finely injected.

Fig. 160.



The *Epididymis* (Fig. 160) is divided into three parts. The upper extremity is the *head* or *globus major* (7), which is divisible into *coni vasculosi;* the central portion is the *body* (8), and the lower extremity the *tail* or *globus minor* (9), which is larger than the body, but not so large as the head. From this the *vas deferens* (10) or duct of the testicle arises, and close to its point of origin may be found a single tube, extending along the cord and called the *vas aberrans* (11).

Fig. 160.—Anatomy of the testis (from Wilson).

1, 1. Tunica albuginea.
2, 2. Mediastinum testis.
3, 3. Lobuli testis composed of tubuli seminiferi.
4, 4. Vasa recta.
5. Rete testis.
6. Vasa efferentia, of which six only are represented in this diagram.
7. Coni vasculosi, constituting the globus major epididymis.
8. Body of the epididymis.
9. Globus minor epididymis.
10. Vas deferens.
11. Vas aberrans.

On making a section of the uninjected testis, little more can be seen than a mass of a drab colour, which may be drawn out in threads, these being the minute seminal tubes. In an injected preparation the tubes may be traced as follows (Fig. 160) :—

Each lobule is composed of convoluted *tubuli seminiferi* (3), which anastomose with one another, and these as they emerge from the lobules become straight, and are called *vasa recta* (4), about twenty in number. Entering the mediastinum, they anastomose to form the *rete testis* (5), which terminates in the *vasa efferentia* (6); and these, from twelve to fifteen in number, pierce the tunica albuginea to form the *coni vasculosi* (7) of the globus major of the epididymis. The ducts are now all collected into one, which by its convolutions forms the body and globus minor of the epididymis, and ends in the vas deferens, which enters the abdomen through the inguinal canal, and has been traced to its opening into the sinus pocularis of the prostate.

Attached to the top of the testis, immediately in front of the epididymis, may generally be found a little vesicle called the *hydatid of Morgagni*, the remains of Müller's duct; and in the cellular tissue of the cord, immediately above the epididymis, may be found a small white body, which has been supposed by M. Giraldès, who first described it, to be part of the remains of the Wolffian body of the fœtus.

Pelvic Viscera in the Female.

[The organs removed from the pelvis are to be laid out upon the table with the rectum upwards; this is to be cleaned, and, after it has been examined, is to be dissected from the uterus.]

The **Rectum** (Fig. 151, 19) corresponds in all particulars to that of the male, but is sometimes much distended. The description of the rectum will be found at page 300.

[The preparation being reversed, the bladder and urethra are next to be dissected and examined. The peritoneum is to be dissected up from the bladder and left attached to the uterus.]

The **Bladder** (Fig. 151, 4) is more capacious than in the male, and is directly continuous with the urethra without the intervention of a prostate, the relation to the vesiculæ seminales and vasa deferentia being of course wanting. The bladder is firmly attached to the neck of the uterus and front wall of the vagina. On each side of the upper part of the vagina the ureters turn upwards to gain the sides of the bladder, running obliquely for a short distance in the vesico-vaginal septum, then forwards obliquely through its coats to open by two orifices an inch and a half apart, about where they would open in the male (Savage). The structure of the bladder in the female corresponds closely to that of the male, which is given at page 302.

The **Urethra** (Fig. 151, 6) of the female is a simple tube about an inch and a half long, the structure of which is best seen by laying it open with the bladder. The urethra is about a quarter of an inch in diameter, but is larger near the bladder, this being also its most dilatable portion. The mucous and muscular coats (circular and longitudinal) resemble those of the membranous urethra of the male.

[The bladder and urethra are to be carefully removed, and the vagina and uterus exposed. The broad ligament of the uterus should be pinned out for the examination of the Fallopian tube and round ligament, and the preparation must afterwards be reversed for the dissection of the ovary, which is placed posteriorly.]

The **Vagina** (Fig. 161, 5) has been seen in its position in the pelvis (p. 290), when the anterior wall was found to be shorter than the posterior, thus giving it a curved direction which is lost when the organs are removed from the body. The vagina is composed of longitudinal muscular fibres enclosing erectile tissue, and lined by a mucous membrane, which, when the tube is opened, will be seen to form transverse *rugæ*. Two longitudinal ridges, at the anterior and posterior surfaces of the vagina, have been named the *columns* of the vagina. At the upper part of the vagina the cervix uteri projects into its cavity, and the vagina will be found to be attached higher on its posterior than its anterior surface. At the lower end will be found the *carunculæ myrtiformes* and remains of the *hymen*, and outside the vagina may be found the two small glands of Bartholin, the ducts of which open within the nymphæ.

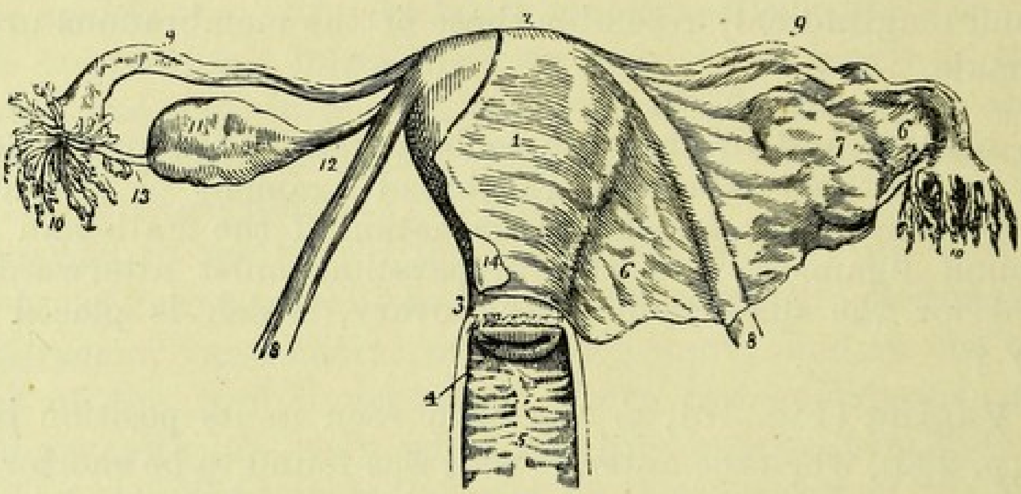
The **Uterus** (Fig. 161, 1) is more or less pyriform in shape, the *fundus* or upper part of the body being broad and somewhat flattened from before backwards, and the lower end or *cervix* being cylindrical. The cervix is perforated by the *os uteri externum* (os tincæ), a transverse opening which divides it into two lips, anterior and posterior, of which the anterior is the thicker.

[The anterior wall is to be divided vertically with scissors, and the cut prolonged on each side towards the Fallopian tube.]

Immediately within the os uteri, on the posterior aspect of the cervix, is seen a vertical ridge with oblique ridges radiating from it, producing the appearance known as the *arbor vitæ*. A similar appearance in the mucous membrane of the anterior surface of the cervix has been necessarily destroyed by the incision. Above the canal of the cervix is the *os internum*, which opens into the general cavity of the uterus.

The *cavity* of the uterus is triangular in shape, the apex being downwards and the extremities of the base corresponding with the

Fig. 161.



orifices of the Fallopian tubes. It is lined by a smooth mucous membrane, in which are the orifices of numerous small glands.

The uterus is composed of pale unstriped muscular fibre together with a large quantity of areolar tissue. In pregnancy the muscular fibres become much developed, and are divisible into three layers.

The arteries of the uterus are derived from the ovarian and the uterine arteries, which become very tortuous when they reach the organ, and anastomose very freely amongst themselves.

Fig. 161.—Uterus with its appendages viewed from the front (from Wilson).

1. Body of the uterus.
2. Fundus.
3. Cervix.
4. Os uteri.
5. Vagina.
6, 6. Broad ligament of the uterus.
7. Convexity of the broad ligament formed by the ovary.
8, 8. Round ligaments of the uterus.
9, 9. Fallopian tubes.
10, 10. Fimbriated extremities of the Fallopian tubes; on the right side the mouth of the tube is turned forwards in order to show its *ostium abdominale*.
11. Ovary.
12. Utero-ovarian ligament.
13. Fallopio-ovarian ligament.
14. Peritoneum of anterior surface of uterus, continuous with the anterior layer of the broad ligament.

The nerves of the uterus are derived from the hypogastric plexus of the sympathetic, the spermatic plexus, and the 3rd and 4th sacral nerves. Dr. Robert Lee described numerous ganglia on the surface of the organ, and believed that the nerves enlarge during pregnancy.

The **Fallopian Tube** (Fig. 161, 9) is found at the upper part of the broad ligament on each side of the uterus, into the angles of which the two tubes open. Each tube is about four inches long, and of very small calibre at the uterus, but gradually expands to form the *fimbriated extremity*, a trumpet-shaped opening surrounded by fringe-like processes (*fimbriæ*). One of the fimbriæ (fallopio-ovarian ligament, 13) is attached to the ovary, and serves to direct the tube in grasping the ovule as it emerges from that organ. The tube is muscular in structure, and is lined by a mucous membrane with ciliated epithelium.

The **Round Ligament** (Fig. 161, 8) placed in the anterior part of the broad ligament has been already traced (p. 290). It is composed of unstriped muscular and areolar tissue, and is covered by peritoneum, which in the child can be traced for a short distance into the inguinal canal, forming the *canal of Nuck.*

The **Ovary** (Fig. 161, 11) is an oval body situated in the posterior part of the broad ligament, on each side of the uterus. In the young subject it is smooth and plump, but in the old subject it is shrivelled and scarred. It is attached to the fundus of the uterus by a slender cord, the *ligament of the ovary* (12), and has one of the fimbriæ of the Fallopian tube attached to its surface (13). It is composed of a fibrous capsule (tunica albuginea) containing the Graafian vesicles, from which the ovules are discharged by a process of dehiscence or bursting, producing a cicatrix on the surface of the ovary, and within it a shrivelled clot called the *corpus luteum*.

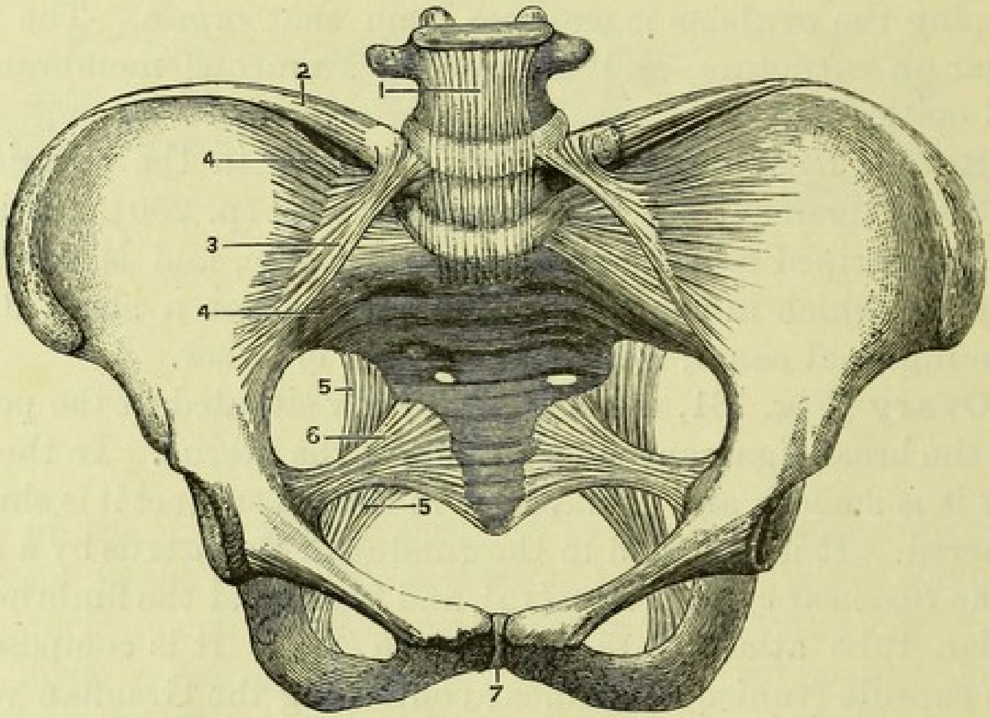
Between the Fallopian tube and the ovary, and contained in the broad ligament, are the remains of the Wolffian body, a fœtal structure which becomes the epididymis in the male, and has been called the *organ of Rosenmüller* in the female. It consists of a number of tubes with blind extremities. Connected with the lower surface of the ovary is a venous erectile tissue, to which the name of *Bulb of the Ovary* was given by the late Mr. Reeves Traer, who first described it. This is supposed to maintain the ovary in its position, and to prepare it for the grasp of the Fallopian tube during the passage of the ovule.

Ligaments of the Pelvis.

[The remaining soft tissues are to be removed from the halves of the pelvis, and the several ligaments to be dissected out.]

Articulation of the Vertebral Column with the Pelvis (Fig. 162).—The last lumbar vertebra is connected with the sacrum by the continuation of the several ligaments common to the vertebral column, and by an intervertebral substance, which is peculiar in being of greater thickness in front than behind. There are also two special ligaments, the lumbo-sacral and ilio-lumbar.

Fig. 162.



The *lumbo-sacral* or *sacro-vertebral ligament* (3) is short, thick, and triangular, being attached to the transverse process of the last lumbar vertebra above, and the upper border of the sacrum below.

The *ilio-lumbar ligament* (2) is triangular, and passes horizontally from the tip of the transverse process of the last lumbar vertebra, to the crest of the ilium close above the sacro-iliac articulation.

Sacro-iliac Articulation.—The *anterior sacro-iliac ligament* (Fig. 162, 4) consists of short fibres passing between the anterior surfaces of the two bones.

Fig. 162.—Ligaments of the pelvis (from Sappey).

1. Lower part of anterior common ligament of vertebræ.
2. Ilio-lumbar ligament.
3. Sacro-vertebral ligament.

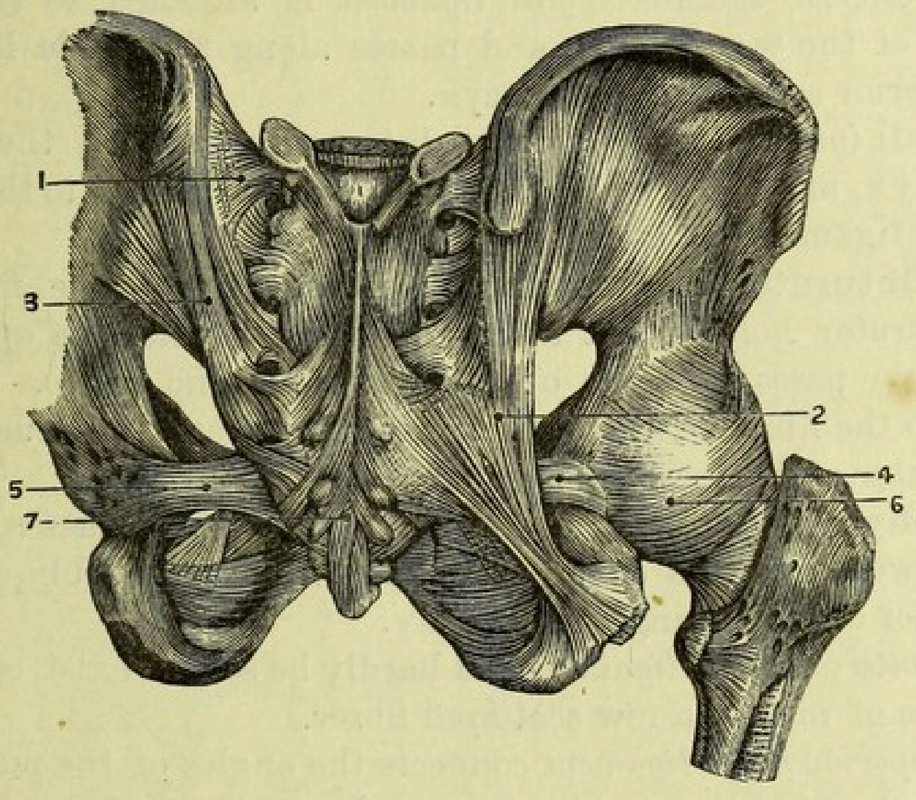
4, 4. Anterior sacro-iliac ligament.
5, 5. Great sacro-sciatic ligament.
6. Small sacro-sciatic ligament.
7. Fibro-cartilage of symphysis.

The *posterior sacro-iliac ligament* (Fig. 163, 1) is composed of strong ligamentous bands, connecting the rough portion of the ilium behind the auricular surface of articulation, with the posterior surface of the sacrum external to the posterior foramina.

The *oblique sacro-iliac ligament* (Fig. 163, 3), is a superficial portion of the posterior ligament, and reaches from the posterior superior spine of the ilium to the third lateral tubercle on the sacrum.

When the ilium and sacrum are separated after the dissection of the other ligaments of the pelvis, a distinct layer of cartilage will

Fig. 163.



be found between the two bones, with occasionally an intervening space, the joint being an instance of 'amphiarthrosis.'

Sacro-Sciatic Ligaments (Fig. 163).—These ligaments have been partially exposed in the dissection of the gluteal region.

The *Great sacro-sciatic ligament* (2) is broad at its upper attachment, which is to the posterior inferior spine of the ilium and to the sides of the sacrum and coccyx, and narrows to its insertion into the inner and back part of the tuberosity of the ischium. A portion of

Fig. 163.—Posterior ligaments of the pelvis and hip-joint (Bonamy and Beau).

1. Posterior sacro-iliac ligament.
2. Great sacro-sciatic ligament.
3. Oblique sacro-iliac ligament.
4. Small sacro-sciatic ligament.
5. The same fully exposed by removal of the great ligament.
6. Capsule of hip-joint.
7. Posterior sacro-coccygeal ligament.

this ligament, by its falciform prolongation to the ramus of the ischium, has been seen to give attachment to the obturator fascia and to protect the pudic vessels and nerve.

The *Small sacro-sciatic ligament* (4, 5) is attached to the side of the sacrum and coccyx close to, but in front of, the great ligament, and reaches to the spine of the ischium; thus separating the greater from the lesser sacro-sciatic foramen. It is closely incorporated with the coccygeus muscle (Fig. 162, 6).

Articulation of the Sacrum and Coccyx.—The *anterior sacro-coccygeal ligament* is a thin fasciculus, passing from the anterior surface of the sacrum to the front of the coccyx.

The *posterior sacro-coccygeal ligament* is attached to the lower opening of the sacral canal, and passes along the whole length of the posterior surface of the coccyx.

A small *inter-articular cartilage* intervenes between the sacrum and coccyx, and the cornua of the latter are connected to the former by short ligamentous bands.

The **Obturator Ligament** is a fibrous membrane filling up the obturator hole except at its upper part, where an opening is left for the passage of the obturator vessels and nerve. It gives origin to the fibres of the obturator externus and internus muscles by its outer and inner surfaces.

Symphysis Pubis.—The *anterior pubic ligament* passes in front of the two bones, the superficial fibres interlacing obliquely, and the deeper ones running transversely.

The *posterior pubic ligament* can hardly be said to exist, consisting as it does of merely a few scattered fibres.

The *superior pubic ligament* connects the angles of the pubes.

The *sub-pubic ligament* is a strong band passing from one pubic bone to the other, and arching beneath the symphysis.

[To see the arrangement of the inter-articular cartilages, a vertical transverse section of the symphysis near its posterior part should be made with the saw.]

An *inter-articular fibro-cartilage* covers the roughly-grooved surface of each pubic bone, the two cartilages being connected in front by strong elastic tissue, but separated posteriorly by a small cavity lined by a synovial membrane. This joint also is an example of amphiarthrosis.

TABLE 3.
MUSCLES OF ABDOMEN.

Muscle.	Origin.	Insertion.	Nerve.
Obliquus externus	Lower ribs 8	Iliac crest $\frac{1}{2}$, Poupart's ligament, pubes, linea alba	Lower six intercostal nerves, and ilio-hypogastric and ilio-inguinal (1st lumbar).
Obliquus internus	Iliac crest $\frac{2}{3}$, Poupart's ligament $\frac{1}{2}$, fascia lumborum	Costal cartilages 8-12, linea alba, pubes, ilio-pectineal line	
Cremaster	Poupart's ligament	Front of pubes and conjoined tendon	
Transversalis	Lower costal cartilages 6, fascia lumborum, iliac crest $\frac{2}{3}$, Poupart's ligament $\frac{1}{3}$	Linea alba, ilio-pectineal line	
Pyramidalis	Front of pubes	Linea alba	
Rectus abdominis	Pubic crest, symphysis	Costal cartilages, 5, 6, 7	
Diaphragm	Ensiform cartilage, lower ribs 6, ligamenta arcuata R. crus 3 lumbar vertebræ; L. crus 2 lumbar vertebræ	Central cordiform tendon	Phrenics (3rd, 4th and 5th cervical).
Psoas magnus	12th dorsal and lumbar vertebræ 5	Lesser trochanter of femur	Lumbar nerves.
Psoas parvus	12th dorsal and 1st lumbar vertebræ	Ilio-pectineal eminence and line	Lumbar nerves.
Iliacus internus	Iliac fossa, ilio-lumbar ligament and sacrum	Below lesser trochanter of femur	Anterior crural.
Quadratus lumborum	Iliac crest, ilio-lumbar ligament	Last rib, lumbar transverse processes	Lumbar nerves.
Levator ani	Back of pubes, pelvic fascia, ischial spine	Median raphé, rectum, coccyx	4th sacral.
Coccygeus	Spine of ischium	Side of coccyx	4th and 5th sacral.
Obturator internus	Back of pubes and inner wall of pelvis, obturator membrane	Top of great trochanter	From sacral plexus.
Pyriformis	Front of sacrum, great sciatic notch	Top of great trochanter	Upper sacral nerves.
Sphincter ani	Tip of coccyx	Central point of perinæum	From 4th sacral.
Accelerator urinæ	Central fibrous raphé	Upper surface of penis, triangular ligament	Pudic.
Erector penis	Ramus and tuber ischii	Crus penis	Pudic.
Transversus perinæi	Ramus ischii	Central point of perinæum	Pudic.
Compressor urethræ	Back of ramus pubis	Median raphé	Pudic.
Sphincter vaginæ	Central point of perinæum	Upper surface of clitoris and triangular ligament	Pudic.
Erector clitoridis	Tuber ischii	Crus clitoridis	Pudic.

PART IV.

DISSECTION OF THE HEAD AND NECK.

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

Before beginning the dissection the student should make himself fully acquainted with the external configuration of the part, and the relation of surface-markings to deeper structures. If he has already dissected this region, he should make the incisions necessary for exposing the common carotid artery and the third part of the subclavian artery, and may also advantageously perform the operations of laryngotomy and tracheotomy, and practise extraction of the teeth and the operation for plugging the posterior nares, which last can be done with a flexible catheter. The surface of the scalp presents nothing worthy of note, but in a well-injected body the temporal artery will be prominent, and arteriotomy may be performed upon it.

The superficial appearances on the face will be described more particularly under that head, and reference may be made to that section now if time allows.

In the neck, the median line is the boundary of the dissection, and presents the following prominences and depressions, which should be fully recognised with the finger. First is the symphysis of the lower jaw, next a depression corresponding to the mylohyoid muscle, followed by the projection of the hyoid bone, the cornua of which can be felt distinctly on each side in some subjects. The depression corresponding to the thyro-hyoid membrane and the prominent *pomum Adami* of the thyroid cartilage are next felt, below which are the interval of the crico-thyroid membrane and the ring of the cricoid cartilage. Below this may occasionally be felt the isthmus of the thyroid gland or body, and even the trachea in a thin subject; and on each side there is (particularly in women) the slight projection of the thyroid gland.

The crico-thyroid membrane and the trachea should be especially noticed, as the positions in which laryngotomy and tracheotomy are performed.

The clavicle and sternum bound the dissection below, and across the side of the neck the prominence of the sterno-mastoid marks the division into anterior and posterior triangles; in an injected body the carotid artery may be felt near the middle of the anterior border of this muscle. The external jugular vein, if full of blood, will probably be seen crossing the sterno-mastoid obliquely, and may be opened *secundum artem* by an incision parallel to the muscle.

It will be found to be impossible to dissect both sides of the head and neck simultaneously, and the students should therefore arrange to work together, and to take turns at dissecting and reading.

The dissection of both sides of the scalp should be completed on the first day, in order that the brain may be removed on the second morning.

The Scalp.

[The head being shaved and raised on a block, one incision is to be carried from the root of the nose to the occiput, and another at right angles to it from the front of the ear across the head to the corresponding point on the opposite side, and the flaps thus marked out are to be dissected by beginning at the top of the head. Great care must be taken to remove only the skin and not the subcutaneous tissues, which are very thin; the best guides are the roots of the hair, which should be exposed on the under surface of the flaps. The flaps having been turned down to the level of the brow in front, and the occipital protuberance behind, the dissector may, if he choose, attempt to define the small muscles of the external ear, which are seldom well developed.]

The **Muscles of the Pinna** (Fig. 164) are the *Attollens aurem* (5) (superior), the *Attrahens aurem* (1) (anterior), and the *Retrahens aurem* (9) (posterior). The names sufficiently indicate their positions, and they are all inserted into the pinna, the anterior *arising* from the anterior part of the aponeurosis of the occipito-frontalis, and being *inserted* into the helix; the superior also *from* the middle part of the same aponeurosis, and *inserted* into the fossa of the antihelix; and the posterior, which consists of two or three stronger bundles of fibres, arising *from* the mastoid process and passing *to* the back of the concha.

[The muscular fibres of the occipito-frontalis are to be cleaned both on the forehead and on the occiput, care being taken not to damage the intervening aponeurosis, or the nerves which pierce the muscle at several points and between which numerous branches of communication may be found.]

The **Occipito-frontalis** (Fig. 164).—The *anterior belly* (2) has no bony attachment, but takes its *origin* from the fibres of the orbicularis palpebrarum and the pyramidalis nasi, and is also connected with the corrugator supercilii on the face. The *posterior belly arises* from the outer half or two-thirds of the superior curved line of the occipital bone, and very slightly from the mastoid process of the temporal bone. Both bellies are *inserted* into the broad tendinous aponeurosis which extends over the top of the skull. The aponeurosis of the two sides is continuous over the top of the head, and is freely movable upon loose areolar tissue which intervenes between it and the periosteum of the skull. The occipito-frontalis wrinkles the forehead transversely and elevates the eyebrows; it is *supplied* by the facial nerve.

Cutaneous Vessels and Nerves (Figs. 164, 165).—In front of the ear will be found branches of the three divisions of the 5th nerve and branches of the facial nerve, together with branches of the ophthalmic and temporal arteries. Behind the ear are, a branch of the facial nerve (posterior auricular), two branches of the cervical plexus (great auricular and small occipital), and a posterior branch of the second cervical nerve (great occipital), together with the posterior auricular and occipital arteries.

The *Supra-orbital nerve* (8) [first div. of 5th] will be most readily found by feeling for the supra-orbital notch, and then cutting through the occipito-frontalis at that spot. It turns round the margin of the orbit at this point, and divides into two branches (inner and outer), which soon pierce the occipito-frontalis and supply the skin as far as the vertex.

The *Supra-trochlear nerve* (6) [first div. of 5th] is a small nerve which leaves the orbit at its inner angle, and then supplies the skin of the forehead by piercing the occipito-frontalis.

The *Supra-orbital artery* (2) [ophthalmic] accompanies the supra-orbital nerve, and also gives superficial branches to the surface of the occipito-frontalis muscle.

The *Frontal artery* (1) [ophthalmic] is of small size, and accompanies the supra-trochlear nerve.

The *Supra-orbital* and *Frontal veins* unite to form the angular vein, which is the commencement of the facial vein; they communicate freely with the ophthalmic vein.

The *Temporal branch* of the *Orbital nerve* (10) [second div. of 5th]

Fig. 164.

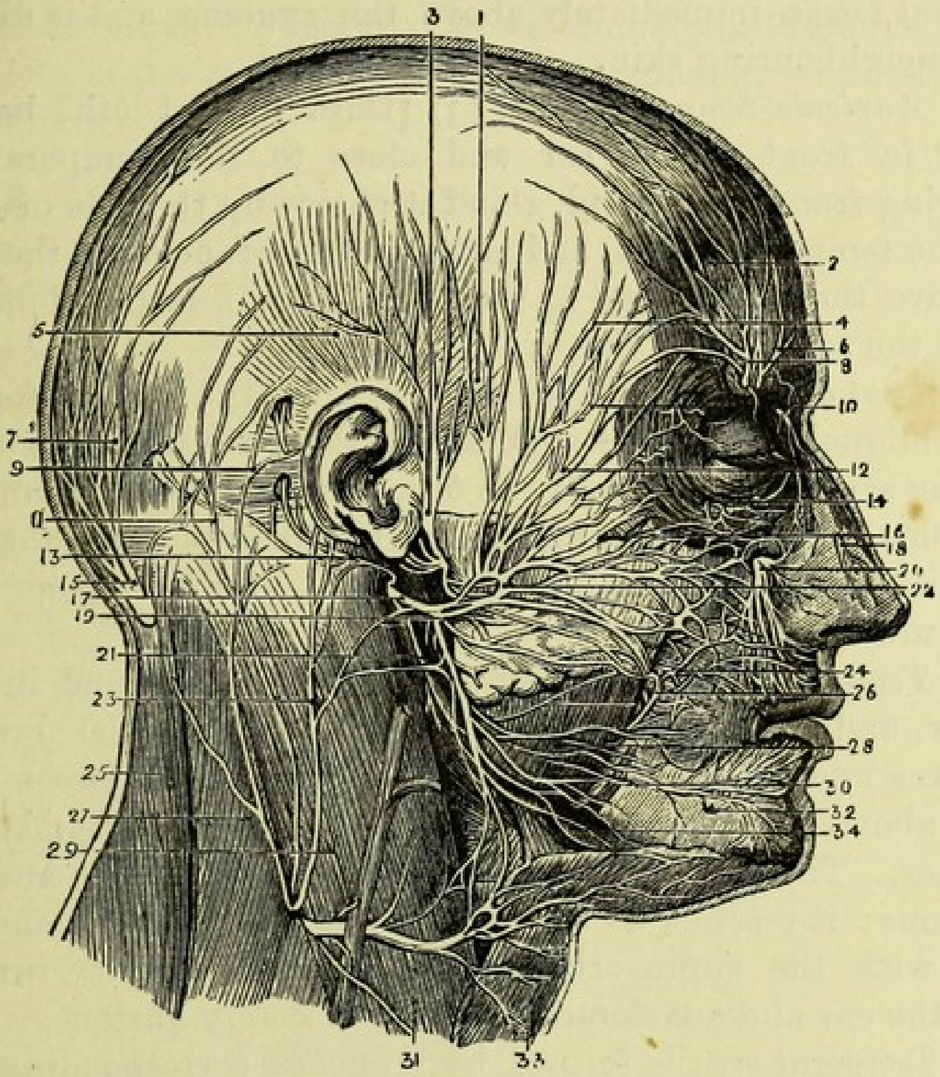


Fig. 164.—Nerves of the scalp and face (from Hirschfeld and Leveillé).

1. Attrahens aurem muscle.
2. Anterior belly of occipito-frontalis.
3. Auriculo-temporal nerve.
4. Temporal branches of facial nerve (7th).
5. Attollens aurem muscle.
6. Supra-trochlear nerve (5th).
7. Posterior belly of occipito-frontalis.
8. Supra-orbital nerve.
9. Retrahens aurem muscle.
10. Temporal branch of temporo-orbital nerve (5th).
11. Small occipital nerve.
12. Malar branches of facial nerve.
13. Posterior auricular nerve (7th).
14. Malar branch of temporo-malar nerve (5th) (ramus subcutaneus malæ).
15. Great occipital nerve.
16. Infra-orbital branches of facial nerve (7th).
17. Facial nerve.
18. Nasal nerve (5th).
19. Cervico-facial division of facial.
20. Infra-orbital nerve (5th).
21. Branches to digastric and stylo-hyoid (facial).
22. Temporo-facial division of 7th.
23. Great auricular nerve.
24. Buccal branches of facial nerve.
25. Trapezius.
26. Buccal nerve (5th).
27. Splenius capitis.
28. Masseter.
29. Sterno-mastoid.
30. Supra-maxillary branches of facial nerve (7th).
31. Superficial cervical nerve.
32. Mental nerve (5th).
33. Platysma.
34. Infra-maxillary branches of facial nerve (7th).

will be found with difficulty, as it is of small size. It pierces the temporal fascia immediately above the zygoma, and is distributed to the neighbouring skin.

The *Auriculo-temporal nerve* (3) [third div. of 5th] lies immediately in front of the ear and close to the temporal artery. Emerging from the parotid gland it passes up the side of the head with the temporal artery, and, after giving branches to the external ear above the meatus and to the meatus itself, is distributed to the skin of the scalp.

Temporal branches of the facial nerve (4) [7th] will be found running obliquely over the zygoma to the temple, where they join with the several branches of the 5th, already described, and supply the orbicularis palpebrarum, the corrugator supercilii, the anterior belly of the occipito-frontalis, and the attrahens and attollens aurem muscles.

The *Temporal artery* (6) [external carotid] is found in front of the ear, and after giving off small anterior auricular branches to the pinna and the middle temporal artery (which pierces the deep fascia above the zygoma), it divides into anterior and posterior branches. The *anterior* lies upon the temporal fascia and is subcutaneous; it reaches as far forward as the forehead, and anastomoses with the supra-orbital artery. The *posterior* turns back above the ear and anastomoses with the occipital artery.

The *Temporal vein* is formed by branches corresponding to those of the artery, and disappears in the parotid gland to join the internal maxillary vein and form the external jugular vein.

Surgery.—It is on the anterior branch of the temporal artery that the operation of arteriotomy is performed, when it is desired to abstract blood from the head. In the operation it is necessary to make only a puncture in the artery, and, when sufficient blood has flowed, to divide the vessel, in order that the ends may be able to retract and prevent the formation of a false aneurism.

The *Posterior Auricular nerve* (13) [facial] will be found immediately behind the ear, and running over the mastoid process with an accompanying artery. It is distributed to the posterior belly of the occipito-frontalis, and to the attollens and retrahens aurem muscles. From this nerve and the temporal branches of the facial the minute muscles of the auricle are supplied.

The *Posterior Auricular artery* (8) [external carotid] accompanies the nerve in this part of its course, and is distributed to the pinna and to the skin behind it. Its *vein* opens into the external jugular.

The *Great Auricular nerve* (23) [2nd and 3rd cervical nerves] ascends to the pinna, to which it gives numerous branches, principally on its posterior surface, forming a junction with the posterior auricular nerve.

Fig. 165.

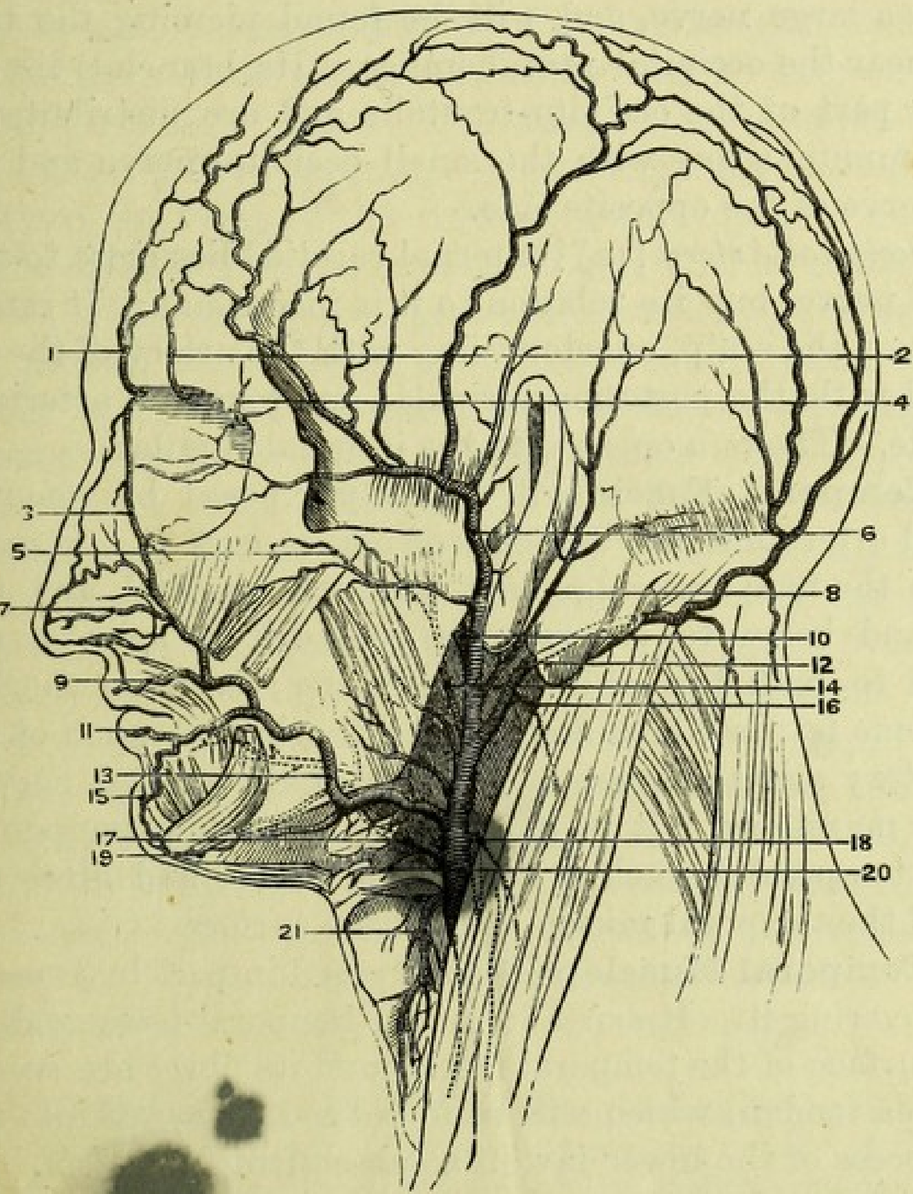


Fig. 165.—Arteries of the scalp and face (from Henle).

1. Frontal artery.
2. Supra-orbital artery.
3. Angular artery.
4. Branch of lacrymal artery.
5. Transverse facial artery.
6. Superficial temporal artery.
7. Lateral nasal artery.
8. Posterior auricular artery.
9. Superior coronary artery and artery to septum.
10. Internal maxillary artery.
11. Inferior coronary artery.
12. Occipital artery.
13. Facial artery.
14. Ascending pharyngeal artery.
15. Inferior labial artery.
16. Sterno-mastoid branch of occipital artery.
17. Lingual artery.
18. Sterno-mastoid branch of carotid artery.
19. Submental artery.
20. Hyoid branch of lingual artery.
21. Superior thyroid artery.

The *Small Occipital nerve* (11) [2nd cervical nerve] will be found about an inch behind the mastoid process and just at the posterior margin of the sterno-mastoid. It is a small nerve, and passes directly upwards to the scalp, which it supplies,—giving also occasionally a branch to the pinna.

The *Great Occipital nerve* (15) [posterior division of 2nd cervical nerve] is a large nerve, and will be found piercing the trapezius muscle near the occipital protuberance. Its branches lie over the posterior part of the occipito-frontalis and are distributed to the scalp, communicating with the small occipital nerve and with the fellow nerve of the opposite side.

The *Occipital Artery* (12) [external carotid] lies close to the great occipital nerve, but its relation to it is inconstant. It ramifies on the back of the scalp, anastomosing with the artery of the opposite side, and with the posterior auricular and temporal arteries of the same side. The *vein* opens into the internal jugular.

The **Temporal Fascia** will be fully exposed by removing the temporal artery and the branches of nerves over it. It is attached above to the temporal ridge on the frontal, parietal, and temporal bones, and below to the zygoma, where it is split so as to be attached to both lips of its upper border; between the layers is found some fat, in which are the small orbital branch of the temporal artery and the temporal branch of the orbital nerve of the superior maxillary. It is pierced by the middle temporal artery and the temporal branch of the orbital nerve, and gives origin to fibres of the temporal muscle by its deep surface.

The **Temporal Muscle** will be exposed in part by removing the fascia covering it. It *arises* from the temporal fossa and from the under surface of the temporal fascia, and its fibres are seen to converge to a tendon, which will be found to be *inserted* into the coronoid process of the lower jaw in a subsequent dissection.

Removal of the Brain.

[Both sides of the scalp having been dissected, the knife should be drawn round the skull, marking out a line an inch above the orbit in front, and half an inch above the occipital protuberance behind, and passing through the temporal muscle between those points. The outer plate of the skull is to be sawn through, special care being taken at the anterior and posterior extremities of the temporal ridge, and at the occiput. With the chisel the remaining thickness of the skull can then be readily divided without injuring the brain, and the calvaria be removed.]

Upon Removing the Skull-cap the rough outer surface of the dura mater will be seen, and it should be noticed that it formed the internal periosteum of the calvaria, which will be found to be bare. The inner surface of the skull-cap presents a longitudinal groove in the median line, which corresponds to the superior longitudinal sinus, and on each side may frequently be seen depressions of variable size, corresponding to the Pacchionian bodies. The groove for the middle meningeal artery will be seen on the inner surface of the parietal bone. The dura mater is cream coloured, but often has a bluish appearance, resulting from its translucency, which allows the veins of the surface of the brain to be partially seen. On each side of the middle line will be seen the *glandulæ Pacchionii*, which are fibrous growths from the pia mater, and frequently project through the dura mater and indent the skull. Ramifying upon the dura mater will be found the large middle meningeal artery [internal maxillary], and in a well-injected body the anterior meningeal [ethmoidal] may sometimes be seen.

The **Superior Longitudinal Sinus** (Fig. 166, I) should be opened at once. It runs along the middle line of the head, and will be seen to be triangular in section, being formed by a splitting of the dura mater and lined with venous endothelium. It commences in a small vein, which enters the skull from the nose through the foramen cæcum, and, running along the whole length of the upper border of the falx cerebri, it ends in the torcular Herophili. Within the sinus may be seen some small tendinous cords—*chordæ Willisii*, and also the orifices of the veins opening into it, which all pass from behind forwards, *i.e.*, in the opposite direction to the current of blood in the sinus itself.

[The dura mater is to be divided longitudinally on each side of the sinus and turned down. By this means the cavity of the arachnoid, now usually called the subdural space, will be opened, and one layer of that membrane will be seen to form the inner layer of the dura mater, whilst the other is reflected upon the pia mater covering the brain. By slightly separating the two hemispheres of the brain with the handle of the knife, the falx cerebri will be seen, and must be detached from the crista galli of the ethmoid bone.]

Removal of the Brain.—The head being tilted a little backwards, the anterior lobes of the cerebrum are to be raised, when the Olfactory nerves and bulbs (1st pair) will probably be detached from the cribriform plate of the ethmoid bone with them, or if not, they can be readily displaced with the handle of the knife. The Optic nerves (2nd pair) of large size, will be seen close to the anterior clinoid processes, and should be divided, when the Internal Carotid Arteries will be brought into view, and must also be cut, together with the *infundibulum* attached to the *pituitary body* in the middle line. The 3rd pair (motores oculorum) will be seen piercing the dura mater behind and a little external to the carotid arteries, and after dividing these, the *tentorium cerebelli* will be brought into view, with the 4th nerve (patheticus vel trochlearis) just at its edge. The tentorium is to be divided on each side by carrying the knife backwards and outwards, parallel to the margin of the petrous bone, and the 4th pair will be cut at the same time. The tentorium having been turned aside, the remaining cranial nerves will be exposed, and must be divided, in their numerical order. The 5th pair (trifacial) will be found to be composed of two parts, the larger superior one being sensory, and the deeper one, which is anterior at its origin, motor in function. The 6th pair (abducentes) will be found nearer the median line. The 7th consists of two distinct nerves with a small intermediate portion. The anterior is the facial nerve, and the posterior the auditory, the intervening portion being called the *pars intermedia*. The entire nerve is seen to disappear through the *meatus auditorius internus* with an accompanying auditory artery. The 8th pair consists of three distinct nerves. The most anterior fibres form the small Glosso-pharyngeal nerve, which pierces the dura mater separately; the next and largest portion is the Pneumo-gastric or Vagus; and the part coming out of the foramen magnum is the Spinal-accessory. The whole nerve disappears through the *foramen lacerum posterius* or jugular hole. The 9th (hypoglossal) nerve consists of two bundles placed near the median line, which pierce the dura mater at separate points to pass together through the *anterior condyloid foramen*. The Veins of Galen, which pass from the brain to the anterior border of the tentorium, should be divided so that the fold of dura mater may be quite free.

The knife is now to be pushed through the foramen magnum so as to divide all the parts passing into the skull, viz., the spinal cord and its membranes, the two vertebral arteries, the small spinal vessels, and the two spinal-accessory nerves; and it should be noticed that the cord can be cut considerably lower than the point at which the vertebral arteries enter the spinal canal. The brain can now be lifted out of the skull, by slipping the fingers beneath the cerebellum and allowing the head to fall back.

[Before placing the brain in methylated spirit, the dissectors should pick off the arachnoid and the pia mater from the base, and carefully lay out the nerves in the proper positions, taking care not to interfere with the arteries. The brain should be placed in a pan with the base upwards, and with a piece of calico bandage beneath it, so that it may be easily lifted out; but if too decomposed to be worth preserving, the vessels of the base should be dissected at once.]

The Dura Mater and Sinuses of the Skull.

The **Dura Mater** is firmly attached to the base of the skull, and sends processes through the several foramina to form sheaths for the nerves. It is continuous with the dura mater of the spinal cord through the foramen magnum, to the margin of which it is closely attached.

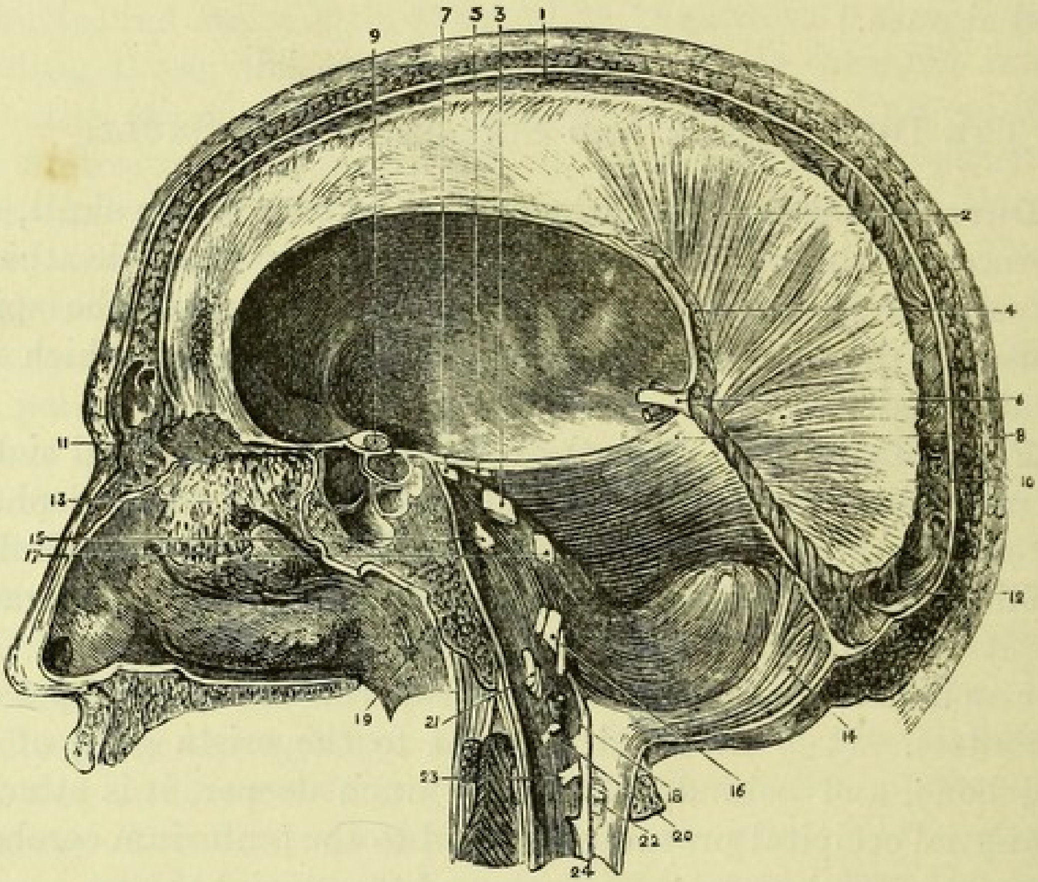
The **Falx Major** (Fig. 166, 2) or *falx cerebri* is a vertical sickle shaped process of dura mater, placed between the two hemispheres of the cerebrum. Above it is convex and attached to the skull in the middle line, below it is free and concave and is directed towards, though it does not actually reach, the corpus callosum. The superior and inferior longitudinal sinuses run along its upper and lower borders. It is attached in front to the crista galli of the ethmoid bone, and behind, where it is much deeper, it is attached to the internal occipital protuberance and to the tentorium cerebelli, at a line corresponding to the position of the straight sinus.

The **Tentorium Cerebelli** (Fig. 166, 8) is the horizontal process of dura mater placed between the cerebrum and cerebellum, and when perfect it leaves only an oval opening of small size, through which the crura cerebri, the superior peduncles of the cerebellum, and the posterior cerebral arteries pass. In front, it is attached to the anterior and posterior clinoid processes of the sphenoid bone and the superior border of the petrous bone, and behind, it is attached to the upper margin of the groove for the lateral sinus on the occipital, parietal, and temporal bones.

The **Falx Minor** (Fig. 166, 14) or *falx cerebelli* is below the tentorium in the median line, and reaches to the foramen magnum, being attached to the median ridge of the occipital bone. It generally divides below, sending a slip to each side of the foramen magnum.

The **Sinuses** are the venous canals of the skull into which the veins of the brain, orbit, and diploë empty themselves, and differ from the ordinary veins, (1) in not having the usual venous coats but being formed by layers of the dura mater lined with venous endothelium, and therefore remaining patent when divided; (2) in having no valves; and (3) that the veins open into them in a direction contrary to that of the current of blood within them.

Fig. 166.



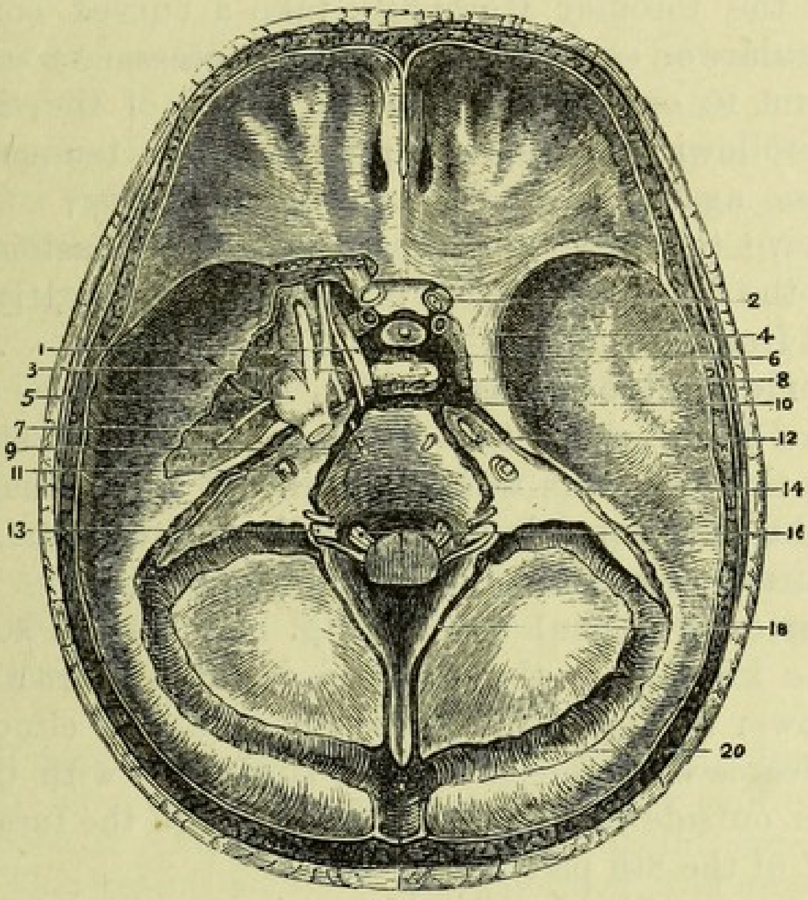
The **Superior Longitudinal Sinus** (Fig. 166, 1) runs along the upper border of the falx major (*v.* p. 323), and along its lower border is a much smaller canal, the **Inferior Longitudinal Sinus** (4). This begins about the middle of the falx and opens into the straight sinus.

Fig. 166.—Sinuses of the skull (side view) (from Hirschfeld and Leveillé)

1. Superior longitudinal sinus
2. Falx cerebri.
3. 5th nerve.
4. Inferior longitudinal sinus.
5. 4th nerve.
6. Venæ Galeni.
7. 3rd nerve.
8. Tentorium cerebelli
9. 2nd nerve.
10. Straight sinus.
11. Crista galli of ethmoid.
12. Torcular Herophili.
13. 1st nerve.
14. Falx cerebelli.
15. 6th nerve.
16. 8th nerve.
17. 7th nerve.
18. Vertebral artery.
19. Eustachian tube.
20. 1st cervical nerve.
21. 9th nerve.
22. Posterior root of 2nd cervical nerve.
23. Anterior root of 2nd cervical nerve.
24. Ligamentum denticulatum.

The **Straight Sinus** (Fig. 166, 10) must be opened along the line of attachment of the falx to the tentorium. It is formed by the *venæ Galeni* of the brain and the inferior longitudinal sinus,

Fig. 167.



and opens into the torcular Herophili, thus connecting the two longitudinal sinuses together.

The **Occipital Sinus** (Fig. 167, 18) communicates above with the torcular Herophili; below it is often bifurcated and joins the posterior spinal veins, being prolonged to the lower end of the lateral sinus.

Fig. 167.—Dissection of the sinuses of the skull and cranial nerves; the cavernous sinus dissected on the left side (drawn by J. T. Gray).

1. 3rd nerve.
2. Optic nerve.
3. 4th nerve.
4. Internal carotid artery.
5. Gasserian ganglion of 5th nerve, with its three divisions.
6. Circular sinus.
7. Superficial petrosal nerve.
8. Cavernous sinus.
9. 6th nerve.
10. Transverse or basilar sinus.
11. 7th pair.
12. Superior petrosal sinus.
13. 8th pair.
14. Inferior petrosal sinus.
16. 9th nerve of left side.
18. Occipital sinus.
20. Lateral sinus.
21. Torcular Herophili.

The **Torcular Herophili** (Fig. 167, 21) is the point where the superior longitudinal, straight, occipital and two lateral sinuses meet. It is usually situated on the right of the internal occipital protuberance, but is sometimes to its left.*

The **Lateral Sinuses** (Fig. 167, 20) are the largest and, commencing at the torcular Herophili, take a curved course to the foramen jugulare on each side. It will be necessary to cut through the tentorium in order to expose the cavity of the sinus, which grooves the following bones,—occipital, parietal, temporal, and the occipital bone again close to the jugular process.† The lateral sinuses receive the mastoid veins through the mastoid foramina, and end in the internal jugular veins, returning nearly the whole of the blood from the brain.

The **Superior Petrosal Sinus** (Fig. 167, 12) will be exposed by running the knife along the upper border of the petrous bone, from which the tentorium was detached. It is of small size, and runs from the cavernous sinus back to the lateral sinus, just where the latter turns downwards in the temporal bone.

The **Inferior Petrosal Sinus** (Fig. 167, 14) will be opened by carrying the knife from the foramen jugulare, directly forwards along the lower border of the petrous bone to the clinoid process. It communicates with the cavernous sinus, and with the internal jugular vein outside the skull, passing through the foramen jugulare in front of the 8th pair.

The **Cavernous Sinus** (Fig. 167, 8) is placed by the side of the pituitary body, and requires careful dissection on account of the nerves in relation with it. They are the 3rd, 4th, ophthalmic division of the 5th, and 6th, and their positions should be at once ascertained. The 3rd, of good size (1), will be recognized close behind the anterior clinoid process; the 4th, very small (3), in the cut edge of the tentorium; the entire 5th nerve, larger than the others and somewhat flattened out (5), will be seen immediately beneath the tentorium; and the 6th, piercing the dura mater nearer the median line, upon the basilar process (9).

[The left sinus will be found the most convenient for dissection, and should therefore be taken first. The 4th nerve is to be fol-

* Usually the longitudinal sinus becomes dilated a little to one side of the internal occipital protuberance, oftener the right side, forming the torcular Herophili, and then is continued into the corresponding lateral sinus. The straight sinus is continued into the lateral sinus of the opposite side, and a cross branch of larger or smaller size passes from the torcular to the point at which it makes the bend to the left or right as the case may be.

† Artificial memory, O P T O.

lowed out carefully to the sphenoidal fissure by dividing the dura mater with a sharp knife, and the 3rd should be taken next. The dura mater over the 5th, having been freely divided, should be torn up from the bone, by which means and a very little dissection, the Gasserian ganglion and middle meningeal artery will be brought fully into view.]

The **Gasserian Ganglion** (Fig. 167, 5) (Ganglion Semilunare) is the largest of the cranial ganglia, is of a pinkish colour, and is placed upon the tip of the petrous portion of the temporal bone. It is formed upon the larger or sensory portion of the 5th, and the smaller or motor portion passes beneath it. From the ganglion the three great divisions of the 5th are to be traced as follows:—The first or ophthalmic division to the sphenoidal fissure; the second or superior maxillary division to the foramen rotundum; and the third or inferior maxillary division to the foramen ovale. The motor trunk of the nerve joins this last division outside the skull. The ophthalmic division is seen to pass along the outer side of the cavernous sinus, and to give off a branch (nasal) before it enters the sphenoidal fissure. It also sends a minute recurrent branch (Arnold) to the tentorium cerebelli.

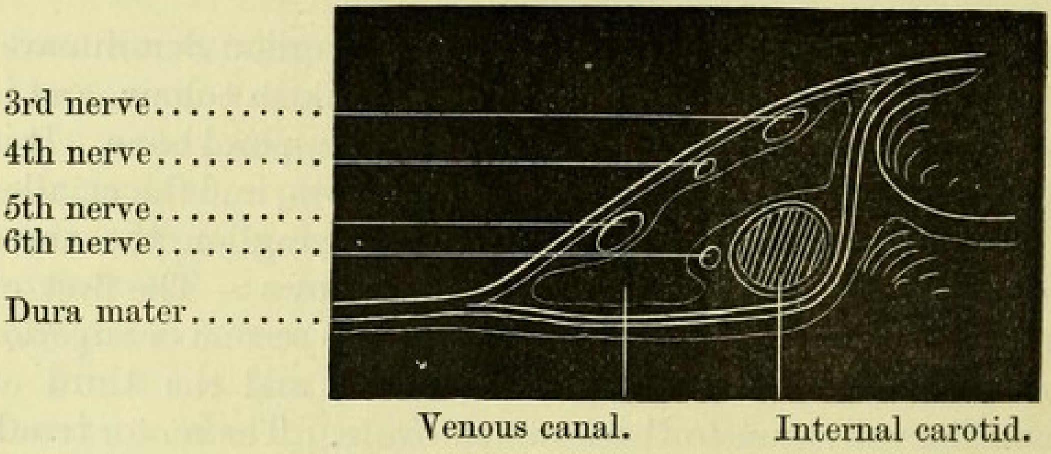
[The 6th nerve is to be followed by dividing the dura mater over it, and will be found to lie against the outer side of the carotid artery, where it makes its sigmoid turn at the side of the sella turcica. This vessel should be fully defined, and an attempt made to see the carotid plexus of the sympathetic upon it, from which a branch goes to join the 6th. It will render the dissection more useful, if a small piece of the lesser wing of the sphenoid is clipped off with the bone forceps so as to open up the sphenoidal fissure, and the nerves can then be carefully followed to their entry into the orbit.]

The 3rd and 4th nerves, and the first division of the 5th nerve, have been seen to lie in the outer wall of the cavernous sinus immediately beneath the dura mater; and between them and the 6th nerve, which is placed against the carotid artery, is the venous canal through which the blood is returned from the orbit. Its wall is very delicate, and can seldom be defined; it receives the ophthalmic vein, and opens into the two petrosal sinuses (Fig. 168).

The relation which the nerves hold to one another in the cavernous sinus is at first from above downwards according to their *numerical* order—*i.e.* 3, 4, 5, 6; and their relations to the sinus have been already described. Before they reach the orbit, however, they change their relative positions, which at the sphenoidal fissure are roughly as follows, from above downward—4, 5, 3, 6.

If, however, the fissure has been opened up as advised, and the

Fig. 168.



dissection be carefully made, the 3rd nerve before entering the orbit will be found to divide into two parts (between which the nasal branch of the 5th takes its course), and the 5th, after giving off the nasal nerve, to divide into the *frontal* and *lacrymal* branches. The order therefore of parts passing through the sphenoidal fissure, from above downwards, would strictly be as follows (Fig. 169) :—

Above the muscles.	Fourth nerve. Frontal and lacrymal nerves [5th].
Between the heads of external rectus.	Upper division of 3rd nerve. Nasal branch of 5th nerve. Lower division of 3rd nerve. Sixth nerve. Ophthalmic vein (most internally).

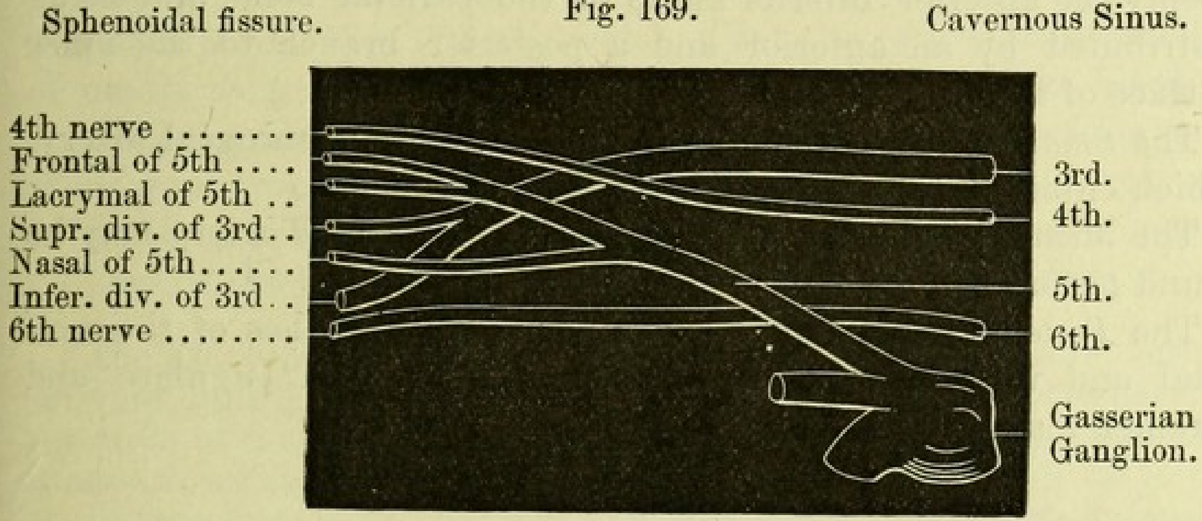
The **Internal Carotid Artery** (Fig. 167, 4) should be traced to the upper opening of the carotid canal at the apex of the petrous bone. It makes a sigmoid turn by the side of the sella turcica, and then winds close behind the anterior clinoid process, where it was cut in removing the brain. In a well-injected body, a few small branches (*arteriæ receptaculi*) may be seen in the cavernous sinus going to the dura mater; and the ophthalmic artery will be

Fig. 168.—Diagram of left cavernous sinus seen in section from behind (drawn by J. T. Gray).

seen entering the optic foramen to the outer side of the optic nerve.

Sympathetic Nerve.—A few filaments may be traced upon the carotid artery, forming the *carotid plexus*, which gives a branch of

Fig. 169.



communication to the sixth nerve; and the *cavernous plexus* may be found also on the artery close to the anterior clinoid process; from both pass several twigs of communication to the neighbouring cranial nerves.

The **Circular Sinus** (Fig. 167, 6) surrounds the pituitary body in the sella turcica, and forms a communication between the two cavernous sinuses.

The **Transverse** or **Basilar Sinus** (Fig. 167, 10) crosses the basilar process at a variable point, and communicates between the two inferior petrosal sinuses.

By displacing the Gasserian ganglion, a little groove in the upper surface of the petrous bone will be seen, in which are a small nerve and artery taking a course to the hiatus Fallopii, through which they disappear. They are the *greater superficial petrosal* nerve and artery, the nerve, the continuation of the Vidian, going to join the facial, and the artery a branch of the middle meningeal. Two small nerves may be found entering the temporal bone, to the outer side of the hiatus Fallopii; one, the *small superficial petrosal*, is the communication between the facial nerve and the otic ganglion; the other, the *external superficial petrosal*, is derived from the sympathetic on the middle meningeal artery.

Fig. 169.—Diagram of the nerves passing through the cavernous sinus (drawn by J. T. Gray).

Meningeal Arteries.—The *Anterior Meningeal Arteries* from the ethmoidal arteries, if injected, will be seen to enter the cranium through the ethmoidal foramina.

The *Middle Meningeal Artery* can be seen entering at the foramen spinosum. It ramifies on the outside of the dura mater, grooving deeply the anterior inferior angle of the parietal bone, and being distributed by an anterior and a posterior branch to the inner surface of the frontal, parietal and occipital bones.

The *Small Meningeal* is a branch of the middle meningeal artery, which enters the skull through the foramen ovale.

The *Meningeal Branch of the Ascending Pharyngeal* artery may be found perforating the foramen lacerum medium.

The *Posterior Meningeal Arteries* are small branches of the occipital and vertebral, which enter by the foramen jugulare and foramen magnum respectively.

Posterior Triangle of the Neck.

[In order to dissect the posterior triangle, the blocks beneath the head should be removed, and it should be drawn downwards and to the opposite side and secured with hooks. The shoulders are to be raised to a convenient height by blocks beneath the scapulæ, and the arm drawn down, and if possible secured in that position. The side of the neck is thus put fully on the stretch, and probably the external jugular vein distended with blood will be seen beneath the skin.

One incision is to be carried from the back of the pinna to the clavicle near its inner end, and another from this point along the whole length of that bone ; a third incision is to be made (if necessary) transversely from the pinna to the occiput, and the flap of skin is then to be reflected backwards. The dissection should be begun at the inferior angle, the dissector of the *right* side standing by the shoulder, and the dissector of the *left* side at the head, of the subject.]

Beneath the skin is the *superficial fascia*, and between the layers of it at the lower part of the neck is the platysma muscle, the fibres of which may be cleaned at once while removing the skin. Care must be taken, as soon as the upper border of the platysma is reached, to keep close to the skin, or the superficial nerves may be injured.

The **Platysma Myoides** (Fig. 170, 6) is only seen now in its lower part, the remainder of it will be found in the dissection of the anterior triangle and face. It is a subcutaneous muscle *arising* from the fascia over the pectoral and deltoid muscles, and very slightly from the front of the clavicle; it passes obliquely across the neck to be *inserted* into the lower border of the lower jaw, near the symphysis, and into the side of the mouth, the fibres of opposite sides interlacing below the symphysis, and the muscle if well developed reaching as high as the zygoma. It is *supplied* by the facial nerve.

Through the platysma will generally be seen the **External Jugular Vein** (Fig. 170, 13), which, it is to be noticed, runs parallel or nearly so to the fibres of the muscle; if therefore, in bleeding from the jugular, an incision were made in the direction of the vein, there would be no opening by which the blood might escape, and hence the rule in practice, viz., to cut parallel to the sterno-mastoid, *i.e.*, across the fibres of the platysma, so that they may retract.

[The platysma is to be detached from the clavicle and turned forward, and the cutaneous nerves are to be sought, some passing upwards to the scalp and cheek, some forwards over the neck, and others downwards to the shoulder and chest. They will be found to diverge from a point about half-way down the posterior border of the sterno-mastoid.]

The **Superficial Branches of the Cervical Plexus** are arranged in two sets,—the ascending, comprising the Superficial Cervical, Great Auricular, and Small Occipital nerves, and the descending set comprising the Sternal, Clavicular, and Acromial branches.

a. The **Superficial Cervical Nerve** (Fig. 170, 17) [from the second and third nerves] will be found turning round the posterior border of the sterno-mastoid, and crossing it transversely beneath the platysma to ramify over the anterior triangle, where it communicates with the infra-maxillary branches of the facial nerve.

b. The **Great Auricular Nerve** (Fig. 170, 11) [from the second and third nerves] is the largest branch of the set, and turning round the posterior border of the sterno-mastoid, passes obliquely to the pinna and ends in three sets of branches, *facial* to the parotid gland and skin covering it, which communicate deeply with the facial nerve; *auricular* to the back of the pinna; and *mastoid* to the skin over the mastoid process.

This last is often of large size, and may be mistaken for the following:

c. The **Small Occipital Nerve** (Fig. 170, 3), [from the second nerve], which is sometimes double, is always to be found at the posterior margin of the sterno-mastoid muscle, and runs directly upwards to the scalp, where it has been already seen (p. 322).

The **Descending Branches** (Fig. 170, 21) sternal clavicular, and acromial [from the loop between the 3rd and 4th nerves], take the directions indicated by their names, and passing over the clavicle are distributed to the skin upon the pectoral muscle and shoulder, where they are seen by the dissector of the arm.

[The anterior and posterior boundaries of the triangle (the sterno-mastoid and trapezius) are now to be defined, but only the edges of the muscles need be cleaned. The descending nerves being detached and turned up, the deep branches of the cervical plexus and the spinal-accessory nerve passing obliquely between the borders of the sterno-mastoid and the trapezius are to be dissected out, and also the omo-hyoid muscle, which will be found passing obliquely downwards and outwards at a variable distance above the clavicle; the external jugular vein is to be followed as far as convenient, and numerous large veins, which form a plexus at the lower part of the triangle and communicate freely with the external jugular, are to be noticed. The deep cervical fascia will be seen and partially removed in this proceeding.]

The **Deep Cervical Fascia,** which is very dense, commences at the spinous processes of the vertebræ and encloses the trapezius muscle, then crosses the posterior triangle, being attached below to the clavicle and, splitting in front to enclose the sterno-mastoid, is continued on to the median line of the neck. At the lower part of the triangle it gives a special covering to the omo-hyoid muscle, which is attached to the back of the clavicle and first rib. It also gives sheaths to the deep muscles and vessels of the neck.

[To see the floor of the triangle the rest of this part of the deep fascia is to be removed; it will be most readily detached by beginning above at the junction of the sterno-mastoid and trapezius, and carrying the knife obliquely downwards and backwards so as to be parallel to the fibres of the muscles beneath. It should be removed only as low as the omo-hyoid at present, and all branches of nerve and artery should be carefully preserved.]

The **Posterior Triangle** (Fig. 170) is the space bounded *in front* by the sterno-mastoid, *behind* by the trapezius; the *base* of the triangle being formed by the middle third of the clavicle, and its *apex* by the meeting of the anterior and posterior boundaries at the occiput. It is covered in by skin, superficial and deep fasciæ, and at the lower part by the platysma. Its *floor* is formed from above downwards by the splenius capitis, levator anguli scapulæ, scalenus posticus and scalenus medius, and the upper digitation of the serratus magnus, which last cannot be seen at present.

The splenius colli does not form part of the floor, because it is

Fig. 170.

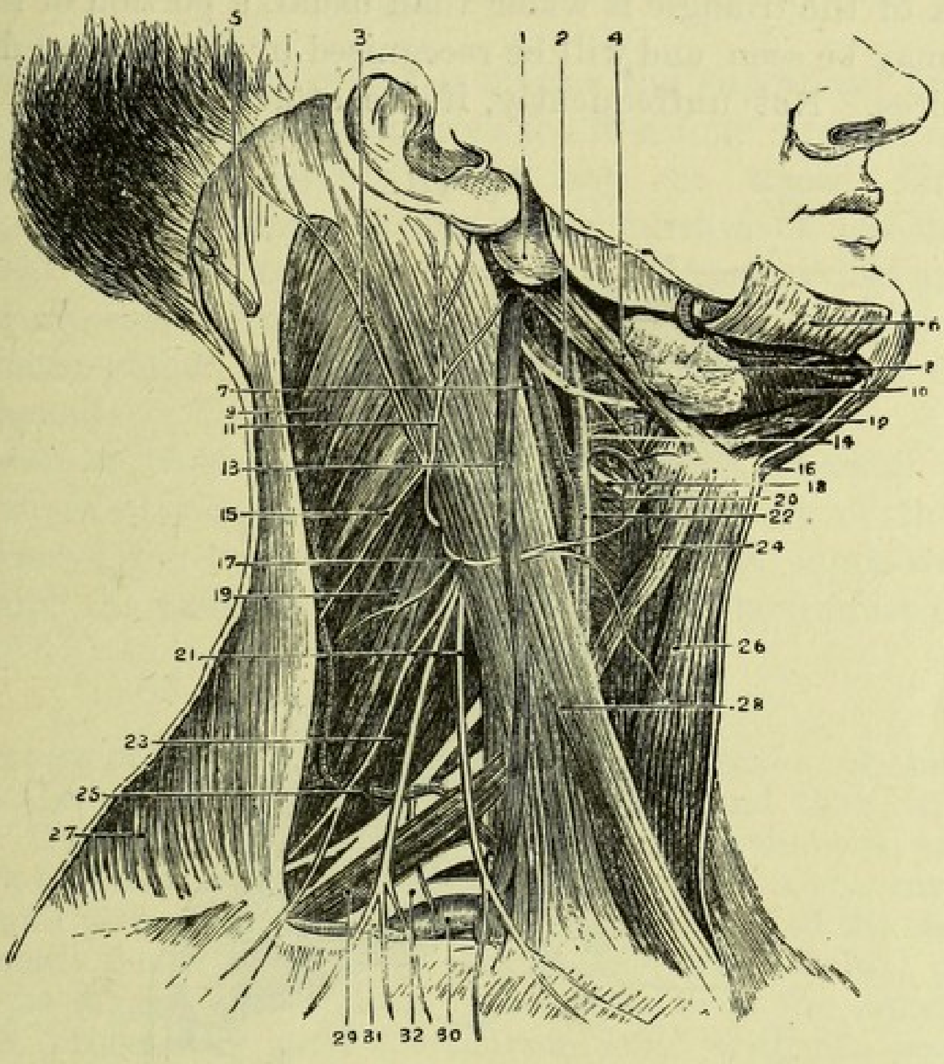


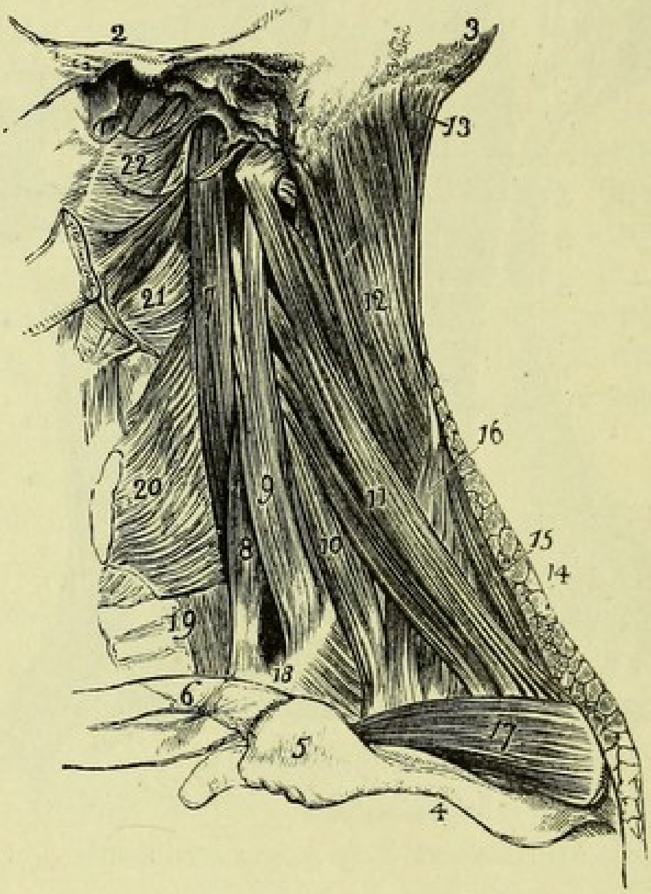
Fig. 170.—Superficial dissection of the triangles of the neck (drawn by J. T. Gray).

(In order to see the relations of the posterior triangle properly, the figure should be placed in the recumbent position, since it is impossible to see the subclavian artery as represented when the body is upright.)

1. Parotid gland.
2. Hypoglossal nerve (9th).
3. Small occipital nerve.
4. Posterior belly of digastric and stylo-hyoid.
5. Occipital artery and great occipital nerve.
6. Platysma (turned up).
7. Internal jugular vein.
8. Submaxillary gland.
9. Splenius capitis.
10. Mylo-hyoid.
11. Great auricular nerve.
12. Anterior belly of digastric.
13. External jugular vein.
14. External carotid artery.
15. Spinal-accessory nerve.
16. Hyoid bone.
17. Superficial cervical nerve.
18. Superior laryngeal nerve.
19. Levator anguli scapulæ.
20. Inferior constrictor of the pharynx.
21. Descending branches of the superficial cervical plexus.
22. Common carotid artery with descendens noni nerve.
23. Scalenus posticus and medius.
24. Anterior belly of omo-hyoid.
25. Transverse cervical artery.
26. Sterno-hyoid.
27. Trapezius.
28. Sterno-mastoid.
29. Posterior belly of omo-hyoid.
30. Subclavian artery.
31. Supra-scapular artery (transversalis humeri).
32. Brachial plexus partly covered by omo-hyoid.

overlain by the levator anguli scapulæ. In some subjects, where the apex of the triangle is wider than usual, a portion of the complexus may be seen, and will be recognised by the vertical direction of its fibres. Not unfrequently, if the attachment of the sterno-

Fig. 171.



mastoid to the clavicle is not well developed, both the anterior scalenus and the phrenic nerve lying on it are seen in the posterior triangle.

The triangle is subdivided into two portions by the posterior belly

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Fig. 171.—Lateral view of the muscles of the prevertebral region and side of the neck (from Wilson).

1. The mastoid process of the temporal bone.
2. The zygoma.
3. The occipital bone.
4. The spine of the scapula.
5. The acromion process.
6. The clavicle.
7. Longus colli muscle.
8. Scalenus anticus.
9. Scalenus medius.
10. Scalenus posticus.
11. Levator anguli scapulæ.
12. Splenius.
13. Complexus.
14. Cut edge of the trapezius.
15. Rhomboideus minor.
16. Serratus posticus superior.
17. Supra-spinatus.
18. The first rib.
19. Œsophagus and trachea.
20. Inferior constrictor of the pharynx.
21. Middle constrictor.
22. Superior constrictor.

of the omo-hyoid muscle, the height of which above the clavicle may vary, the contents of each subdivision being modified accordingly.

The *upper* or *occipital portion* contains the superficial branches of the cervical plexus derived from the first four cervical nerves; the spinal-accessory nerve (which may be traced into the trapezius, where it communicates with branches of the 3rd and 4th cervical nerves); muscular branches of the cervical plexus; the transverse cervical vein; and some of the *glandulæ concatenatæ* or lymphatic glands placed along the posterior border of the sterno-mastoid.

The *lower* or *clavicular portion* contains the brachial plexus and its supra-clavicular branches; the third part of the subclavian artery; the transverse cervical artery; the supra-scapular vessels; and the external jugular vein, all of which must now be dissected.

[The process of deep fascia binding down the tendon of the omo-hyoid is to be traced to its attachment below, and then carefully removed. The external jugular vein, and the transverse cervical and supra-scapular arteries and veins, are then to be carefully dissected and preserved; the latter will be found behind the clavicle, and the small nerve to the subclavius from the brachial plexus must also be sought as it passes downwards over the subclavian artery. A process of deep fascia connected with the scalenus anticus binds down the subclavian artery, and must be removed to expose it.]

The tendon of the **Omo-hyoid Muscle** (Fig. 170, 29) is bound down to the back of the clavicle and to the first rib by a process of the deep cervical fascia, so that either belly of the muscle may act on this fixed point. Upon the back of the tendon may be traced a branch of the descendens noni nerve, which supplies the posterior belly. The origin and insertion of the muscle are found in other dissections.

The **Transverse Cervical Artery** (Fig. 170, 25) is generally found at the level of the tendon of the omo-hyoid, and the vein a little above it, so that their relations to the subdivisions of the triangle are different.

The artery, a branch of the thyroid axis [subclavian], passes transversely under the sterno-mastoid and over the scalene muscles, crosses the posterior triangle, and divides under the border of the trapezius into the superficial cervical and the posterior scapular arteries. The *superficial cervical* goes to the trapezius, the anterior border of which it supplies; the *posterior scapular* runs under the levator anguli scapulæ muscle to the base of the scapula,

Fig. 172.

where it is seen in the dissection of the back. The posterior scapular artery often arises as a separate trunk from the second or third part of the subclavian artery, the superficial cervical then alone occupying the position of the transverse cervical. The transverse cervical *vein* lies above the level of the artery, and usually joins the external jugular.

The **Supra-scapular Artery** and **Vein** (Fig. 170, 31) lie close behind the clavicle. The artery is a branch of the thyroid axis, or sometimes arises from the third part of the subclavian. The *vein* opens into the external jugular, just before it joins the subclavian vein.

The **Subclavian Artery** (Fig. 170, 30) (3rd portion) extends from the outer border of the anterior scalenus, obliquely downwards and outwards beneath the clavicle, to the lower border of the first rib, where it becomes the axillary artery. It has *in front* the skin,

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Fig. 172.—Incisions for tying (*e*) the common carotid and (*b*) the subclavian artery (from Fergusson's 'Practical Surgery').

platysma, superficial nerves and deep fascia; the clavicle, subclavius muscle, and supra-scapular artery; and is crossed by the external jugular vein, joined by the supra-scapular and transverse cervical veins, which often form a plexus in this situation, and by the small nerve to the subclavius. *Behind* it are the lowest cord of the brachial plexus, the scalenus medius, and the first rib. *Above* it are the remaining cords of the brachial plexus; and *below* (at some distance) the subclavian vein. Ordinarily this portion gives off no branch, but should there be one it will probably be the posterior scapular artery.

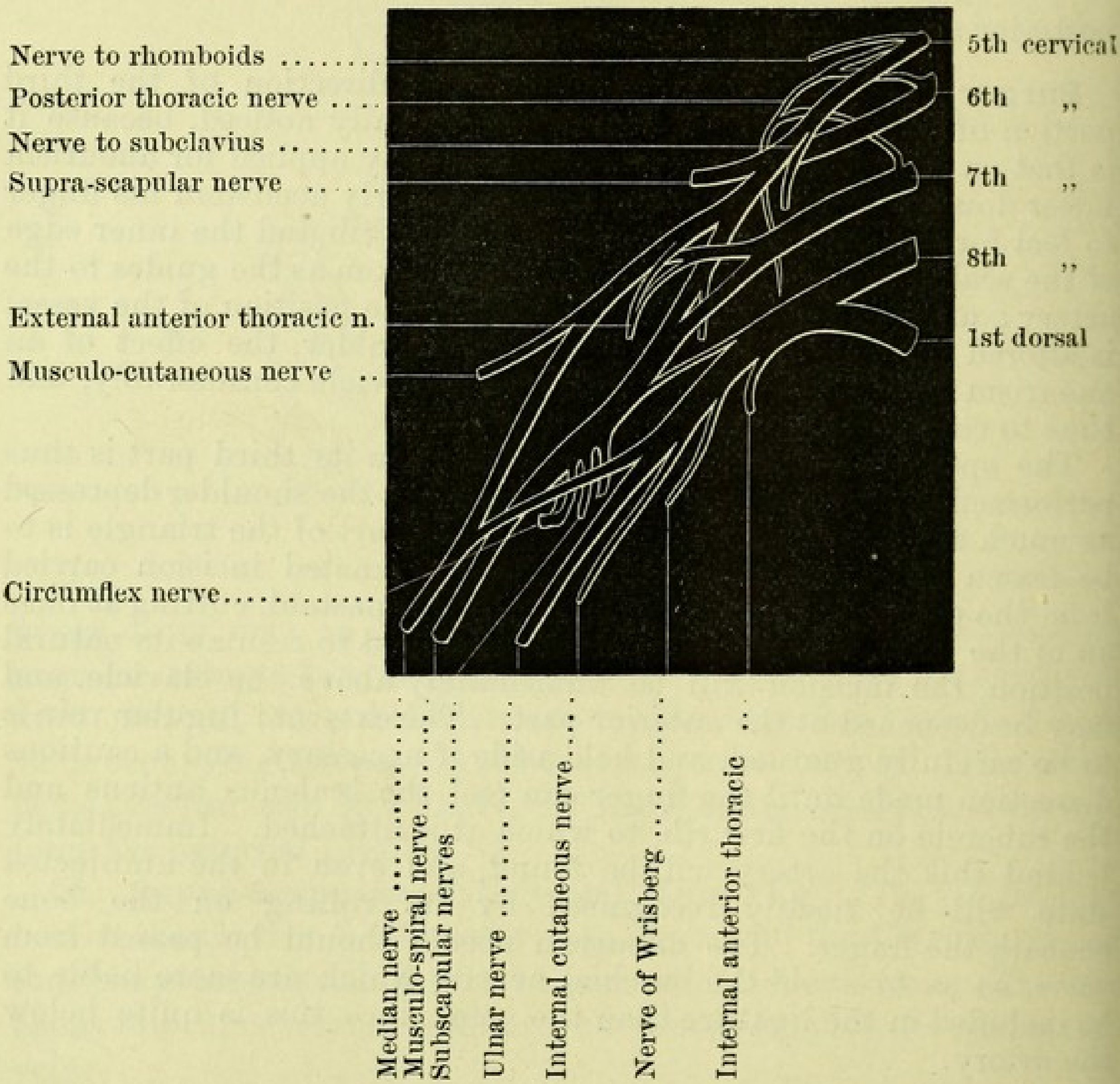
Surgery.—The position, relations and direction of the third portion of the subclavian should be especially noticed, because it is that on which a ligature is most frequently applied for aneurism lower down. The student should particularly accustom his finger to feel for the scalene tubercle on the first rib and the inner edge of the scalenus anticus muscle, which are taken as the guides to the artery; and should notice how materially the position of the vessel is altered by raising or depressing the shoulder, the effect of an aneurism in the axilla being to raise the clavicle considerably, and thus to complicate the operation.

The operation of tying the subclavian in its third part is thus performed. The head being thrown back and the shoulder depressed as much as possible, the skin of the lower part of the triangle is to be drawn down upon the clavicle, and a lunated incision carried from the edge of the trapezius to the sterno-mastoid, cutting at once on to the bone. The skin being then allowed to resume its natural position, the incision will be immediately above the clavicle, and may be deepened at the anterior part. The external jugular vein is to be carefully guarded, and held aside if necessary, and a cautious dissection made until the finger can feel the scalenus anticus and the tubercle on the first rib, to which it is attached. Immediately behind this the artery will be found, and even in the uninjected state will be readily recognised by its rolling on the bone beneath the finger. The aneurism needle should be passed from *above*, so as to avoid the brachial nerves, which are more liable to be included in the ligature than the vein, since this is quite below the artery.

[Supposing the dissection of the axilla to be sufficiently advanced, the clavicle should now be divided at the outer border of the sterno-mastoid, and again at the edge of the trapezius. The knife being then passed carefully beneath and close to the bone to detach the subclavius, the piece may be removed, but the parts will still be retained in position by the muscle. The supra-scapular artery and vein will now also be better seen, and can be thoroughly cleaned. The subclavius muscle is to be divided close to the trapezius, when the scapula will fall back, and the brachial plexus will be fully exposed and should be carefully cleaned. The upper digitation of the serratus magnus, which was mentioned as forming part of the floor of the triangle, can now be seen.]

The **Brachial Plexus** (Fig. 173) is formed by the 5th, 6th, 7th, and 8th cervical nerves and part of the 1st dorsal nerve, a small branch of communication being given by the lowest cord of the

Fig. 173.



cervical plexus (4th). The nerves appear at the outer border of the anterior scalenus as four cords, because the 8th cervical and 1st dorsal unite close to the vertebral foramina; they lie against the scalenus medius and posticus, and all, with the exception of the

Fig. 173.—Diagram of the Brachial Plexus (after Lucas).

lowest, above the level of the subclavian artery. The 5th and 6th next unite, and thus three cords are formed.

The three trunks, formed by the junction of the five nerves, subdivide and reunite to form three cords, as follows. Each divides into an anterior and a posterior branch; the anterior branches of the upper and middle trunks form the outer cord, the anterior branch of the lowest forms the inner cord, and the three posterior branches unite to form the posterior cord. Several varieties have been described in the arrangement of the cords; but this will be found to be the most common.

The *branches above the clavicle* (Fig. 4, p. 19)—

a. The *nerve to the subclavius* is a small branch lying on the front of the plexus, and derived from the trunk formed by the 5th and 6th nerves above the supra-scapular nerve.

b. The *nerve to the rhomboids* is from the 5th nerve, and piercing the scalenus medius passes beneath the levator anguli scapulæ, to which it gives a branch, and reaches the under surface of the rhomboids, in which it ends.

c. The *Supra-scapular nerve* is the largest branch above the clavicle, and appears at the outer side of the plexus, being given off from the upper cord of the plexus (5th and 6th). It disappears beneath the trapezius to reach the supra-scapular notch.

d. The *nerve to the serratus magnus* (posterior thoracic, external respiratory of Bell) lies behind the plexus against the serratus magnus muscle, and is derived from the 5th and 6th (and often from the 7th) nerves before they unite.

e. A *branch to the phrenic nerve*, of very variable size, is given by the 5th nerve at the upper part, or sometimes the branch appears to pass from the phrenic to the 5th. A root to the phrenic is sometimes supplied by the nerve to the subclavius.

f. Small *branches to the longus colli and scaleni* muscles arise from the nerves close to the foramina.

[If the time for turning the subject has not arrived when both the posterior triangles of the neck are dissected, the orbit should be at once proceeded with; but if not now dissected, this had better be postponed until after the dissection of the anterior triangle.]

The Orbit.

[The head being raised to a convenient height, the saw is to be applied to the edge of the skull close to the inner and outer angles of the orbit (the proper points being readily ascertained with the finger), and the cuts carried into the orbit through the frontal bone. With the chisel these incisions are to be prolonged backwards across the roof of the orbit till they meet at the sphenoidal fissure, when the triangle of bone can be readily tilted forward by a blow with the hammer. Any small remnant of bone can be removed so as to expose fully the cavity, but the margin of the optic foramen should be left untouched.]

The first thing seen on opening the orbit is the **Periosteum**, which is detached from the triangle of bone, and will be seen to be continuous with the dura mater of the skull through the sphenoidal fissure and the optic foramen. At the margin of the orbit the periosteum splits into two layers : one, which is continuous around the margin with the external periosteum of the skull, and the other, which is continuous with the palpebral ligament of each eyelid.

[The periosteum being divided in the centre and carefully turned aside, and some soft fat removed, three nerves and two arteries are brought into view—the *frontal nerve* [5th] with the *supra-orbital artery* in the centre, the *lacrymal nerve* and *artery* on the outer side, and the little *fourth nerve* on the inner side ; the lacrymal gland is also seen at the upper and outer part.]

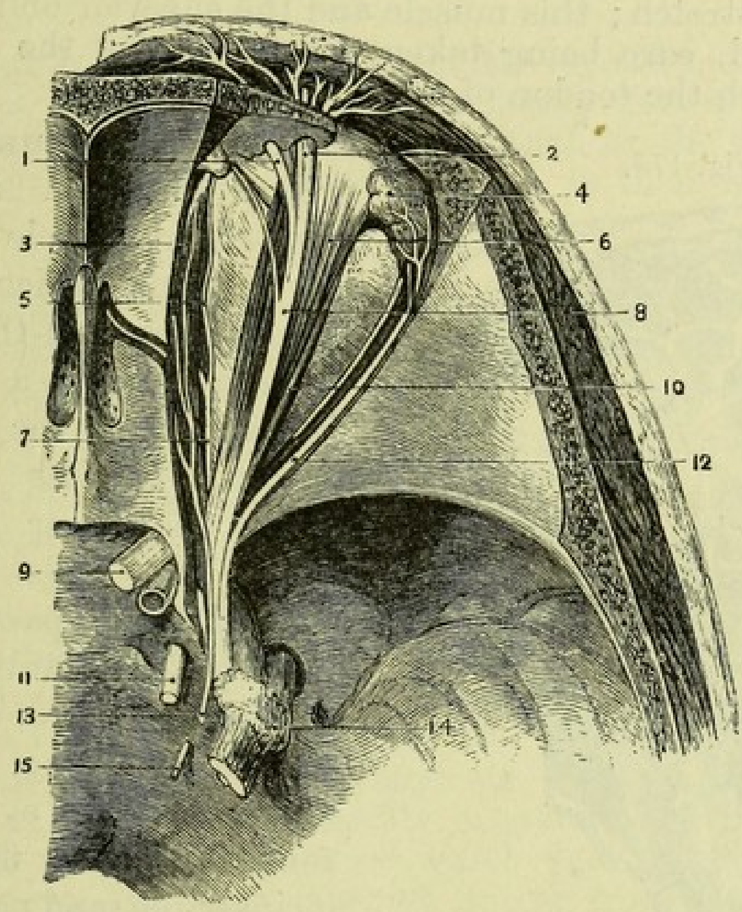
The **Fourth Nerve** (Fig. 174, 13) (*trochlearis* or *patheticus*) has already been traced through the cavernous sinus to the sphenoidal fissure, where it occupies the highest position, and is now seen passing on the inner side of the orbit to enter the superior oblique muscle close to the edge of its *orbital* surface ; this arrangement differing from that of the other muscles of the orbit, which are supplied on their *ocular* surfaces.

The **Frontal Nerve** (Fig. 174, 8) [5th], the largest nerve entering through the sphenoidal fissure, lies in the centre of the orbit and divides at its anterior part into the *supra-orbital* and *supra-trochlear* branches ; these turn round the margin of the orbit to the forehead, the supra-orbital through the supra-orbital notch, and the supra-trochlear close to the inner angle of the orbit. Frequently the supra-trochlear nerve, the more internal of the two, is double.

The **Lacrymal Nerve** (Fig. 174, 12) [5th] lies on the outer side of the orbit and passes to the lacrymal gland, which it supplies. It sends a twig to join the temporo-malar nerve, and finally perforates the palpebral ligament, and is distributed in the upper eyelid.

The **Supra-Orbital Artery** (Fig. 175, 8) is a branch of the ophthalmic artery, and accompanies the supra-orbital nerve to the forehead.

Fig. 174.



The **Lacrymal Artery** (Fig. 175, 12) is a smaller branch also from the ophthalmic, and supplies the lacrymal gland. It is joined by twigs from the middle meningeal, and sends some small branches to the eyelids, and others through the temporal bone to the temporal fossa.

The **Lacrymal Gland** (Fig. 175, 4) is about the size and shape of a small almond, of a reddish-brown colour, situated in the anterior and outer part of the orbit. It is convex on its superior aspect, to fit against the orbital plate of the frontal bone; concave beneath, where it is placed over the eye-ball. It secretes the tears,

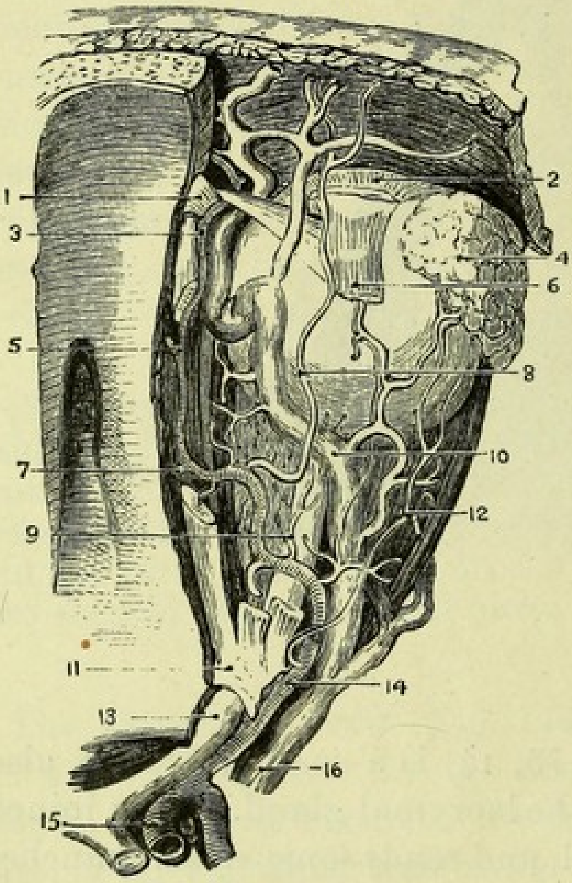
Fig. 174.—Superficial dissection of the nerves of the orbit (from Hirschfeld and Leveillé).

1. Supra-trochlear nerve.
2. Supra-orbital nerve.
3. Obliquus superior.
4. Lacrymal gland.
5. Infra-trochlear nerve.
6. Levator palpebræ superioris.
7. Nasal nerve (5th).
8. Frontal nerve (5th).
9. Second nerve.
10. Rectus superior.
11. Third nerve.
12. Lacrymal nerve.
13. Fourth nerve.
14. Gasserian ganglion of fifth.
15. Sixth nerve.

which its ducts, seven or eight in number, carry to the surface of the conjunctiva beneath the upper eyelid.

[The frontal nerve is to be divided, and a hook inserted into the upper eyelid so as to put the levator palpebræ in the centre of the orbit on the stretch; this muscle and the superior oblique are then to be cleaned, care being taken not to destroy the little pulley through which the tendon of the latter works.]

Fig. 175.



The **Obliquus Superior** (Fig. 174, 3) is the most superficial muscle of the orbit at its *origin*, which is from the upper margin of the optic foramen, above and a little to the inner side of the levator palpebræ. It lies superficially along the inner side of the orbit, and ends in a round tendon which, passing through the *trochlea* or pulley-like ring of fibrous tissue attached to the frontal bone, turns down abruptly to the eye-ball. The tendon becomes flattened near its insertion, and passes beneath the superior rectus to be *inserted* on the outer side of the eye-ball, between the superior and the external rectus. With a little dissection a delicate synovial membrane can be seen, lubricating the tendon where it passes through the *trochlea*. The superior oblique is *supplied* by the 4th nerve on its orbital aspect.

The **Levator Palpebræ Superioris** (Fig. 174, 6) *arises* from the

Fig. 175.—Arteries and veins of the orbit (from Hirschfeld and Leveillé).

1. Pulley of superior oblique tendon.
2. Levator palpebræ (cut).
3. Trunk of ophthalmic artery from which the frontal, nasal, and palpebral branches are derived.
4. Lacrymal gland.
5. Anterior ethmoidal artery.
6. Rectus superior (cut).
7. Posterior ethmoidal artery.
8. Supra-orbital artery.
9. Ciliary arteries.
10. Ophthalmic vein.
11. Origins of obliquus superior, levator palpebræ, and superior rectus.
12. Lacrymal artery.
13. Optic nerve.
14. Ophthalmic artery.
15. Carotid artery.
16. Cavernous sinus.

upper margin of the optic foramen, below the superior oblique muscle and partly overlapped by it; it is narrow at its origin, but expands in front to be *inserted* into the anterior surface of the tarsal cartilage of the upper eyelid. It is *supplied* by the 3rd nerve.

[The hook is to be removed from the eyelid and fixed into the conjunctiva, which is to be drawn gently forwards; the levator palpebræ is to be cut, and the little branch of the 3rd nerve traced to it, and the superior rectus, which is then seen, should be cleaned.]

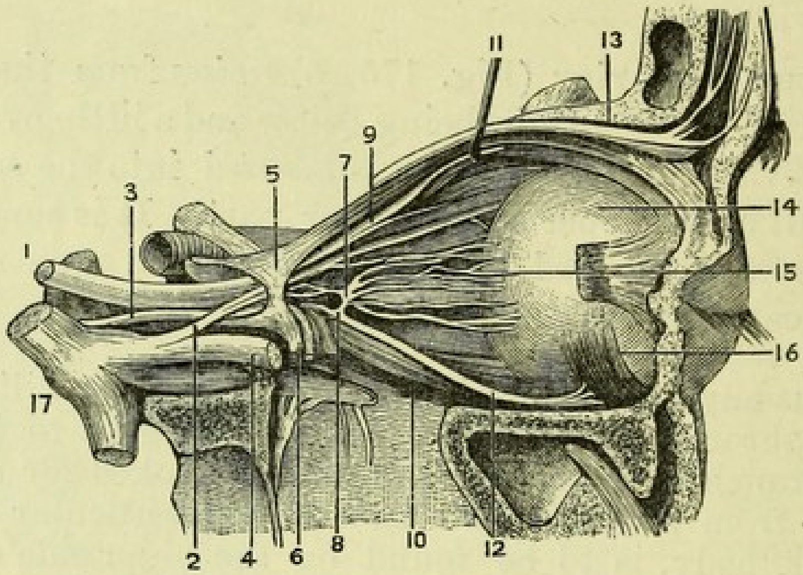
The **Rectus Superior** (Fig. 175, 6) *arises* from the margin of the optic foramen, the origin being below and a little overlapped by that of the levator palpebræ; and is *inserted* into the sclerotic coat of the eyeball at its upper and anterior part. It is *supplied* by the upper division of the 3rd nerve, which can be seen entering its under-surface when the muscle is divided.

[The rectus having been divided, a quantity of fat will be brought into view, through which the optic nerve passes to the eyeball. The nasal branch of the 5th is at once to be looked for crossing the optic nerve from without inwards, and the lenticular ganglion, a minute pink body, is to be found on the outer side of the optic nerve. This will be most readily accomplished by tracing back some of the small *ciliary* nerves which pass to the eyeball round the optic nerve, and some of which spring from the ganglion. Its two roots, one from the nasal and one from the deep part of the 3rd nerve, should also be sought. All branches of the ophthalmic artery should be preserved.]

The **Nasal Nerve** (Figs. 174, 7, and 176, 2), [5th] enters the orbit between the heads of the external rectus, and then crosses the optic nerve from without inwards to pass through the anterior ethmoidal foramen. It thus re-enters the cranium, and next passes into the nose by a slit in front of the cribriform plate of the ethmoid bone, to appear ultimately on the face between the nasal bone and the lateral nasal cartilage. It gives off, 1, the *long root* to the lenticular ganglion on the outer side of the optic nerve; 2, one or two *long ciliary nerves*, which run along the optic nerve to the eyeball and perforate the sclerotic after joining with the short ciliary branches; 3, the *infra-trochlear nerve*, which, arising just before the nerve enters the ethmoidal hole, passes forwards to the eyelids close to the inner angle of the orbit.

The **Lenticular Ganglion** (Fig. 177) (*ciliary* or *ophthalmic*) is a minute pink body placed on the outer side of the optic nerve near the back of the orbit, which has (like all the cranial ganglia) three roots, sensory, motor, and sympathetic. The *sensory* or long root (2) is derived from the nasal branch of the 5th, and enters the posterior superior angle of the ganglion. The *motor* or short root (4) is derived from the branch of the 3rd nerve supplying the inferior oblique, which can be seen passing to the bottom of the orbit; this

Fig. 176.



root enters the ganglion at its posterior inferior angle. The *sympathetic* root (6) is from the cavernous plexus, which is derived from the plexus on the carotid artery, and enters the orbit through the sphenoidal fissure; it joins the ganglion between the other two roots, and can rarely be seen.

The *short ciliary branches* of the ganglion arise from its upper and lower angles in front, and are eight or ten in number. They run

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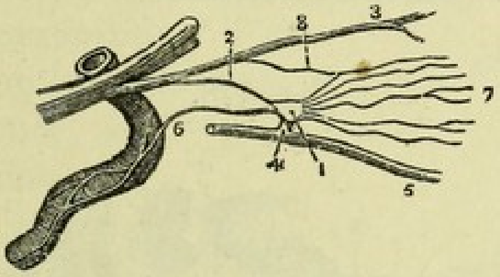
Fig. 176.—Nerves of the orbit, seen from the outer side (from Hirschfeld and Leveillé).

1. Third nerve.
2. Nasal nerve, giving off a long ciliary nerve in the orbit, and the long root of the lenticular ganglion before entering the orbit.
3. Sixth nerve.
4. Trunk of ophthalmic nerve (5th).
5. Ligament of Zinn.
6. Origin of external rectus.
7. Lenticular ganglion (the long root is joining it behind).
8. Short root of lenticular ganglion.
9. Branch of third nerve to levator palpebræ superioris and superior rectus.
10. Inferior rectus.
11. Hook placed on superior rectus.
12. Branch of third nerve to obliquus inferior.
13. Frontal nerve (cut).
14. Eyeball.
15. Short ciliary nerve.
16. Inferior oblique.
17. Gasserian ganglion.

along the optic nerve to the eyeball, which they pierce to supply the iris, the ciliary muscle, and the cornea.

Fig. 177.



The **Ophthalmic Artery** (Fig. 178, 2) arises from the internal carotid close to the anterior clinoid process, and enters the orbit through the optic foramen with the optic nerve, but to its outer side. It gives off the following branches :—

a. The *Lacrymal artery* (5) accompanies the lacrymal nerve along the outer side of the orbit to the lacrymal gland, which it supplies. It gives twigs to the eyelids, and others through small foramina to reach the temporal fossa. It is joined by a twig from the middle meningeal.

b. The *Supra-orbital artery* (11) ascends to join the frontal nerve, and afterwards accompanies the supra-orbital nerve through the supra-orbital notch to the forehead.

c. *Muscular branches* (4) are given to all the muscles of the orbit, entering them on their ocular surfaces.

d. The *Ciliary branches* (6) are numerous small arteries, which run by the side of the optic nerve to pierce the sclerotic, and have been divided into *anterior* and *posterior*, the former piercing the sclerotic near the entrance of the optic nerve, the latter close to the margin of the cornea. One of them enters the optic nerve to run in it to the retina, and is called the *arteria centralis retinæ* (3).

e. The *Ethmoidal arteries*, anterior (9) and posterior (7), pass through the ethmoidal foramina in the inner wall of the orbit, the anterior accompanying the nasal nerve. They supply meningea twigs, and branches to the nose, the anterior ending on the face.

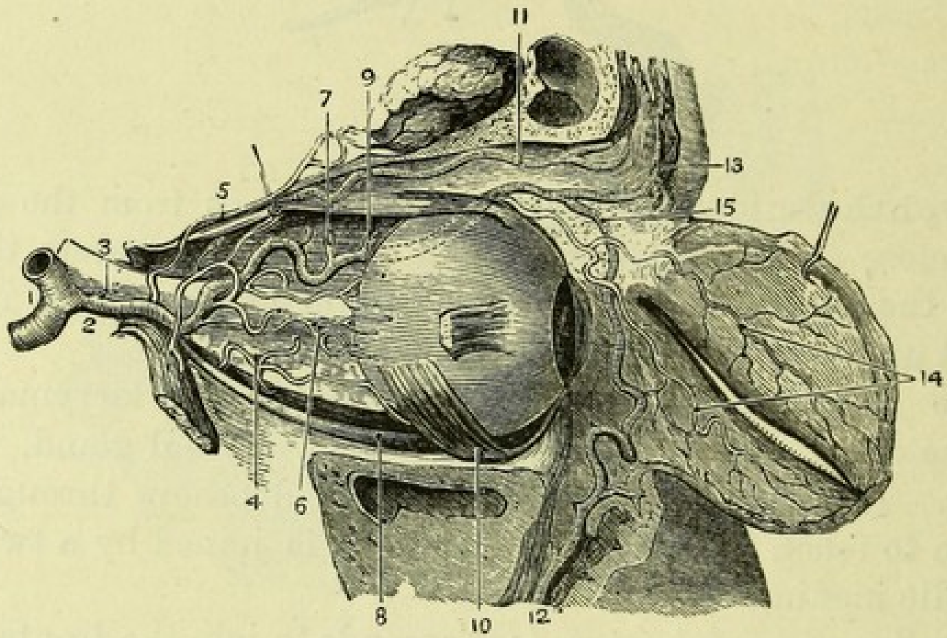
Fig. 177.—Diagram of the lenticular ganglion (from Hirschfeld and Leveillé).

1. Lenticular ganglion.
2. Long root from—
3. Nasal branch of fifth.
4. Short root from—
5. Inferior division of 3rd.
6. Sympathetic root from cavernous plexus.
7. Short ciliary nerves.
8. Long ciliary nerves.

f. The *Palpebral arteries*, two in number (14), leave the orbit at the inner side, to be distributed to the upper and lower eyelids.

g. The *Frontal artery* (13), one of the terminal branches, turns round the margin of the orbit at its inner angle to accompany the supra-trochlear nerve on the forehead.

Fig. 178.



h. The *Nasal artery* (15), the other terminal branch, leaves the orbit at the inner side above the tendo oculi, and anastomoses on the side of the nose with the angular branch of the facial artery (12).

The **Ophthalmic Vein** (Fig. 175, 10) has branches corresponding to those of the artery, which unite to form a single trunk passing between the heads of the external rectus to the cavernous sinus.

The **Optic Nerve** (Fig. 175, 13) (2nd) enters by the optic foramen, and passes through the centre of the orbit to the eyeball, where it ends in the retina. It pierces the back of the sclerotic about $\frac{1}{10}$th of an inch to the inner side of the axis of the eyeball.

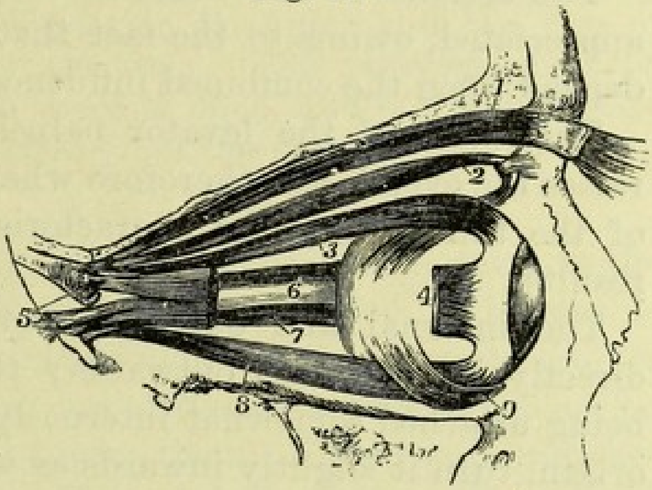
Fig. 178.—Arteries of the orbit from the outer side (from Hirschfeld and Leveillé).

1. Internal carotid.
2. Ophthalmic artery.
3. Arteria centralis retinæ.
4. Muscular branches.
5. Lacrymal artery.
6. Ciliary artery.
7. Posterior ethmoidal artery.
8. Rectus inferior.
9. Anterior ethmoidal artery.
10. Obliquus inferior.
11. Supra-orbital artery.
12. Facial artery.
13. Frontal artery.
14. Palpebral arteries.
15. Nasal artery.

[The optic nerve is to be divided, and the globe turned forwards to bring into view the muscles beneath.]

The remaining **Recti Muscles** (Fig. 179) are seen below, and to the inner and outer sides of, the optic nerve, and are named accordingly, *inferior*, *internus*, and *externus*. They *arise* by a common tendinous origin (ligament of Zinn), which is attached round the upper, inner, and lower sides of the optic foramen, and then stretches across the inner part of the sphenoidal fissure to be fixed to a prominent bony tubercle on its lower margin. The external rectus is fixed partly to this tubercle, blending with the inferior rectus, partly by another head from the upper margin of the sphenoidal fissure, which blends with the superior rectus. Between these two heads is a tendinous arch, beneath which pass the 3rd nerve, the nasal branch of the 5th nerve, the 6th nerve, and the ophthalmic vein.

Fig. 179.



The recti muscles are to be traced forward to their *insertion* into the sclerotic coat, a quarter of an inch behind the cornea.

The **Sixth Nerve** (Fig. 176, 8) (abducens) is seen on the inner surface of the rectus externus, which it supplies.

The **Third Nerve** (Fig. 176, 13) (motor oculi) enters the orbit in two parts, one above and the other below the nasal nerve.

The upper division has been traced to the levator palpebræ and superior rectus muscles; the lower division (14) is now seen to give small branches to the internal and inferior recti, and the long branch which runs on the inferior rectus to the inferior oblique muscle, from which the short root to the lenticular ganglion is derived.

[To expose the obliquus inferior, it will be necessary to draw the eyeball to the upper and outer part of the orbit, and to remove the conjunctiva at the lower and inner angle.]

Fig. 179.—Muscles of the eyeball. The view is taken from the outer side of the right orbit (from Wilson).

1. Levator palpebræ superioris.
2. Obliquus superior.
3. Rectus superior.
4. Insertion of rectus externus.
5. Double origin of rectus externus.
6. Optic nerve.
7. Rectus internus.
8. Rectus inferior.
9. Obliquus inferioı

The **Obliquus Inferior** (Fig. 179, 9) muscle lies transversely in the orbit beneath the rectus inferior. It *arises* from the superior maxilla outside the lacrymal groove, and passing below the inferior rectus, but between the external rectus and globe, is *inserted* into the sclerotic above the level of the rectus externus and close to the insertion of the obliquus superior.

The actions of the muscles of the orbit are not very readily appreciated, owing to the fact that the movements of the eyeball depend upon the combined influence of several of them.

The action of the levator palpebræ is implied by its name; it raises the eyelid, and therefore when paralysed from some affection of the third nerve, the characteristic dropping of the lid, ptosis, results.

The internal and external recti turn the eyeball respectively directly inwards and outwards; the superior and inferior recti, being attached somewhat internally to the axis of the eye at their origin, turn it slightly inwards as well as upwards and downwards respectively. The superior and inferior oblique rotate the eyeball downwards and outwards, and upwards and outwards, respectively, and thus the superior serves to correct the tendency of the superior In
rectus to rotate the eyeball in, and the inferior the same tendency
Supr of the inferior rectus. Oblique movements of the eyeball are produced by the combined action of two or more muscles. Internal and external strabismus are produced by the direct action of the internal and external recti respectively.

If all the contents of the orbit are removed, the orbital branch of the superior maxillary nerve (temporo-malar) may be seen passing through the spheno-maxillary fissure, and dividing into two branches—the *subcutaneous malæ*, which pierces the malar bone, and the *temporal branch*, which pierces the outer wall of the orbit to get between the two layers of the temporal fascia (p. 318).

The Side of the Neck.

[The head is to be drawn as far back as possible by means of a hook placed in the chin, and the side to be dissected (by preference the right side first) should be fully exposed by means of blocks placed beneath. Before beginning the dissection, the student should pass his finger along the median line of the neck, and recognise the following points. The lower jaw, and from an inch and a half to two inches below it the slight projection of the hyoid bone; next a hollow, corresponding to the thyro-hyoid membrane, and below it the projecting angle of the thyroid cartilage (pomum Adami), which is very small in women. About an inch below the pomum Adami is a dip corresponding to the crico-thyroid space, and this is especially to be noticed, as it is the space in which laryngotomy is performed. Below this will be felt the hard ring of the cricoid cartilage, and in a thin subject the rings of the trachea may be recognised lower down; sometimes also the isthmus of the thyroid body may be felt crossing the trachea at a variable point.

An incision is to be made from the chin to the sternum, and another outwards along the clavicle as far as the incision previously made in the dissection of the posterior triangle, and the flap of skin is to be dissected up over the face. The platysma may be cleaned in the upper part of the space at once, and it will facilitate the operation if the part detached from the clavicle is held down with hooks.]

The **Platysma Myoides** (Fig. 170, 6) is now seen to reach to the side of the lower jaw, where it is partially inserted. The muscle decussates in the median line with its fellow of the opposite side for a short distance close to the jaw, but at the lower part of the neck a large triangular interval exists between them. A few small branches of the superficial cervical nerve will be found piercing the muscle, and an anterior jugular vein may sometimes be seen through its fibres.

[The platysma is to be carefully reflected upwards like the skin, the superficial nerves are to be dissected out, and the sterno-mastoid cleaned by removing that part of the deep cervical fascia which forms the superficial layer of its sheath.]

The **Superficial Cervical Nerve** (Fig. 170, 17), which is of small size, is seen to divide into two or three branches supplying the skin over the anterior triangle, the upper one communicating with branches of the facial nerve below the jaw.

The **Sterno-Cleido-Mastoid Muscle** (Fig. 170, 28) *arises* by a rounded tendon from the anterior surface of the manubrium sterni, and by a broad tendinous origin from the inner third of the upper part of the clavicle. This latter is of a very variable extent, and between the two heads of origin is a cellular interval, which may extend for some distance up the neck. The muscle is *inserted* into the anterior border and outer surface of the mastoid process of the temporal bone, and into the outer half of the superior curved line of the occipital bone. The *action* of each sterno-mastoid is to twist the head and flex it, so as to throw the chin over the opposite shoulder; if both muscles act together, they draw the head and upper part of the spine forwards, as in rising from a pillow. The sterno-mastoid is *supplied* by the spinal-accessory nerve and by deep branches of the cervical plexus. Along the posterior border of and beneath the sterno-mastoid will be seen several small lymphatic glands (*glandulæ concatenatæ*).

The **Deep Cervical Fascia,** which has been described as extending from the spinous processes of the cervical vertebræ across the posterior triangle, and then as forming a sheath for the sterno-mastoid (p. 334), is now seen to cover in the parts included in the anterior triangle, and to extend to the median line; the anterior border of the sterno-mastoid should be dissected up a little, and turned back to see the continuation of the fascia beneath it. The fascia encases all the muscles of the front of the neck, and it forms the sheath of the carotid vessels, which is now to be seen beneath the sterno-mastoid. The most superficial layer, viz., that between the sterno-mastoid muscles, is fixed to the upper border of the sternum, just above which bone it splits into two parts, between which are included some fat and the two anterior jugular veins, as well as a transverse branch uniting them together. The layer of fascia behind the sterno-hyoid and sterno-thyroid will afterwards be seen to supply sheaths to the thyroid body, and to be continued down to the back of the sternum, where it is said to be continuous with the pericardium.

[Opportunity should be taken, before the tissues are in any way disturbed, to notice the parts involved in the operation of tying the common carotid artery. The vessel may be felt and indistinctly seen enclosed in a sheath of fascia, and the point where the ligature would be applied is at the angle formed by the sterno-mastoid and omo-hyoid muscles, the latter of which can now be seen through the fascia. The anterior triangle is then to be dissected, after the enumeration of its contents in the following four paragraphs has been carefully read.]

The **Anterior Triangle** (Fig. 170) of the neck is bounded *in front* by the median line of the neck; and *behind* by the sterno-mastoid muscle. Its *base* is above, and is formed by the lower jaw and a line from the angle of the jaw to the mastoid process; the *apex* is below, at the top of the sternum. It is thus a very small space until the sterno-mastoid has been relaxed by dissection.

The skin and superficial fascia, the platysma, the deep fascia, and the superficial nerves have been turned aside to expose the contents of the triangle, which are as follows. The digastric and stylo-hyoid muscles are seen to cut off an upper portion, called the *submaxillary triangle*, in which is lodged the submaxillary gland, resting upon the mylo-hyoid muscle between the jaw and the hyoid bone.

Below the hyoid bone will be seen the sterno-hyoid, the sterno-thyroid, and the thyro-hyoid muscles; and the anterior belly of the omo-hyoid, which runs obliquely across the triangle.

The common carotid artery comes into view between the sterno-mastoid and omo-hyoid muscles, with the decendens noni nerve superficial to it, and the internal jugular vein to its outer side; the pneumo-gastric nerve being concealed behind the vessels, and the sympathetic nerve lying still deeper beneath their sheath. The external and internal carotids are seen at, or near, the upper border of the thyroid cartilage, and are crossed superficially by the hypoglossal nerve, a small twig of which to the thyro-hyoid muscle should be preserved; both cross the superior laryngeal nerve, which is seen to the inner side of the carotid vessels, passing to the larynx in the interval between the hyoid bone and the thyroid cartilage, between the middle and inferior constrictors of the pharynx. Lower down, a branch of this nerve, the external laryngeal should be sought for.

The superior thyroid, lingual, and facial arteries are seen in part in the anterior portion of the space; and the occipital artery is seen turning backwards below the digastric, and in relation with the hypoglossal nerve.

[It will be advisable to examine the ligaments of the inner end of the clavicle, before detaching it in order to reflect the sterno-mastoid muscle. The sternal origin of the sterno-mastoid must be cut, and any remains of the pectoralis major must be removed, in order that the ligaments between the clavicle, sternum, and first rib, and also between the two clavicles, may be cleaned.]

Sterno-Clavicular Articulation (Fig. 180).

The *Inter-clavicular ligament* (2) is a strong band passing across the inter-clavicular notch of the

Fig. 180.

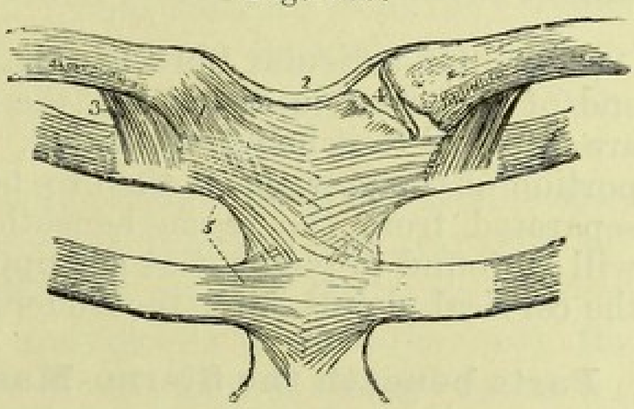


Fig. 180.—Ligaments of the sterno-clavicular and costo-sternal articulations (from Wilson).

1. Anterior sterno-clavicular ligament.
2. Inter-clavicular ligament.
3. Costo-clavicular or rhomboid ligament; seen on both sides.
4. Inter-articular fibro-cartilage, brought into view by the removal of the anterior and posterior ligaments.
5. Anterior costo-sternal ligaments of the first and second ribs.

sternum, and is attached to that bone as well as to the inner extremities of the two clavicles.

The *Sterno-clavicular ligament* (1) may be considered to form a *capsule* to the joint, or may be divided into *anterior* and *posterior* ligaments. The fibres pass obliquely from the inner extremity of the clavicle to the margin of the articular surface of the sternum.

The *Costo-clavicular* or *Rhomboid ligament* (3) is a strong band of fibres of a rhomboidal shape, attached to the upper surface of the cartilage of the first rib, and to the rough impression on the under surface of the inner end of the clavicle, close to the articulation.

[It is supposed that the clavicle has been cut close to the attachment of the sterno-mastoid in the dissection of the posterior triangle of the neck, but if this has not been the case it should now be divided. The inner end of the clavicle being then drawn up, the costo-clavicular ligament is to be divided, and the knife passed into the sterno-clavicular articulation from below, and close to the clavicle. By this, one of the two synovial membranes will be opened, and the other can be exposed by cutting from above close to the sternum, thus leaving the inter-articular cartilage uninjured.]

The *Inter-articular fibro-cartilage* (4) is circular and flat, and is thinner in the centre than at the circumference, being occasionally perforated. It is attached to the clavicle above, and to the sternum and cartilage of the first rib below, and by its circumference to the ligaments of the articulation. A synovial membrane is placed on each side of it. The sterno-clavicular is an arthrodial joint admitting of extensive movements of the clavicle in all directions.

[The inter-articular fibro-cartilage is to be divided and the inner end of the clavicle dislocated, the fibres of the sterno-hyoid which are attached to it being separated. The sterno-mastoid (with the portion of the clavicle) is then to be turned back, being carefully separated from the fascia beneath. The spinal-accessory nerve will be found to pierce it at the upper part, and some branches of the cervical plexus enter the under-surface of the muscle.]

Parts beneath the Sterno-Mastoid Muscle.—By the removal of the sterno-mastoid the following structures will be brought into view, which must be subsequently studied in detail. Above is seen the posterior belly of the digastric and the stylo-hyoid; with the posterior auricular artery and parotid gland at the upper border, and the occipital artery at the lower border, of the digastric. Lower down and posteriorly are parts of the splenius capitis, levator anguli scapulæ, and scalenus medius, with the cervical nerves and lymphatic glands. In front, immediately below the digastric, the spinal-accessory nerve will be found, and the hypoglossal nerve arching forward over the carotid vessels. The common carotid, with the internal jugular vein external to it, and the pneumogastric nerve lying deeply between the two, will be found in a sheath of fascia above the border of the omo-hyoid, and the descendens noni nerve lies either upon or in the sheath, and forms one or more loops with the communicating branches from the cervical plexus. The bifurcation of the carotid will be seen about the level of the upper border of the thyroid cartilage, the internal carotid passing upwards by the side of the jugular vein, with the external carotid in front of it, the anterior branches of the latter reaching forward beyond the sterno-mastoid. Near the clavicle are the omo-hyoid, sterno-hyoid and sterno-thyroid muscles, and, deeper, the anterior scalenus with the phrenic nerve upon it. On the left side of the body, the small thoracic duct will be found arching across the phrenic nerve and anterior scalenus to open into the junction of the internal jugular and subclavian veins. A similar but smaller duct (right lymphatic) may be found on the right side.

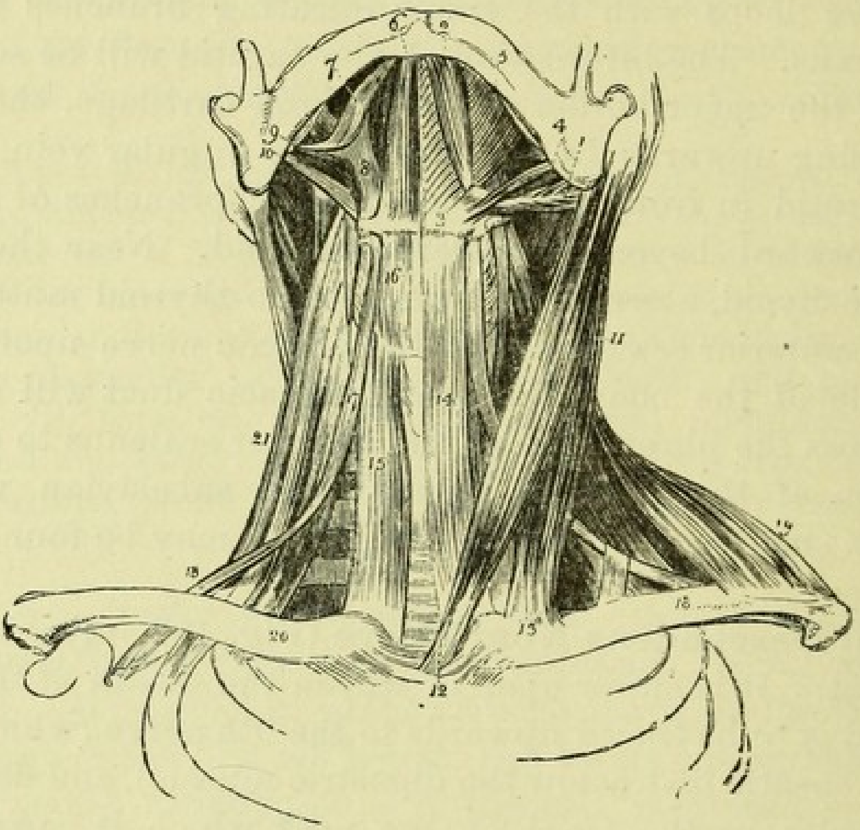
The small **Descendens Noni Nerve** (Fig. 182, 14) is now to be dissected out. It is either upon or within the sheath of the carotid vessels, and is to be traced upwards to the 9th nerve (which crosses the carotid sheath just below the digastric muscle), and downwards to the muscles in the front of the neck which it supplies, viz. sterno-hyoid, sterno-thyroid, and omo-hyoid. A branch, which may be double, will be found to come forward from the cervical plexus to join the nerve and form a loop beneath the sterno-mastoid. This is the *communicans noni* nerve (7), and comes from the 2nd and 3rd cervical nerves.

The **Anterior Jugular Vein** will be found of very variable size, depending upon that of the external jugular, and varying inversely with it. It begins beneath the chin by the union of some superficial and deep branches, and passes downwards near the middle line. At the lower part of the neck it usually receives a communicating branch from the fascial vein, sometimes of large size. It then pierces the deep fascia, and passes outwards beneath the sterno-mastoid to open into the subclavian or external jugular vein. Just above the sternum, the two anterior jugular veins are joined by a transverse branch, which, with a little fat, occupies an interval between two layers of the deep cervical fascia attached to the upper border of the sternum.

[The fascia is now to be removed from the superficial muscles of the triangle, but the carotid sheath should be left untouched for the present.]

The **Sterno-hyoid** (Fig. 181, 14) is the most superficial muscle; it is next to the median line, and only separated by a small cellular

Fig. 181.



interval from its fellow of the opposite side. It *arises* from the back of the first piece of the sternum, from the first costal cartilage,

Fig. 181.—Muscles of the anterior aspect of the neck; on the left side of the figure the superficial muscles are seen, on the right the deep (from Wilson).

1. Posterior belly of digastric.
2. Its anterior belly. Aponeurotic pulley, through which its tendon is seen passing, attached to the body of the os hyoides, 3.
4. Stylo-hyoid muscle.
5. Mylo-hyoid muscle.
6. Genio-hyoid muscle.
7. Stylo-glossus.
8. Hyo-glossus.
9. Styloid process.
10. Stylo-pharyngeus.
11. Sterno-cleido-mastoideus.
12. Its sternal origin.
13. Its clavicular origin.
14. Sterno-hyoid.
15. Sterno-thyroid of the right side.
16. Thyro-hyoid.
17. Anterior belly of the omo-hyoid.
18, 18. Its posterior belly; on the left side, the tendon of the muscle is seen to be bound down by a portion of the deep cervical fascia.
19. Clavicular portion of the trapezius.
20. Scalenus anticus, of the right side.
21. Scalenus posticus; the scalenus medius is seen between the two.

and from the back of the inner extremity of the clavicle; and is *inserted* into the body of the hyoid bone.

The **Sterno-thyroid** (Fig. 181, 15) is deeper and broader than the preceding muscle, by which it is partly covered. It *arises* from the back of the sternum immediately below the sterno-hyoid, and from the first and sometimes the second costal cartilage; and is *inserted* into the oblique line on the side of the thyroid cartilage. It very generally has a transverse tendinous intersection in its fibres.

The **Thyro-hyoid** (Fig. 181, 16) is a direct continuation of the last muscle. It *arises* from the oblique line of the thyroid cartilage, and is *inserted* into the body and part of the great cornu of the hyoid bone beneath the omo-hyoid. A small special branch of nerve from the 9th should be traced to this muscle.

The **Omo-hyoid** (Fig. 181, 17) can now be seen in its whole length, crossing the neck beneath the sterno-mastoid, and consisting of two bellies united by a small tendon, which has been seen to be held down to the clavicle and first rib by a process of the deep cervical fascia (*v.* p. 337). It *arises* from the upper margin of the scapula close to the notch, and from the transverse ligament which converts the supra-scapular notch into a hole. It is *inserted* into the body of the hyoid bone externally to the sterno-hyoid, and superficially to the thyro-hyoid muscle.

These four muscles are direct or indirect depressors of the hyoid bone. They are all *supplied* by the descendens noni nerve, except the thyro-hyoid, which receives a special branch from the 9th nerve.

The **Digastric** (Fig. 181, 1) muscle consists of two portions, placed respectively in front of and behind the submaxillary gland above the hyoid bone, to which the intermediate tendon is attached by fascia. It *arises* from the digastric fossa on the inner side of the mastoid process of the temporal bone; and is *inserted* into a rough surface at the lower border of the inferior maxilla, close to the median line. Its action is to open the mouth, or if the jaw is fixed, to raise the hyoid bone and larynx. Its posterior belly is *supplied* by a branch of the facial nerve, and the anterior by the mylo-hyoid branch of the inferior dental nerve (5th).

The **Stylo-hyoid** (Fig. 181, 4) is the muscle in immediate connection with the posterior belly of the digastric, the tendon of which passes through the fibres of the stylo-hyoid close to the hyoid bone. It *arises* from the outer or posterior part of the base of the styloid process of the temporal bone; and is *inserted* into the upper surface of the body of the hyoid bone at its junction with the great cornu. It is *supplied* by a branch of the facial nerve.

[In order to show the sheath of the carotid vessels completely, the sterno-hyoid and sterno-thyroid must be reflected. But before doing so the dissector of the left side should seek the termination of the thoracic duct. This will be found curving outwards and downwards on the anterior scalenus near the edge of the sterno-thyroid muscle to enter into the junction of the subclavian and internal jugular veins (*v.* p. 368).

After the muscles have been reflected the sheath is to be opened. The descendens noni nerve has already been traced upon it, and within will now be found the common carotid artery nearest the median line; external to that the pneumo-gastric (or vagus) nerve, and still more externally the internal jugular vein. Behind the sheath will be found the trunk of the sympathetic nerve lying parallel with the vessels, and crossing transversely behind them at the lower part will be seen the inferior thyroid artery. The sheath is to be carefully dissected away, and the branches of the artery and the vein followed out and cleaned, as far as the dissection will permit. The large 9th nerve will be found crossing the external and internal carotids in a curved direction immediately below the digastric muscle, and the superior laryngeal branch of the pneumogastric crosses behind them a little lower down.]

The **Common Carotid Artery** (Fig. 182, 14) has the same relations on both sides of the neck from the sterno-clavicular articulation upwards, though its origin is different on the two sides. On the right side it commences at the sterno-clavicular articulation, by the bifurcation of the innominate into common carotid and subclavian arteries, but on the left side it begins at the arch of the aorta. Its direction in the neck is upwards and a little outwards, and would be sufficiently indicated by a line from the inner end of the clavicle to the external auditory meatus. It ordinarily divides at the level of the upper border of the thyroid cartilage into external and internal carotids, which lie at first side by side, the external being nearer the median line.

It has *in front* of it the sternal origin and anterior border of the sterno-mastoid, and the lower parts of the sterno-hyoid and sterno-thyroid muscles; it is crossed, at the upper part, by the omo-hyoid muscle and superior thyroid vein, and quite superficially by the platysma; close upon the vessel throughout are the descendens noni nerve and the sheath, and crossing it at the lower part is the middle thyroid vein, and at a variable point the sterno-mastoid artery; the anterior jugular vein is separated from the vessel by the sterno-thyroid and sterno-hyoid. *Behind* the artery are the sheath, the sympathetic cord with its middle cervical ganglion, the inferior thyroid artery, and the longus colli and rectus capitis anticus major muscles. To its *outer* side are the pneumo-gastric nerve and

Fig. 182.

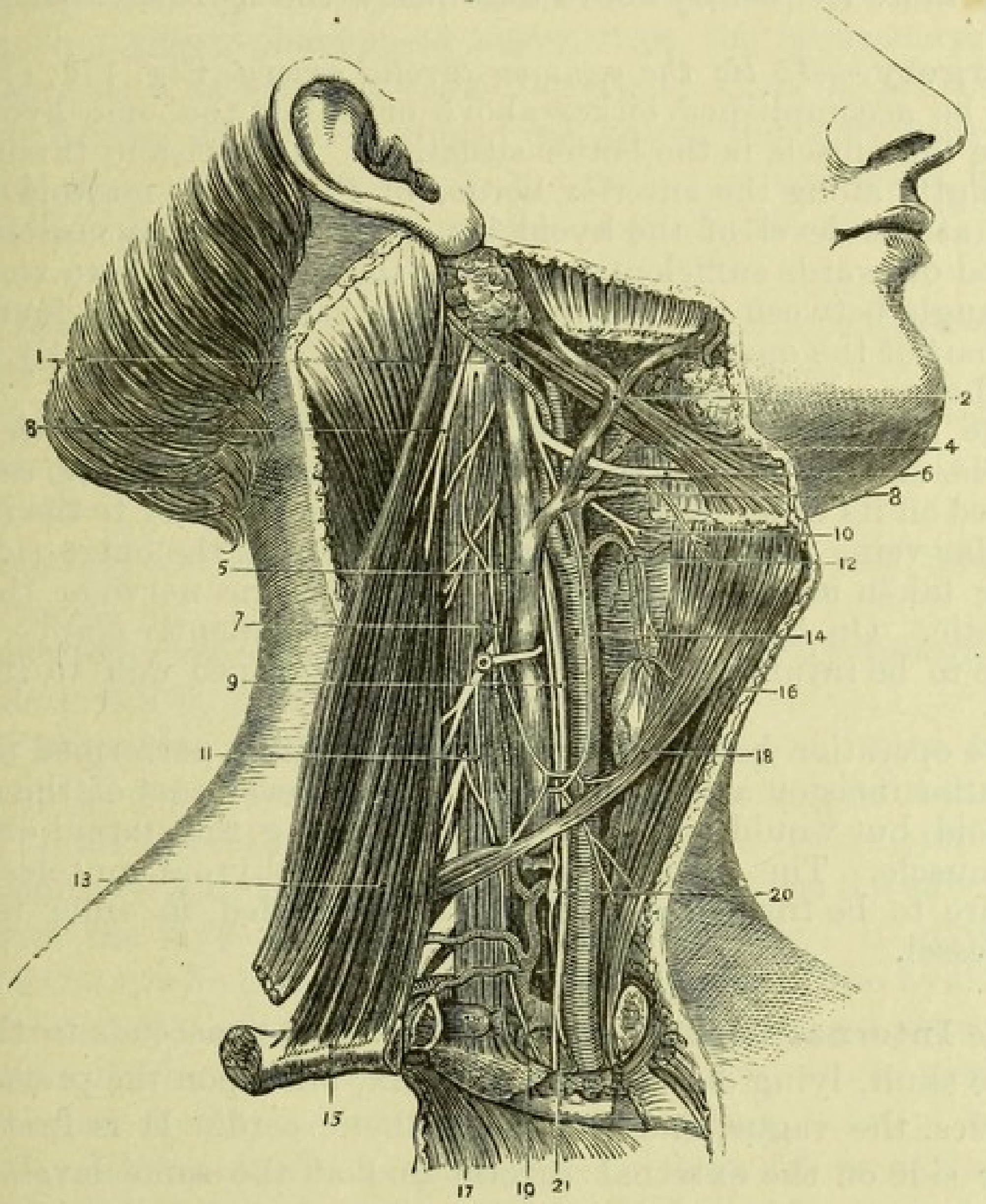


Fig. 182.—The side of the neck (drawn by J. T. Gray).

1. Occipital artery.
2. Facial vein.
3. Spinal-accessory nerve.
4. Facial artery.
5. Internal jugular vein.
6. Hypoglossal nerve.
7. Communicans noni nerve.
8. Lingual artery.
9. Pneumo-gastric nerve.
10. Superior laryngeal nerve.
11. Phrenic nerve.
12. Superior thyroid artery.
13. Sterno-cleido-mastoid (reflected).
14. Common carotid artery with descendens noni nerve.
15. Inner end of clavicle (reflected).
16. Sterno-hyoid.
17. Subclavian vein (cut).
18. Omo-hyoid.
19. Subclavian artery giving off the thyroid axis and the internal mammary artery.
20. Middle cervical ganglion of sympathetic.
21. Apex of pleura.

the internal jugular vein ; and to the *inner* side the trachea, larynx, and thyroid body, the pharynx, œsophagus, and recurrent laryngeal nerve.

The point of bifurcation of the common carotid may vary a little, but is more frequently above than below the thyroid cartilage.

Surgery.—*To tie the common carotid artery* (Fig. 172, *e*). This may be accomplished either above or below the omo-hyoid, but above the muscle is the better situation. An incision, three inches in length, along the anterior border of the sterno-mastoid, beginning at the level of the hyoid bone, will allow that muscle to be turned outwards sufficiently to bring the omo-hyoid into view. In the angle between the two muscles the carotid is to be found, and this part of the operation will be much facilitated by slightly reflecting the omo-hyoid towards the median line (Fig. 170).

The descendens noni nerve may be seen on the sheath of the vessels, and is to be avoided, and the sheath is to be carefully opened on its inner side, so as to avoid possible injury to the internal jugular vein. The needle is to be passed from the outer side, care being taken not to include the pneumo-gastric nerve or the sympathetic. On the dead body the vein is frequently empty, and is liable to be injured unless the sheath be opened well to its inner side.

The operation below the omo-hyoid might be performed through a similar incision along the border of the lower part of the sterno-mastoid, but would be facilitated by dividing the sternal origin of the muscle. The sterno-hyoid and sterno-thyroid muscles would require to be turned inwards, or even divided, in order to reach the vessel.

The **Internal Carotid Artery** (Fig. 185, 2) ascends to the base of the skull, lying close to the pharynx, and upon the prevertebral muscles, the vagus, and the sympathetic cord. It is first to the outer side of the external carotid and at the same level, and is crossed by the 9th nerve with the digastric and stylo-hyoid muscles, and the posterior auricular and occipital arteries; but it crosses the superior laryngeal branch of the pneumo-gastric. Its course is then deeper than the external carotid, from which it is separated by the styloid process, with the stylo-pharnygeus muscle and glosso-pharyngeal nerve, and the pharyngeal branch of the vagus, until it finally enters the carotid canal in the petrous bone.

The internal carotid will be more fully traced out in the deep dissection of the neck and pharynx.

The **External Carotid Artery** (Fig. 182) is derived from the common carotid opposite the upper border of the thyroid cartilage, and, lying at first to the inner side of and then superficial to the internal carotid, ascends beneath the sterno-mastoid to a point opposite the neck of the condyle of the lower jaw, where it gives off its terminal branches. It is crossed by two muscles and a nerve (the digastric and stylo-hyoid muscles and the 9th nerve), and is separated by the styloid process, with the stylo-pharyngeus muscle and glosso-pharyngeal nerve, from the internal carotid at the upper part, where that vessel lies deeper than it. It is crossed by the lingual and facial veins, and enters the substance of the parotid gland behind the angle of the jaw, where it lies beneath the facial nerve and the commencement of the external jugular vein.

Its *branches* may be divided into three sets, each containing three branches.

Anterior set: 1, Superior Thyroid; 2, Lingual; 3, Facial.

Posterior set: 1, Occipital; 2, Posterior Auricular; 3, Sterno-Mastoid.*

Ascending set: 1, Temporal; 2, Internal Maxillary; 3, Ascending Pharyngeal.

The anterior and posterior sets can now be partly dissected; the ascending will be given in other dissections.

The **Superior Thyroid Artery** (Fig. 182, 12) runs forward beneath the depressor muscles of the hyoid bone, and then downward to the thyroid body, which it supplies on its anterior aspect, anastomosing with the inferior thyroid artery from the subclavian, and with the thyroid vessels of the opposite side. It gives off a *hyoid branch*, which runs along the lower border of the hyoid bone, and anastomoses with the hyoid branch of the lingual artery upon the upper border; the *superior laryngeal branch*, which pierces the thyro-hyoid membrane with the corresponding nerve; and the *crico-thyroid branch*, which anastomoses with its fellow of the opposite side across the crico-thyroid membrane. Also, a *superficial descending branch*, which supplies the depressor muscles of the hyoid bone, and from which a *sterno-mastoid artery* is derived.

The crico-thyroid branch is considered to be one of the causes of danger in laryngotomy, but the fact of its being parallel to the knife when entered transversely, as it ordinarily is in the operation, renders its division unlikely, whilst its small size would cause such an accident to be of slight importance.

The **Lingual Artery** (Fig. 182, 8).—Only a very small portion

* The sterno-mastoid is perhaps more frequently derived from one of the branches of the external carotid (superior thyroid or occipital) than from the trunk itself, but is inserted here to complete the three branches of the posterior set.

of the lingual artery is now visible, running transversely upon the middle constrictor of the pharynx, immediately above the hyoid bone, and disappearing beneath the edge of the hyoglossus muscle, being usually crossed by the digastric and stylo-hyoid muscles and the hypoglossal nerve. The remainder of the vessel will be given in the dissection of the submaxillary region.

The **Facial Artery** (Fig. 182, 4) passes upwards and forwards beneath the digastric and stylo-hyoid muscles, and forms a remarkable sigmoid curve as it lies in a deep groove on the posterior part of the submaxillary gland before reaching the jaw, which it crosses immediately in front of the masseter muscle; it will be followed out in the dissection of the face. Its *inferior palatine* branch may be seen disappearing between the stylo-glossus and stylo-pharyngeus muscles, and the *tonsillar* branch between the stylo-glossus and pterygoideus internus, and these will be afterwards dissected; its *submaxillary* branches (two or three) enter the gland; and the *submental* branch, often of large size, runs forward over the mylohyoid muscle to the chin, where it supplies the surrounding tissues.

The facial frequently arises in common with the lingual artery, in which case the vessel passes beneath the hypoglossal nerve.

The **Occipital Artery** (Fig. 182, 1) is only seen in its first part. It runs backwards along the inferior border of the digastric, and may usually be recognised by the fact that the 9th nerve (hypoglossal) hooks round it. The occipital artery crosses the following important structures, the hypoglossal nerve, internal carotid artery, pneumo-gastric nerve, internal jugular vein, spinal-accessory nerve, and sympathetic trunk. It gives a small *posterior meningeal branch* to enter the jugular foramen.

The **Posterior Auricular Artery** runs along the upper border of the digastric, and can only be seen by turning that muscle a little down. Near the mastoid process it gives the *stylo-mastoid branch* to the stylo-mastoid foramen, and then supplies the pinna and the structures behind it, sending a branch beneath the posterior belly of the occipito-frontalis.

The **Sterno-Mastoid Artery** is a small but constant branch of uncertain origin, coming either from the external carotid artery near its commencement, or from the occipital artery, the hypoglossal nerve winding round it. It is of small size and enters the under surface of the sterno-mastoid muscle, crossing the carotid sheath.

Veins corresponding to the branches of the external carotid artery take nearly the same courses as those vessels, and terminate as follows: The internal maxillary and temporal veins unite in the parotid to form the temporo-maxillary vein, which afterwards receives the posterior auricular vein, and passes down in the substance of the gland on the outer side of the external carotid artery. At the angle of the jaw this divides into the External Jugular and the facial communicating. The latter joins the facial vein to form the common facial, which enters the Internal Jugular. All the other veins open into the Internal Jugular Vein directly, or into an Anterior Jugular if one exists.

The **Internal Jugular Vein** (Fig. 182, 5) is deeply placed to the outer side of the internal carotid artery immediately below the base of the skull, being crossed by the styloid process and stylopharyngeus muscle, and the spinal-accessory nerve, which, however, is sometimes beneath the vein. Having been crossed by the digastric and stylo-hyoid and the occipital artery, it is covered by the sterno-mastoid for the rest of its course. It lies to the outer side of the internal and common carotid arteries, having the pneumo-gastric nerve between it and them, and is enclosed in the carotid sheath of cervical fascia. The internal jugular vein receives the facial, lingual, occipital, pharyngeal, superior and middle thyroid veins, and unites with the subclavian vein to form the *vena innominata.*

[The inner end of the clavicle having been removed with the sterno-mastoid, a little dissection close above the sternum will readily expose the scalenus anticus muscle attached to the first rib, having the phrenic nerve lying upon it, and branches of the thyroid axis crossing it. The pneumo-gastric if traced down will be found to cross the first part of the subclavian artery, which with its branches is to be defined. The sympathetic, and the thoracic duct on the left side, are to be carefully preserved.]

The **Subclavian Arteries** differ on the two sides, the right beginning at the sterno-clavicular articulation, and the left at the arch of the aorta, and having therefore a course in the thorax. Both arteries may be divided into three parts, of which the second and third correspond precisely on the two sides of the body, and the cervical portion of the first part of the left nearly with the first part on the right side.

The *first part on the right side* extends from the bifurcation of the innominate artery at the sterno-clavicular articulation, to the inner border of the scalenus anticus. Its course is obliquely upwards and outwards, and it has *in front* of it the inner end of the clavicle, with the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles; being crossed by the pneumo-gastric, cardiac, and phrenic nerves, and the internal jugular and vertebral veins. It lies *against* the recurrent laryngeal nerve and the apex of the pleura, which intervenes between it and the neck of the first rib, and also invests its lower border; the cord of the sympathetic also passes down behind it. The innominate vein is somewhat in front of, but quite below the level of, this part of the artery; the anterior jugular also crosses it transversely, but is separated from it by the sterno-hyoid and sterno-thyroid.

The *first part on the left side* extends from the arch of the aorta to the inner border of the scalenus anticus, and may be conveniently subdivided into a thoracic and a cervical portion. The relations of the cervical part are the same as those on the right side, with these exceptions:—The recurrent laryngeal nerve does not wind beneath it, and the thoracic duct arches outwards beneath the jugular vein, and close above or over the artery.

The Branches of the first part of the subclavian artery are (1) Vertebral, (2) Internal Mammary, and (3) Thyroid Axis, and their distribution is the same on both sides of the body. The Superior Intercostal artery arises to the inner border of the scalenus on the left side, and may be considered to be a branch of the first part of the subclavian.

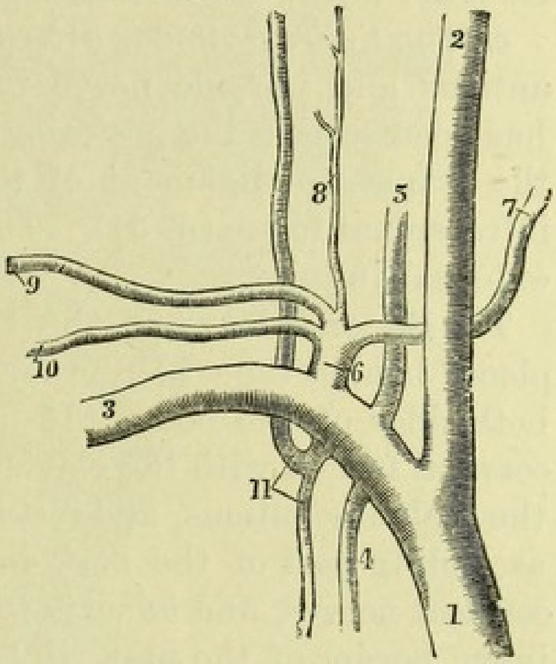
1. The **Vertebral Artery** (Fig. 183, 5) is seen now in only a small part of its course. It ascends between the scalenus anticus and longus colli muscles, being crossed by the inferior thyroid artery and, on the left side, by the thoracic duct; and enters the foramen in the transverse process of the sixth cervical vertebra (usually), being accompanied by a branch from the inferior cervical ganglion of the sympathetic. The corresponding vein lies in front of it. The artery passes through the transverse processes of all the upper cervical vertebræ, giving off *muscular* and *spinal* branches in its course, and is seen, in the suboccipital region, to wind inwards upon the atlas and enter the foramen magnum, to supply the brain.

The *Vertebral vein* has no course in the skull, but commences in small branches about the atlas. It takes the same course as the artery, receiving corresponding branches, and also the *ascending cervical* and *deep cervical* veins, and, after crossing the subclavian artery, opens into the termination of the subclavian vein. It often passes through the foramen in the transverse process of the seventh cervical vertebra.

2. The **Internal Mammary Artery** (Fig. 183, 4) arises from the lower surface of the subclavian artery, and at once descends into

the thorax, being crossed superficially and obliquely by the phrenic nerve. The artery passes behind the costal cartilages, and divides opposite the seventh costal cartilage into two terminal branches—superior epigastric and musculo-phrenic. They will be further seen in the dissection of the thorax.

Fig. 183.



3. The **Thyroid Axis** (Fig. 184, 25) is a short thick trunk arising from the anterior surface of the subclavian, close to the scalenus, which divides immediately into three branches, (*a*) inferior thyroid, (*b*) transversalis colli, and (*c*) supra-scapular or transversalis humeri.

a. The *Inferior Thyroid artery* runs first upwards and then inwards and downwards, across the vertebral artery and behind the carotid sheath and sympathetic trunk, to the posterior aspect of the thyroid body, in which it anastomoses with its fellow of the opposite side, and with both the superior thyroid arteries. Besides *œsophageal*, *tracheal*, and a small *inferior laryngeal* branch, it usually gives off a branch close to its origin, the *ascending cervical*, which ascends upon the vertebræ between the scalenus anticus and rectus capitis anticus major, supplying the prevertebral muscles and anastomosing with branches of the vertebral artery.

The *Inferior Thyroid veins* pass down the front of the trachea, after forming a plexus below the isthmus of the thyroid body. They open into the innominate veins, the right often crossing obliquely over the innominate artery, to open either into the junction of the two innominate veins or less frequently into the right innominate.

b. The *Transverse Cervical artery* runs transversely outward in front of the scalenus anticus and phrenic nerve, and has been seen, in the posterior triangle of the neck, to divide into superficial

Fig. 183.—Plan of the great arteries of the right side of neck (from Wilson).

1. Innominate.
2. Common carotid.
3. Subclavian.
4. Internal mammary.
5. Vertebral.
6. Thyroid axis.
7. Inferior thyroid.
8. Ascending cervical.
9. Transversalis colli.
10. Supra-scapular.
11. Superior intercostal and deep cervical.

cervical and posterior scapular branches. The *transverse cervical vein* opens into the external jugular.

This artery is frequently of small size or altogether wanting, as the posterior scapular or the transverse cervical itself may arise from the third, or sometimes the second, part of the subclavian.

c. The *Supra-scapular artery* runs outward in front of the scalenus anticus and phrenic nerve immediately behind the clavicle, and has been seen in the posterior triangle of the neck. It passes over the transverse ligament of the scapula to supply the supra and infra-spinal fossæ (p. 34). The *supra-scapular vein* opens into the external jugular.

The **Second Part of the Subclavian Artery** (Fig. 184, 27) is placed behind the scalenus anticus, and has the same relations on both sides of the body. It has *in front* of it the platysma and cervical fascia, with the clavicular origin of the sterno-mastoid and the scalenus anticus, and rests *against* the scalenus medius and the ascending part of the first dorsal nerve. *Above* it are the lower cervical nerves, and *below* is the pleura with a small portion of the inner border of the first rib.* The *subclavian vein* is quite below the level of the artery at this point, and separated by the scalenus anticus. The only branch of the second part of the subclavian artery is the superior intercostal artery, which arises usually to the inner side of the anterior scalenus on the left side, and is to be traced into the thorax, if this have been already opened, by removing the pleura from the upper intercostal spaces on both sides.

The *Superior Intercostal artery* (Fig. 183, 11) descends into the thorax in front of the necks of the ribs, giving branches to the first and second intercostal spaces, and anastomosing with the upper intercostal artery from the aorta. The branches to the intercostal spaces divide into anterior and posterior branches, and are distributed like the aortic intercostals. The *deep cervical branch* arises from the superior intercostal close to its origin, and passes backwards between the first rib and the transverse process of the seventh cervical vertebra, to be distributed to the muscles of the back.

The *superior intercostal vein* opens into the innominate vein on the left side, after crossing the arch of the aorta and communicating with the left upper azygos vein; on the right side the superior intercostal vein ends in the vena azygos major.

* The phrenic nerve is commonly given as one of the anterior relations of this part of the artery, but it reaches the inner border of the scalenus above the vessel, and is in relation with the first part of the subclavian.

Fig. 184.

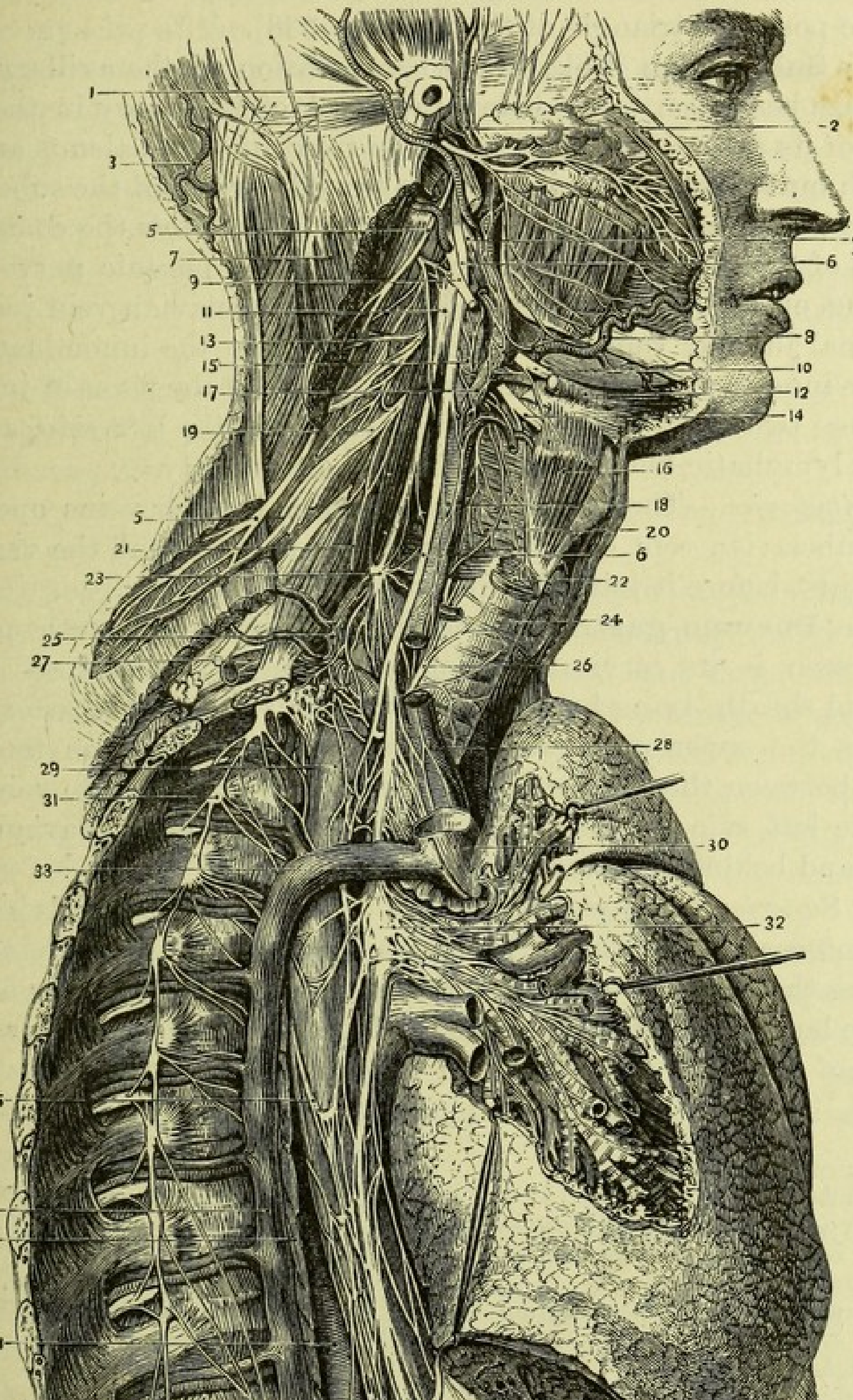


Fig. 184.—Distribution of the eighth pair of nerves of the right side (from Hirschfeld and Leveillé).

1. Posterior auricular artery.
2. Temporal artery.
3. Occipital artery.
4. Glosso-pharyngeal nerve.
5, 5. Spinal-accessory nerve.
6, 6. Pneumo-gastric nerve.

The **Third Part of the Subclavian Artery** has been dissected in the posterior triangle of the neck (p. 338).

The **Subclavian Vein** is the continuation of the axillary vein, and has been seen to lie below the level of its artery in the third part of its course. It then passes in front of the scalenus anticus, which muscle separates it from the second portion of the subclavian artery; and lastly lies in front of and a little below the commencement of the first part of the artery, with the phrenic nerve intervening on both sides of the body. Each subclavian vein joins the internal jugular vein of the same side to form the innominate vein at the inner border of the anterior scalenus; at the point of junction of these two veins the thoracic duct opens on the left side, and the right lymphatic duct on the right side of the body.

Tributaries.—The external and anterior jugular veins open into the subclavian vein outside the scalenus anticus, and the vertebral vein just before it joins the internal jugular.

The **Pneumo-gastric Nerve** (Figs. 184 & 185) (8th pair) is only seen in its cervical portion at present. It is enclosed in the carotid sheath, lying between the jugular vein and the artery, and enters the superior aperture of the thorax, passing, on the right side, between the subclavian artery and the innominate vein, and on the left side between the common carotid and subclavian arteries, and behind the innominate vein.

Its *Superior Laryngeal* branch (14 & 9), curving forwards beneath the internal carotid artery, appears opposite the hyoid bone, and pierces the thyro-hyoid membrane to supply the mucous membrane of the larynx. Before entering the larynx the nerve gives a small *external laryngeal* branch, which runs obliquely downwards under

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7. Sterno-mastoid (cut).
8. Facial artery.
9. Hypoglossal nerve with communication from 2nd cervical nerve.
10. Lower end of ditto.
11. Superior cervical ganglion of sympathetic.
12. Digastricus.
13. Third cervical nerve.
14. Superior laryngeal nerve.
15. Internal carotid.
16. Thyro-hyoideus.
17. External carotid.
18. Common carotid.
19. Fourth cervical nerve.
20. Inferior constrictor of pharynx.
21. Phrenic nerve on scalenus anticus.
22. Crico-thyroideus.
23. Middle cervical ganglion.
24. Trachea.
25. Thyroid axis.
26. Recurrent laryngeal nerve.
27. Subclavian artery.
28. Innominate artery.
29. Œsophagus.
30. Vena cava superior (cut).
31. Gangliated cord of sympathetic.
32. Posterior pulmonary plexus.
33. Phrenic nerve (cut).
35. Œsophageal plexus.
37. Vena azygos major.
39. Thoracic duct.
41. Thoracic aorta.
43. Great splanchnic nerve.

the sterno-thyroid muscle to supply the crico-thyroid, one of the intrinsic muscles of the larynx.

The *Recurrent Laryngeal Nerve* (26 & 21) (inferior) is seen running along the side of the trachea between it and the œsophagus, and disappears beneath the lower border of the inferior constrictor of the pharynx. It takes a different course on the two sides of the body; on the right arising from the pneumogastric in the neck, and winding round the subclavian artery; on the left arising in the thorax, and turning round the arch of the aorta.

The *Cardiac Nerves* (17) are one or two slender branches of the pneumo-gastric in the upper part and one in the lower part of the neck, running into the thorax to join the cardiac plexuses.

The *pharyngeal* branch and some other small branches arising at the upper part of the nerve are not yet visible.

The **Hypoglossal Nerve** (Fig. 184, 9) (9th pair) appears below the posterior belly of the digastric muscle, hooking round the occipital artery and its sterno-mastoid branch, and then curving forward superficially to the great vessels. It afterwards passes beneath the tendon of the digastric close to the hyoid bone, where it is seen in the angle between the two bellies of the muscle lying upon the hyo-glossus muscle, and finally disappears beneath the posterior border of the mylo-hyoid muscle to supply the muscles of the tongue (Fig. 185, 11).

Its *descending branch* (ramus descendens noni) arises opposite the occipital artery, and runs downward and forward either upon or within the carotid sheath, to supply the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, and to form a loop (*ansa hypoglossi*) with one or more branches from the cervical plexus, the *communicantes noni* (Fig. 182, 7).

The *nerve to the thyro-hyoid muscle* is a very delicate branch derived from the 9th nerve, just before it passes beneath the digastric.

The **Sympathetic** (Figs. 184 & 185) in the neck lies behind the carotid sheath upon the prevertebral muscles. It is a greyish nerve which has three cervical ganglia developed upon it, of which only one can now be seen, the lowest being on the neck of the first rib, and the superior ganglion being more satisfactorily examined at a later stage.

The *middle cervical* or *thyroid ganglion* (23 & 24), which is often scarcely distinguishable, is opposite the 5th cervical vertebra, and usually over the inferior thyroid artery. From this ganglion

Fig. 185.

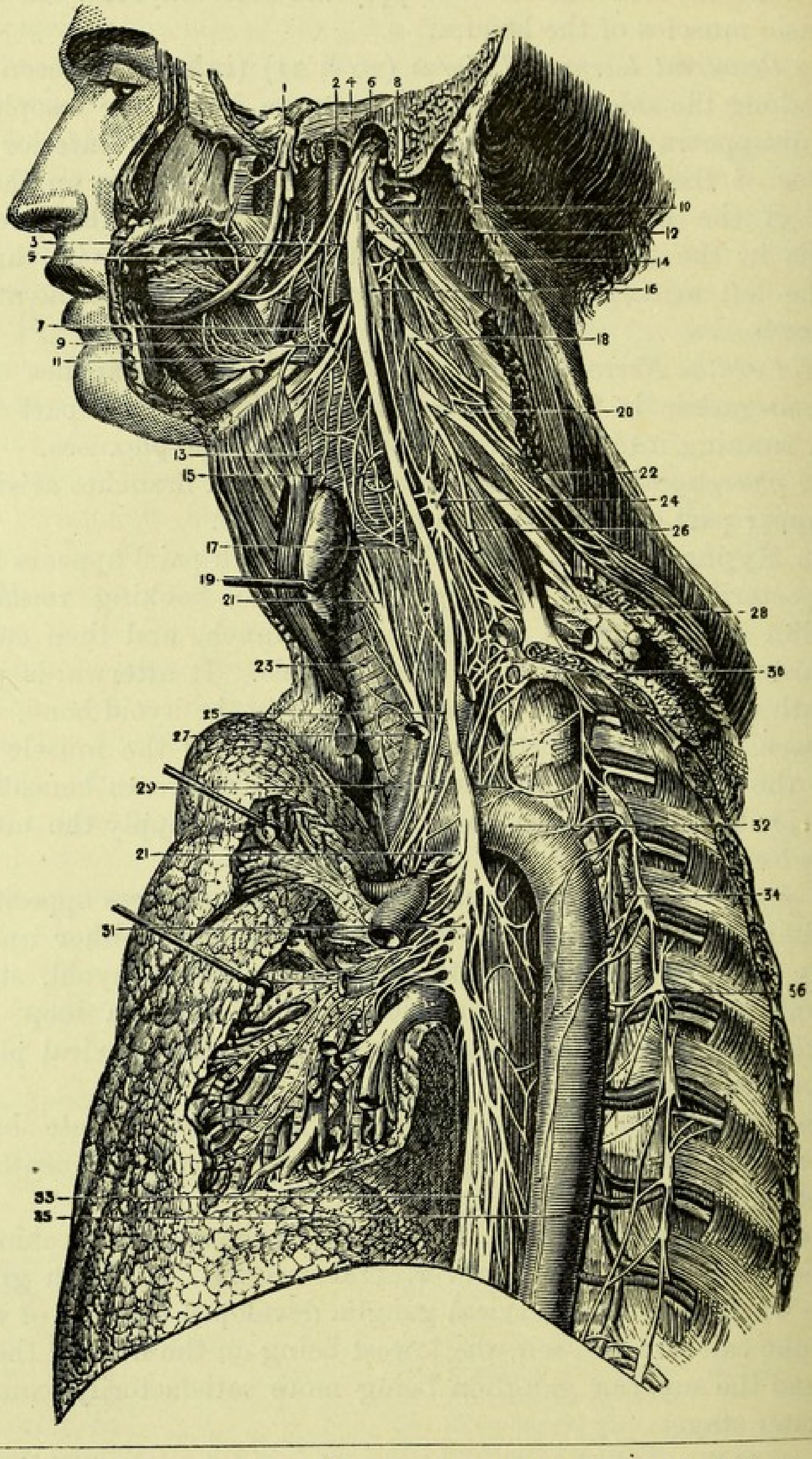

Fig. 185.—Distribution of the eighth pair of nerves on the left side (from Hirschfeld and Leveillé).

1. Gasserian ganglion of 5th nerve. 2. Internal carotid artery.

branches of *communication* go to the fifth and sixth cervical nerves; thyroid branches are *distributed* upon the inferior thyroid artery; and the *middle cardiac nerve* (the deep or great cardiac nerve) passes into the thorax, communicating with the recurrent laryngeal nerve (Fig. 186).

The **Spinal-Accessory Nerve** (Fig. 184, 5) (8th pair) appears below the digastric and close to the transverse process of the atlas, after passing generally superficial to, sometimes beneath the internal jugular vein. In the sterno-mastoid it communicates with the nerve from the cervical plexus to that muscle, and in the posterior triangle it is joined by branches from the third and fourth cervical nerves. It pierces the deep surface of the sterno-mastoid muscle, giving branches to it, and then emerging, crosses the posterior triangle to the trapezius, which it supplies.

The **Cervical Plexus** (Fig. 182) is formed by the anterior branches of the four upper cervical nerves, but the loop from the 1st nerve to the 2nd is of very small size, and cannot be well seen in this stage of the dissection. The 2nd, 3rd, and 4th nerves appear between the rectus capitis anticus major and the middle scalenus, lying beneath the sterno-mastoid. Each of these nerves communicates with the one above and below it, and gives off superficial and deep cervical branches. The superficial branches of the cervical plexus have been already dissected in the posterior triangle, and can now be traced to their sources,—the great auricular, small

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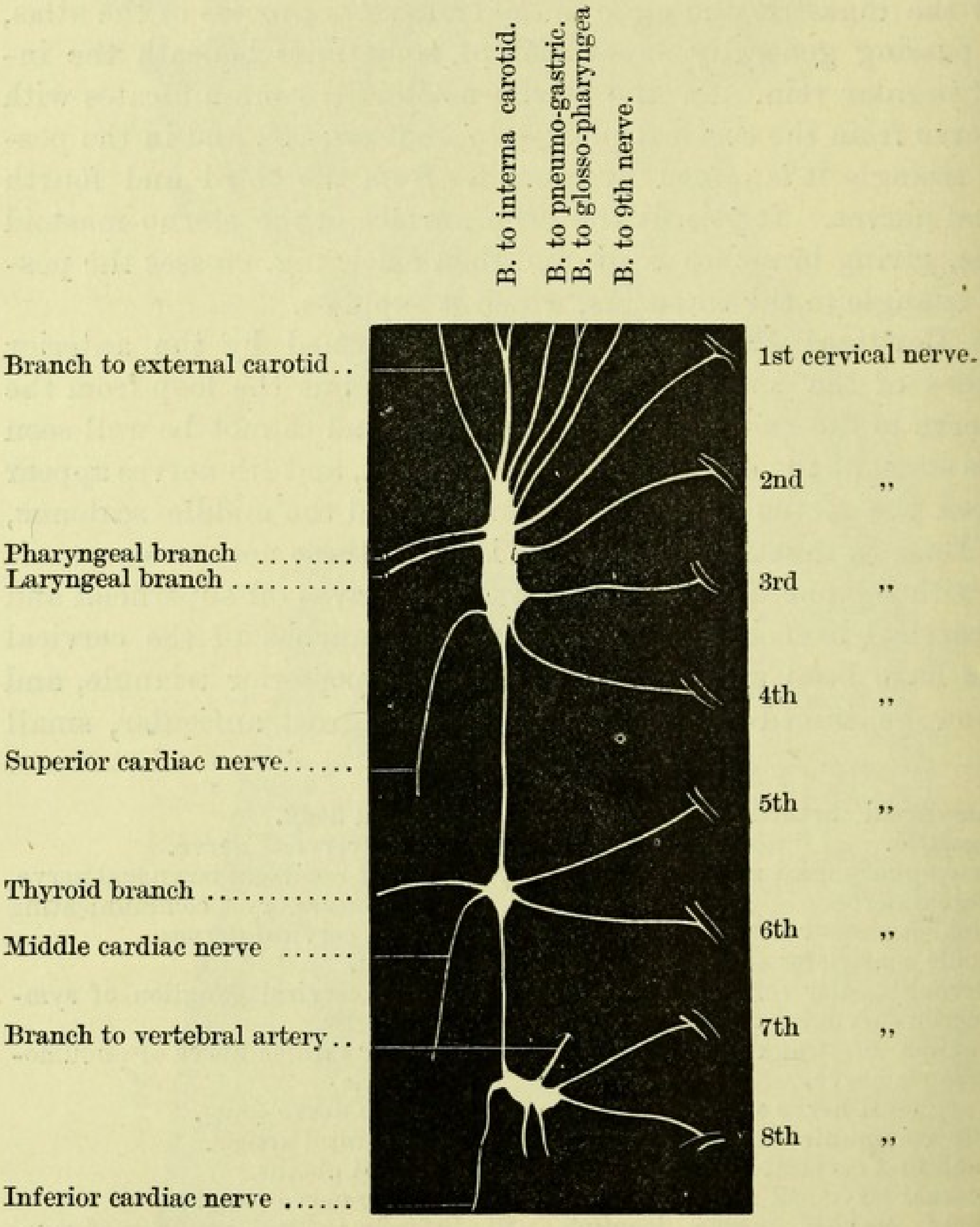
3. Pharyngeal branch of pneumogastric.
4. Glosso-pharyngeal nerve.
5. Lingual nerve.
6. Spinal-accessory nerve.
7. Middle constrictor of pharynx.
8. Internal jugular vein (cut).
9. Superior laryngeal nerve.
10. Ganglion of trunk of pneumogastric nerve.
11. Hypoglossal nerve on hyo-glossus.
12. Ditto communicating with eighth and first cervical nerve.
13. External laryngeal nerve.
14. Second cervical nerve looping with first.
15. Pharyngeal plexus on inferior constrictor.
16. Superior cervical ganglion of sympathetic.
17. Superior cardiac nerve of pneumogastric.
18. Third cervical nerve.
19. Thyroid body.
20. Fourth cervical nerve.
21. 21. Left recurrent laryngeal nerve.
22. Spinal-accessory communicating with cervical nerves.
23. Trachea.
24. Middle cervical ganglion of sympathetic.
25. Inferior cardiac nerve of pneumogastric.
26. Phrenic nerve (cut).
27. Left carotid artery.
28. Brachial plexus.
29. Phrenic nerve (cut).
30. Inferior cervical ganglion of sympathetic.
31. Pulmonary plexus of pneumogastric.
32. Thoracic aorta.
33. Œsophageal plexus.
34. Vena azygos superior.
35. Vena azygos minor.
36. Gangliated cord of sympathetic.

occipital, and superficial cervical branches to the 2nd and 3rd nerves, and the descending branches to the 3rd and 4th nerves.

The deep branches of the cervical plexus are—

Fig. 186.



1. *Communicating* branches with the 8th and 9th cranial nerves and the sympathetic, which will afterwards be dissected.

Fig. 186.—Diagram of the superior, middle, and inferior cervical ganglia of the Sympathetic (drawn by J. T. Gray).

2. *Muscular branches* pass forwards to the rectus capitis anticus major, rectus minor, and rectus lateralis. Others are directed backwards, which go to the sterno-mastoid, levator anguli scapulæ, and trapezius muscles, and also to the scalenus medius. Those to the sterno-mastoid and the trapezius communicate with the spinal accessory nerve.

3. The *Communicantes noni* (7) usually consisting of two branches from the 2nd and 3rd nerves, which join the descendens noni branch.

4. The *Phrenic nerve* (11) arising from the 4th nerve (or from the 3rd and 4th) and having often in addition a branch of communication with the 5th. It lies upon the scalenus anticus, getting to its inner border at the lower part of the neck, and has a communicating branch from the sympathetic, and also, frequently, from the nerve to the subclavius from the brachial plexus. The phrenic will subsequently be traced to the diaphragm in the dissection of the thorax.

The **Trachea** (Fig. 184, 24) is now sufficiently exposed for the examination of its relations, but its structure will be given with that of the lungs. The trachea extends from the lower border of the larynx, about the level of the fifth cervical vertebra, to the level of the fifth dorsal vertebra, where it bifurcates into the bronchi. The trachea occupies the middle line, lying in front of the œsophagus and vertebral column, and has the following structures in front of it in the neck: the sterno-hyoid and sterno-thyroid muscles with the deep cervical fascia; the isthmus of the thyroid body with the inferior thyroid veins; and the *arteria thyroidea ima* from the innominate, if it exists.

The **Thyroid body** (Fig. 185, 19) is now fully exposed for examination. It consists of two symmetrical conical *lobes*, placed on each side of the upper part of the trachea, and reaching back as far as to touch the pharynx. The apices of the lobes are directed upwards and touch the sides of the thyroid cartilage, the bases reach the 5th or 6th ring of the trachea; they are united at their lower parts, *i.e.*, opposite the second and third rings of the trachea by the *isthmus*; but this may be much higher, in children often covering the cricoid cartilage. The lobes are subject to great variations in size, and when much hypertrophied constitute Bronchocele or Goître. The gland is encased in a capsule derived from the deep cervical fascia.

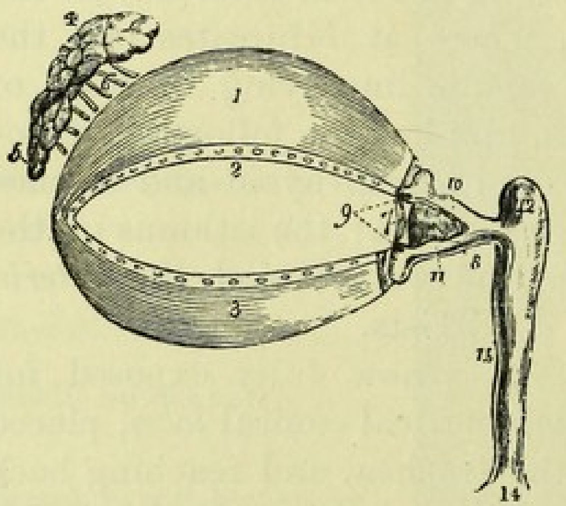
The thyroid body is covered by the sterno-hyoid and sterno-thyroid muscles, and occasionally a few muscular fibres pass from the hyoid bone to the isthmus, constituting the *levator glandulæ thyroideæ* of Soemmering. It is abundantly supplied with blood by the superior thyroid and inferior thyroid arteries of each side, and occasionally by an additional branch from the innominate, the *thyroidea ima*, which however may come from the right common carotid, the aorta, or, more rarely, from the right internal mammary or right subclavian. The arteries freely anastomose in the substance of the body, and return their blood by three veins on each side, viz., the superior and middle thyroid, which join the internal jugular vein, and the inferior thyroid, which may be traced down the front of the trachea to the innominate vein.

The thyroid body is composed of numerous closed vesicles containing a yellow fluid, but its function is not yet clearly understood.

The Face.

The face is a region in which it will be convenient to make different dissections on the two sides, *i.e.*, of the muscles and vessels on one, and of the nerves on the other; and the dissectors are therefore advised to adopt this method of proceeding.

Fig. 187.



Before commencing the dissection, the student should observe the external anatomy of the eye and its appendages, so that they may be seen in as natural a condition as possible (Fig. 187).

On the margin of the orbit is the *supercilium* or eyebrow, a ridge of thickened skin covered with hairs. The eyelids or *palpebræ* are two thin folds

Fig. 187.—Appendages of the eye (from Wilson).

1. Superior tarsal cartilage.
2. Lower border of the cartilage, on which are seen the openings of the Meibomian glands.
3. Inferior tarsal cartilage; along the upper border of this cartilage the openings of the Meibomian glands are likewise seen.
4. Lacrymal gland; its superior or orbital portion.
5. Inferior or palpebral portion.
6. Lacrymal duct.
7. Plica semilunaris.
8. Caruncula lacrymalis.
9. Puncta lacrymalia of the lacrymal canals.
10. Superior lacrymal canal.
11. Inferior lacrymal canal.
12. Lacrymal sac.
14. Dilatation of the nasal duct, where it opens into the inferior meatus of the nose.
15. Nasal duct.

composed of cartilage, muscle, and fascia, covered by the skin externally, and lined by the conjunctiva continued from the surface of the eyeball. The points of junction of the two lids are called the inner and outer *canthi*, and along the free borders of the lids will be seen the *cilia* or eyelashes, which in health curve upwards from the upper, and downwards from the lower lid.

Before opening the lids they should be drawn forcibly outward towards the temple, in order to make tense and prominent the little *tendo oculi* at the inner canthus, by which they are attached to the bone.

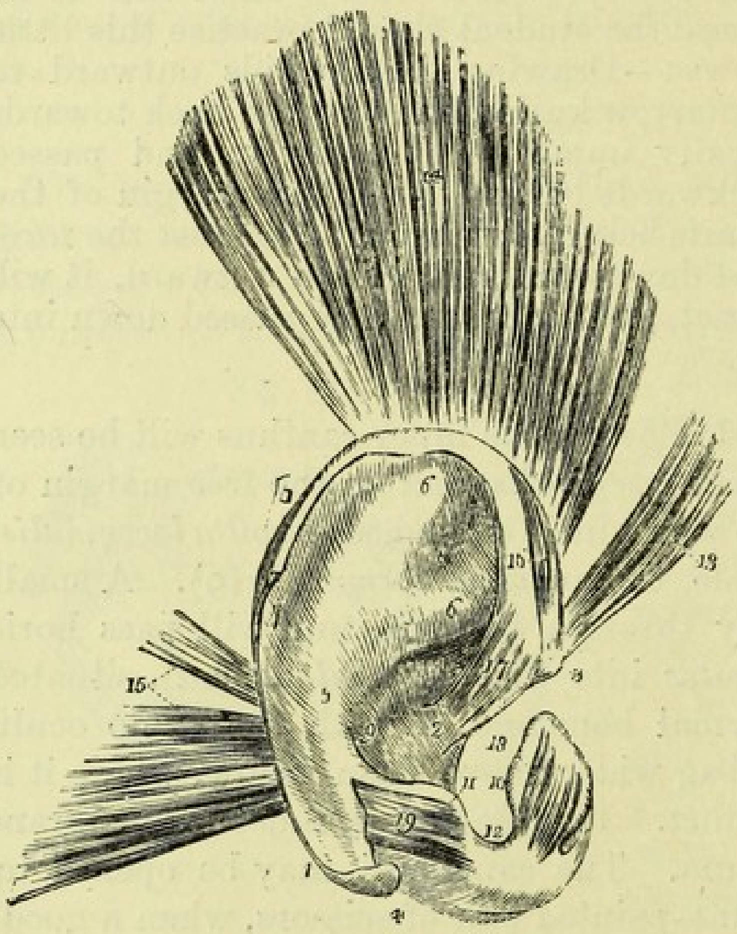
Surgery.—The tendo oculi is important as the guide to the lacrymal sac when it is necessary to introduce a knife into it in cases of lacrymal abscess, and the student should practise this little operation at once as follows:—Drawing the eyelids outward to render the tendon tense, a narrow knife held with the back towards the nose is entered vertically immediately below it, and passed downwards and a little backwards behind the lower margin of the orbit; the handle of the knife being then brought against the forehead, and the point pushed downward and a little outward, it will be felt to be in the nasal duct, and a probe can be passed down into the nose without difficulty.

The lids being separated, close to the inner canthus will be seen a small space called the *lacus lacrymalis*, and on the free margin of each lid close to this will be seen a little eminence (*papilla lacrymalis*) perforated by a minute hole, the *punctum lacrymale* (9). A small probe introduced vertically through the punctum will pass horizontally along the *canaliculus* into the *lacrymal sac* (12), situated in the groove in the lacrymal bone and beneath the tendo oculi. This is a delicate fibrous bag wider above than below, where it is continuous with the nasal duct. It is lined with mucous membrane having a ciliated epithelium. The canaliculi may be opened up upon the probe or with a fine-pointed pair of scissors, when a good-sized probe may be readily introduced into the sac, and be pushed down into the nasal duct and nose. If the upper lid is everted over a probe, the conjunctiva lining it, with the *Meibomian glands* beneath running in parallel rows to the free margin, will be seen.

Close to the inner canthus is a reddish body, the *caruncula lacrymalis* (8), containing some modified sweat-glands, some sebaceous glands, and covered with a few small hairs; and externally to it is a minute semilunar fold of conjunctiva, called the *plica semilunaris* (7), the representative of the *membrana nictitans* of birds, crocodiles, and batrachia. The conjunctiva is the mucous lining of the lids, and is continued on to the eyeball, where it is loosely attached to the sclerotic, but inseparably to the cornea. If the conjunctiva be carefully divided over the sclerotic, the attachments of the muscles of the eyeball may be seen.

The student should recognise with his finger the prominences of the nasal, malar, and jaw bones, and also the margin of the orbit; and it will be well also to examine the state of tension of the eyeball by pressing upon it gently with the fore-fingers, since this varies very much according to the freshness of the subject. Opportunity should be taken also to examine the external ear, and, if possible, to see the membrana tympani with a speculum.

Fig. 188.



The **Pinna** (Fig. 188) is composed of cartilage covered with skin, and is divided into the following parts:—The outer rim is the *helix* (1), and that next to it the *antihelix* (5), the groove between the two being the *fossa of the helix* (7). The deep cavity leading to the *meatus externus* is the *concha* (9), and the little nodule in front of it the *tragus* (10), the corresponding nodule

Fig. 188.—The pinna and its muscles (from Wilson, after Arnold).

1, 1. Helix.
2. Crus helicis.
3. Spina helicis.
4. Processus caudatus helicis.
5. Antihelix.
6, 6. Crura antihelicis.
7. Fossa scaphoidea or fossa of the helix.
8. Fossa of the antihelix.
9. Concha.
10. Tragus.
11. Antitragus.
12. Incisura intertragica.
13. Attrahens aurem.
14. Attollens aurem.
15. Retrahens aurem.
16. Major helicis muscle.
17. Minor helicis muscle.
18. Tragicus.
19. Antitragicus.

behind being the *antitragus* (11). The lowest part of the ear is the *lobule*, which consists of fat.

The extrinsic muscles of the ear (Attrahens, Attollens, and Retrahens) have been seen in the dissection of the scalp. Various small muscles have been described as passing from one point to another of the cartilage of the pinna, but do not require special description. They can be sufficiently seen in Figs. 188 and 189, and will not repay the trouble of dissection.

[The cheeks are now to be distended with cotton wool and the lips carefully sewn together. A little piece of wool may also be introduced beneath the eyelids with advantage. An incision is to be made from the temple in front of the ear, along the jaw to the chin (the scalp having been already dissected), and the skin is to be carefully reflected towards the median line. A cut around the orbit and mouth will avoid interference with the eyelids and lips. The position of the various muscles may be ascertained from the two following figures; they, as well as the vessels, are to be carefully preserved, but the small nerves are to be cut away, together with all the loose fat. The parotid

Fig. 189.

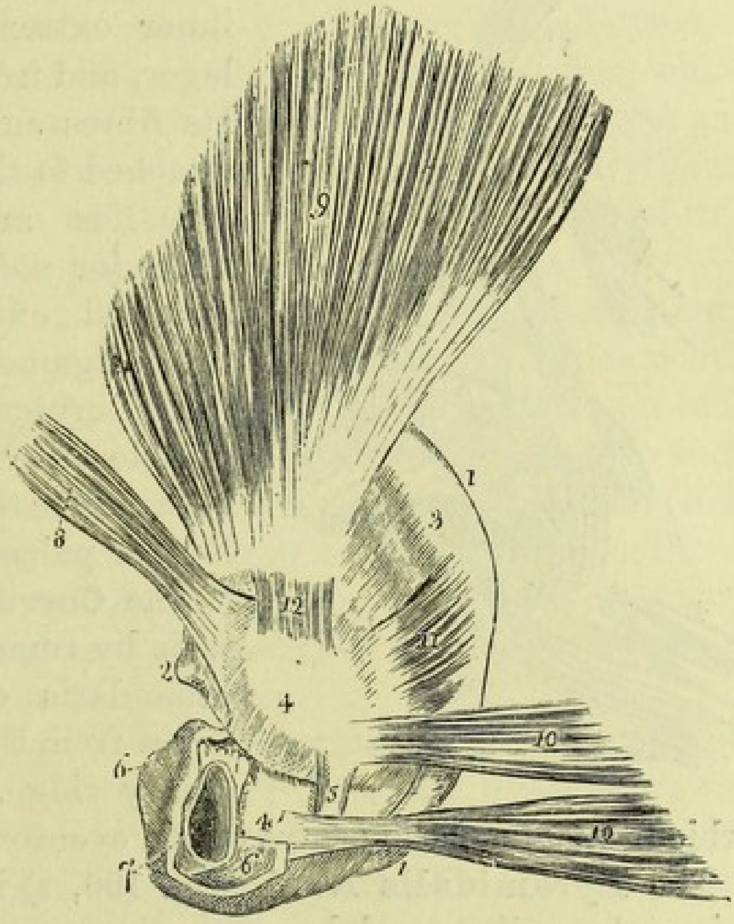


Fig. 189.—The pinna and its muscles, as seen from behind (from Wilson, after Arnold).

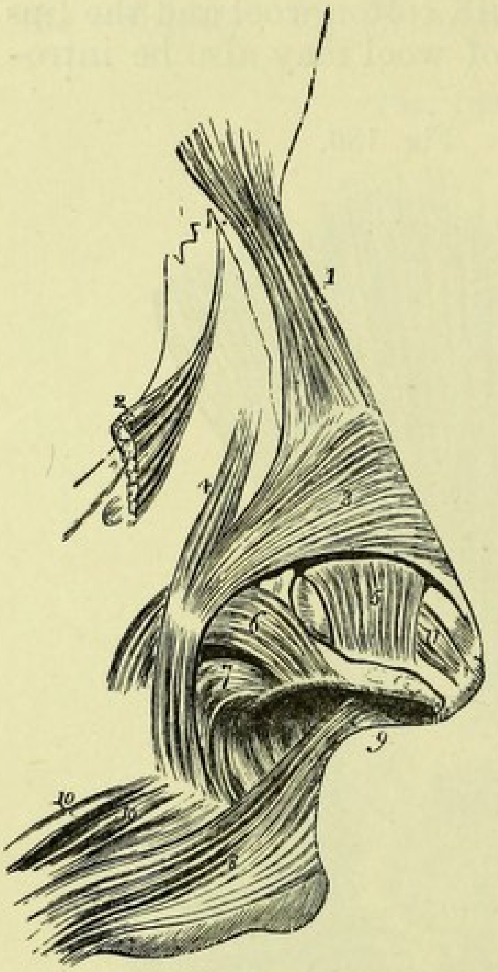
1, 1. Border of the helix.
2. Spine of the helix.
3. Convexity corresponding with the fossa scaphoidea.
4, 4. Convexity of the concha; the fissure between the numbers corresponds with the crus helicis.
5. Ponticulus conchæ.
6, 6. Cartilage of the meatus.
7. Aperture of the meatus.
8. Attrahens aurem.
9. Attollens aurem.
10. Retrahens aurem.
11. Transversus auriculæ.
12. Obliquus auriculæ.

gland in front of the ear is to be preserved, and its duct traced across the face below the malar bone.]

Muscles of the Face or Muscles of Expression.

The **Orbicularis Palpebrarum** (Fig. 191, 4) is a broad muscle surrounding the orbit and attached to its inner angle, being continuous above with the fibres of the occipito-frontalis (*v.* p. 318). It *arises* from the inner part of the orbital arch of the frontal bone, from the tendo oculi passing between the nasal process of the superior maxilla and the inner extremities of the tarsal cartilages, and from the nasal process itself. Its fibres surround the orbit and are attached to the skin; those passing on the lids are called the palpebral fibres (or *palpebralis* muscle), and are attached externally to the external tarsal ligament.

Fig. 190.



The orbicularis palpebrarum is the muscle which closes the eye-lids, and is therefore the direct antagonist of the levator palpebræ.

The **Corrugator Supercilii** will be seen by removing the portion of the orbicularis covering the brow. It *arises* from the inner part of the superciliary ridge, and is *inserted* into the orbicularis about the centre of the eyebrow.

The **Pyramidalis Nasi** (Fig. 190, 1) is a small slip of muscle lying along the nasal bone, continuous with the occipito-frontalis

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Fig. 190.—Muscles of the nose (from Wilson, after Arnold).

1. Pyramidalis nasi.
2. Upper part of the levator labii superioris alæque nasi, turned aside.
3. Compressor naris.
4. An anomalous slip.
5. Levator proprius alæ nasi anterior.
6. Levator proprius alæ nasi posterior.
7. Part of the depressor alæ nasi.
8. Upper segment of the orbicularis oris.
9. Naso-labialis.
10, 10. Fasciculi accessorii of the orbicularis.
11. A small muscle termed by Arnold compressor narium minor; it extends between the end of the nose and the alar cartilage. Its existence is doubtful.

above, and lost on the nasal cartilage, where it joins the tendon of the compressor naris.

The **Levator Labii Superioris Alæque Nasi** (Fig. 191, 8) *arises* from the upper part of the nasal process of the superior maxilla close to the margin of the orbit; it widens as it descends, and divides into two slips, which are *inserted* into the ala of the nose and into the upper lip, where it is attached to the skin and blends with the orbicularis and levator labii superioris.

The **Compressor Naris** (Fig. 190, 3) is to be traced beneath the preceding muscle to its *origin* from the canine fossa of the superior maxilla. The muscle is triangular in shape, and passes to be *inserted* on the bridge of the nose by means of a fascia, which is intimately connected with the skin but glides over the cartilages; here it unites with the opposite muscle and the pyramidalis nasi.

The **Depressor Alæ Nasi** (Fig. 190, 7) is a small muscle, which can only be properly seen by everting the lip (at a later stage) and removing the mucous membrane. It *arises* from the myrtiform fossa over the incisor teeth of the upper jaw, and is *inserted* into the posterior part of the columna and the ala of the nose.

The **Orbicularis Oris** (Fig. 191, 7) is the sphincter muscle surrounding the mouth. It is joined by all the other muscles which are inserted into the lips, and specially by the buccinator on each side, the fibres of which interlace with it. It is *attached* to each side of the septum of the nose by a small slip (naso-labialis) (Fig. 190, 9), and to the superior maxilla close to the canine tooth on each side, by small slips which have been named the fasciculi accessorii (10). Professor Ellis has described similar attachments to the lower jaw close to the canine teeth.

The **Levator Labii Superioris Proprius** (Fig. 191, 9) *arises* from the superior maxilla and margin of the malar bone above the infra-orbital foramen, and is *inserted* into the upper lip externally to the slip from the common elevator with which, as well as with the orbicularis, it blends and is also attached to the skin.

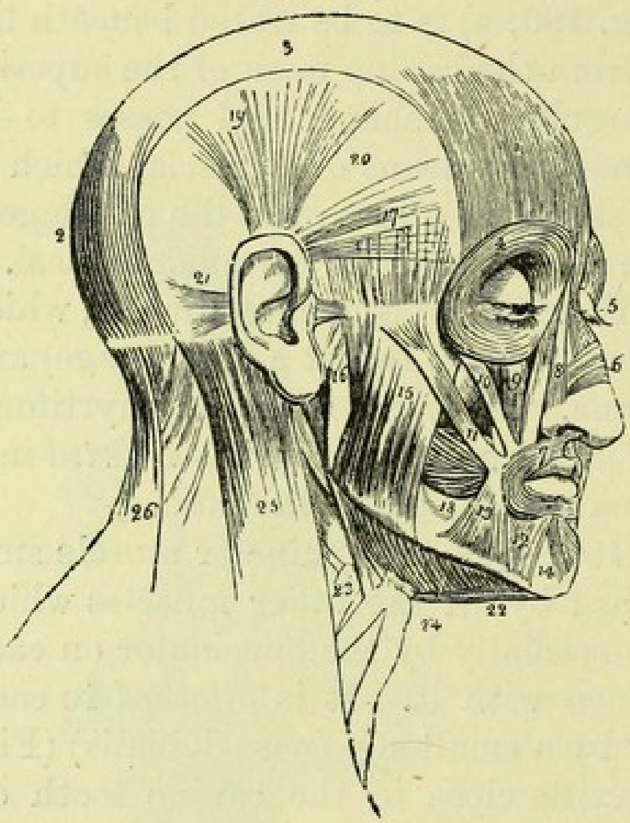
The **Levator Anguli Oris** (Fig. 191) *arises* from the canine fossa of the superior maxilla immediately below the infra-orbital foramen, and passes downwards and outwards beneath the preceding muscle to the angle of the mouth, joining the fibres of the orbicularis, the zygomaticus major, and the depressor anguli oris.

The **Zygomaticus** (Fig. 191) is either a single muscle, or has two slips forming the zygomaticus major and minor.

The Zygomaticus major (11) *arises* from the malar bone close to its junction with the zygoma, and passes obliquely to the angle of the mouth, where it blends with the orbicularis oris, the depressor anguli oris and the skin.

The Zygomaticus minor (10), much smaller, usually looks like a part of the orbicularis palpebrarum; it *arises* from the malar bone in front of the preceding, and is *inserted* between it and the levator labii superioris, with which it unites.

Fig. 191.



On the side of the jaw will be seen the insertion of the **Platysma Myoides**, continuous more or less with the orbicularis oris at the angle of the mouth, and with the muscles below the lip. Occasionally there is a strong slip passing transversely from the fascia over the masseter to the angle of the mouth, called the **Risorius Muscle of Santorini.**

The **Depressor Anguli Oris** (Fig. 191, 13) (triangularis menti) is a triangular muscle *arising* from the outer surface of the lower jaw, below and a

Fig. 191.—Muscles of the head and face (from Wilson).

1. Frontal portion of the occipito-frontalis.
2. Its occipital portion.
3. Its aponeurosis.
4. Orbicularis palpebrarum, which conceals the corrugator supercilii and tensor tarsi.
5. Pyramidalis nasi.
6. Compressor naris.
7. Orbicularis oris.
8. Levator labii superioris alæque nasi; the adjoining fasciculus between figures 8 and 9 is the labial portion of the muscle.
9. Levator labii superioris proprius; the lower part of the levator anguli oris is seen between the muscles 10 and 11.
10. Zygomaticus minor.
11. Zygomaticus major.
12. Depressor labii inferioris.
13. Depressor anguli oris.
14. Levator menti.
15. Superficial portion of the masseter.
16. Part of its deep portion.
17. Attrahens aurem.
18. Buccinator.
19. Attollens aurem.
20. Temporal fascia covering the temporal muscle.
21. Retrahens aurem.
22. Anterior belly of the digastric.
23. Stylo-hyoid pierced by posterior belly of the digastric.
24. Mylo-hyoid.
25. Sterno-mastoid.
26. Trapezius.

little externally to the mental foramen, and *inserted* into the angle of the mouth, blending with the other muscles.

The **Depressor Labii Inferioris** (Fig. 191, 12) (quadratus menti) *arises* from the outer surface of the lower jaw, between the symphysis and the mental foramen, and ascends obliquely to join the orbicularis and meet its fellow in the median line at the lower lip, thus leaving a triangular interval between them.

The **Levator Menti** (Fig. 191, 14) is a triangular muscle placed internally to the depressor of the lower lip, *arising* from the incisive fossa of the lower jaw and *inserted* into the skin of the chin. It is best dissected by everting the lower lip and removing the mucous membrane.

All the muscles of the face, muscles of expression, are *supplied* by the facial nerve (portio dura of 7th). In health the muscles of the two sides of the face antagonise one another, and an equilibrium is unconsciously maintained; but should the nerve of one side be divided, or become paralysed from disease of the temporal bone, the balance of power will be destroyed, and the face will be at once drawn to the healthy side by the preponderating muscles. The paralysed side will remain immovable, the eye will be open, and the patient will be unable to whistle, etc.

The **Parotid Gland** is the largest of the salivary glands, and is placed between the ear and the lower jaw, its superficial part overlapping the masseter muscle and being called the *socia parotidis.* It reaches as high as the zygoma and as far back as the mastoid process, and below, it is separated from the submaxillary gland by the stylo-maxillary ligament. Its deep surface presents three processes; one occupies the posterior part of the glenoid fossa, a second accompanies the internal maxillary artery beneath the lower jaw, and the third passes backwards beneath the sterno-mastoid, and reaches the root of the styloid process and the deep vessels and nerves of the neck. The duct of Stenson (ductus Stenonis) arises from the anterior part below the socia parotidis, and passes transversely across the masseter, to open into the mouth through the buccinator muscle opposite the second molar tooth of the upper jaw. Immediately below the duct is a large branch of the facial nerve, and above it the transverse facial artery. The gland is traversed by the external carotid artery, which gives off its two terminal branches (temporal and internal maxillary) in its substance; by the temporo-maxillary and external jugular veins; and by the facial and auriculo-temporal nerves. The structure of the parotid is that of a compound racemose gland, like that of the other salivary glands.

It receives *parotid branches* from the temporal artery, and its special nervous supply from the auriculo-temporal and sympathetic, as well as from the facial and great auricular nerves.

[The remains of the platysma are to be removed to show the facial artery and vein in front of the masseter, and the artery is to be followed out to the inner angle of the eye, with as little injury to the muscles as possible.]

The **Facial Artery** (Fig. 192) [external carotid], the cervical portion of which has been already dissected (p. 362), appears on the face immediately in front of the masseter muscle, where it lies on the lower jaw and is crossed by the platysma. It then becomes very tortuous, and passes upwards and inwards beneath the zygomatici to the side of the nose, lying upon the buccinator, levator anguli oris, and levator labii superioris muscles in its course. At the side of the nose it is crossed by the outer portion of the levator labii superioris alæque nasi, and reaches the angle of the orbit to anastomose with the nasal branch of the ophthalmic artery. This is therefore one of the points of communication between the external and internal carotid vessels. The branches of the facial anastomose at various points with those of the internal maxillary and the superficial temporal.

Branches.—As the artery crosses the jaw it gives—

1. *Masseteric* and *buccal* branches to the corresponding muscles.

2. The *Inferior Labial* (13) branch, which runs midway between the chin and the mouth, passing transversely beneath the depressor anguli oris.

3. The *Inferior Coronary* (15) branch, taking the same course as the preceding, but nearer the margin of the lip. Its size depends upon that of the inferior labial, with which it anastomoses, and also with the vessel of the opposite side.

4. The *Superior Coronary* (17) branch, often arising in common with the inferior coronary. It pierces the orbicularis oris, and runs beneath the mucous membrane of the lip to anastomose with the vessel of the opposite side. It gives a little branch to the septum of the nose (*artery of the septum*).

5. The *Lateral Nasal* (19) branch, passing beneath the levator labii superioris alæque nasi to be distributed to the ala.

6. The *Angular artery* (21), which is the terminal branch and anastomoses with the ophthalmic.

Surgery.—The facial artery may be compressed or tied immediately in front of the masseter, where its pulsation can be readily felt through the thin platysma. The position of the coronary arteries immediately beneath the mucous membrane should be

Fig. 192.

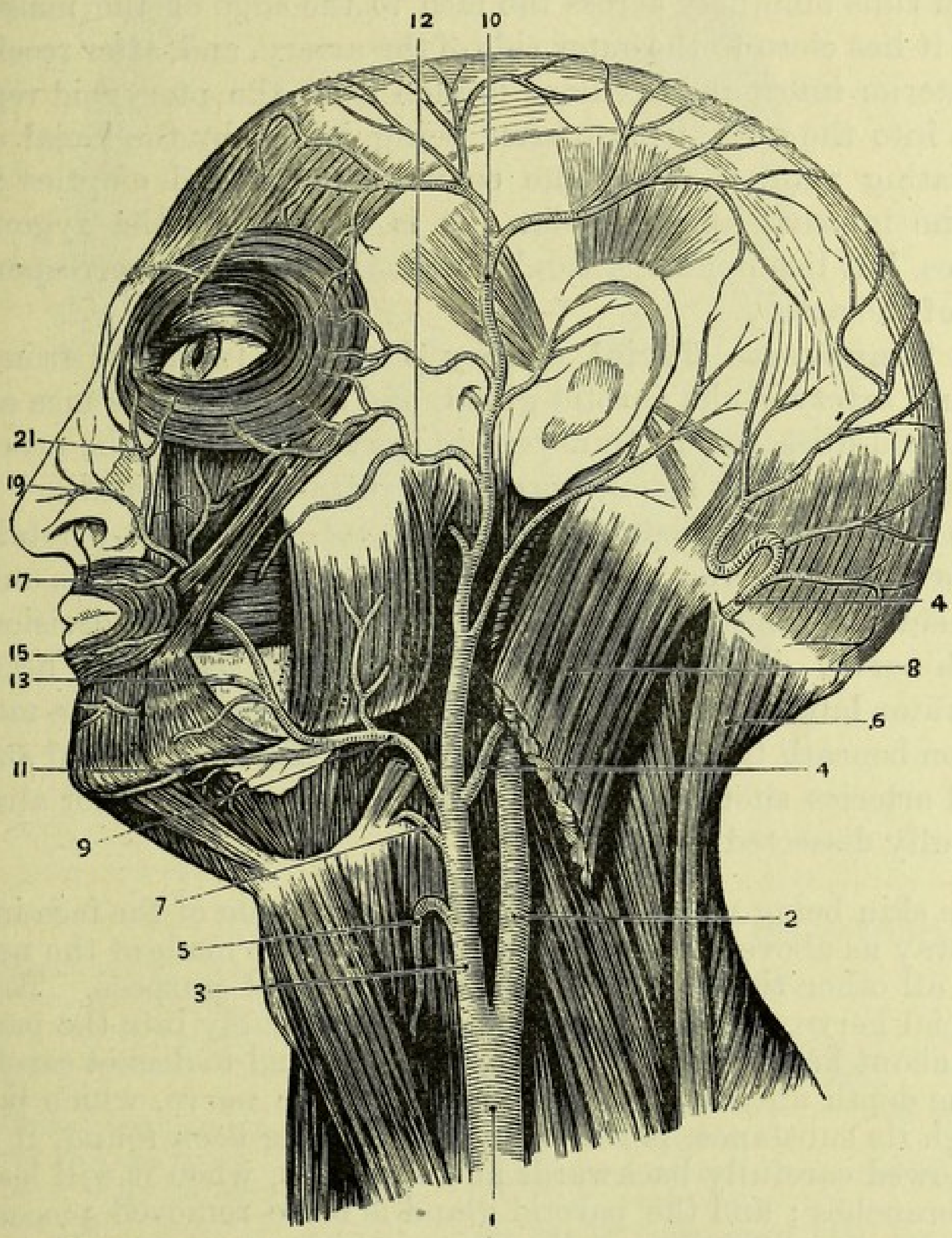


Fig. 192.—The arteries of the face and head (drawn by G. E. L. Pearse).

1. Common carotid.
2. Internal carotid.
3. External carotid.
4, 4. Occipital artery.
5. Superior thyroid artery.
6. Trapezius.
7. Lingual artery.
8. Sterno-mastoid.
9. Facial artery.
10. Temporal artery, dividing into anterior and posterior branches.
11. Submental branch.
12. Transverse facial artery.
13. Inferior labial branch.
15. Inferior coronary branch.
17. Superior coronary branch.
19. Lateral nasal branch.
21. Angular branch.

borne in mind in operating for hare-lip or cancer, as it is necessary to thrust the hare-lip pin deeply into the substance of the lip, in order to control the hæmorrhage effectually.

The **Facial Vein** commences at the inner angle of the orbit in the angular vein, formed by the frontal and supra-orbital veins. It then runs obliquely across the face to the edge of the masseter, where it lies close to the outer side of the artery, and, after receiving the anterior internal maxillary branch from the pterygoid region, passes into the neck, where, after being joined by the facial communicating vein, it forms the common facial and empties itself into the internal jugular vein. It is crossed by the zygomatic muscles, but lies upon Stenson's duct. Its branches correspond to those of the artery.

The **Transverse Facial Artery** (Fig. 192, 12) arises from the temporal artery in the parotid gland, and appears on the face above the parotid duct, to run transversely inwards towards the nose and anastomose with the facial, buccal and infra-orbital arteries.

In a well-injected body the terminations of the infra-orbital and inferior dental arteries will be found emerging at the infra-orbital and mental foramina, with branches of the 2nd and 3rd divisions of the 5th nerve. The infra-orbital foramen will be found between the levator labii superioris and levator anguli oris, and the mental foramen beneath the depressor anguli oris. The frontal and supra-orbital arteries should also be traced, if the scalp has not already been fully dissected (*v.* p. 318).

[The skin being removed from the opposite side of the face in the same way as above directed, a dissection is to be made of the nerves alone, all other tissues being sacrificed for that purpose. To find the facial nerve, the best way is to cut transversely into the parotid gland about half an inch below the zygoma, and to dissect carefully to some depth until some large branch of the nerve, which passes through its substance, is reached. One having been found, it is to be followed carefully backwards and forwards, when it will lead to other branches; and the parotid gland is to be removed piecemeal to show the ramifications of the nerve, which are then to be traced as far as possible towards the median line.]

The **Facial Nerve** (portio dura of the 7th pair) (Fig. 193, 17) leaves the skull at the stylo-mastoid foramen, and gives off immediately the *posterior auricular*, *digastric*, and *stylo-hyoid* branches.

The *posterior auricular nerve* (13) winds below the meatus to the back of the ear and communicates with the great auricular nerve (23). It divides into an *auricular* branch, which supplies the

Fig. 193.

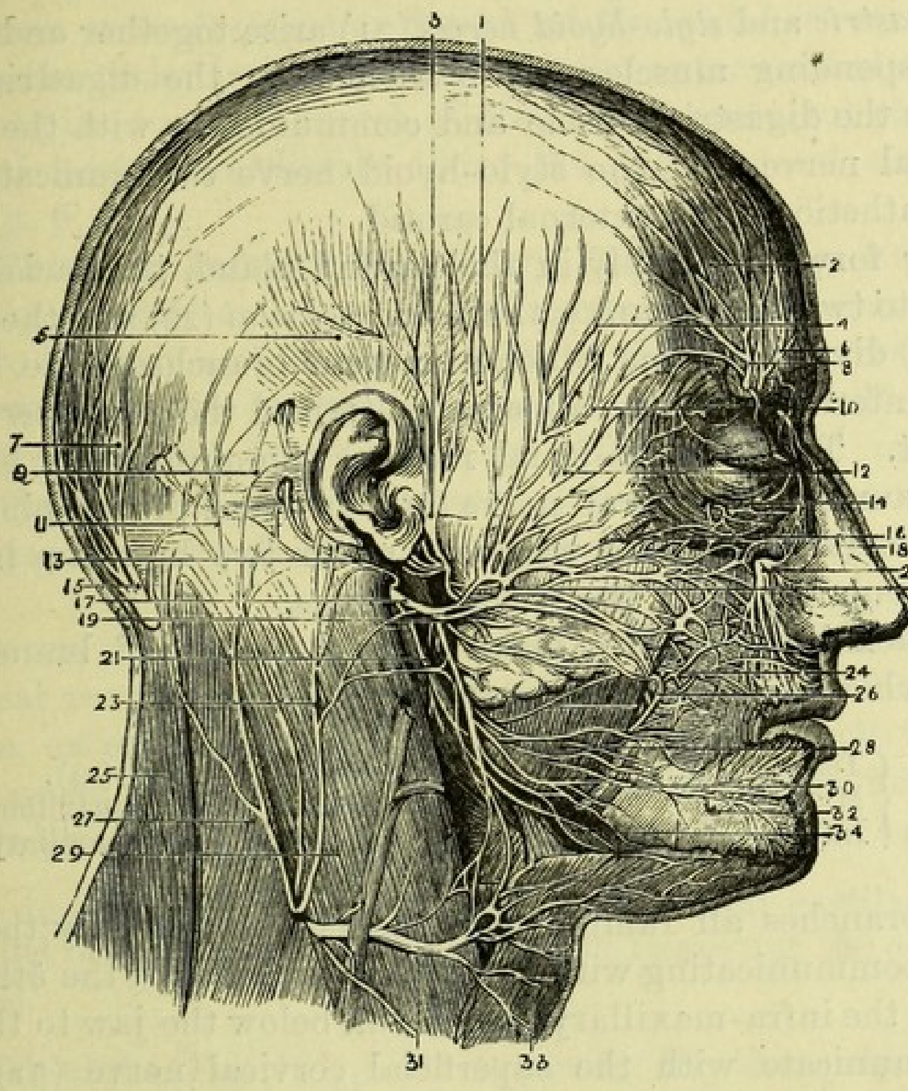


Fig. 193.—Nerves of the face and scalp (from Hirschfeld and Leveillé).

1. Attrahens aurem muscle.
2. Anterior belly of occipito-frontalis.
3. Auriculo-temporal nerve.
4. Temporal branches of facial nerve (7th).
5. Attollens aurem muscle.
6. Supra-trochlear nerve (5th).
7. Posterior belly of occipito-frontalis.
8. Supra-orbital nerve (5th).
9. Retrahens aurem muscle.
10. Temporal branch of orbital nerve (5th).
11. Small occipital nerve.
12. Malar branches of facial nerve.
13. Posterior auricular nerve (7th).
14. Malar branch of orbital nerve (5th) (ramus subcutaneus malæ).
15. Great occipital nerve.
16. Infra-orbital branches of facial nerve (7th).
17. Facial nerve (7th).
18. Nasal nerve (5th).
19. Cervico-facial division of 7th.
20. Infra-orbital nerve (5th).
21. Branches to digastric and stylo-hyoid (7th).
22. Temporo-facial division of 7th.
23. Great auricular nerve.
24. Buccal branches of facial nerve.
25. Trapezius.
26. Buccal nerve (5th).
27. Splenius capitis.
28. Masseter.
29. Sterno-mastoid.
30. Supra-maxillary branches of facial nerve (7th).
31. Superficial cervical nerve.
32. Mental nerve (5th).
33. Platysma.
34. Infra-maxillary branches of facial nerve (7th).

retrahens aurem muscle, and an *occipital* branch, which supplies the posterior belly of the occipito-frontalis.

The *digastric* and *stylo-hyoid nerves* (21) arise together and supply the corresponding muscles. A branch from the digastric nerve perforates the digastric muscle and communicates with the glosso-pharyngeal nerve, and the stylo-hyoid nerve communicates with the sympathetic on the external carotid.

Passing forwards deeply in the parotid gland, the facial nerve divides into two large trunks, the *temporo-facial* (22) and the *cervico-facial* (19) divisions, from which numerous branches arise, causing by their interlacement the appearance termed the *pes anserinus*, or goose-foot. The temporo-facial receives communicating branches from the auriculo-temporal nerve (5th) in front of the pinna, and the cervico-facial division receives one or two branches from the great auricular nerve of the cervical plexus.

From each division of the facial nerve three sets of branches are derived, whose direction is indicated by their names.

Temporo-facial division	Temporal (4). Malar (12). Infra-orbital (16).	Cervico-facial division	Buccal (24). Supra-maxillary (30). Infra-maxillary (34).

These branches all ramify upon the face and supply the facial muscles, communicating with the several divisions of the 5th nerve, excepting the infra-maxillary, which run below the jaw to the neck and communicate with the superficial cervical nerve (31). The branches are to be traced to all the "muscles of expression," and also to the buccinator, one of the muscles of mastication as well as of expression.

The *three* divisions of the **5th Nerve** appear upon the face, and each of them will be found *three* times in front of the ear.

The **First or Ophthalmic Division** (Fig. 193) appears (1) as the *supra-trochlear nerve* (6) at the inner angle of the orbit; (2) at the supra-orbital notch as the *supra-orbital nerve* (8), which has been traced to the forehead; and (3) as the *nasal nerve* (18), which will now be found emerging from between the nasal bone and lateral cartilage on the side of the nose. (Small terminal twigs of the infra-trochlear and lacrymal nerves may also be sometimes found with care.)

The **Second or Superior Maxillary Division** (Fig. 193) appears (1) as the *infra-orbital nerve* (20) at the infra-orbital foramen, between the levator labii superioris and the levator anguli oris, and is to be traced to the upper lip, which it supplies with numerous large branches, forming a plexus with the facial nerve, it also sends branches to the nose and the lower eyelid; (2) as the *ramus subcutaneus malæ* (14) (*malar branch of the orbital nerve*) appearing through the malar bone after piercing the outer wall of the orbit; and (3) as the *temporal branch of the orbital nerve* (10) piercing the temporal fascia immediately above the zygoma and already dissected (*v.* p. 318).

The **Third or Inferior Maxillary Division** (Fig. 193) appears (1) as the *mental nerve* (32) at the mental foramen, and is to be traced to the chin and lower lip; (2) as the *buccal nerve* (26) upon the surface of the buccinator muscle, where it will be found lying beneath, but communicating with, the facial nerve; and (3) as the *auriculo-temporal nerve* (3), piercing the parotid gland and running upwards over the zygoma immediately in front of the ear.

These are all purely sensory nerves. They all join freely with the facial nerve, and supply sensation to the whole of the skin of the face, except that covering the parotid gland, which is supplied by the great auricular nerve of the cervical plexus, hence called auriculo-parotidean.

[The anatomy of the eyelids and of the nasal cartilages can be examined on either side of the face, by removing the superjacent tissues.]

The **Eyelids** (Fig. 187).—On removing the thin palpebral fibres of the orbicularis from the lids, a piece of thin fibrous tissue will be seen extending from the margin of the orbit to the lid, which is called the *palpebral ligament.* It is continuous with the periosteum of the skull at the margin of the orbit, and is attached to the edge of the tarsal cartilage in each lid. The *tarsal cartilage*, which consists of dense connective tissue, and according to the best observers contains no cartilage, is larger in the upper than the lower lid, being semilunar in shape in the former, and nearly straight in the latter. Each is attached externally by the *external tarsal ligament*, which is really a thickening of the palpebral ligament, to the margin of the orbit, whilst internally the *tendo oculi* divides to be attached to both cartilages, and thus holds them in position. The fibres of the orbicularis must be cut away from the tendo oculi to show it thoroughly, and it will be seen to be attached to the nasal process of the superior maxilla, immediately in front of the groove for the lacrymal sac.

Beneath the palpebral ligament in the upper lid, will be found the expansion of the tendon of the levator palpebræ superioris, attached to the anterior surface of the tarsus. Both lids are lined with conjunctiva, on removing which the Meibomian glands may be seen to be embedded in the substance of the tarsi.

The structures composing the upper eyelid are—

1. Skin.
2. Orbicularis palpebrarum.
3. Palpebral ligament.
4. Tendon of levator palpebræ.
5. Tarsal cartilage.
6. Meibomian glands.
7. Conjunctiva.

The structures in the lower lid are the same, *minus* the levator palpebræ.

This will be the best opportunity to dissect the **Tensor Tarsi Muscle** of Horner, by dividing the outer tarsal ligaments and detaching the eyelids, so as to turn them over the nose and expose their internal surfaces. By removing the conjunctiva over the tendo oculi, the two little slips of muscular fibre will be seen above and below it. The muscle *arises* from the ridge on the lacrymal bone, and is *inserted* into the tarsal cartilages and canaliculi. It is thus apparent that the lacrymal sac occupies a position between the tendo oculi and the tensor tarsi.

Cartilages of the Nose (Figs. 194 and 195).—Only the lateral cartilages and cartilages of the aperture on each side can now be seen, the cartilage of the septum being dissected with the nose. The *lateral cartilage* is triangular, its posterior border being continuous with the nasal bone and the nasal process of the maxillary bone, and its anterior border touching that of the opposite side above, while below the two are separated by, but intimately united with, the anterior edge of the cartilage of the septum.

The *cartilage of the aperture* (alar) is an elongated plate of cartilage, so bent upon itself that while the angle between the two parts forms one half of the point of the nose, the two parts themselves surround the anterior part of the nostril. It has no attachment to bone, being embedded in the dense cellular tissue of the ala nasi, in which there are frequently two or three little additional nodules, *sesamoid cartilages*, which prolong the outer part of this cartilage backwards. The cartilages of the two sides adjoin at the tip of the nose, and are attached to the lateral cartilages by fibrous tissue.

Fig. 194.

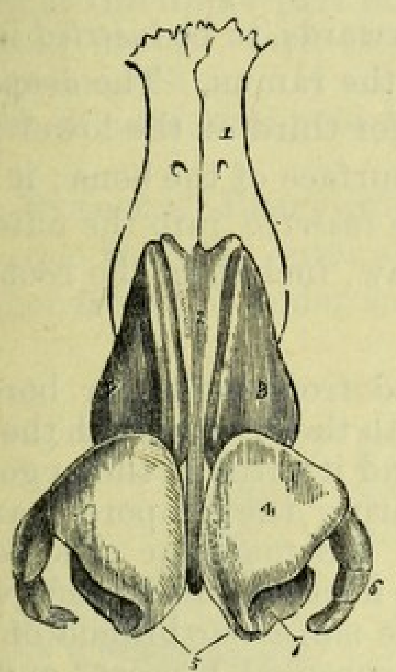
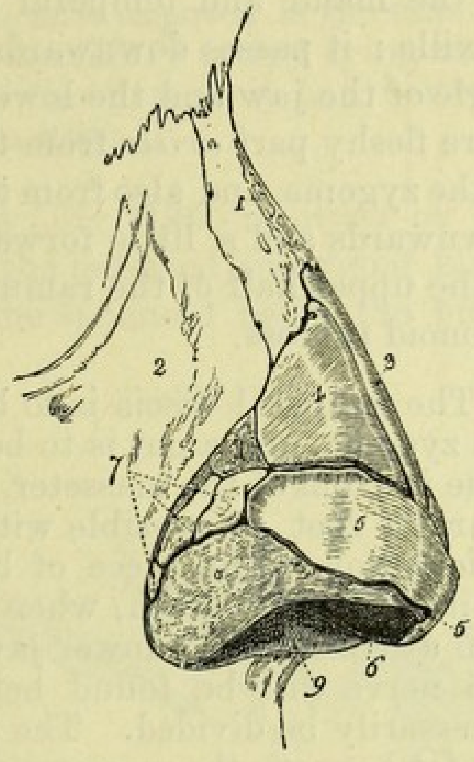


Fig. 195.



The Pterygo-Maxillary Region.

[The head being laid on one side, the facial nerve and parotid duct are to be divided and turned forward, and the remains, if any, of the parotid gland are to be cleaned out from between the ear and the jaw, the auriculo-temporal nerve being carefully preserved. The surface of the masseter muscle is then to be cleaned.]

The **Masseter** (Fig. 191, 15) is the most superficial muscle of mastication, and is divisible into a superficial and a deep portion, a small part of the latter being seen behind and above the fibres of the former. The superficial and more tendinous part *arises* from the

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Fig. 194.—The fibro-cartilages of the nose (from Wilson).

1. One of the nasal bones.
2. Cartilage of the septum.
3. Lateral cartilage.
4. Alar cartilage.
5. Central portions of the alar cartilages which constitute the columna.
6. Cartilagines minores or sesamoid cartilages.
7. The nostril.

Fig. 195.—The fibro-cartilages and bones of the nose viewed from the side (from Wilson, after Arnold).

1. Nasal bone.
2. Nasal process of the superior maxillary bone.
3. Cartilage of the septum.
4. Lateral cartilage.

5, 5. Alar cartilage.
6. Inner portion of the alar cartilage.
7. Sesamoid cartilages.
8. Areolar tissue of the ala nasi.
9. Aperture of the nostril.

anterior two-thirds of the lower border of the zygomatic arch, formed by the malar and temporal bones, and slightly from the superior maxilla; it passes downwards and backwards, to be *inserted* into the angle of the jaw and the lower half of the ramus. The deeper and more fleshy part *arises* from the posterior third of the lower border of the zygoma, and also from the inner surface of the bone; it passes downwards and a little forwards, to be *inserted* into the outer side of the upper half of the ramus of the jaw, including the root of the coronoid process.

[The temporal fascia is to be detached from the upper border of the zygoma, and a cut is to be made with the saw through the malar bone in front of the masseter, and behind it through the zygoma, as near its root as possible without injuring the temporo-maxillary articulation. The piece of bone with the masseter attached can then be turned down, when the deep fibres of the muscle will be seen attached to the lower jaw, and the *masseteric* branch of artery and nerve will be found behind the coronoid process, and must necessarily be divided. The temporal muscle is to be cleaned and the fat beneath the masseter removed, so as to expose the buccinator muscle thoroughly, together with its branch of nerve and artery, which appear in front of the coronoid process and are to be preserved.]

The **Temporal Muscle** (Fig. 201, 2) *arises* from the whole of the temporal fossa, except the anterior wall formed by the malar bone, and from the under surface of the temporal fascia, which has been seen to be attached to the whole length of the temporal ridge. Its anterior fibres are nearly vertical, the posterior nearly horizontal; they converge to a tendon, which is *inserted* into the apex of the outer surface of the coronoid process, and into the inner surface of the coronoid process and ramus of the lower jaw, as far as the last molar tooth. It is also connected with the pterygo-maxillary ligament.

[With the saw and bone forceps the coronoid process and the anterior part of the ramus of the jaw are to be carefully cut off and turned up. The neck of the jaw is then to be sawn through transversely just below the condyle, and the ramus divided transversely at the level of the molar teeth. In making this last cut the saw should only go through half the thickness of the jaw, after which the bone-forceps can be applied at the upper border so as to split the piece of bone, and allow of its removal in two pieces without injury to the nerve.

On removing the portion of ramus thus separated, the periosteum will probably be left behind, and on this being dissected away, the inferior dental nerve and artery will be seen lying on the internal lateral ligament before entering the dental foramen, and in front of these the lingual (gustatory) nerve. Crossing both nerves transversely at the upper part of the space now exposed is the external pterygoid muscle, with the internal maxillary artery lying either upon or beneath it. If superficial to the muscle it had better be cleaned, divided, and held aside with a hook.]

The **External Pterygoid Muscle** (Fig. 196, 1) *arises* by two heads, one from the outer surface of the external pterygoid plate; the other from the under surface of the sphenoid below the pterygoid crest. Its fibres run transversely to be *inserted* into the hollow on the front of the neck of the lower jaw, and into the inter-articular fibro-cartilage of the joint.

Fig. 196.

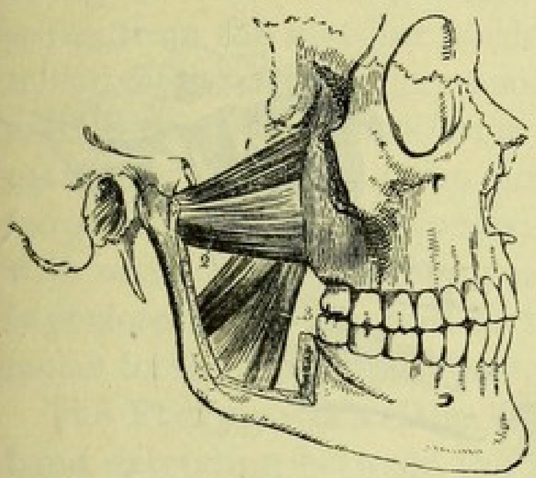
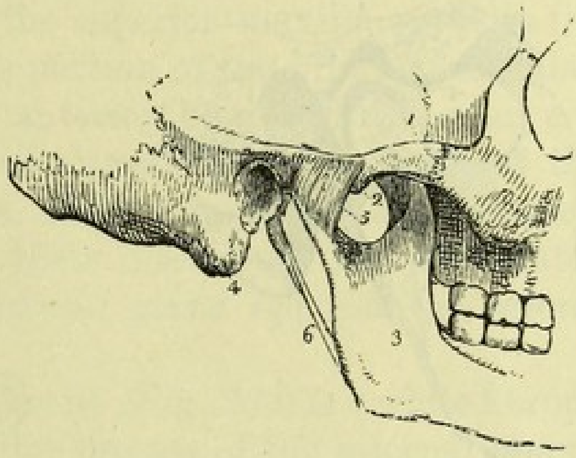


Fig. 197.



Temporo-Maxillary Articulation.—The *external lateral ligament* (Fig. 197, 5) is a short thick band of fibres, broader above than below, and passes obliquely downwards and backwards from the lower border of the root of the zygoma to the neck of the jaw. It is continuous with the *capsular ligament*, which is attached to the margins of the articular surfaces, and is sometimes described as consisting of anterior, posterior, and internal portions. By dividing the ligaments, the inter-articular cartilage and the synovial membranes above and below it will be brought into view.

Fig. 196.—The two pterygoid muscles (from Wilson). The zygomatic arch and the greater part of the ramus of the lower jaw have been removed in order to bring the muscles into view.

1. The sphenoid origin of the external pterygoid.
2. Its pterygoid origin.
3. The internal pterygoid.

Fig. 197.—External view of the articulation of the lower jaw (from Wilson).

1. Zygomatic arch.
2. Tubercle of the zygoma.
3. Ramus of the lower jaw.
4. Mastoid portion of the temporal bone.
5. External lateral ligament.
6. Stylo-maxillary ligament.

The *inter-articular fibro-cartilage* (Fig. 198, 3) is seen to fit into the glenoid cavity, and its upper surface is accordingly concavo-convex from before backwards, the lower surface being concave. The condyle being detached from the temporal bone and turned forward with the external pterygoid muscle, the cartilage will be found to be oval in outline and thicker at the margins than in the centre, where it is occasionally perforated.

The *internal lateral ligament* (Fig. 199, 4), now fully exposed, is a membranous band, narrow above, where it is attached to the spine of

Fig. 198.

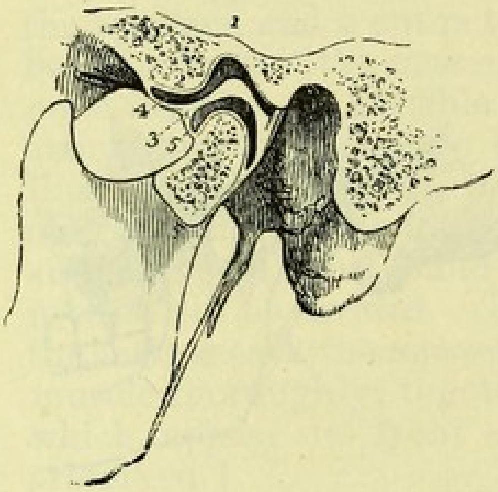
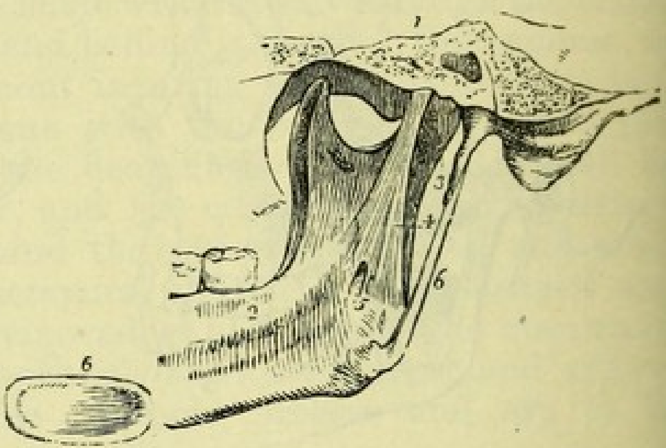


Fig. 199.



the sphenoid bone, and widening below to be attached to the projecting margin of the dental foramen. Between the internal lateral ligament and the jaw are found the external pterygoid muscle, the internal maxillary artery, the auriculo-temporal nerve, and the inferior dental nerve and artery at the lower part; it is pierced by the mylo-hyoid branches of artery and nerve near the bone.

Fig. 198.—A section of the temporo-maxillary articulation to show the position of the inter-articular fibro-cartilage, and the manner of its adaptation to the articulating surfaces (from Wilson).

1. Glenoid fossa.
2. Eminentia articularis.
3. Inter-articular fibro-cartilage.
4. Superior synovial cavity.
5. Inferior synovial cavity.
6. An inter-articular fibro-cartilage, removed from the joint, in order to show its oval and concave form; it is seen from below.

Fig. 199.—Internal view of the articulation of the lower jaw (from Wilson).

1. Section through the petrous portion of the temporal bone and spinous process of the sphenoid.
2. Internal surface of the ramus and body of the lower jaw.
3. Capsular ligament.
4. Internal lateral ligament.
5. Aperture through which the mylo-hyoid nerve passes.
6. Stylo-maxillary ligament, a process of the deep cervical fascia.

The **Internal Pterygoid Muscle** (Fig. 196, 3) is placed beneath the internal lateral ligament. It *arises* from the internal surface of the external pterygoid plate, and from the tuberosity of the palate bone and superior maxilla; and is *inserted* into the inner surface of the angle of the lower jaw, its fibres running parallel to the superficial portion of the masseter. That portion of the internal pterygoid which arises from the outer surface of the tuberosity of the superior maxilla is anterior to the fibres of the pterygoideus externus (Fig. 201).

The **Buccinator** (Fig. 201, 14) forms the greater part of the cheek, and has been partly seen in the dissection of the face. It *arises* from the alveolar border of the superior maxilla opposite the molar teeth; from a corresponding portion of the inferior maxilla; and between the jaws from the anterior border of the pterygo-maxillary ligament. The muscle is *inserted* into the angle of the mouth, joining the orbicularis oris, and its middle fibres decussate with one another as they pass to their insertion. The buccinator is perforated by the duct of the parotid gland opposite the second molar tooth of the upper jaw.

The **Pterygo-Maxillary Ligament** (Fig. 202) is a white fibrous band extending between the hamular process of the internal pterygoid plate and the lower jaw, close to the last molar tooth. By its anterior border it gives attachment to the buccinator, and by its posterior border to the superior constrictor of the pharynx; it thus establishes the connection between the cavities of the mouth and the pharynx, the mucous membrane covering its inner surface.

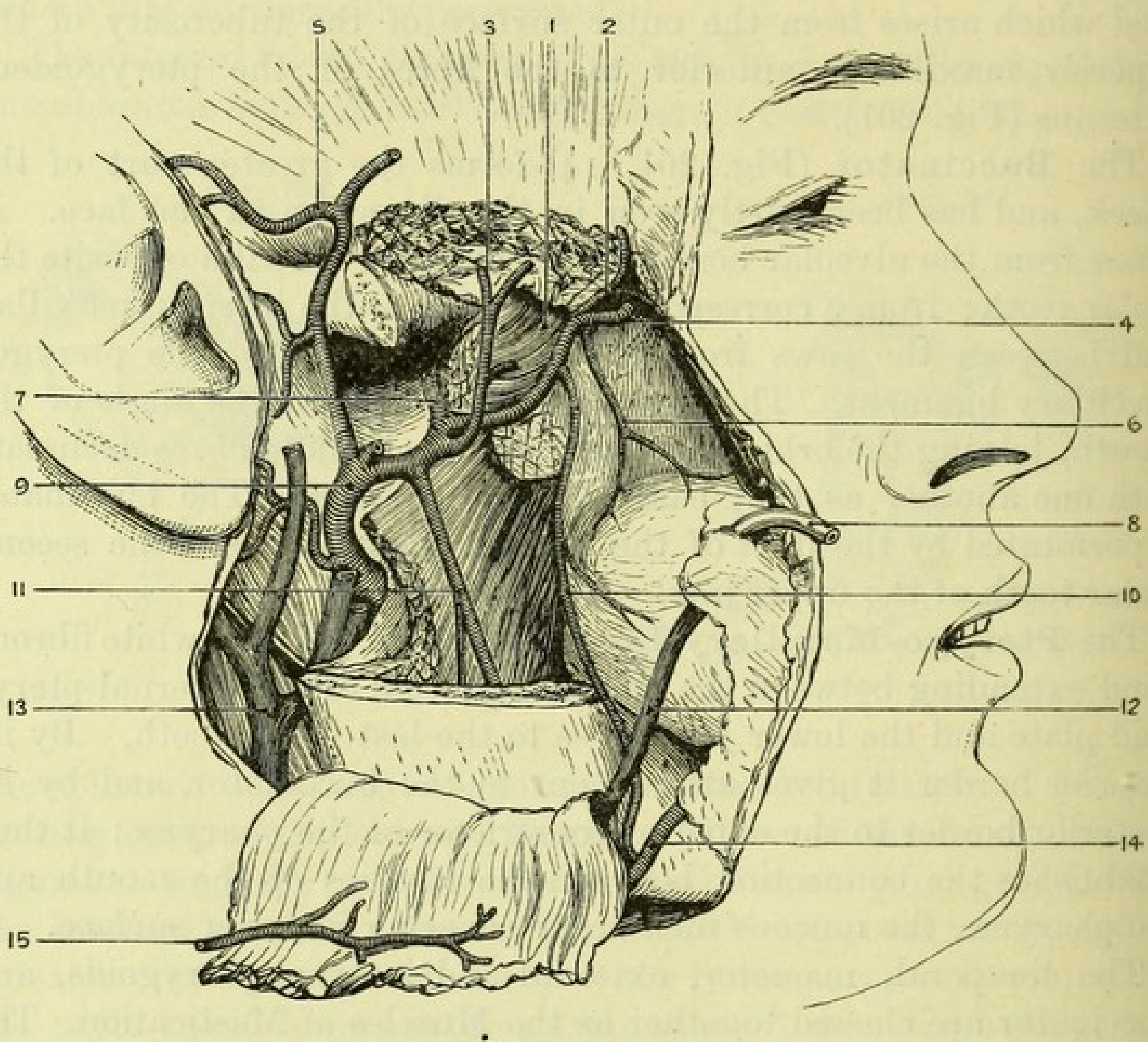
The temporal, masseter, external and internal pterygoids, and buccinator are classed together as the Muscles of Mastication. The temporal, masseter, and internal pterygoid muscles close the jaws, but the superficial part of the masseter and internal pterygoid draw the lower jaw forward, whilst the posterior part of the temporal draws it back, thus producing the antero-posterior movement. The lateral movements of the jaw are produced by the alternate action of the two external pterygoid muscles, which, if acting together, protrude the chin.

The principal action of the buccinator is to keep the food between the teeth during mastication, but it also expels air from the mouth (and hence the name "trumpeter"), as is well seen in using the blowpipe.

The muscles of mastication are all *supplied* by the motor portion of the third division of the 5th nerve, except the buccinator, which is supplied by the facial nerve (7th), as is shown by the fact that in paralysis of that nerve the buccinator fails in its action, and food collects between the teeth and the cheek.

The **Internal Maxillary Artery** (Fig. 200) is seen in this dissection in its first and second portions, the third being in the

Fig. 200.



spheno-maxillary fossa. One of the terminal branches of the external carotid artery, it arises in the parotid gland immediately behind the neck of the jaw.

The **First Part** of the internal maxillary artery, with its accompanying veins, passes forwards between the neck of the jaw and the

Fig. 200.—The internal maxillary artery (from University College Museum).

1. External pterygoid muscle.
2. Anterior deep temporal artery.
3. Posterior deep temporal artery, giving a pterygoid branch.
4. Infra-orbital artery.
5. Temporal artery.
6. Posterior dental artery.
7. Middle meningeal artery.
8. Stenson's duct.
9. External carotid.
10. Buccal branch communicating with facial artery.
11. Inferior dental artery giving off mylo-hyoid branch.
12. Facial vein.
13. External jugular vein.
14. Facial artery.
15. Masseteric branch (turned down).

internal lateral ligament. It gives off a descending branch, the *Inferior dental*, and an ascending branch, the *Middle meningeal*.

a. The *Inferior dental artery* (11) descends on the internal lateral ligament to the inferior dental foramen, by which it enters the lower jaw, usually giving off before doing so a small branch to accompany the lingual (gustatory) nerve; it then runs in a canal in the substance of that bone supplying the posterior teeth, and, after supplying an *incisor branch* to the front teeth, appears on the face at the mental foramen with the third division of the 5th nerve. Immediately before entering the dental foramen it gives off the *mylo-hyoid branch*, which pierces the internal lateral ligament with a nerve of the same name, and runs in a groove on the internal surface of the lower jaw to the cutaneous surface of the mylo-hyoid and to the digastric muscle, joining the sub-mental artery.

b. The *Middle meningeal artery* (7) ascends beneath the external pterygoid muscle, which must be turned forwards with the condyle as above directed, to see the whole of its course. It passes between the two roots of the auriculo-temporal nerve to the foramen spinosum, by which it enters the skull. Before doing so, it usually gives off the *meningea parva* to enter the foramen ovale (Fig. 202, 11).

c, d. Two small arteries, the *tympanic* entering the Glasserian fissure, and the *deep auricular* passing to the external meatus, are irregular in their origin, and often arise together from the middle meningeal.

The **Second Part** of the internal maxillary artery passes forwards and upwards to the pterygo-maxillary fossa, varying in position in different subjects. It is always intermuscular, but it may lie between the temporal and external pterygoid, or between the external and internal pterygoid muscles. If it lies superficially to the external pterygoid muscle, it passes between its two heads to reach the pterygo-maxillary fossa. Its branches are all *muscular*, *i.e.*, to the muscles of mastication. There are two *deep temporal* branches (anterior (2) and posterior (3)) running in the substance of the temporal muscle; a *masseteric* branch (15) of small size passing through the sigmoid notch to the under surface of the muscle (now necessarily divided); two *pterygoid* branches, uncertain in origin and course; and a *buccal* branch (10), which generally pierces the external pterygoid muscle to accompany the nerve to the surface of the buccinator.

The *Posterior dental artery* (6), one of the branches of the third part of the internal maxillary artery, can be seen entering one of the foramina on the posterior surface of the superior maxilla, in which it ramifies, supplying that bone and the molar teeth.

The **Internal Maxillary Vein** receives branches corresponding to those of the artery, and between the muscles forms the *pterygoid plexus*, which communicates with the facial vein by the *anterior internal maxillary vein*, a vessel of considerable size which passes downwards and forwards over the buccinator. By means of the veins coming from the orbit, the pterygoid plexus communicates with the ophthalmic vein and the cavernous sinus. The internal maxillary vein finally enters the parotid gland, to join the temporal vein and form the external jugular vein.

The **Inferior Maxillary Nerve** (Figs. 201 and 202) (3rd division of 5th), as soon as it emerges from the foramen ovale, divides into a motor and a sensory portion, the latter, however, having a few motor fibres mingled with it.

The **Motor Portion** (Fig. 201), with which there are also sensory fibres, is of small size, is placed externally to the sensory portion, and is distributed to the muscles of mastication, running with the corresponding branches of the internal maxillary artery. Its branches are, *anterior* and *posterior temporal* (4 & 5), *masseteric* (9), *pterygoid* and *buccal* (8), and are difficult to find, except the last, which is of good size, and may be traced to the surface of the buccinator, where it communicates with the facial nerve.

The **Sensory Portion** (Fig. 202) gives off a branch to the internal pterygoid, which is connected with the otic ganglion. It then divides, close to the base of the skull, into three trunks, the *Lingual Nerve* (or gustatory) the most anterior; the *Inferior Dental Nerve* (which has some motor fibres) in the middle; and the *Auriculo-Temporal Nerve* most posterior and smallest.

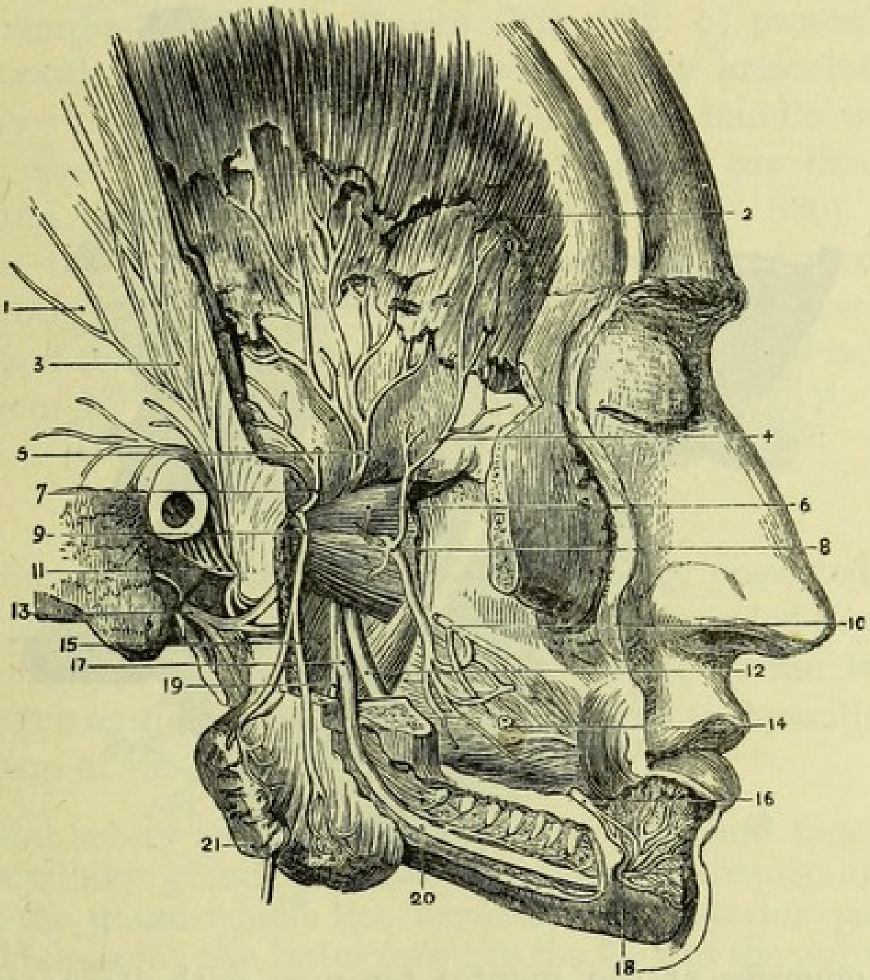
[The auriculo-temporal nerve is to be carefully dissected out from the tough fibrous tissue of the articulation, and traced through the parotid to the pinna and temple.]

The **Lingual** or **Gustatory Nerve*** (Fig. 202, 16) lies at first between the two pterygoid muscles, and then passes forward between the internal surface of the ramus of the jaw and the internal pterygoid muscle; it will be afterwards traced to the side and tip of the tongue. Beneath the external pterygoid the nerve is joined at an acute angle by the small *chorda tympani nerve* (7), a branch

* Since the glosso-pharyngeal nerve has been conclusively shown to be the special nerve of taste, it is desirable that the term "gustatory" as applied to the lingual branch of the fifth should be abandoned.

of the facial nerve in the temporal bone, which passes through the tympanum between the handle of the malleus and the long process of the incus, and emerges through the canal of Huguier at the

Fig. 201.



inner side of the Glasserian fissure, to which it should now be traced.

The **Inferior Dental Nerve** (Fig. 202, 18) has a branch of communication with the lingual trunk, and then descends upon the

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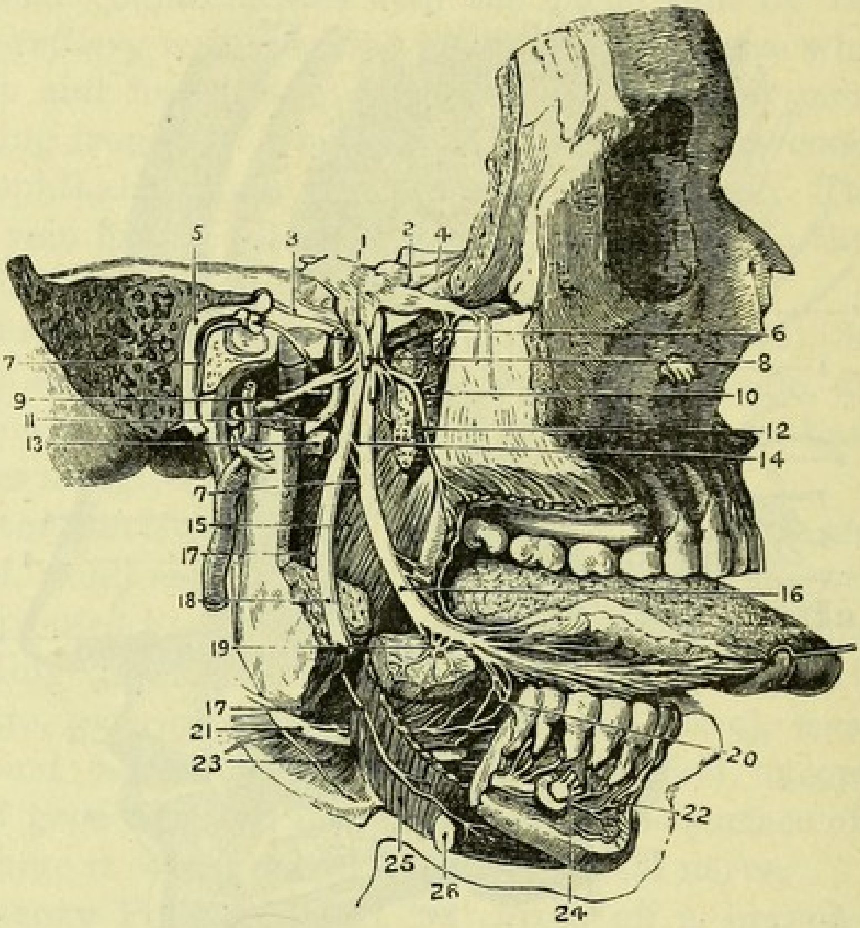
Fig. 201.—Pterygo-maxillary region and fifth nerve (from Hirschfeld and Leveillé).

1. Temporal fascia.
2. Temporal muscle.
3. Temporal branches of auriculo-temporal nerve.
4. Anterior deep temporal branch from buccal nerve.
5. Posterior deep temporal nerve.
6. Pterygoideus externus.
7. Deep temporal branch of masseteric nerve (inconstant).
8. Buccal nerve.
9. Masseteric nerve.
10. Buccal branch of facial (7th).
11. Auriculo-temporal nerve.
12. Lingual nerve.
13. Facial nerve (7th) at stylo-mastoid foramen.
14. Buccinator muscle.
15. Pterygoideus internus.
16. Supra-maxillary branch of facial.
17. Inferior dental nerve.
18. Its mental branches.
19. Its mylo-hyoid branch.
20. Inferior dental canal opened.
21. Masseter (turned down).

pterygoideus internus, and afterwards upon the internal lateral ligament to the dental foramen. After entering the bone it supplies all the teeth of the lower jaw, either directly or by its *incisor* branch

Fig. 202.



(22), and emerges at the mental foramen with its accompanying artery. Immediately before entering the dental foramen it gives

Fig. 202.—Third or inferior maxillary division of the fifth nerve (from Hirschfeld and Leveillé).

1. Third division of fifth nerve.
2. First division of fifth nerve.
3. Superficial petrosal nerve.
4. Second division of fifth nerve.
5. Facial nerve (7th).
6. Meckel's ganglion.
7, 7. Chorda tympani.
8. Muscular branches (divided).
9. Auriculo-temporal nerve.
10. Pterygoideus externus.
11. Middle meningeal artery.
12. Buccal nerve.
13. Internal maxillary artery.
14. Communicating branch of lingual and inferior dental nerves.
15. Pterygoideus internus.
16. Lingual nerve.
17, 17. Mylo-hyoid nerve.
18. Inferior dental nerve.
19. Submaxillary ganglion on the deep portion of submaxillary gland.
20. Communication between fifth and ninth nerves.
21. Hypoglossal nerve (9th).
22. Incisor branches of inferior dental nerve.
23. Hyo-glossus muscle.
24. Mental branch of inferior dental nerve.
25. Mylo-hyoid muscle.
26. Anterior belly of digastric.

off the *mylo-hyoid* nerve (17), which pierces the internal lateral ligament with the accompanying artery, and, after running in a groove on the inner surface of the bone, is distributed on the cutaneous surface of the mylo-hyoid muscle, and also supplies the anterior belly of the digastric.

The **Auriculo-Temporal Nerve** (Fig. 202, 9) passes horizontally backwards behind the temporo-maxillary articulation, and often has two roots of origin which embrace the middle meningeal artery. It then turns upwards in front of the ear through the parotid gland, and is distributed on the temple (*v.* p. 320). It gives branches to the ear (auricular), to the external auditory meatus, to the parotid (of which it is the excitory nerve according to Bernard), and to the joint; and communicates with the facial nerve and by one of its roots with the otic ganglion.

The Submaxillary Region.

The Submaxillary region has been partially dissected with the anterior triangle of the neck. It is seen to be bounded superficially by the two bellies of the digastric muscle and by the lower jaw, thus being triangular in shape, and contains the submaxillary gland and a portion of the facial artery.

[The facial artery is to be divided at the jaw, and together with the submaxillary gland turned back, without displacing a deep portion of the gland which lies beneath the posterior part of the mylo-hyoid muscle ; the latter forming the floor of the submaxillary triangle will be exposed, and on its surface will be seen the mylo-hyoid branch of artery and nerve derived from the inferior dental trunks, the artery anastomosing with the submental branch of the facial. By cutting through the digastric muscle at its insertion, detaching it and the stylo-hyoid from the hyoid bone, and turning them back, the mylo-hyoid muscle will be fully exposed, and should be put on the stretch by means of a hook attached to the larynx.]

The **Mylo-hyoid Muscle** (Fig. 202, 25) *arises* from the mylo-hyoid ridge on the inner surface of the lower jaw, and its fibres pass downwards and forwards to be *inserted* into the body of the hyoid bone, and to meet the muscle of the opposite side in a median tendon between the hyoid bone and the lower jaw, thus forming the floor of the mouth.

The mylo-hyoid is an elevator of the hyoid bone, and is *supplied* (with the anterior belly of the digastric) by the mylo-hyoid branch of the inferior dental nerve.

[The mylo-hyoid is to be detached from the lower jaw and turned forward, when three structures will be seen lying in the following order from above downwards on the hyo-glossus muscle, viz., the lingual nerve (5th), the deep portion of the submaxillary gland with Wharton's duct, and the hypoglossal nerve (9th). In addition, immediately below the 9th nerve there is very frequently a large vein corresponding to the lingual artery. In front of the hyo-glossus will be seen the genio-hyoid stretching between the chin and the hyoid bone, and a few fibres of the genio-hyo-glossus, together with a branch (ranine) of the lingual artery. The jaw should now be divided just externally to the genio-hyoid, when it can be turned up, and the tongue being drawn out of the mouth, the fold of mucous membrane forming the *frænum linguæ* will be seen, and may be divided so as to allow all the parts to be put on the stretch with hooks; the dissection can be proceeded with by cleaning the deep part of the submaxillary gland and its duct, and raising the mucous membrane from the sublingual gland, beneath which the duct passes.]

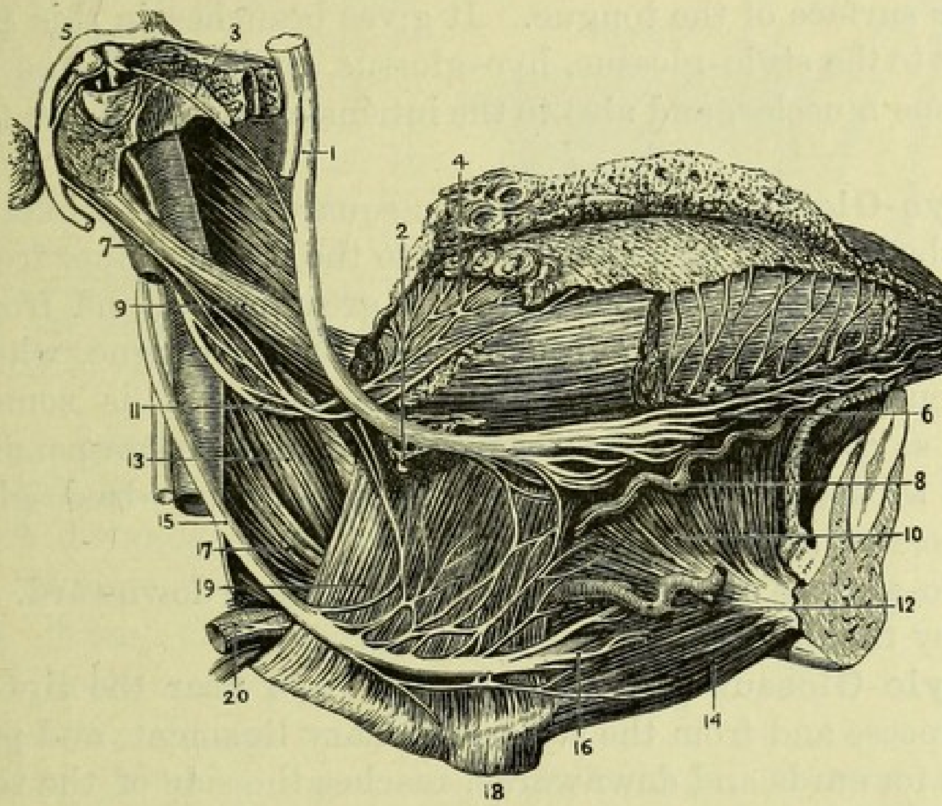
The **Submaxillary Gland** (Fig. 202, 19) consists of two portions, one, the larger, placed superficially on the mylo-hyoid in the submaxillary triangle, and the other winding round the posterior margin of the mylo-hyoid to rest on the hyo-glossus. From this deep portion the duct (Wharton's) arises, and lies at first between the lingual and hypoglossal nerves, but at the anterior part of the hyo-glossus will be found ascending beneath the lingual nerve to lie at a higher level than it. If followed beneath the mucous membrane of the mouth, the duct will be found to cross again over the lingual nerve at the side of the tongue, and to open into the mouth close at the summit of a small papilla to the frænum linguæ.

The **Sublingual Gland** (Fig. 202) is situated beneath the mucous membrane by the side of the tongue, and lies on the genio-hyo-glossus close to Wharton's duct, into which several of its ducts (ductus Riviniani) open, the others opening into the mouth in a crescent near the frænum.

The **Lingual Nerve** (Fig. 203, 1) (Gustatory of 5th) appears at the anterior border of the pterygoideus internus, where it lies against the pterygo-maxillary ligament, and afterwards runs between the jaw and the mucous membrane of the mouth to reach the hyo-glossus, upon which it is at first placed above Wharton's duct and the 9th nerve. Upon the hyo-glossus it crosses the duct and lies below it, but, if followed to the side of the tongue, will be found to pass again beneath the duct, and to be distributed to the side and tip of the tongue, supplying the fungiform and filiform papillæ. Branches of communication pass across the hyo-glossus to the 9th nerve, and a little below the level of the trunk, opposite the deep portion of the submaxillary gland, may be found the following ganglion.

The *submaxillary ganglion* (2) is of small size, and lies below the lingual nerve. It has three roots, the sensory derived from the

Fig. 203.



lingual; the motor from the facial (7th) by means of the *chorda tympani*, which is prolonged on the lingual nerve to the ganglion; and a sympathetic root from the plexus on the facial artery. The branches of distribution are given to the submaxillary gland. The

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Fig. 203.—Nerves of the tongue (from Hirschfeld and Leveillé).

1. Lingual nerve (5th).
2. Submaxillary ganglion.
3. Chorda tympani nerve.
4. Distribution of glosso-pharyngeal nerve to circumvallate papillæ.
5. Facial nerve (7th).
6. Distribution of lingual nerve (5th).
7. Communication between facial and glosso-pharyngeal nerves.
8. Ranine artery.
9. Stylo-glossus.
10. Genio-hyo-glossus.
11. Glosso-pharyngeal nerve.
12. Sublingual artery.
13. Stylo-pharyngeus.
14. Genio-hyoideus.
15. Hypoglossal nerve (9th).
16. Distribution of ninth nerve.
17. Middle constrictor of pharynx.
18. Hyoid bone.
19. Hyo-glossus.
20. Lingual artery.

chorda tympani is afterwards prolonged to the tongue, but its distribution there is unknown.

The **Hypoglossal Nerve** (Fig. 203, 15) (9th)* has been seen crossing the upper part of the anterior triangle, after hooking round the occipital artery, to disappear beneath the posterior border of the mylo-hyoid. It is now seen to lie on the hyo-glossus, which separates it from the lingual artery, and after communicating with the lingual nerve, it passes on to the genio-hyo-glossus muscle and the under surface of the tongue. It gives branches in this part of its course to the stylo-glossus, hyo-glossus, genio-hyoid, and genio-hyo-glossus muscles, and also to the intrinsic muscles of the tongue itself.

The **Hyo-Glossus** (Fig. 204, 6) is a square muscle, which *arises* from the body of the hyoid bone close to the median line, from the upper margin of the whole length of its great cornu, and from the lesser cornu. It is *inserted* into the side of the tongue, where its fibres blend with those of the stylo-glossus. It is sometimes described as consisting of three separate portions, corresponding to its three separate attachments to the hyoid bone—basio-glossus, kerato-glossus, and chondro-glossus.

The hyo-glossus draws the sides of the tongue downward. It is *supplied* by the 9th nerve.

The **Stylo-Glossus** (Fig. 204, 9) *arises* from near the tip of the styloid process and from the stylo-maxillary ligament, and passing obliquely forwards and downwards, reaches the side of the tongue, into which it is *inserted*, the fibres joining those of the hyo-glossus at a right angle, and blending with the fibres of the lingualis.

The stylo-glossus raises the margins of the tongue and draws it upwards and backwards, and therefore back into the mouth when it has been protruded, thus assisting the anterior fibres of the genio-hyo-glossus. It is *supplied* by the 9th nerve.

The **Stylo-Pharyngeus** (Fig. 204, 11) *arises* from the root of the styloid process on its inner side, and passes downward to disappear between the upper and middle constrictors of the pharynx opposite the hyoid bone. Its *insertion* will be seen in the dissection of the pharynx.†

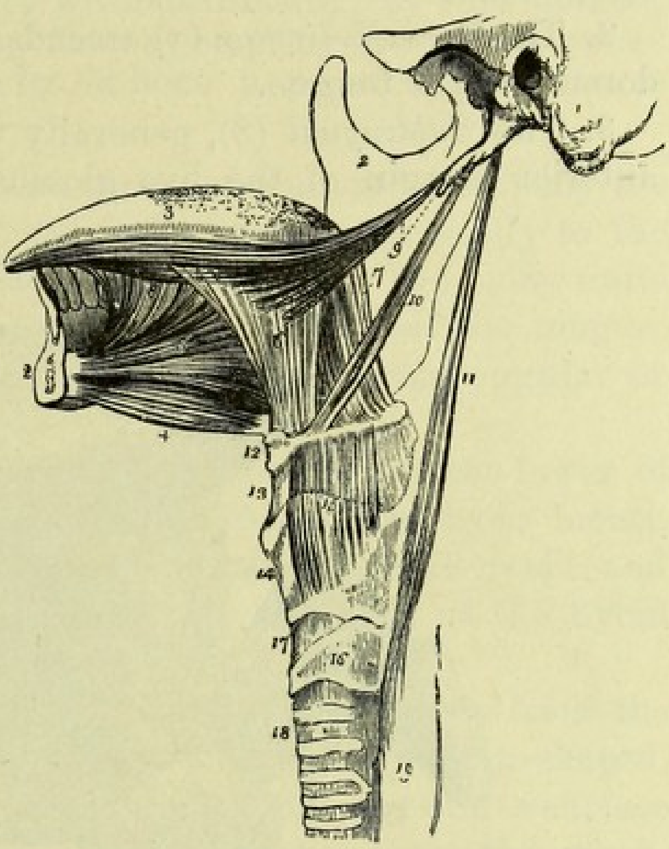
* Lingual nerve of Harrison.

† It will assist the student in remembering the origins of the muscles from the styloid process if he notice that the origins are inversely as the insertions, *i.e.*, that the muscle which arises highest is inserted lowest down. Thus the order of the origins from above downwards is stylo-pharyngeus, stylo-hyoid, and stylo-glossus.

The stylo-pharyngeus is *supplied* by the glosso-pharyngeal nerve, which winds round its posterior border.

[The hyo-glossus is to be divided near the hyoid bone to expose the lingual artery, the branches of which are to be cleaned. The tongue being put on the stretch, all remains of mucous membrane covering the genio-hyoid and genio-hyo-glossus muscles are to be removed, and the muscles cleaned. It will be noticed that by stretching the tongue the natural curves of the lingual artery are more or less obliterated.]

Fig. 204.



The **Lingual Artery** (Fig. 205) has been seen for a short distance in the anterior triangle, viz. from its origin from the external carotid until crossed by the hyo-glossus. It was crossed by the hyo-glossus, digastric, and stylo-hyoid muscles, and by the hypoglossal nerve, and is now seen to lie against the origin of the middle constrictor of the pharynx immediately above the hyoid bone, and then to pass on to the genio-hyo-glossus, by which it is conducted to the tip of the tongue. At the posterior border of the

Fig. 204.—Styloid muscles and muscles of the tongue (from Wilson).

1. Temporal bone of the left side.
2, 2. The right side of the lower jaw divided at its symphysis; the left side having been removed.
3. Tongue.
4. Genio-hyoid.
5. Genio-hyo-glossus.
6. Hyo-glossus; its basio-glossus portion.
7. Its kerato-glossus portion.
8. Anterior fibres of the lingualis issuing from between the hyo-glossus and genio-hyo-glossus.
9. Stylo-glossus with part of the stylo-maxillary ligament.
10. Stylo-hyoid.
11. Stylo-pharyngeus.
12. Os hyoides.
13. Thyro-hyoid membrane.
14. Thyroid cartilage.
15. Thyro-hyoid muscles arising from the oblique line of the thyroid cartilage.
16. Cricoid cartilage.
17. Crico-thyroid membrane.
18. Trachea.
19. Commencement of the œsophagus.

hyo-glossus the hypoglossal nerve is at a slightly higher level than the artery.

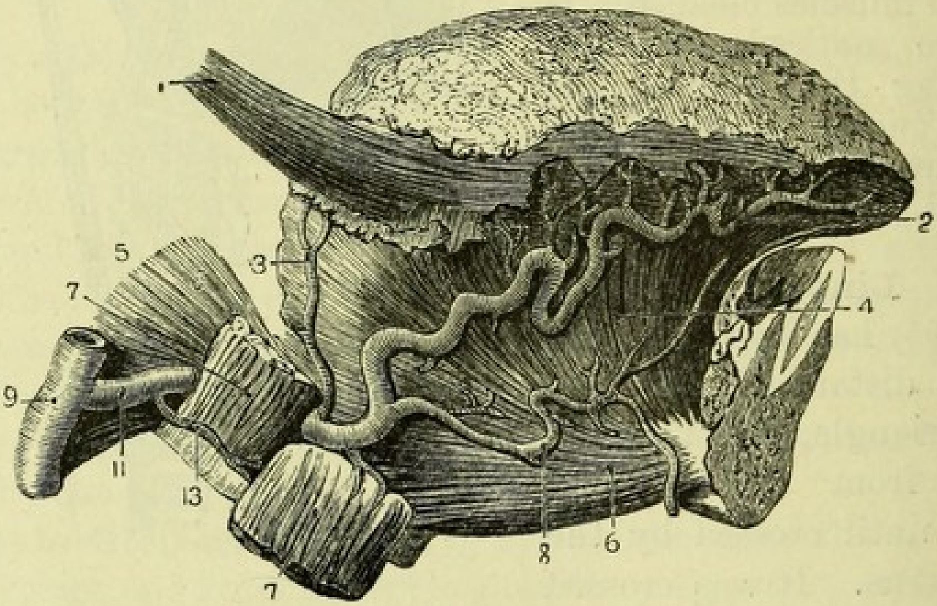
Its *branches* are four in number :—

1. The *Hyoid* (13) branch runs along the upper border of the hyoid bone.

2. The *Dorsalis linguæ* (3) ascends beneath the hyo-glossus to the dorsum of the tongue.

3. The *Sublingual* (8), generally of good size, comes off at the anterior margin of the hyo-glossus, and is directed to the chin

Fig. 205.



across the genio-hyo-glossus, which muscle it supplies, together with the sublingual gland.

4. The *Ranine* (2) is the termination of the lingual artery, and after leaving the genio-hyo-glossus enters the under surface of the tongue, to be continued in its substance to the tip, where it anastomoses, though slightly, with the vessel of the opposite side.

Surgery.—The lingual artery can be most conveniently tied in the triangle formed by the two bellies of the digastric and the hypoglossal nerve, by dividing the fibres of the hyo-glossus horizontally near the hyoid bone. A curved incision from the symphysis menti

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Fig. 205.—Lingual artery and branches (from Hirschfeld and Leveillé).

1. Stylo-glossus.
2. Ranine artery.
3. Dorsalis linguæ artery.
4. Genio-hyo-glossus muscle.
5. Middle constrictor.
6. Genio-hyoid muscle.

7, 7. Hyo-glossus (cut).
8. Sublingual artery.
9. External carotid artery.
11. Lingual artery.
13. Hyoid branch.

to near the angle of the jaw, reaching to the level of the hyoid bone, will expose the lower border of the submaxillary gland, which must be drawn upwards so as to expose the digastric muscle. The 9th nerve, with an accompanying vein, being drawn upwards, the hyo-glossus will be seen and can be divided. The author has on two occasions tied the lingual artery without difficulty by this method, which is much more satisfactory than attempting to find the vessel opposite the great cornu of the hyoid bone, to which its relation is uncertain.

The **Lingual Veins.**—Two small venæ comites accompany the lingual artery, but the large *ranine* vein passes superficially to the hyo-glossus muscle, with the hypoglossal nerve. They may unite with the veins corresponding to the dorsal artery of the tongue, or all three sets may open separately into the internal jugular or the common facial vein.

The **Genio-hyoid** muscle (Fig. 205, 6) *arises* from the lower of the two genial (or mental) tubercles close to the symphysis menti, and passes downwards immediately beneath the mylo-hyoid and close to the median line, to be *inserted* into the body of the hyoid bone.

The **Genio-hyo-glossus** muscle (Fig. 205, 4) *arises* from the upper of the genial tubercles, and is triangular or fan-shaped, being *inserted* close to the median line all along the under surface of the tongue, and to the body of the hyoid bone above the genio-hyoid.

The genio-hyoid and genio-hyo-glossus are elevators of the hyoid bone or depressors of the jaw, as they alternately take their fixed point above or below. The genio-hyo-glossus has an important action on the tongue, the posterior and middle fibres drawing up the hyoid bone and thrusting the tongue out of the mouth (and to the opposite side if acting singly), and the anterior fibres drawing the tongue into the mouth again, being assisted by the stylo-glossus. Both the genio-hyoid and the genio-hyo-glossus are *supplied* by the 9th nerve.

The **Stylo-maxillary Ligament** (Fig. 199, 6) will be seen attached to the angle of the jaw, which is turned up. It is a process of deep cervical fascia attached to the apex of the styloid process (where it gives origin to fibres of the stylo-glossus), and inserted into the inner surface of the angle of the jaw, where it is much widened. It intervenes between the parotid and submaxillary glands.

The **Stylo-hyoid Ligament** is a narrow band passing from the styloid process, where some fibres of the stylo-glossus are attached to it, downwards and forwards to the lesser cornu of the hyoid bone, where it gives origin to fibres of the middle constrictor. It is frequently ossified to a considerable extent.

The **Inferior Palatine** and **Tonsillitic** branches of the *facial artery* can be seen ascending, the former between the stylo-glossus and stylo-pharyngeus muscle, and the latter either with it or between the stylo-glossus and pterygoideus internus, to the outside of the pharynx, where they lie upon the superior constrictor. They will be more fully seen in the dissection of the pharynx.

The **Glosso-pharyngeal Nerve** (Fig. 203, 11) (8th) is seen emerging from between the jugular vein and internal carotid artery, and winding round the stylo-pharyngeus muscle; if the stylo-glossus be now divided, the nerve may be followed beneath that muscle to the base of the tongue, where it divides into two parts and supplies the *papillæ circumvallatæ*, and the mucous membrane of the sides and back of the tongue and the front of the epiglottis. It gives branches to the stylo-pharyngeus and to the pharynx in this part of its course, and will be again seen in another dissection.

Deep Dissection of the Side of the Neck.

On one side only of the subject it will be useful to make a deep dissection, bringing into view, from the side, parts which will be afterwards seen from behind in the dissection of the pharynx.

[Divide the internal lateral ligament of the lower jaw, and cut through the inferior dental and lingual nerves and reflect them carefully upwards. The branch to the internal pterygoid muscle, from the deep surface of the inferior maxillary nerve, can now be traced to the posterior border of the muscle, and in close connection with it may possibly be found a small pink body, the otic ganglion.]

The **Otic Ganglion** (Fig. 217) is a minute body, which receives its motor root (short root of Arnold) from the internal pterygoid nerve of the inferior maxillary division of the fifth. It is situated just below the foramen ovale on the deep surface of the inferior maxillary nerve, and close to the cartilaginous portion of the Eustachian tube. Its sensory root may be traced from the auriculo-temporal nerve, where the latter embraces the middle meningeal artery, and a second sensory root is derived from the tympanic branch of the glosso-pharyngeal (Jacobson's nerve) through the small superficial petrosal nerve (long root of Arnold), by means of which nerve it is also probably placed in communication with the facial.

The sympathetic root enters the ganglion behind, coming from that upon the middle meningeal artery. A branch passes from the ganglion forwards and downwards to the tensor palati muscle, and another backwards to the tensor tympani.

[The internal pterygoid muscle is to be cut through and completely removed from its attachment to the inner surface of the external pterygoid plate. The tensor palati lying upon the internal pterygoid plate will now be exposed, and posterior to it the superior constrictor of the pharynx, with the ascending pharyngeal artery lying upon it.]

The *Ascending Pharyngeal Artery* (Fig. 208, 9) can now be traced from the external carotid artery near its origin, and lies between the internal carotid and the pharynx. It gives branches to the prevertebral muscles, anastomosing with the ascending cervical artery, and near the base of the skull divides into pharyngeal and meningeal branches.

The *meningeal branches* are very small, and enter the skull by the foramen lacerum medium and the foramen jugulare, to supply the dura mater.

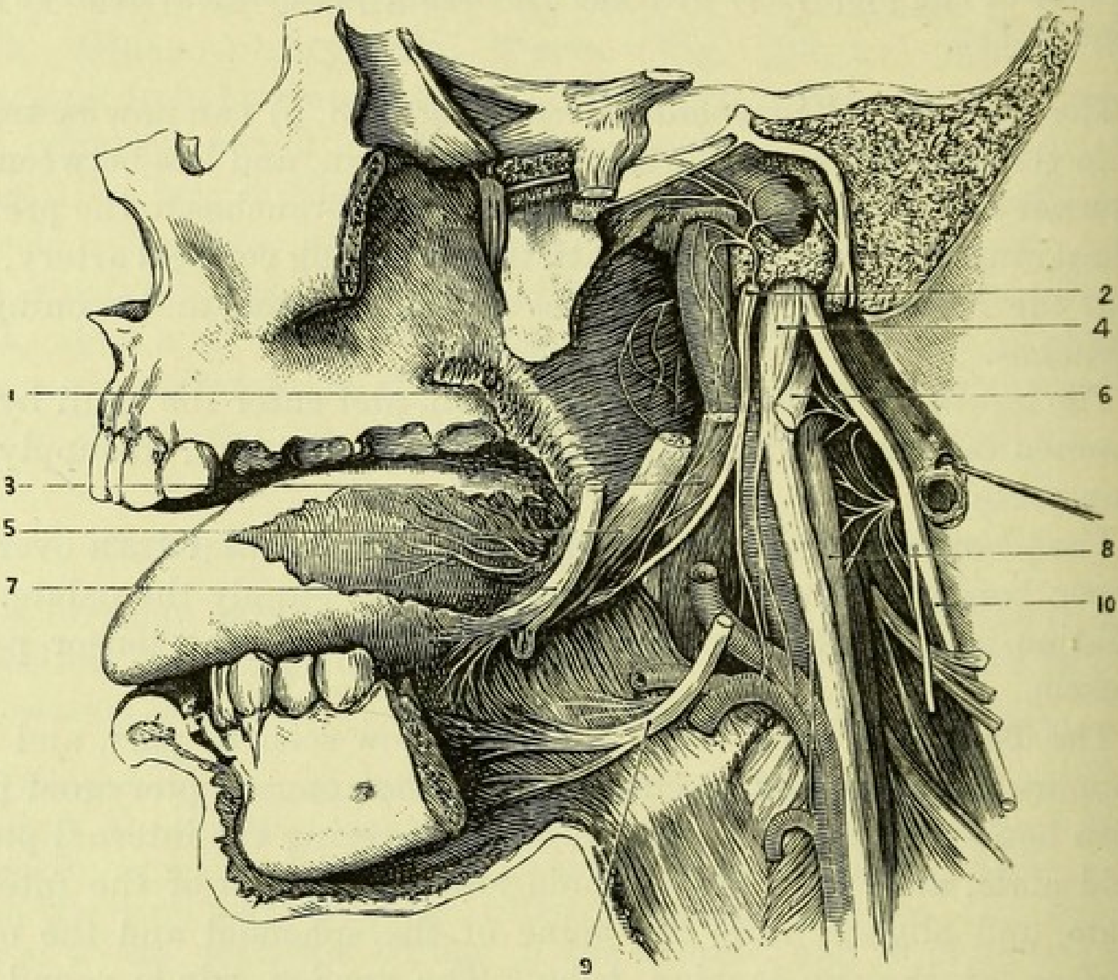
The *pharyngeal branches* supply the pharynx, and turn over the upper border of the superior constrictor to supply the palate. A palatine branch also accompanies the tendon of the tensor palati muscle.

The **Tensor Palati** (Fig. 212, 6) is now seen in part, and will be more fully exposed by cutting away the external pterygoid plate with bone-forceps. Its vertical fibres, covering the internal pterygoid plate, *arise* from the scaphoid fossa at the root of the internal plate, and slightly from the spine of the sphenoid and the outer surface of the Eustachian tube. The tendon winds round the hamular process to its *insertion* into the palate; but this is obscured at present by the attachment of the fibres of the superior constrictor to the internal pterygoid plate.

The **Superior Constrictor of the Pharynx** (Fig 206, 1) is now seen *arising* from the lower third of the internal pterygoid plate, and from the hamular process of the sphenoid bone; from the pterygo-maxillary ligament opposite the attachment of the buccinator; from the inner surface of the lower jaw above the posterior extremity of the mylo-hyoid ridge, and slightly from the side of the tongue. The fibres curve backwards, leaving an interval between the muscle and the base of the skull in which the fibrous bag of the pharynx is visible, to be *inserted* in the median raphé (Fig. 208, 1).

[In order to complete a side-view of the Internal Carotid, Jugular Vein, and Eighth nerve, it will be necessary to remove the remains of the digastric and stylo-hyoid muscles, and the external carotid artery, cutting it above the origin of the ascending pharyngeal branch. The stylo-glossus, which has been already dissected, will now be thoroughly exposed and should be carefully removed, when the Glosso-pharyngeal nerve lying upon the stylo-pharyngeus will be seen.]

Fig. 206.



The **Glosso-pharyngeal Nerve** (Fig. 206, 2) leaves the jugular foramen in front of the pneumo-gastric, and arches forward over the internal carotid artery to the stylo-pharyngeus muscle, against which it lies. Opposite the base of the tongue it turns forward

Fig. 206.—The deep vessels and nerves of the base of the skull (from Hirschfeld and Leveillé).

1. Superior constrictor of pharynx.
2. Glosso-pharyngeal nerve.
3. Stylo-pharyngeus.
4. Pneumo-gastric nerve.
5. Stylo-glossus.
6. Hypoglossal nerve communicating with first cervical.
7. Lingual nerve (5th).
8. Superior cervical ganglion.
9. Hypoglossal nerve.
10. Spinal-accessory nerve.

across the stylo-pharyngeus beneath the stylo-glossus, and has been traced to the base of the tongue, where it is distributed to the mucous membrane (p. 406). The connections and branches of the nerve will be subsequently dissected. Its point of emergence from the skull cannot yet be seen satisfactorily.

The **Stylo-pharyngeus Muscle** (Fig. 206, 3) is now fully exposed in its upper part. It *arises* from the inner surface of the root of the styloid process of the temporal bone, and passing obliquely forwards and downwards with the glosso-pharyngeal nerve, between the external and internal carotid arteries, it disappears between the superior and middle constrictors of the pharynx, and will be subsequently followed to its insertion.

The **Stylo-hyoid Ligament** lies between the stylo-glossus and stylo-pharyngeus muscles, and gives origin to some fibres of the stylo-hyoid above, and of the middle constrictor of the pharynx below. It is attached above to the tip of the styloid process, and below to the lesser cornu of the hyoid bone.

[The styloid process is to be cut through at its base and turned aside with the stylo-pharyngeus, when the careful removal of a process of fascia will expose the internal carotid, the jugular vein, and the eighth pair up to the base of the skull; also the loop between the first and second cervical nerves, and the superior cervical ganglion of the sympathetic. But, in order to show the nerves distinctly, the internal jugular vein is to be divided close to the jugular foramen, after its description has been read, and is to be turned down.]

The **Internal Carotid Artery** (Fig. 206) commences at the point of bifurcation of the common carotid, usually opposite the upper border of the thyroid cartilage. It is at first behind the external carotid, and, like it, is *covered by* the sterno-mastoid and platysma muscles, and crossed by the hypoglossal nerve, the occipital and posterior auricular arteries, with the digastric and stylo-hyoid muscles. It then lies beneath the parotid gland and to the inner side of the external carotid, and is crossed by the styloid process and the stylo-pharyngeus muscle, with the glosso-pharyngeal nerve and pharyngeal branch of the vagus. *Posteriorly* it rests against the sympathetic trunk, and the rectus capitis anticus major, and is crossed on the inner side, and somewhat posteriorly, by the superior and external laryngeal branches of the pneumo-gastric. The pneumo-gastric nerve and internal jugular vein lie to its *outer* side in the whole of its course, and to the *inner* side is the pharynx, with the tonsil and the ascending pharyngeal artery.

The artery enters the carotid canal of the temporal bone, in which it will be subsequently traced.

The **Internal Jugular Vein** (Fig. 206) which is the continuation of the lateral sinus, commences outside the skull at the posterior part of the jugular foramen, in a dilated portion called the *sinus* or *bulb*, and is at once joined by the inferior petrosal sinus. It lies at first behind the internal carotid artery in front of the rectus capitis lateralis, the eighth and ninth nerves intervening. It afterwards descends on the outer side of the internal and common carotid arteries, being inclosed in the same sheath as the latter. It receives no branch above the hyoid bone, but below that level it is much increased in size by the influx of the superior thyroid, lingual, facial, occipital, pharyngeal, and middle thyroid veins; and joins the subclavian vein behind the inner end of the clavicle to form the innominate or brachio-cephalic vein (p. 368). Near the lower end is a single or double valve, often imperfect.

The **Pneumogastric Nerve** or **Vagus** (Fig. 206, 4) leaves the skull at the foramen jugulare in front of the jugular vein, and in the same sheath as the spinal-accessory nerve. It follows the carotid artery, lying between it and the jugular vein, and close to the skull is joined by the accessory portion of the spinal-accessory nerve, and expands to form the large *ganglion of the trunk*, from which the two following branches can now be traced. The pneumogastric communicates with the hypoglossal, the spinal-accessory, the glosso-pharyngeal, the loop between the first two cervical nerves, and the upper ganglion of the sympathetic.

The *pharyngeal branch* (Fig. 185, 3) leaves the upper part of the ganglion, receives a branch from the spinal-accessory nerve, and then passes in front of the internal carotid artery to the pharynx, where it joins the pharyngeal plexus (p. 419).

The *superior laryngeal nerve* (Fig. 185, 9) leaves the middle of the ganglion and takes an oblique course, behind and to the inner side of the internal carotid, to the thyro-hyoid membrane.

The *external laryngeal nerve* is a branch of the preceding, and runs downwards and inwards to supply the crico-thyroid muscle.

The cranial branches of the pneumo-gastric will be subsequently described (p. 417).

The **Spinal-Accessory Nerve** (Fig. 206, 10) leaves the jugular foramen in the sheath of the pneumo-gastric nerve, with which it has communicating branches. It gives branches, by means of the accessory part which joins the vagus in the jugular foramen, to join the pharyngeal and superior laryngeal branches of the latter.

The principal or spinal part passes over or under the internal jugular vein, and pierces the sterno-mastoid muscle to end in the trapezius (p. 337).

The **Hypoglossal Nerve** (Fig. 206, 6), emerging at the anterior condyloid foramen, comes forward between the pneumo-gastric and spinal-accessory nerves, being closely united with the ganglion of the trunk of the former nerve, and crosses the external carotid artery. It has branches of communication with the pneumo-gastric and sympathetic, and also with the first three spinal nerves. Its distribution to the muscles of the tongue has been already seen (p. 402).

The **Rectus Capitis Lateralis** (Fig. 207, 8), is now seen from the side, between the jugular vein and the vertebral artery. It *arises* from the upper surface of the transverse process of the atlas, and is *inserted* into the under surface of the jugular process of the occipital bone.

[By carefully removing the rectus lateralis, the small anterior branch of the first cervical nerve may be found beneath it upon the anterior arch of the atlas, forming a loop with the second nerve.]

The **First Cervical Nerve** (sub-occipital nerve) (Fig. 206) has a small anterior division, which leaves the posterior division on the posterior arch of the atlas. It runs forward beneath the vertebral artery, and lies on the anterior arch to the inner side of the rectus lateralis, which it supplies, giving also branches to the pneumo-gastric and the hypoglossal nerves, and to the superior ganglion of the sympathetic. In front of the vertebræ the first nerve forms a loop with the second cervical nerve, which is much larger than itself, and supplies twigs to the two anterior recti.

The **Superior Cervical Ganglion** (Fig. 206, 8) of the sympathetic can now be seen. It is a considerable fusiform enlargement of the sympathetic nerve behind the internal carotid artery, and lying upon the rectus capitis anticus major over the 2nd and 3rd vertebræ. It gives branches of *communication* to the 8th and 9th nerves, and also to the four upper cervical nerves; and branches of *distribution* to the internal carotid artery; to the branches of the external carotid artery (nervi molles); to the pharynx, joining the pharyngeal plexus; to the superior laryngeal nerve (occasionally); and the *superior cardiac nerve* to the cardiac plexus (Fig. 186). It will be much more satisfactorily examined later on from behind (Fig. 208, 12).

Prevertebral Region.

[The carotid arteries, with the jugular veins and the pneumogastric and sympathetic nerves, are to be divided at the level of the top of the sternum, and the trachea with the œsophagus is to be severed a little lower down. The neck is then to be bent forcibly backward so as to make the cut surface of the skull rest upon the table, and the œsophagus and trachea, with the vessels and nerves, being drawn forcibly forward, the cellular tissue between the pharynx and the front of the vertebral column is to be cautiously dissected through, until the under surface of the base of the skull is exposed. The saw is now to be applied close behind the mastoid process, and an oblique cut made, which is to be carried through the whole thickness of the temporal bone into the jugular foramen, and prolonged through the remaining portion of the parietal bone to the cut which was made in removing the brain. A similar cut having been made on the opposite side, a broad chisel is to be applied to the basilar process of the occipital bone, where it is exposed behind the pharynx, and it is to be divided. The chisel being again applied on each side of the middle line will unite this cut with those made by the saw, and the preparation will then be divided into two parts; the anterior part of the skull, with the pharynx and deep vessels and nerves, is to be wrapped up for subsequent examination, and the muscles attached to the vertebral column, with the posterior part of the skull, are now to be examined.]

The Scalene muscles have been seen already in part, but can now be fully dissected.

The **Scalenus Anticus** (Fig. 207, 2) *arises* from the tubercle on the inner border and upper surface of the first rib (scalene tubercle), and ascends to be *inserted* into the anterior tubercles on the transverse processes of the 3rd, 4th, 5th and 6th cervical vertebræ. The phrenic nerve will probably still be found on the anterior surface of the muscle, and behind it the brachial nerves emerge and the subclavian artery passes.

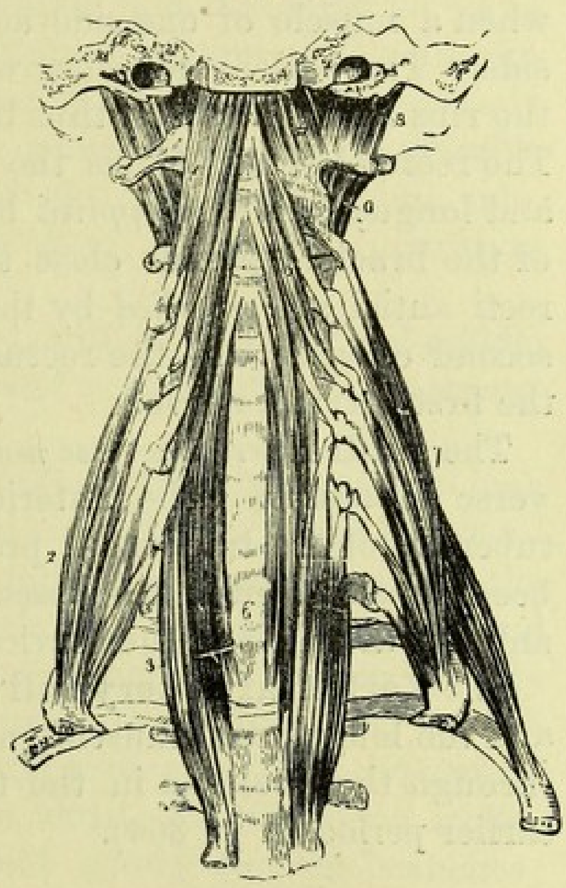
The **Scalenus Medius** (Fig. 207, 7) lies behind the brachial nerves, *arising* from the rough marking upon the upper surface of the first rib behind the groove for the subclavian artery. It ascends to be *inserted* into the posterior tubercles on the transverse processes of the lower six cervical vertebræ.

The **Scalenus Posticus** (Fig. 207), which is the smallest of the three muscles, *arises* from a rough mark on the outer surface of the second rib, posterior to the attachment of the serratus magnus; and is *inserted* into the posterior tubercles on the transverse processes of the lowest three cervical vertebræ.

The **Rectus Capitis Anticus Major** (Fig. 207, 1) *arises* from the anterior tubercles on the transverse processes of the 3rd, 4th, 5th and 6th cervical vertebræ (thus corresponding to the insertion of the scalenus anticus), and is *inserted* into the under surface of the basilar process of the occipital bone, close to the median line. The insertions of this and the following muscles are very generally damaged by the division of the base of the skull.

The **Rectus Capitis Anticus Minor** (Fig. 207, 4) is beneath the preceding muscle, which must be turned aside to show it. It *arises* from the front of the lateral mass of the atlas, and partly from its transverse process, and ascends obliquely inwards to be *inserted* into the under surface of the basilar process of the occipital bone, posterior to, and further from the median line than, the rectus major.

Fig. 207.



The **Rectus Capitis Lateralis** (Fig. 207, 8) is now exposed, although not a prevertebral muscle. It *arises* from the upper surface of the transverse process of the atlas, and is *inserted* into the under surface of the jugular process of the occipital bone. It separates the internal jugular vein from the vertebral artery.

The **Longus Colli** (Fig. 207) lies on the front of the cervical vertebræ, and is most conveniently divided into three portions, two oblique and one vertical.

The *inferior oblique portion* (3) *arises* from the bodies of the 1st and 2nd dorsal vertebræ, and passes obliquely upwards to be *inserted* into the transverse processes of the 5th and 6th cervical vertebræ.

Fig. 207. Prevertebral muscles of the neck (from Wilson).

1. Rectus capitis anticus major.
2. Scalenus anticus.
3. Lower oblique part of the longus colli of the right side.
4. Rectus capitis anticus minor.
5. Upper oblique portion of the longus colli.
6. Vertical portion of longus colli.
7. Scalenus medius; behind which is seen the scalenus posticus.
8. Rectus lateralis, left side.
9. One of the inter-transversales.

The *superior oblique portion* (5) *arises* from the anterior tubercles on the transverse processes of the 3rd, 4th, and 5th cervical vertebræ, and passes upwards and outwards to be *inserted* into the anterior tubercle of the atlas.

The *vertical portion* (6) *arises* from the bodies of the three lower cervical and three upper dorsal vertebræ, and receives slips from the transverse processes of some of the lower cervical vertebræ. It is *inserted* into the bodies of the 2nd, 3rd, and 4th cervical vertebræ.

All the prevertebral muscles draw forward the upper part of the vertebral column or bow the head, when acting symmetrically; or when a muscle of one side acts alone, it draws the spine to that side. The scalene muscles, when the vertebræ are fixed, act upon the ribs and raise them, thus being ordinary muscles of inspiration. The rectus lateralis bends the head to its own side. The scaleni and longus colli are *supplied* by branches derived from the nerves of the brachial plexus close to the intervertebral foramina. The recti antici are *supplied* by the anterior branches of the first and second cervical, and the rectus lateralis by the anterior branch of the first cervical nerve.

The small *Intertransverse muscles* may be seen between the transverse processes. The anterior ones pass between the anterior tubercles of the transverse processes, and the posterior ones have been already seen in the dissection of the back. Between them the anterior divisions of the cervical nerves appear.

The **Vertebral Artery** will be seen between the scalenus anticus and the longus colli muscles, and may be more conveniently traced through the foramina in the transverse processes now than at an earlier period (*v.* p. 364).

DISSECTION OF THE PHARYNX.

Before dissecting the anterior half of the skull with the pharynx, the dissector should examine the fauces and upper part of the pharynx from the mouth. The soft palate, with the uvula in the median line, will be readily recognised, and passing from the soft palate on each side will be seen the two pillars of the fauces, with the tonsil between them. The anterior pillar extends from the soft palate to the tongue, being vertical in direction, and formed by the palato-glossus muscle. The posterior pillar passes obliquely backwards, and is lost in the pharynx, being formed by the palato-pharyngeus muscle. The tonsil is generally much shrunken in a subject which has arrived at this stage of dissection.

[The pharynx and upper part of the œsophagus are to be carefully distended with cotton wool or tow, and the preparation being placed with the face downwards, is to be secured over a small block with hooks, one set of which should draw the œsophagus down and keep the pharynx tense. The vessels and nerves at the back of the pharynx are to be examined before the muscular bag itself is dissected.

The vessels and nerves now to be examined have all been seen in part in previous dissections, and then from either the front or the side. They are now all seen from behind, and this must be borne in mind thoroughly, or it will lead to misconception of the description. The section of the base of the skull is seldom precisely similar on the two sides, and it will generally be found advisable therefore to trace the parts first brought into view on one side, and the carotid artery, etc., on the other, as in the illustration (Fig. 208).

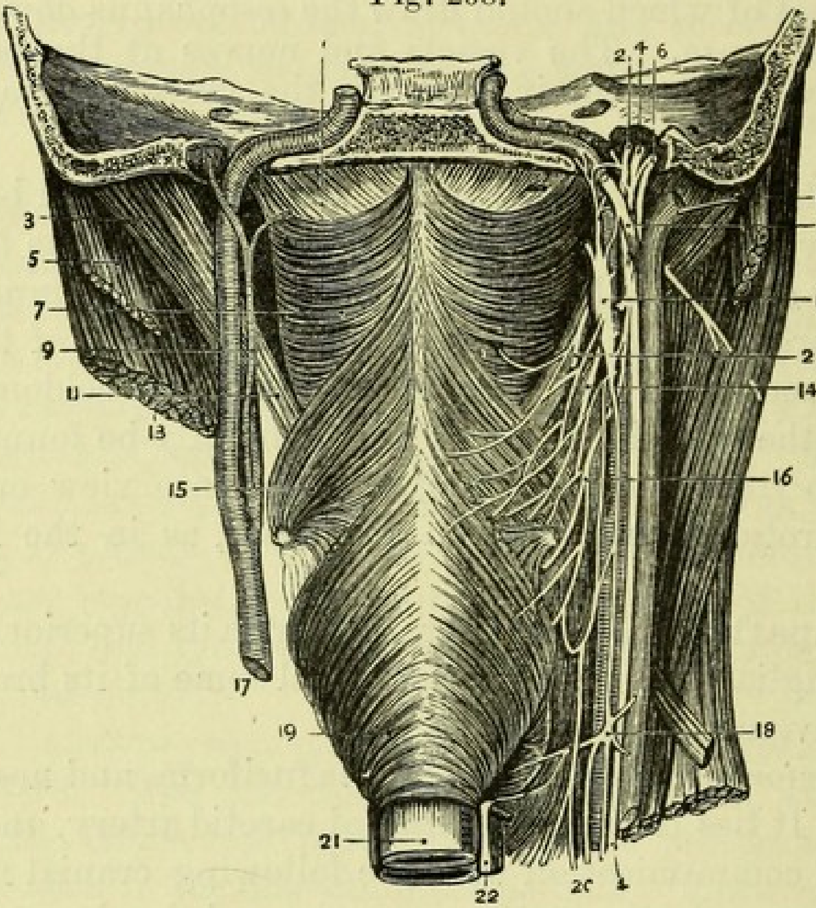
The **Sympathetic Nerve** (Fig. 208), with its superior and middle cervical ganglia, is at once exposed, and some of its branches may be very conveniently traced.

The *Superior cervical ganglion* (12) is fusiform, and nearly an inch in length. It lies behind the internal carotid artery, and has small branches of communication with the following cranial nerves—the glosso-pharyngeal, the pneumo-gastric, and the hypoglossal, and with the four upper cervical nerves, which have been already seen. The branches of distribution are, (1) the ascending branch which passes up on the internal carotid artery to form the carotid and cavernous plexuses inside the skull; (2) the *nervi molles*, distributed upon the external carotid artery and its branches; (3) the *pharyngeal branch*, which can now be traced to the pharynx, where it enters into the formation of the pharyngeal plexus; (4) the *laryngeal branch* to the superior laryngeal nerve; (5) the *superior cardiac nerve*, which has been already seen.

The *Middle cervical ganglion* (18) is of small size, and is usually connected with the 5th and 6th spinal nerves; it gives off (1) *thyroid* branches upon the inferior thyroid artery, and (2) the *middle cardiac nerve* (Fig. 186).

The **Ninth** or **Hypoglossal Nerve** (Fig. 208, 10) is necessarily cut off at the anterior condyloid foramen in making the dissection, and should therefore be traced from below, where it will be found in relation with the occipital artery. The nerve is at first posterior to the internal carotid artery and jugular vein, and then passes between them, and also between the pneumo-gastric and spinal-accessory nerves, with the former of which it has a communication, as well as with the superior cervical ganglion of the sympathetic.

Fig. 208.



A small branch, connected with the hypoglossal at one end and loose at the other, is the communicating branch from the first and second cervical nerves (Fig. 209, 19).

The **Internal Jugular Vein** (Fig. 208, 8) commences outside

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Fig. 208.—Dissection of the pharynx with the carotid vessels and the eighth, ninth, and sympathetic nerves (drawn by J. T. Gray).

1. Fibrous bag of pharynx.
2, 2. Glosso-pharyngeal nerve.
3. Posterior belly of digastric.
4, 4. Pneumo-gastric nerve.
5. Splenius capitis.
6. Spinal-accessory nerve.
7. Superior constrictor of pharynx.
8. Internal jugular vein.
9. Ascending pharygeal artery.
10. Hypoglossal nerve.
11. Stylo-pharyngeus.
12. Superior ganglion of sympathetic.
13. Sterno-mastoid.
14. Pharyngeal branch of pneumo-gastric.
15. Middle constrictor of pharynx.
16. Superior laryngeal nerve.
17. Common carotid artery.
18. Middle ganglion of sympathetic.
19. Inferior constrictor of pharynx.
20. Cardiac nerves.
21. Œsophagus.
22. Recurrent laryngeal nerve.

the skull, by the junction of the lateral sinus with the inferior petrosal sinus. Its course in the neck has been already seen, and it should now be divided close to the skull and removed, if this has not been previously done.

The **Spinal-accessory Nerve** (Fig. 208, 6) emerges from the foramen jugulare, where it is closely connected with the pneumo-gastric nerve, and may be traced to the deep surface of the sterno-mastoid muscle (Fig. 209, 4).

The **Pneumo-gastric Nerve** (Fig. 208, 4) leaves the foramen jugulare in the same sheath as the spinal-accessory nerve, with which it has communicating branches. Two ganglia are found upon the pneumo-gastric nerve, viz., the superior or ganglion of the root, and the inferior or ganglion of the trunk.

The *ganglion of the root* is very small, and is placed in the jugular foramen. It has minute branches of communication with the glosso-pharyngeal, spinal-accessory, sympathetic, and facial nerves. The communication with the latter is through a minute *auricular* branch (*Arnold's nerve*), which enters a hole within the jugular fossa, and passes through the temporal bone to the pinna (Fig. 209, 17).

The *ganglion of the trunk* is nearly an inch long, and of a pink colour, and has branches of communication with the hypoglossal, the sympathetic, and the loop of the first and second cervical nerves. It gives off pharyngeal and superior laryngeal branches, which have been described at p. 410.

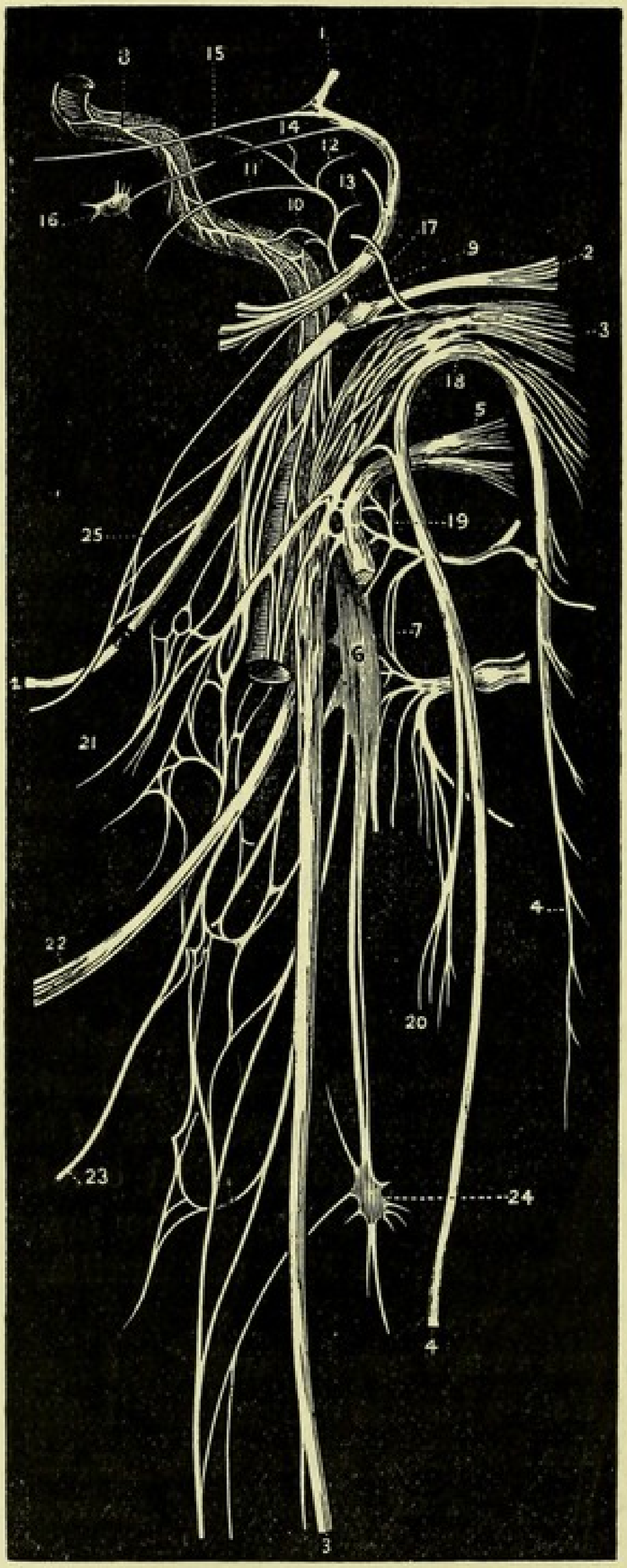
The **Glosso-pharyngeal Nerve** (Fig. 209, 2) lies in a little special notch in the lower border of the petrous bone as it leaves the jugular foramen, being thus isolated from the remainder of the eighth nerve. It then passes forward over the internal carotid artery, and reaches the stylo-pharyngeus muscle, at the lower border of which it has already been seen in the submaxillary region, and has been traced to the tongue.

It presents two small ganglia, one at the upper part of the foramen, the *superior* or *jugular ganglion*, which is of very small size, and the other at the lower part of the foramen, which is larger, and is called the *inferior* or *petrous ganglion* or *ganglion of Andersch* (Fig. 209, 2).

The upper ganglion involves only some of the fibres of the nerve, but they all pass through the lower ganglion.

The lower ganglion has branches of communication with the pneumo-gastric nerve, one going to its superior ganglion, and another to the auricular nerve; also with the superior ganglion of the sympathetic; and with the facial nerve by a branch which pierces the posterior belly of the digastric (Fig. 209, 25).

Fig. 209.



The glosso - pharyngeal nerve gives off the following branches in its course to the tongue :—

1. *Carotid branches*, which join the sympathetic plexus on that vessel, and communicate with the pharyngeal branch of the pneumo-gastric.

2. *Muscular branches* to the stylo-pharyngeus.

3. *Pharyngeal branches*, which assist in forming the pharyngeal plexus.

4. *Tonsillitic branches* to the tonsils and the soft palate.

5. *Lingual branches* which have been before traced to their termination (p. 406.)

[By cautiously cutting away the temporal bone with the bone-forceps so as to open the cavity of the tympanum, the dissector may, in a favourable subject, see some of the branches of Jacobson's nerve on the inner wall of this cavity.]

The *Tympanic branch of the glosso-pharyngeal nerve* (Jacobson's nerve) (Fig. 209, 9) arises from the petrous ganglion, and enters an aperture in the ridge of bone be-

Fig. 209.—Diagram of the eighth, ninth, and sympathetic nerves (from Hirschfeld and Leveillé).

1. Facial nerve.
2. Glosso-pharyngeal nerve with its petrous ganglion.
3. Pneumo-gastric nerve.
4. Spinal-accessory nerve.
5. Hypoglossal nerve.

tween the carotid foramen and the jugular fossa. It pierces the floor of the tympanum and grooves the *promontory* on its inner wall, giving branches to the *fenestra ovalis* (12), the *fenestra rotunda* (13), and the lining membrane of the tympanum and Eustachian tube (11).

The communicating branches of Jacobson's nerve are three in number; one joining the carotid plexus in the carotid canal (10); the second joining the great superficial petrosal nerve (15); and the third running through the temporal bone, to end in the otic ganglion, as the small superficial petrosal nerve of Arnold (14). (*See* also Fig. 217.)

Opportunity may be taken at this point to examine the ossicles of the tympanum (p. 440).

The **Pharyngeal Plexus** (Figs. 208 and 209) is to be found upon the middle and inferior constrictors of the pharynx. It supplies the constrictors and sends branches to the mucous membrane of the pharynx, tongue and larynx. Minute ganglia are sometimes seen on the nerves. The branches forming the plexus are derived from the nerves which have been examined, viz., the glosso-pharyngeal, the pneumo-gastric (pharyngeal and superior laryngeal branches), and the sympathetic.

[In all probability the carotid canal in the temporal bone will have been opened on one side in making the section of the skull, but if not, this may now be done with the bone-forceps or chisel.]

The **Internal Carotid Artery** (Fig. 208) has been already seen from the front in the dissection of the neck, its connections before it enters the skull are given at p. 409. The danger of the close proximity of the carotid to the pharynx has been exaggerated, since (as will be afterwards seen) an ordinary incision may be made in

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6. Superior cervical ganglion of sympathetic.
7. Loop between 1st and 2nd cervical nerves.
8. Carotid branch of sympathetic.
9. Tympanic nerve (Jacobson).
10. Its branch to carotid plexus.
11. Its branch to Eustachian tube.
12. Its branch to fenestra ovalis.
13. Its branch to fenestra rotunda.
14. Its union with small superficial petrosal nerve.
15. Its union with large superficial petrosal nerve.
16. Otic ganglion.
17. Auricular nerve of pneumo-gastric.
18. Junction of pneumo-gastric with spinal-accessory.
19. Junction of 9th nerve and 1st cervical nerve.
20. Junction of mastoid branch of spinal-accessory and 2nd cervical nerve.
21. Pharyngeal plexus.
22. Superior laryngeal nerve.
23. External laryngeal nerve.
24. Middle cervical ganglion of sympathetic.
25. Junction of digastric nerve (7th) with glosso-pharyngeal.

the tonsils or back of the pharynx without any risk of injuring the vessel, which lies quite to the side.

The carotid takes a tortuous course in the temporal bone and cranium, making two sigmoid turns, one, the longer, in the petrous bone, and the other by the side of the sella turcica. In this part of its course it is more or less surrounded by a plexus of nerves derived principally from the sympathetic.

The **Ascending Pharyngeal Artery** has been described at p. 407. Its *vein* opens into the internal jugular.

[The constrictor muscles of the pharynx are to be cleaned, in the direction of the fibres, by removing a firm fascia which covers them. beginning at the lower border of the inferior constrictor. In order to see the origin of the superior constrictor, it will be necessary to remove the internal pterygoid on one side, if this has not been already done. The pharyngeal plexus must necessarily be destroyed in the course of the dissection, but the superior and inferior laryngeal, and the glosso-pharyngeal nerves are to be preserved.]

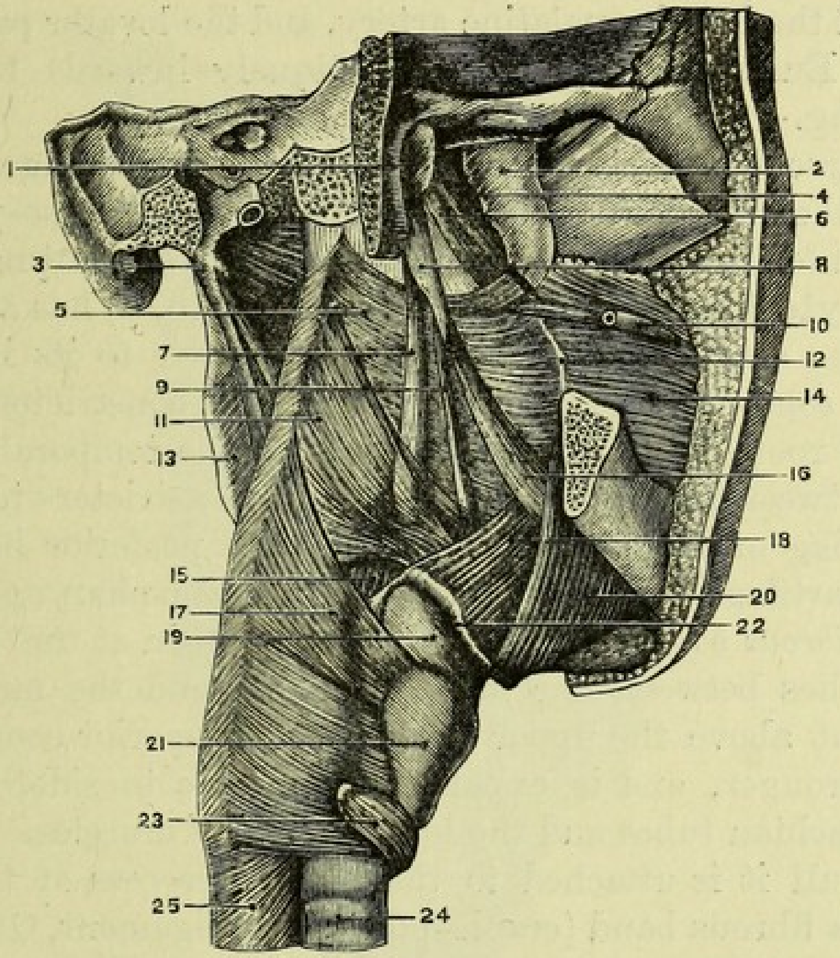
The **Inferior Constrictor** (Fig. 210, 17) is the most superficial of the three muscles of the pharynx, the upper oblique border overlapping the middle constrictor, and the lower straight border being continuous with the œsophagus. It *arises* from the side of the cricoid cartilage, in front of the articular facet for articulation with the inferior cornu of the thyroid, and from the ala of the thyroid cartilage behind the oblique line. All the fibres are *inserted* into the median raphé. The recurrent laryngeal nerve passes beneath the lower border of the inferior constrictor, and the superior laryngeal nerve and artery intervene between it and the middle constrictor.

The **Middle Constrictor** (Fig. 210, 11) is a fan-shaped muscle, which with its fellow of the opposite side forms a trapezium in the median line. It *arises* from the upper surface of the great cornu of the hyoid bone, from the lesser cornu, and from the stylo-hyoid ligament; and its fibres radiate, the upper ascending and the lower descending obliquely, to be *inserted* into the median raphé of the pharynx.

The middle constrictor is overlapped by the inferior constrictor, and itself covers the superior constrictor in part. It is separated from the inferior constrictor by the superior laryngeal nerve and vessels, and from the superior constrictor by the stylo-pharyngeus muscle and glosso-pharyngeal nerve.

The **Superior Constrictor** (Fig. 210, 5) *arises* from the lower third of the internal pterygoid plate and from the hamular process of the sphenoid bone; from the pterygo-maxillary ligament opposite the attachment of the buccinator; from the inner surface of the lower jaw above the posterior extremity of the mylo-hyoid ridge, and slightly from the side of the tongue. The fibres curve

Fig. 210.



backwards, leaving an interval between the muscle and the base of the skull in which the fibrous bag of the pharynx is visible, and are *inserted* into the median raphé, being overlapped at the lower part by the middle constrictor. Distinct tendinous fibres may occa-

Fig. 210.—Side view of the pharynx (from Sappey).

1. Eustachian tube.
2. External pterygoid plate.
3. Left styloid process.
4. Tensor palati.
5. Superior constrictor.
6. Levator palati.
7. Stylo-pharyngeus, upper part.
8. Right styloid process.
9. Stylo-hyoid muscle.
10. Stenson's duct.
11. Middle constrictor.
12. Pterygo-maxillary ligament.
13. Internal pterygoid.
14. Buccinator muscle.
15. Stylo-pharyngeus, lower part.
16. Stylo-glossus.
17. Inferior constrictor.
18. Hyo-glossus.
19. Thyro-hyoid membrane.
20. Mylo-hyoid muscle.
21. Thyroid cartilage.
22. Hyoid bone.
23. Crico-thyroid muscle.
24. Trachea.
25. Œsophagus.

sionally be traced to the tubercle on the under surface of the basilar process of the occipital bone, to which the fibrous bag of the pharynx is attached. The superior constrictor is separated from the middle constrictor by the stylo-pharyngeus muscle and glosso-pharyngeal nerve. Above its upper curved border the ascending pharyngeal artery sends a branch to the palate, together with a branch of the inferior palatine artery, and the levator palati muscle and the Eustachian tube cross obliquely inwards beneath the fibrous bag.

The three constrictors are *supplied* by the pharyngeal plexus of nerves; the superior has also branches from the glosso-pharyngeal, and the inferior from the external and recurrent laryngeal nerves.

The **Stylo-Pharyngeus Muscle** (Fig. 210, 7) has already been seen at its origin, and can now be followed to its insertion by dividing some of the fibres of the middle constrictor. It *arises* from the root of the styloid process of the temporal bone, and passes between the superior and middle constrictors to be *inserted* into the bag of the pharynx, and into the posterior border of the thyroid cartilage. It is *supplied* by the glosso-pharyngeal nerve.

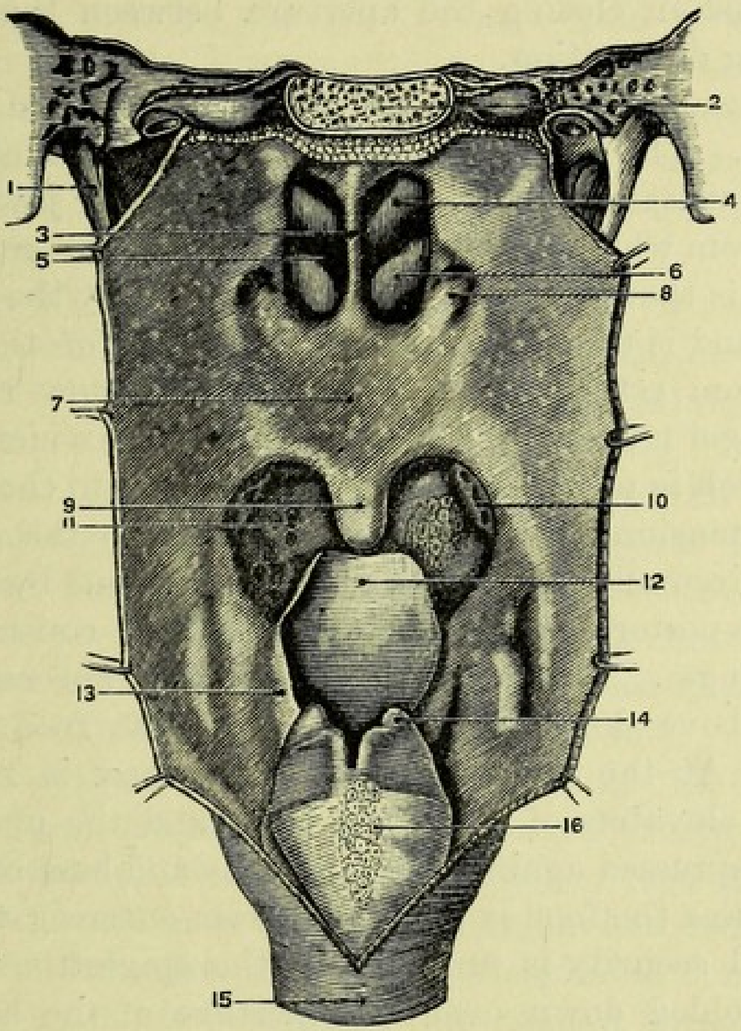
The *Fibrous bag of the Pharynx* is very thin at the lower part, where it lies between the muscular fibres and the mucous membrane, but above the upper border of the superior constrictor it is much stronger, and is expanded from side to side, covering in the Eustachian tubes and the levatores palati muscles. At the base of the skull it is attached to the basilar process of the occipital bone by a fibrous band (cranio-pharyngeal ligament, Quain), to the Eustachian tube, and to the under surface of the petrous portion of the temporal bone; and is carried forwards to the root of the pterygoid process and the internal pterygoid plate of the sphenoid bone, becoming continuous with the pterygo-maxillary ligament.

[The pharynx is to be opened from behind by an incision in the median line, from the basilar process to the commencement of the œsophagus. The fibrous bag is to be detached from the occipital bone on each side and held widely open with hooks, and the whole of the cotton wool is to be removed from the interior of the pharynx.]

The **Interior of the Pharynx** (Fig. 211) presents seven openings in the following order from above downwards; (1 and 2) the two posterior nares separated by the vomer; (3 and 4) the two Eustachian tubes; (5) the *isthmus faucium* or opening of the mouth; (6) the superior aperture of the larynx guarded by the epiglottis; and (7) the opening into the œsophagus.

The *soft palate* or *velum pendulum palati* (7) intervenes between the nose and the mouth, and consists of a fibrous membrane which s attached to the palate bones, and is strengthened by expansions from the several muscles of the palate; it is covered by mucous membrane, which is ciliated on the upper but not on the lower sur-

Fig. 211.



face. The centre of its free border is prolonged into the *uvula*, and on each side will be seen the two folds called the *pillars of the fauces*, formed by mucous membrane reflected upon the palato-glossi and palato-pharyngei muscles.

The mucous membrane of the pharynx is continuous with both that of the nose and that of the mouth, and its epithelium varies

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Fig. 211.—Pharynx laid open from behind (from Sappey).

1. Styloid process.
2. Body of occipital bone.
3. Septum nasi.
4. Middle turbinate bone.
5. Posterior naris.
6. Inferior turbinate bone.
7. Soft palate.
8. Eustachian tube.
9. Uvula.
10. Tonsil.
11. Back of tongue.
12. Epiglottis.
13. Arytæno-epiglottidean fold.
14. Tip of arytænoid cartilage.
15. Œsophagus.
16. Back of cricoid cartilage.

in different situations, being squamous throughout the canal below the level of the palate, but columnar and ciliated above that point. Close to the base of the skull is a collection of follicular glands, extending from one Eustachian tube to the other, and forming the *pharyngeal tonsil* of Kölliker. These glands are hypertrophied in cases of congenital cleft-palate, when they can be readily seen, and appear to assist in closing the aperture between the nose and the mouth during deglutition.

This is the best opportunity for studying the **Process of Deglutition.** The food having been duly masticated and insalivated, the mouth is closed in order that the lower jaw may afford a fixed point from which the muscles of the tongue may act. The bolus of food is then carried back to the fauces by the movement of the tongue, and is there grasped by the pillars of the fauces and prevented from returning. The pharynx is now raised by the stylo-pharyngei muscles and is at the same time widened to receive the food, which is prevented from ascending into the nares by the raising and tension of the soft palate, due to the action of the levator and circumflexus palati of both sides, and by the approximation of the posterior pillars by means of the contraction of the palato-pharyngei. The constrictors, by their successive contraction from above downwards, next force the food towards the œsophagus. At the same moment the larynx is raised by the action of the elevators of the hyoid bone, and the aperture of the larynx is compressed against the epiglottis and base of the tongue; by which means the food is prevented from entering the windpipe. An additional security is provided by the epiglottis, which, when healthy, is folded down over the aperture of the larynx by the passage of the food; but that the epiglottis is not essential, is shown by cases in which the cartilage has been destroyed by ulceration, the process of deglutition still remaining perfect. Lastly the contraction of the œsophagus carries the food down to the stomach.

The Palate.

[The soft palate is to be stretched by inserting a hook into the uvula, and the mucous membrane is to be removed from the upper surface of the palate and the neighbouring bones, so as to expose the muscles above the palate and the Eustachian tube. The levator palati will be found passing obliquely inwards, the azygos uvulæ in the median line of the palate, and the tensor palati can be best seen by dividing the levator and detaching the fibres of the superior constrictor from the hamular process, when the muscle will be found upon the internal pterygoid plate.]

The **Soft Palate** (*velum pendulum palati*) is a musculo-membranous curtain attached to the posterior border of the hard palate in front, and with a free border behind terminating in the uvula. It consists of an aponeurosis attached to the palate bones, overlaid by expansions from the palatine muscles, and covered on both surfaces with mucous membrane, which on the oral surface presents a thick layer of mucous glands. From behind forwards the soft palate consists of 1. Pharyngeal mucous membrane; 2. Thin attachment of palato-pharyngeus; 3. Azygos uvulæ; 4. Levator palati; 5. Thicker attachment of palato-pharyngeus; 6. Tendon of tensor palati; 7. Fibrous aponeurosis; 8. Palato-glossus; 9. Oral mucous membrane with mucous glands.

The **Azygos Uvulæ** (Fig. 212, 8) consists of two small muscular slips placed parallel to, and on each side of, the median line. It *arises* from the posterior nasal spine of the palate bone, and is *inserted* into the uvula.

The **Levator Palati** (Fig. 212, 5) *arises* from the under surface of the apex of the petrous portion of the temporal bone, and from the inner and hinder part of the Eustachian tube. The muscle passes inwards above the border of the superior constrictor muscle, and is *inserted* into the soft palate by a broad expansion, which meets that of its fellow muscle in the median line.

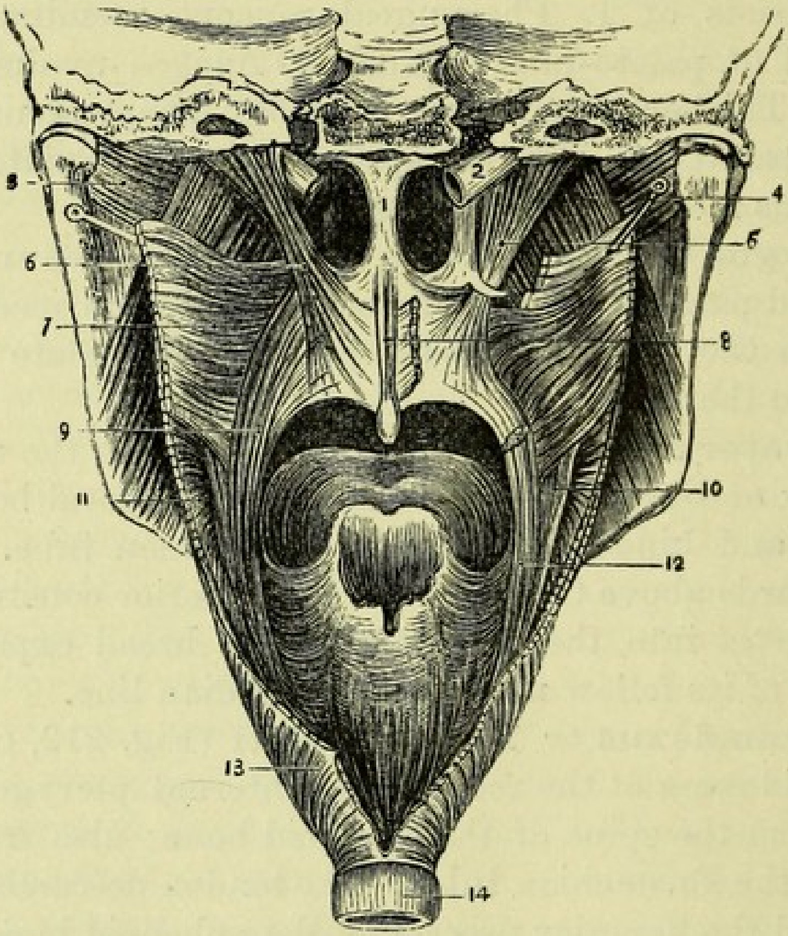
The **Circumflexus** or **Tensor Palati** (Fig. 212, 6) *arises* from the scaphoid fossa at the root of the internal pterygoid plate, and slightly from the spine of the sphenoid bone; also from the outer surface of the Eustachian tube. The tendon descends vertically to wind round the hamular process of the sphenoid bone, where it is lubricated by a minute bursa, and then takes a horizontal direction to the soft palate. It is *inserted* into the palate by an expansion beneath the levator, and also into the transverse ridge on the under surface of the palate bone.

The levator palati raises the soft palate, and the circumflexus makes it tense on each occasion of swallowing. The azygos uvulæ can have but a slight and unimportant action, viz., that of shortening the uvula. The levator palati and azygos uvulæ are *supplied* by palatine branches from the spheno-palatine (Meckel's) ganglion; the tensor palati receives a branch from the otic ganglion.

Surgery.—The muscles above the palate, and especially the levator palati, are of interest surgically in relation to the operation of staphyloraphy, or that for closure of a congenital fissure of the palate. Sir W. Fergusson showed that the two segments of a fissured soft palate are drawn asunder by the levatores palati on every occasion of swallowing, and he therefore proposed and carried out the division of these muscles, by means of a knife having a lancet-shaped blade set at right angles to the handle, which is passed through the fissure.

Opportunity is to be taken, before the pillars of the fauces are dissected, to observe the important surgical fact that a bistoury, if

Fig. 212.



made to transfix the tonsil from before backwards, will pass internally to the carotid artery, unless the point of the instrument is directed purposely to one side, in which case only would it be possible to injure this important vessel.

The **Eustachian Tube** (Fig. 212, 2) is the communication between the pharynx and the tympanum or middle ear. The osseous portion of the canal is in the temporal bone, but the cartilaginous

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Fig. 212.—Muscles of the palate (drawn by J. T. Gray).

1. Septum narium.
2. Eustachian tube.
3. Pterygoideus externus.
4. Pterygoideus internus.
5. Levator palati.
6. Circumflexus palati.
7. Superior constrictor of pharynx.
8. Azygos uvulæ.
9. Palato-pharyngeus.
10. Stylo-pharyngeus.
11. Middle constrictor of pharynx.
12. Palato-pharyngeus (cut).
13. Inferior constrictor of pharynx.
14. Œsophagus.

portion is now seen to be nearly an inch in length, and to terminate in a broad trumpet-shaped end at the posterior extremity of the inferior turbinate bone. The cartilage of which the tube is formed is triangular in shape, and is doubled upon itself, the deficiency at the lower part being completed by fibrous tissue. In the recent condition the thick mucous membrane converts the opening into a mere vertical slit, which is generally closed, but during the process of deglutition is opened by the action of the circumflexus palati muscle, and thus the equilibrium of the air in the tympanum is maintained.

[The palate is to be drawn up so as to put the pillars of the fauces on the stretch as much as possible, and the mucous membrane is to be removed to expose the palato-glossus and palato-pharyngeus muscles.]

The **Palato-glossus** is placed in front of the tonsil, and is very small and indistinct. The muscle *arises* from the middle line of the soft palate in common with its fellow, and descends to the side of the tongue, where it is *inserted*, joining the fibres of the stylo-glossus and hyo-glossus muscles.

The **Palato-pharyngeus** (Fig. 212, 9) is larger than the palato-glossus, and is placed behind the tonsil. It *arises* in the palate by two slips, which are separated by the levator palati and azygos uvulæ muscles, and the fibres of which meet those of the opposite muscle in the median line. The muscle passes obliquely downwards to the pharynx, to be *inserted* into the posterior border of the thyroid cartilage with the stylo-pharyngeus, and to be lost in the wall of the pharynx itself.

The palato-glossus muscle is a constrictor of the fauces, and grasps the bolus of food when it has passed out of the mouth, thus preventing its return. The palato-pharyngeus raises the pharynx, but its most important action is to approximate the posterior pillars of the fauces, which with the uvula then make an inclined plane, along which the bolus passes into the grasp of the constrictors. Both the palato-glossus and the palato-pharyngeus are *supplied* by branches from Meckel's ganglion.

The **Amygdala** or **Tonsil** is placed between the palato-glossus and palato-pharyngeus muscles, and is usually much shrunken after death. It consists of lymphoid tissue with a number of mucous follicles, the orifices of which may be seen on the internal surface. The outside of the tonsil is in close relation with the superior constrictor of the pharynx and with the ascending pharyngeal artery. It is to be noticed that it is anatomically impossible for any enlargement of the tonsil to obstruct the Eustachian tube, and thus produce deafness.

[The tongue and the larynx are to be detached by dividing all the structures between them and the palate, and are to be carefully preserved for subsequent examination. By inverting the skull the hard palate will then be brought into view.]

The **Hard Palate** (Fig. 215, 10) is continuous with the soft palate, but its mucous membrane is much more dense, being inseparably united in great part with the periosteum of the maxillary and palate bones. The mucous membrane presents a median ridge indicative of the fœtal division of the parts, and is thrown into more or less transverse folds near the anterior part, where it is prolonged on to the gums. Numerous mucous glands lie immediately beneath the mucous membrane, and open upon its surface.

The **Gums** (Fig. 213) are composed of dense fibrous tissue inse-

Fig. 213.

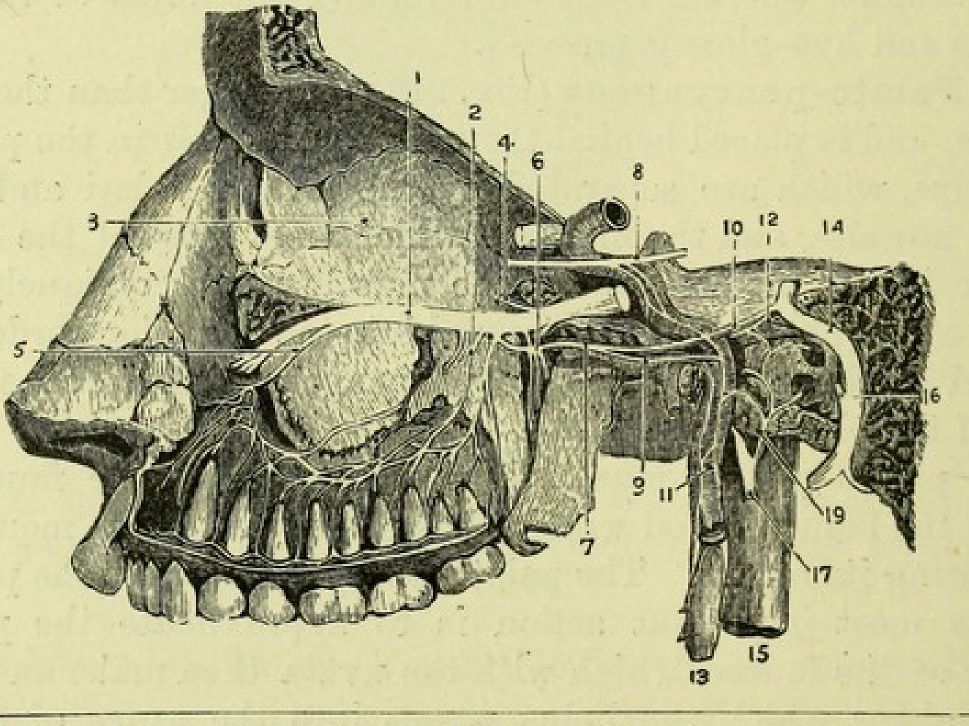


Fig. 213.—Dissection of the superior maxillary nerve and Meckel's ganglion (from Hirschfeld and Leveillé).

1. Superior maxillary nerve.
2. Posterior dental nerves.
3. Inner wall of orbit.
4. Orbital branch (cut).
5. Anterior dental nerve.
6. Meckel's ganglion.
7. Vidian nerve.
8. Sixth nerve.
9. Carotid branch of Vidian.
10. Superficial petrosal nerve.
11. Carotid plexus of sympathetic.
12. Lesser petrosal nerve.
13. Superior cervical ganglion.
14. Facial nerve.
15. Internal jugular vein.
16. Chorda tympani.
17. Glosso-pharyngeal nerve.
18. Jacobson's nerve.

parably united with the periosteum of the alveolus, and covered by the mucous membrane of the mouth, which is prolonged into the sockets of the teeth, where it becomes continuous with the periodontal membrane covering them.

The **Teeth** (Fig. 213) of the upper jaw are 16 in number, viz., 4 incisors, 2 canines, 4 bicuspids, and 6 molars, the most posterior molars being the *dentes sapientiæ* or wisdom teeth. Each tooth consists of a crown, a neck, and a fang, and upon extracting a molar tooth it will be found to have three fangs, two being on the outer (buccal) and one on the inner (palatine) side.

The teeth of the lower jaw correspond in number to those of the upper jaw, but have been necessarily interfered with in the progress of the dissection. The lower molar teeth differ from those of the upper jaw in presenting only two fangs.

The **Lips** (Fig. 213) are formed externally by skin, and internally by mucous membrane, which is reflected on to them from the gums; and between the two are the fibres of the orbicularis oris, with some cellular tissue and mucous glands, and the coronary arteries. The fold of mucous membrane connecting each lip with the alveolus in the median line is called the *frœnum labii*, and is more prominent in the upper than in the lower lip.

The Superior Maxillary Nerve.

[The skull being placed with the base downwards, a cut with the chisel is to be carried in a straight line from the sphenoidal fissure to the foramen ovale. The side of the skull is then to be sawn through at right angles to the first incision, meeting it at the foramen ovale. The saw being then placed obliquely on the malar bone, so that the incision shall pass downwards and outwards from the lower and outer angle of the orbit, the cut is to be carried into the spheno-maxillary fissure. The piece of bone will now be detached and may be removed, and with the bone-forceps any remaining bone is then to be take away, so as to expose the whole extent of the superior maxillary nerve.]

The **Superior Maxillary Nerve** (Fig. 213, 1) (second division of the 5th) leaves the cranium at the foramen rotundum, and, having crossed the spheno-maxillary fossa, enters the infra-orbital canal and appears on the face at the infra-orbital foramen. It gives off the following branches:—

1. *Orbital branch* (temporo-malar) (4), which enters the orbit by the spheno-maxillary fissure, and divides into two branches (malar

and temporal), which have been seen in the dissection of the face and scalp.

2. *Spheno-palatine branches* (6), which descend into the spheno-maxillary fissure to Meckel's ganglion, which is placed opposite the spheno-palatine foramen, and will be afterwards dissected.

3. *Posterior dental branches* (2), which supply the gums, and enter the canals on the posterior aspect of the upper jaw, to supply the molar and bicuspid teeth and to communicate with the anterior dental nerve.

4. *Anterior dental branch* (5), which arises from the nerve in the infra-orbital canal, and can only be seen by laying the canal open. It descends in a special canal in the wall of the antrum to the incisor and canine teeth, and has a communication with the posterior dental nerve.

The branches of the dental nerves can only be traced to the teeth by removing the outer plate of the alveolus, but the expenditure of time and trouble necessary for this will not be repaid by the results.

The *facial branches* of the superior maxillary nerve have been seen in the dissection of the face (p. 386).

The **Infra-orbital Artery** accompanies the superior maxillary nerve. It is the terminal branch of the internal maxillary artery, and gives a branch to the orbit, and an *anterior dental* branch which accompanies the anterior dental nerve to the teeth. It ends, like the nerve, in twigs which are distributed to the nose, the eyelid, and the upper lip.

The *infra-orbital vein* communicates with the facial vein, and ends in the internal maxillary vein.

The Cavity of the Nose.

[In making a section of the nasal cavities, it will be found to be almost impossible to preserve the septum and the turbinate bones of both sides uninjured, and the better plan therefore is to preserve the septum carefully at the expense of the turbinate bones of one side, and afterwards to remove it so as to obtain a good view of the turbinate bones and meatuses of the nose on the opposite side. The saw being placed on one side of the septum and parallel to it, is to be carried through the cribriform plate of the ethmoid bone and the palatine processes of the maxillary and palate bones, and the soft palate having been split in the middle line, the skull will be divided into two portions, one of which can be used for the examination of the nose, and the other for the dissection of Meckel's ganglion, etc.]

The **Septum Narium** (Fig. 215, *i*) is a vertical plate, which upon removal of the mucous membrane will be found to be partly bony and partly cartilaginous. The bones entering into its formation are the following:—the crest of the nasal bone, the nasal spine of the frontal bone, the large perpendicular plate of the ethmoid bone, the vomer, a part of the rostrum of the sphenoid bone, and the crests of the maxillary and palate bones, upon which the vomer rests below. The *cartilage of the septum* is triangular in shape, and fits into the interval between the vertical plate of the ethmoid and the vomer, but it not unfrequently extends backwards for a considerable distance between those bones, when they are not so fully developed as usual.

The whole septum may be bent considerably to one side as the result of congenital malformation or of violence, and the cartilage may be perforated either congenitally or from disease. The vomer presents an oblique groove for the naso-palatine nerve, which will be afterwards seen upon the opposite side of the bone.

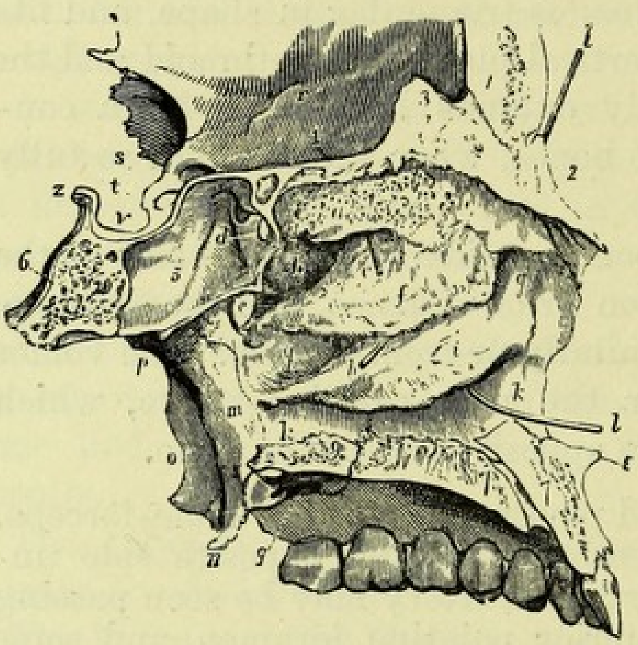
[The septum is to be removed piecemeal with the bone-forceps, so as to leave the mucous membrane on the opposite side untouched. The naso-palatine nerve and artery may be seen passing from behind forwards to the anterior palatine foramen, and some branches of the olfactory nerve, at the upper part of the membrane, may also be detected if putrefaction is not too far advanced. The mucous membrane is then to be detached below and turned up, when the nasal cavity will be exposed.]

The **Nasal Fossa** (Fig. 214) is a cavity bounded *above* by *a roof* which slopes downwards both anteriorly and posteriorly, but is horizontal in the middle, being formed anteriorly by the nasal bone and the nasal spine of the frontal bone; in the middle by the horizontal cribriform plate of the ethmoid bone; and posteriorly by the under surfaces of the body of the sphenoid bone and of the sphenoidal process of the palate bone. The *floor* is slightly concave from side to side, and is formed by the palatine processes of the maxillary and palate bones. The *inner* wall is formed by the septum, which has been examined. The *outer* wall is divided into three *meatuses* by the projection from it of the three turbinate bones, of which the upper two are portions of the ethmoid bone, but the lowest is a separate bone, which articulates with the superior maxillary, and helps to close the orifice of the antrum.

The *Superior Meatus* (*b*) is between the superior and middle turbinate bones, and is the smallest of the three, extending for not more than one-third of the length of the outer wall. The posterior ethmoidal cells and the sphenoidal sinus open into this meatus, and the spheno-palatine foramen is immediately opposite to it.

The *Middle Meatus* (*g*) is between the middle and inferior turbinate bones, and extends along the posterior two-thirds of the outer wall, curving upwards anteriorly. The anterior ethmoidal cells, the frontal sinus (through the infundibulum of the ethmoid bone), and the antrum of Highmore open into this meatus.

Fig. 214.



The *Inferior Meatus* (*k*) is between the inferior turbinate bone and the floor of the nasal fossa. It extends the whole length of the fossa, and at the anterior part has the nasal duct opening into it.

It should be noticed that the orifice of the Eustachian tube is close to the posterior extremity of the inferior turbinate bone, and that in using the Eustachian catheter, the point of the instrument has therefore to be raised before it can enter the tube.

The *Mucous Membrane* lining the nasal fossæ is termed the *pituitary* or *Schneiderian membrane*, and is thickest over the turbi-

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Fig. 214.—The meatuses of the nose on the left side (from Wilson).

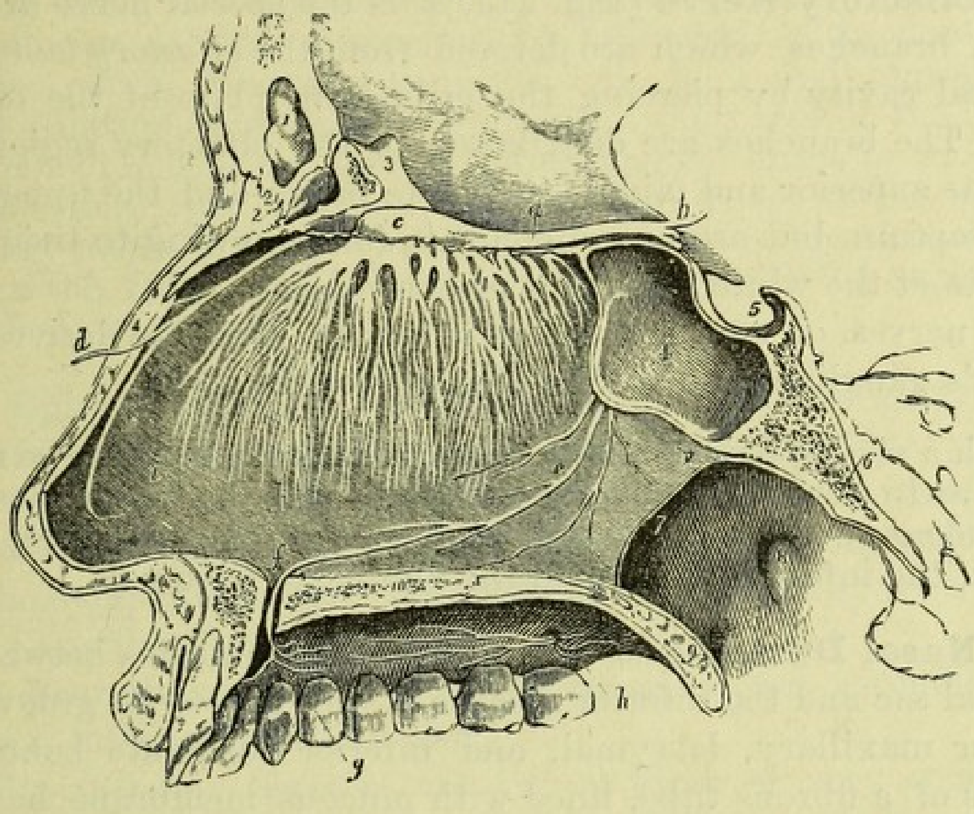
1. Frontal bone.
2. Nasal bone.
3. Crista galli of the ethmoid.
4. Cribriform plate of the ethmoid.
5. Part of the sphenoidal sinus.
6. Basilar portion of the sphenoid bone.
7, 7. Palatine process of the superior maxillary bone.
8. Nasal spine.
9. Palatine process of the palate bone.

a. Superior turbinate bone.
b. Superior meatus.
c. A probe passed into the posterior ethmoidal cells.
d. Opening of the sphenoidal sinus into the superior meatus.
e. Spheno-palatine foramen.
f. Middle turbinate bone.
g, *g*. Middle meatus.
h. A probe passed into the infundibulum leading from the frontal sinus and anterior ethmoidal cells; the triangular aperture immediately above the latter is the opening of the antrum.
i. Inferior turbinate bone.
k, *k*. Inferior meatus.
l, *l*. A probe passed up the nasal duct.
m. Internal pterygoid plate.
n. Its hamular process.
o. External pterygoid plate.
p. Root of the pterygoid process.
q. Posterior palatine foramina.

nate bones, particularly the lowest, and on the septum; but is thin on the floor, and in the sinuses connected with the nose.

The upper part of the mucous membrane both on the outer and inner walls of the fossa is peculiar, and this has been named the Olfactory Region, from the fact that the branches of the olfactory

Fig. 215.



or first nerve are distributed to it. It is impossible to distinguish this region except immediately after death, but it comprises the upper and a portion of the middle turbinate bones, and the corresponding portion of the septum. The mucous membrane of the olfactory region is of a yellow colour in the recent state, and its

Fig. 215.—Left Olfactory nerve, with its distribution on the septum narium (from Wilson).

1. Frontal sinus.
2. Nasal bone.
3. Crista galli of ethmoid bone.
4. Sphenoidal sinus of left side.
5. Sella turcica.
6. Basilar process of sphenoid and occipital bone.
7. Posterior opening of the right naris.
8. Opening of the Eustachian tube in the upper part of the pharynx.
9. Soft palate divided through its middle.
10. Cut surface of the hard palate.

a. Olfactory nerve.
b. Its three roots of origin.
c. The olfactory bulb.
d. Nasal nerve (ophthalmic div. of 5th).
e. Naso-palatine nerve (from the spheno-palatine ganglion).
f. The anterior palatine foramen.
g. Branches of the naso-palatine nerve.
h. Anterior and posterior palatine nerves.
i. Septum narium.

epithelium is of the columnar variety, and has peculiar spindle-shaped cells connected with the terminations of the olfactory nerve. The remainder of the mucous membrane has columnar and ciliated cells, except at the anterior part corresponding to the cartilaginous portion of the nose, where the epithelium is squamous.

The **Olfactory Nerve** (Fig. 215, *a*) is the special nerve of smell, and its branches, which are derived from the *olfactory bulb*, reach the nasal cavity by piercing the cribriform plate of the ethmoid bone. The branches are distributed to the olfactory region, *i.e.*, upon the superior and middle turbinate bones and the upper third of the septum, but are very difficult to follow, owing to their being destitute of the white substance of Schwann.

The nerves of common sensation to the nose are derived from Meckel's ganglion, and will be afterwards dissected.

[With a strong pair of scissors the turbinate bones may be readily cut, so as to expose the several openings into the three meatuses. The student should observe the small size of the openings of the antrum, the infundibulum, and the ductus ad nasum.]

The **Nasal Duct** (*ductus ad nasum*) communicates between the lacrymal sac and the inferior meatus of the nose. It grooves the superior maxillary, lacrymal, and inferior turbinate bones, and consists of a fibrous tube, lined with mucous membrane having a ciliated epithelium.

The *nasal branch of the fifth nerve* (ophthalmic division) (Fig. 215, *d*) may be found in a groove on the under surface of the nasal bone in its passage from the orbit to the face; in its course it gives a branch to the septum (pp. 345 and 386).

Dissection of Meckel's Ganglion, etc.

Before beginning this dissection, the student should ascertain the position of the spheno-palatine foramen (Fig. 214, *e*), opposite to which the spheno-palatine ganglion is placed, and through which the internal maxillary artery enters the nose. This will be found on either half of the skull, immediately behind the superior meatus of the nose.

[The mucous membrane lining the vertical plate of the palate bone is to be removed without injuring the nerves emerging from the spheno-palatine foramen. It must also be taken away from the back of the floor of the nasal fossa, and from the roof of the mouth behind the level of the posterior dental foramen, in doing which the terminal branches of the descending palatine nerve will be exposed, and may be traced forward to the hard palate and backwards to the soft palate. The hard palate is next to be chipped away behind the level of the posterior palatine foramen; the descending palatine nerves and vessels may then be easily exposed by cutting away with the chisel the thin plate of bone covering them, in a line between the spheno-palatine foramen and the posterior palatine foramen. By following up the descending palatine nerve, Meckel's ganglion will be found opposite the spheno-palatine foramen. By chipping away parts of the body of the sphenoid and other bones surrounding the space in which the ganglion lies, two branches may be traced up to the superior maxillary nerve, and the Vidian nerve may be followed backwards through the Vidian canal, but some difficulty will be experienced in the last proceeding.]

The **Spheno-palatine**, or **Meckel's Ganglion** (Fig. 216, 1) is a minute red body situated opposite the spheno-palatine foramen, and is connected with the superior maxillary nerve by one or two branches (p. 430); with the facial nerve by the Vidian nerve; and with the sympathetic upon the internal carotid artery by a branch which joins the Vidian nerve (Fig. 213).

The **Branches** (Fig. 216) of the ganglion are ascending, descending, internal, and posterior.

1. The *ascending branches* are two or three of very small size, which pass to the periosteum of the orbit through the spheno-maxillary fissure.

2. The *descending branches* go to the palate, and are three in number:—

The *anterior* or *great palatine nerve* (14) descends through the posterior palatine canal to the hard palate, where it forms a junction with the naso-palatine nerve passing through the anterior palatine canal (Fig. 215, *g*). Whilst in the canal the nerve gives off *inferior nasal branches* to the inferior turbinate bone.

The *middle* or *external palatine nerve* (16) is very small, and descends to the soft palate and tonsil.

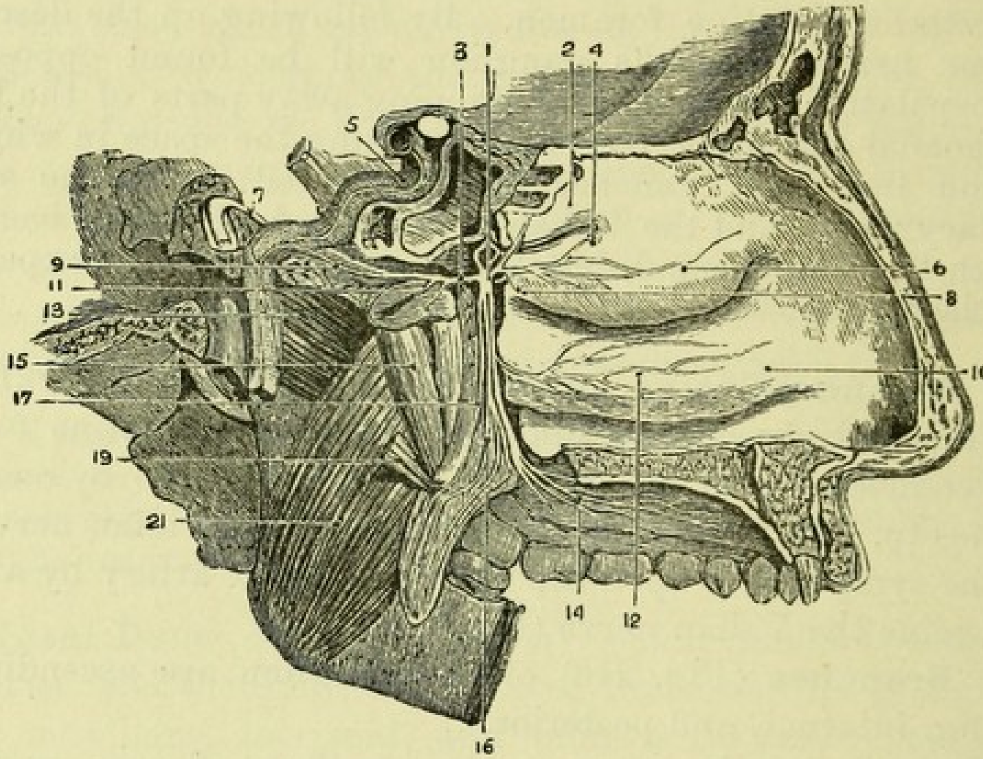
The *posterior* or *small palatine nerve* (17) descends through a small canal behind the great nerve, and is distributed to the soft palate and uvula, supplying the levator palati and the azygos uvulæ muscles, *i.e.* the two *elevators* of the palate (*v.* otic ganglion).

3. The *internal branches* pass through the spheno-palatine foramen to the nose, and are the superior nasal and the naso-palatine nerves.

The *superior nasal branches* (4) supply the mucous membrane of the upper and middle turbinate bones.

The *naso-palatine nerve* (8) crosses the nasal fossa to the septum, along which it passes through a groove in the vomer to the anterior palatine canal. In the canal the left nerve lies in front of the naso-palatine arteries and the right behind them, and both descend to the front of the hard palate to unite with the great palatine nerve (Fig. 215, *e*).

Fig. 216.



4. The *posterior branches* are the Vidian and the pterygo-palatine nerves.

The *Vidian nerve* (3) runs through the Vidian canal in the pterygoid process, and divides into the great superficial petrosal and the carotid branches.

Fig. 216.—Meckel's ganglion and its branches (from Hirschfeld and Leveillé).

1. Spheno-palatine ganglion (Meckel).
2. Superior turbinate bone.
3. Vidian nerve.
4. Nasal branches.
5. Carotid artery in temporal bone.
6. Middle turbinate bone.
7. Greater superficial petrosal nerve joining the facial.
8. Naso-palatine nerve (cut).
9. Carotid branch of Vidian.
10. Inferior turbinate bone.
11. Pharyngeal nerve.
12. Inferior nasal branches.
13. Pterygoideus externus.
14. Anterior or great palatine nerve.
15. Tensor palati.
16. Middle or external palatine nerve.
17. Posterior palatine nerve.
19. Levator palati (cut).
21. Pterygoideus internus.

The *great superficial petrosal branch* (7) pierces the cartilage which fills up the foramen lacerum medium basis cranii, and runs in a groove on the surface of the petrous portion of the temporal bone to the hiatus Fallopii, through which it passes to join the facial nerve.

The *carotid branch* (9) joins the sympathetic plexus upon the internal carotid artery.

The *pterygo-palatine* or *pharyngeal nerve* (11) is very small, and passes through the pterygo-palatine canal to the mucous membrane of the upper part of the pharynx.

The **Internal Maxillary Artery** gives off the following branches in the spheno-maxillary fossa : the descending palatine, Vidian, pterygo-palatine, spheno-palatine, and infra-orbital, the last of which has been already examined.

1. The *posterior* or *descending palatine artery* accompanies the great palatine nerve through the posterior palatine canal. It gives branches to the soft palate and uvula, which descend through the smaller palatine canals, and then runs forward on the hard palate, supplying it, and anastomosing with the nasal or spheno-palatine artery at the anterior palatine canal.

2. The *Vidian artery* accompanies the nerve through the Vidian canal, and supplies the upper part of the pharynx and the Eustachian tube.

3. The *pterygo-palatine artery* is very small, and runs backwards through the pterygo-palatine canal.

4. The *nasal* or *spheno-palatine artery* enters the nose by the spheno-palatine foramen, and gives branches to the mucous membrane of the upper part of the cavity, which anastomose with the anterior and posterior ethmoidal branches of the ophthalmic artery. The *naso-palatine* branch runs down the septum of the nose with the naso-palatine nerve, and anastomoses with the artery of the septum from the facial trunk, and also with the descending palatine artery through the anterior palatine canal.

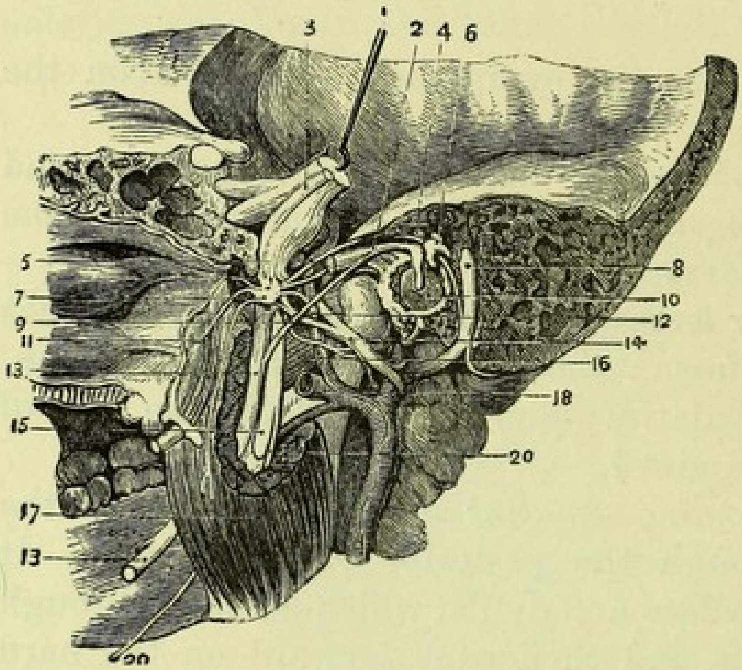
The *veins* correspond, and open into the internal maxillary vein.

The Otic Ganglion.

[If the part is not too much decomposed, the otic ganglion may be exposed, from within, on the side upon which the internal pterygoid muscle has not been cut away. The levator palati muscle and the Eustachian tube are to be carefully removed, when upon the inner surface of the pterygoid muscle will be found the nerve to that muscle, which if traced upwards will lead to the ganglion.]

The **Otic Ganglion** (Fig. 217, 7) (Arnold's) is a minute body lying on the inner surface of the third division of the fifth nerve, and especially connected with the branch to the internal pterygoid muscle. Like all the cranial ganglia, the otic has motor, sensory, and sympathetic roots; the motor root from the 5th nerve; the sensory roots from the auriculo-temporal nerve, and from Jacobson's nerve by means of a small superficial petrosal nerve of Arnold; and the sympathetic root from that upon the middle meningeal artery.

Fig. 217.



The otic ganglion gives branches to two muscles, the tensor tympani and the circumflexus or tensor palati, *i.e.*, it supplies two *tensors* as Meckel's ganglion does two *elevators* (*v.* p. 435).

The Tympanum.

[If the tympanum has not been damaged in the previous dissections, an attempt may be made to trace the facial nerve through the temporal bone, thus: the base of the skull being turned upward, the saw is to be carried through a line drawn from the stylo-mastoid foramen to the foramen ovale; or a more complete view may be obtained by making a vertical saw-cut in the skull, in a line from the interval between the external auditory meatus and the anterior border of the mastoid process towards the internal

Fig. 217.—Internal view of the Otic ganglion and Tympanum (from Hirschfeld and Leveillé).

1. Sensory portion of 5th nerve with Gasserian ganglion.
2. Tensor tympani muscle.
3. Motor portion of 5th passing beneath the ganglion.
4. Malleus.
5. Small superficial petrosal nerve of Arnold.
6. Incus.
7. Otic ganglion.
8. Facial nerve.
9. Chorda tympani.
10. Membrana tympani.
11. Tensor palati muscle.
12. Middle meningeal artery.
13, 13. Lingual nerve (5th).
14. Auriculo-temporal nerve.
15. Inferior dental nerve (5th).
16. Pterygoideus externus.
17. Pterygoideus internus.
18. Internal maxillary artery.
20, 20. Mylo-hyoid nerve.

auditory meatus, until the posterior part of the aqueduct of Fallopius and the stylo-mastoid foramen are opened. The rest of the bone surrounding the aqueduct is then to be chipped away with bone forceps. By either of these cuts the tympanum will be divided, and it will be possible to examine its walls and ossicula, together with the seventh nerve and the chorda tympani.]

The **Tympanum** or **Middle Ear** (Fig. 217) is an irregular six-sided cavity, which may be conveniently said to resemble a room with a passage (meatus auditorius externus) leading to it.

The *outer* wall of the chamber is formed by the membrana tympani, which is placed obliquely at the end of the meatus, and consists of three layers, epithelial, fibrous and mucous; the *inner* wall corresponds to the outer wall of the *vestibule* and *cochlea*, parts of the internal ear; *in front*, is the opening of the Eustachian tube, with the special tube for the tensor tympani muscle formed by the processus cochleariformis; *behind*, is the opening into the mastoid cells. The *roof* of the chamber is a thin portion of bone separating it from the cavity of the cranium; the *floor* is a thicker portion corresponding to the jugular fossa.

The inner wall is the most important, and presents the following points for examination (Fig. 213): (1) the *fenestra ovalis*, in which the base of the stapes articulates; below this (2) the *fenestra rotunda*, an opening into the cochlea closed by a membrane, the *secondary membrane of the tympanum;* anterior to these a slight eminence (3) the *promontory*, corresponding to the first turn of the cochlea, and marked by slight grooves for the tympanic plexus and Jacobson's nerve; and, posterior to the fenestra ovalis and fenestra rotunda and close to the opening of the mastoid cells, (4) the *pyramid*, a conical projection of bone pierced at the tip by a small hole, through which the *stapedius* muscle works.

The *Aqueduct of Fallopius*, or canal for the facial nerve, forms a slight projection curving behind the pyramid and above the fenestra ovalis, and may be opened with bone-forceps in the part which has not been already divided with the saw. It extends from the bottom of the meatus auditorius internus to the stylo-mastoid foramen, its course being at first outwards to the inner wall of the tympanum, and then backwards along the upper part of the wall, lastly downwards to the stylo-mastoid foramen. In the upper part of the canal is the *intumescentia gangliformis*, an enlargement of the facial nerve at the point where it is joined by the petrosal nerves, through the hiatus Fallopii. The facial nerve as it descends behind the tympanum gives off a minute branch to the stapedius muscle, and the chorda tympani.

The *Chorda Tympani* (Fig. 217, 9) enters the tympanum just below the pyramid, and passes forward across the membrana tympani, between the handle of the malleus and the long process of the incus, to an opening between the Glasserian fissure and the Eustachian tube (canal of Huguier), by which it leaves the temporal bone to join the lingual nerve (p. 401).

The **Ossicula Auditus** (Fig. 217) are the malleus, incus, and stapes.

The *Malleus* (hammer) (4) consists of a head, neck, handle (manubrium), and two processes (processus gracilis and processus brevis). The head looks upwards and articulates by its internal and posterior aspect with the body of the incus; the manubrium is inserted between the mucous and fibrous layers of the membrana tympani, and is directed downwards and slightly forwards; the processus gracilis passes forwards and somewhat downwards, and is inserted into the Glasserian fissure; the processus brevis gives attachment to the tensor tympani muscle.

The *Incus* (anvil) (6) consists of a body and two processes. The body articulates with the head of the malleus; the short process is attached to the margin of the orifice of the mastoid cells; the long process is nearly parallel to the handle of the malleus, and has at its extremity a small nodule of bone, the *os orbiculare*, which in the fœtus is separate, but becomes united in adult life and articulates with the stapes.

The *Stapes* (stirrup) is articulated by its head with the long process of the incus, and being at right angles to it is almost horizontal in position. The base (to which the two crura are united) is attached to the fenestra ovalis, but not quite closely, so that a certain amount of movement is allowed; both the base of the stapes and the fenestra ovalis are coated with hyaline cartilage, and the two surfaces are united by elastic fibres; the neck gives attachment to the small stapedius muscle.

The articulation of the ossicula to one another takes place by small capsular joints and synovial membranes. Their attachment to the walls of the tympanum is strengthened by minute ligaments, three of which are fixed to the malleus and one to the incus.

The **Muscles** of the Tympanum are two in number, viz., the tensor tympani, and stapedius; but some anatomists add a laxator tympani, and laxator tympani minor.

The *Tensor Tympani* (Fig. 217, 2) *arises* from the cartilaginous Eustachian tube and the adjoining surface of the sphenoid, and runs backwards in a distinct canal formed by the processus cochleariformis, round the margin of which it bends as over a pulley, to be *inserted* into the root of the handle and the processus brevis of the malleus. It is *supplied* by a branch of the otic ganglion.

The *Stapedius arises* from the interior of the pyramid, and emerges from its apex to be *inserted* into the neck of the stapes. It is *supplied* by a branch of the facial nerve.

Other muscles have been described, but their existence is not generally allowed.

As the malleus and incus move together round an antero-posterior axis, any movement inwards of the membrana tympani must produce a similar though slighter movement inwards of the base of the stapes, and, as the cavity of the inner ear is full of fluid, a corresponding bulging of the secondary membrane of the tympanum closing the fenestra rotunda must result.

The Tongue.

[The tongue and larynx, which were laid aside, are to be examined without separating them from one another. The branches of nerves and the several muscles, which were necessarily divided in removing the tongue, are to be identified before the examination of the organ itself is proceeded with.]

The **Tongue** (Fig. 218) is connected with the os hyoides by muscular fibres, and by a membrane (hyo-glossal) which is deeply placed between the muscles. On its under surface and sides will be found the attachments of the extrinsic muscles of the tongue, viz., the hyo-glossus, stylo-glossus, palato-glossus, and superior constrictor (glosso-pharyngeus); and close to the median line will be seen the large genio-hyo-glossus of each side.

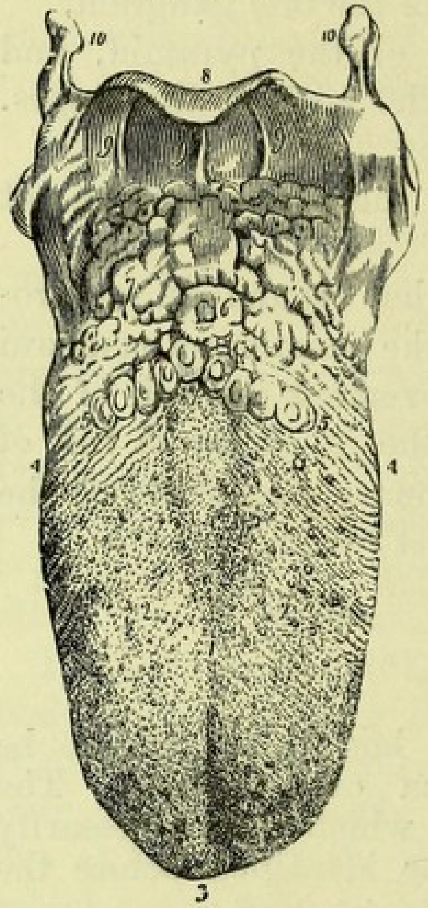
All the anterior part of the dorsum of the tongue is covered by papillæ, but behind a V-shaped row of large (circumvallate) papillæ the surface only presents the orifices of numerous mucous glands and follicles.

The **Papillæ** (Fig. 218) of the tongue are of three kinds, the Circumvallate, Fungiform, and Filiform or Conical.

The *papillæ circumvallatæ* (5) are from eight to fifteen in number, and are arranged in two oblique rows, which meet at the *foramen cæcum*, a deep mucous follicle. Each papilla is surrounded by a fossa, and is covered on its free surface with secondary papillæ. The circumvallate papillæ are supplied by the glosso-pharyngeal nerve.

The *papillæ fungiformes* are scattered over the tongue, but particularly at the tip and sides. They are globular in form and have slender attachments to the surface of the tongue; they are of a dark red colour and are covered with secondary papillæ.

Fig. 218.



The *papillæ conicæ* and *filiformes* exist all over the tongue, but are most extensively developed at the tip. The conical papillæ are covered with minute secondary papillæ, and the filiform are prolonged into thread-like processes, which in the carnivora are developed into spines.

The orifices of mucous follicles may be found among the papillæ on the dorsum of the tongue, and behind the *papillæ circumvallatæ* are numerous compound racemose lingual glands, which lubricate the posterior portion of the organ.

Beneath the mucous membrane is a fibrous layer or *corium*, which gives attachment to many of the muscular fibres. In the centre of the tongue and dividing it into two symmetrical halves is a fibrous septum, the existence of which is marked by a raphé in the median line.

The **Intrinsic Muscles** are the Lingualis Superior, the Lingualis Transversus, and the Lingualis Inferior.

The *Lingualis Superior* extends along the surface of the tongue

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Fig. 218.—The tongue with its papillæ (from Wilson).

1. The raphé, which sometimes bifurcates on the dorsum of the tongue, as in the figure.
2, 2. Lobes of the tongue; the rounded eminences on this part, and near its tip, are the papillæ fungiformes. The smaller papillæ, among which the former are dispersed, are the papillæ conicæ and filiformes.
3. Tip of the tongue.
4, 4. Its sides.
5, 5. The V-shaped row of papillæ circumvallatæ.
6. Foramen cæcum.
7. Mucous glands of the root of the tongue.
8, 8. Epiglottis.
9, 9 Fræna epiglottidis.
10, 10. Greater cornua of the os hyoides.

immediately beneath the mucous membrane, being connected with the septum internally.

The *Lingualis Transversus* constitutes the chief bulk of the tongue, and is placed beneath the lingualis superior. Its fibres are attached to the median septum and pass outwards to the mucous membrane, giving passage to the ascending fibres of the lingualis inferior.

The *Lingualis Inferior* is to be seen on the under surface of the tongue by removing the hyo-glossus, lying between this muscle and the genio-hyo-glossus. It is larger than the lingualis superior, and extends along the under surface of the tongue, giving ascending fibres which pass between those of the transverse muscle, and being closely connected with the stylo-glossus muscle.

Glands of the Frænum (Blandin).—By removing the mucous membrane on the under surface of the tongue near the tip, a couple of oval glands may be seen. They are similar in structure to the sublingual glands, although distinct from them, and are sometimes united in front, forming a single mass of an arched form (Deville).

The **Nerves** (Fig. 203) of the tongue have been already examined, but may now be followed out minutely. They are the *Hypoglossal nerve* (9th) to the muscular structure of the tongue; the *Lingual nerve* (5th) to the fungiform and filiform papillæ on the dorsum and apex of the tongue; the *Glosso-pharyngeal nerve* (8th) to the circumvallate papillæ at the base of the tongue and to the surface behind them.

The Larynx.

The **Larynx** or organ of voice is closely connected with the hyoid bone and tongue. On tracing the mucous membrane from the dorsum of the tongue, it will be found to form three little *fræna* between the base of that organ and the prominent cartilage of the epiglottis; these are the *glosso-epiglottidean folds* (Fig. 218, 9). After being reflected over the epiglottis, the mucous membrane forms the two *arytæno-epiglottidean folds*, which bound the superior aperture of the larynx; and is then carried to the interior of the larynx and over its posterior surface into the œsophagus.

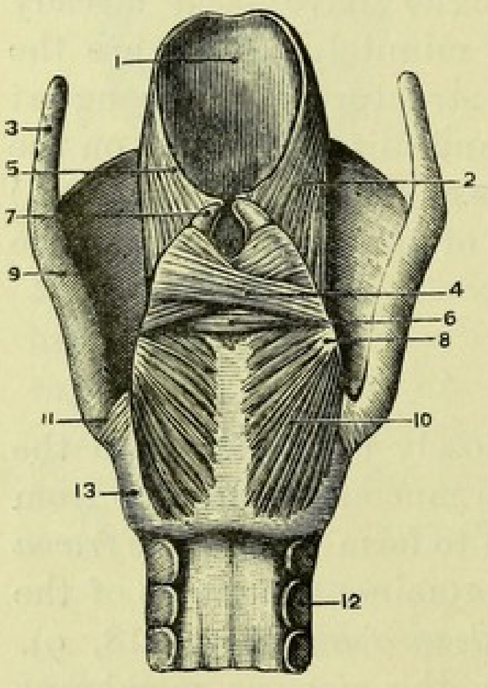
The **Superior Aperture of the Larynx** (Fig. 211) is bounded in front by the epiglottis, behind by the arytænoid cartilages, and on each side by the arytæno-epiglottidean folds. On looking through it the Glottis or Rima Glottidis will be seen, *i.e.*, the space between the two inferior or true vocal cords, which varies from a mere chink to a triangular aperture with the apex forwards, according to the movements of the arytænoid cartilages. Above the true vocal cords will be seen the less distinct false cords, and through the glottis may be seen the interior of the trachea. This view of the parts deserves especial notice, as it is exactly that which is seen reversed when reflected in the laryngoscope.

[The larynx is to be fastened upon a table by driving a nail or pin through the tongue and putting the trachea on the stretch with hooks, the anterior surface being exposed; the extrinsic muscles of the larynx, the sterno-hyoid, sterno-thyroid, thyro-hyoid, and inferior constrictor of the pharynx, are then to be carefully removed without injuring the crico-thyroid muscle or the external laryngeal nerve, which are now to be cleaned.]

Intrinsic Muscles of the Larynx.

The **Crico-thyroid Muscle** (Fig. 184, 22) is placed on the side of the crico-thyroid membrane, and is somewhat triangular in shape, being narrow below and expanded above. It *arises* from an oval surface on the side of the cricoid cartilage, and ascends to be *inserted* into the posterior part of the lower border and inner surface, and into the inferior cornu of the thyroid cartilage. It is *supplied* by the external laryngeal branch of the superior laryngeal nerve.

Fig. 219.



[The preparation is to be turned over and the mucous membrane is to be dissected off the back of the larynx, the remnant of the œsophagus being removed. The crico-arytænoidei postici muscles on the back of the cricoid cartilage are readily dissected; but in

Fig. 219.—Posterior view of the larynx (from Sappey).

1. Epiglottis.
2. Arytæno-epiglottideus.
3. Superior cornu of thyroid.
4. Oblique fibres of arytænoideus.
5. Arytæno-epiglottidean fold.
6. Deep fibres of arytænoideus.
7. Tip of arytænoid cartilage.
8. External angle of base of arytænoid cartilage.
9. Thyroid cartilage.
10. Crico-arytænoideus posticus.
11. Articulation between inferior cornu of thyroid and cricoid.
12. Trachea.
13. Back of cricoid.

order to clean the cross-fibres of the arytænoideus it will be necessary to over-distend the larynx so as to stretch the muscle; and this may be most readily done by the finger of an assistant.]

The **Arytænoideus** (Fig. 219, 4) is an example of a single muscle in the median line, its fibres crossing one another and being equally distributed on each side. It occupies the concave posterior surfaces of the two arytænoid cartilages, the fibres passing from one to the other, and being divisible into superficial and deep layers. The superficial fibres cross obliquely from the apex of one cartilage to the base of the other, and *vice versâ*, so as to form an X, and are now generally described as parts of the arytæno-epiglottideus, or depressor of the epiglottis, whilst the deeper fibres pass transversely between them, and constitute the arytænoideus proper. The arytænoideus is *supplied* by the inferior laryngeal nerves.

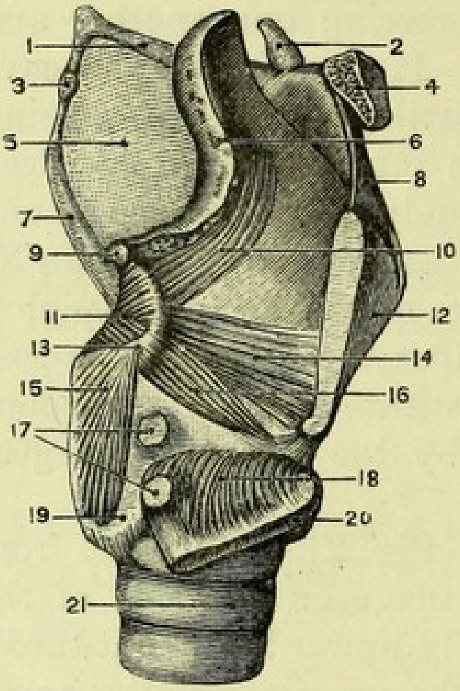
The **Crico-Arytænoideus Posticus** (Fig. 219, 10) *arises* from the posterior surface of the cricoid cartilage on one side of the median ridge, and its fibres pass obliquely upwards and outwards, to be *inserted* on the posterior aspect of the prominent outer angle of the base of the arytænoid cartilage. It is *supplied* by the inferior laryngeal nerve.

[To see the crico-arytænoideus lateralis and the thyro-arytænoideus muscles, the superior and inferior cornua of one half of the thyroid cartilage should be cut through and the ala drawn forward, any tissue being detached from its inner surface to within a quarter of an inch of the median line. A vertical cut is then to be made through it there with strong scissors or the bone-forceps, and the piece is to be removed. The larynx being distended as before, the muscles can be readily dissected.]

The **Crico-Arytænoideus Lateralis** (Fig. 220, 16) *arises* from the upper border of the side of the cricoid cartilage, and its fibres pass obliquely upwards and backwards to be *inserted* into the anterior aspect of the prominent outer angle of the base of the arytænoid cartilage. This muscle is always more or less closely connected with the thyro-arytænoideus, which is above it, and is *supplied* by the inferior laryngeal nerve.

The **Thyro-Arytænoideus** (Fig. 220, 14) has a more horizontal direction than the preceding muscle. It *arises* from the receding angle of the thyroid cartilage immediately external to the inferior or true vocal cord, the origin reaching down to the crico-thyroid membrane, to which some of its fibres are attached. It passes backwards, the upper fibres being more oblique than the lower ones, to be *inserted* into the anterior border of the arytænoid cartilage external to the attachments of the vocal cords. It is *supplied* by the inferior laryngeal nerve.

Fig. 220.



[If a second larynx can be procured, a very satisfactory way of seeing the thyro-arytænoid muscle is to cut the thyroid cartilage horizontally at the level of the true vocal cords, when the muscles can be readily displayed immediately outside them.]

Above the preceding muscles a few muscular fibres may be traced to the epiglottis from both the thyroid and the arytænoid cartilages.

These are the *thyro-epiglottideus* and the *arytæno-epiglottideus* (Fig. 220, 10), or the two may be considered as one muscle under the name of *thyro-arytæno-epiglottideus.* The upper muscle is contained in the arytæno-epiglottidean fold of mucous membrane; the lower one spreads over the mucous pouch of the larynx, and was termed *compressor sacculi laryngis* by Mr. Hilton. The fibres of the arytæno-epiglottideus are continued over the arytænoideus, and form what was formerly described as its superficial portion.

Actions of the Laryngeal Muscles.

The cartilages are moved upon one another by the several muscles, producing an effect upon either the tension of the vocal

Fig. 220.—Side view of larynx, one ala of the thyroid cartilage partially removed, the lower part being turned down (from Sappey).

1. Great cornu of hyoid.
2. Small cornu of hyoid.
3. Cartilago triticea in thyro-hyoid ligament.
4. Body of hyoid bone.
5. Thyro-hyoid membrane.
6. Epiglottis.
7. Superior cornu of thyroid.
8. Front of thyro-hyoid membrane.
9. Cartilage of Santorini.
10. Arytæno-epiglottideus.
11. Arytænoideus.
12. Thyroid cartilage.
13. Outer angle of base of arytænoid cartilage.
14. Thyro-arytænoideus.
15. Crico-arytænoideus posticus.
16. Crico-arytænoideus lateralis.
17. Articulation between inferior cornu of thyroid and cricoid laid open.
18. Crico-thyroideus, turned down.
19. Cricoid cartilage.
20. Lower part of right ala of thyroid cartilage, turned down.
21. Trachea.

cords or the size of the opening between them—the glottis. The action of these muscles will be better understood if it be remembered that the thyroid rotates round an axis passing between the tips of the two inferior cornua, while the arytænoids are capable of rotation round a vertical axis, and of gliding movements from side to side and from before backwards.

The *Crico-thyroidei* draw the thyroid cartilage downwards and forwards on the cricoid cartilage, and thus tighten the vocal cords.

The *Thyro-arytænoidei* being parallel to, and attached to the same points as, the vocal cords, must necessarily by their contraction approximate the points of attachment, and so relax the cords.

The *Crico-arytænoidei postici* swing the arytænoid cartilages outwards, and thus dilate the glottis; as can be easily shown by making traction upon the two muscles simultaneously with the points of a pair of forceps.

The *Crico-arytænoidei laterales* are antagonists to the postici, and bring the arytænoid cartilages back to their old positions, and afterwards approximate them, thus narrowing the glottis.

The *Arytænoideus* draws the arytænoid cartilages together, and thus (according to Mr. Bishop) narrows the glottis; but it may be doubted whether the superficial fibres, which are inserted farthest out, would not swing the cartilages upon their axes and thus widen the glottis.

The *thyro-arytæno-epiglottideus* and the *arytænoideus* together approximate the sides of the upper aperture of the larynx and depress the epiglottis.

[A side view of the interior of the larynx is now to be obtained by cutting away the crico-arytænoideus lateralis, with the vocal cords and mucous membrane of the same side, but the cricoid cartilage is to be left entire.]

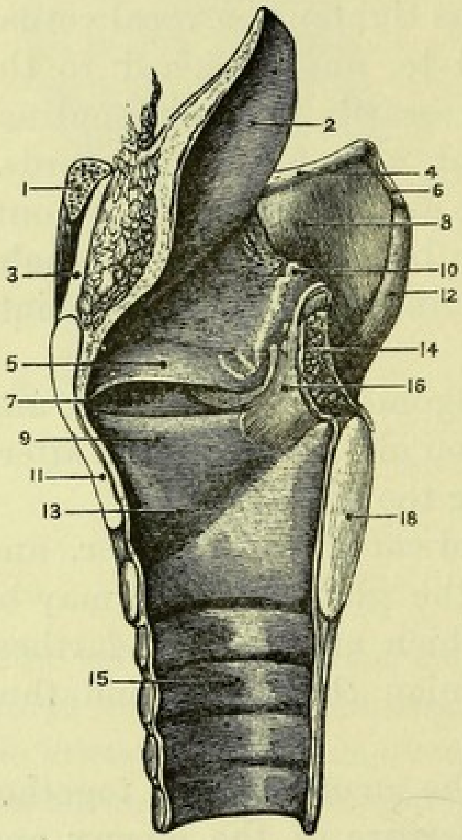
On a Side-view (Fig. 221) of the interior of the larynx will be seen the horizontal projections of the mucous membrane, formed by the superior and inferior vocal cords beneath it. Between the two cords is the cavity of the *ventricle* (7) of the larynx, and from the front of this a probe can be carried into the *laryngeal pouch* or *sacculus laryngis*, which projects upward between the upper cord and the thyroid cartilage. The mucous membrane is continued from the ventricle into the sac, in which it is provided with numerous mucous glands.

[The mucous membrane is to be dissected from the vocal cords, and their attachments are to be clearly shown.]

The **Vocal Cords** or **Thyro-arytænoid Ligaments** (Fig. 221) are four in number, two on each side of the larynx, the inferior pair, or *chordæ vocales*, being composed of yellow elastic fibrous tissue.

The *superior ligament* or *false cord* (5) has an arched direction, and is much more slender than the inferior ligament. It is attached in front to the receding angle of the thyroid cartilage, and behind to the projection on the upper part of the front of the arytænoid cartilage.

Fig. 221.



The *inferior ligament* or *true cord* (9) is horizontal in direction, being attached in front to the receding angle of the thyroid cartilage below the superior ligament, and behind to the prominent anterior angle of the base of the arytænoid cartilage. The true cord is the free upper edge of the crico-thyroid membrane. The interval between the two true vocal cords is the *rima glottidis*.

The **Arteries** of the larynx are derived from the superior and inferior thyroid arteries.

The *superior laryngeal artery*, derived from the superior thyroid, enters the larynx through the thyro-hyoid membrane, and divides into ascending and descending branches, which supply the muscles and mucous membrane.

The *inferior laryngeal artery*, derived from the inferior thyroid artery, reaches the back of the cricoid cartilage and anastomoses with the superior artery.

The **Nerves** (Fig. 185) of the larynx are the superior and the inferior (or recurrent) branches of the pneumogastric.

Fig. 221.—Vertical section of larynx showing its ligaments (from Sappey).

1. Body of hyoid bone.
2. Epiglottis.
3. Front of thyro-hyoid membrane.
4. Great cornu of hyoid.
5. False vocal cord
6. Thyro-hyoid ligament.
7. Ventricle of larynx.
8. Thyro-hyoid membrane.
9. True vocal cord.
10. Arytæno-epiglottidean fold and cartilage of Wrisberg.
11. Thyroid cartilage.
12. Superior cornu of thyroid.
13. Crico-thyroid membrane.
14. Arytænoideus muscle.
15. Trachea.
16. Arytænoid cartilage.
18. Cricoid cartilage.

The *superior laryngeal nerve* (9) has been seen to give a branch (*external laryngeal*) to the crico-thyroid muscle, and then to pierce the thyro-hyoid membrane with the superior laryngeal artery. It supplies the mucous membrane of the larynx and back of the tongue, and gives a communicating branch to the inferior laryngeal nerve.

The *inferior* or *recurrent nerve* (21) is the motor nerve of the larynx, and has been seen to take a different course on the two sides, winding around the subclavian artery on the right, and around the aorta on the left side, but in the larynx the nerves have similar distributions. Each nerve, running up the side of the trachea, passes beneath the border of the inferior constrictor of the pharynx and beneath the ala of the thyroid cartilage, to end in branches to the muscles of the larynx. It supplies all the muscles of the larynx except the crico-thyroid.

[In order to see the ligaments which bind the several parts of the larynx together, it will be necessary to remove cautiously all the muscular fibres and mucous membrane.]

The **Thyro-hyoid Ligament** (Fig. 220, 5) connects the upper border of the thyroid cartilage with the hyoid bone. It is chiefly composed of yellow elastic tissue, and may be divided into a central portion or *membrane*, and two rounded lateral portions (3), which pass from the great cornu of the hyoid bone to the superior cornu of the thyroid cartilage, and in which a nodule of cartilage is often developed. The upper attachment of the central portion is to the upper part of the posterior surface of the hyoid bone, a small bursa sometimes intervening between the membrane and the bone. This allows of the drawing up of the thyroid cartilage behind the thyroid bone. The thyro-hyoid membrane is perforated by the superior laryngeal nerve and artery.

The **Crico-thyroid Membrane** or **Ligament** (Fig. 221, 13) is also chiefly composed of elastic tissue, and passes between the borders of the cricoid and thyroid cartilages in the median line, but at the sides is prolonged upwards to the inferior vocal cords, with which it is incorporated.

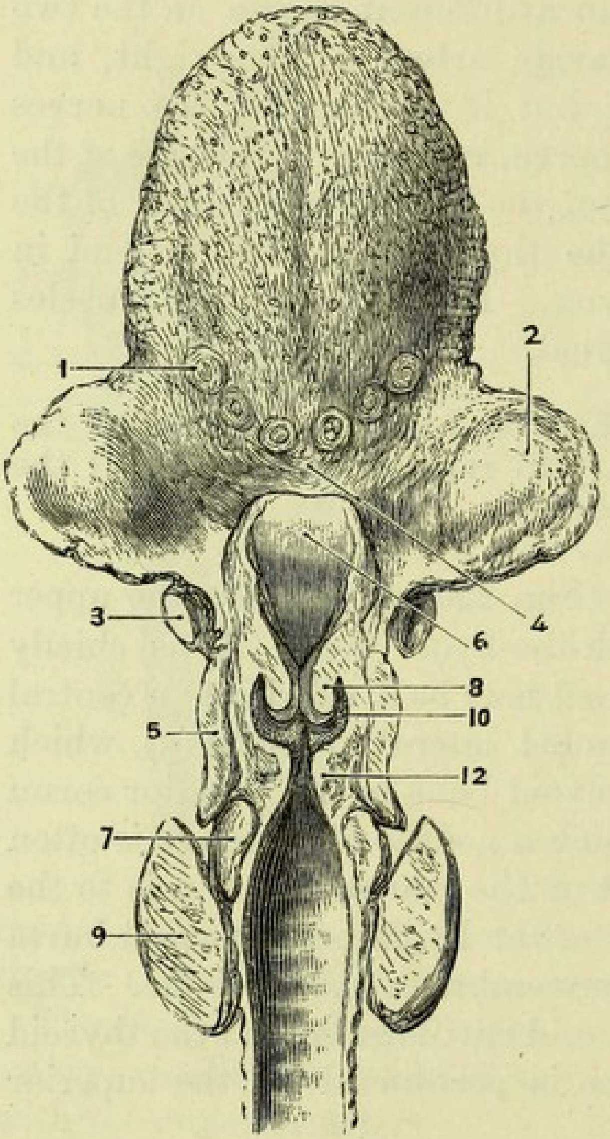
The **Crico-tracheal Ligament** is between the lower border of the cricoid cartilage and the upper ring of the trachea, and is a simple membrane like that between the several rings of the trachea.

Capsular Ligaments surround the articular extremities of the cartilages, which are also furnished with synovial membranes.

These exist in the articulations between the *cricoid* and the inferior cornua of the *thyroid cartilage;* and between the *cricoid* and the bases of the two *arytænoid cartilages.*

The **Thyro-epiglottidean Ligament** connects the lower border of the epiglottis with the back of the thyroid cartilage, opposite the notch in its upper border.

Fig. 222.



The **Hyo - epiglottidean Ligament** is a band of yellow elastic tissue passing between the apex of the epiglottis and the upper border of the hyoid bone.

Cartilages of the Larynx.

[The large cartilages of the larynx, viz. the thyroid, cricoid, two arytænoid, and the cartilage of the epiglottis, are readily recognized, but two pairs of minute cartilages, the cornicula laryngis and the cuneiform cartilages, are to be looked for in the arytæno-epiglottidean folds of mucous membrane.]

The **Thyroid Cartilage** (Fig. 219, 9) (*θυρεὸς εἶδος,* like a shield) is the largest cartilage of the larynx, and consists of two halves or *alæ*, which meet at an angle in front and form the *pomum Adami.* Each ala is quadrilateral in shape, and has a rounded posterior border into which the stylo-pharyngeus and palato-pharyngeus muscles are inserted, and which is prolonged into a *superior* and an *inferior cornu.* The superior cornu is the longer of the two and is

Fig. 222.—Vertical transverse section of larynx with tongue (from University College Museum).

1. Papillæ circumvallatæ.
2. Tonsil.
3. Hyoid bone.
4. Foramen cæcum.
5. Thyroid cartilage.
6. Epiglottis.
7. Cricoid cartilage.
8. Superior vocal cord.
9. Thyroid body.
10. Sacculus laryngis.
12. Inferior vocal cord.

non-articular, but the inferior cornu has been seen to articulate with the cricoid cartilage, and to give attachment to the crico-thyroid muscle.

On the side of the ala is an *oblique ridge*, extending from a tubercle at the root of the superior cornu to another tubercle about the middle of the lower border of the cartilage. The ridge gives attachment to the sterno-thyroid and thyro-hyoid muscles, and the surface behind it to the inferior constrictor of the pharynx. The inner surfaces of the alæ are smooth, and in the receding angle formed by their junction seven structures are attached, viz. the thyro-epiglottidean ligament, the two pairs of thyro-arytænoid ligaments (false and true vocal cords), and the two thyro-arytænoid muscles, just external to the inferior ligaments or true cords.

The **Cricoid Cartilage** (Fig. 211, 18) (*κρίκος εἶδος*, like a ring) is a ring of cartilage, shallow in front (where it has been seen to be connected with the thyroid cartilage by a membrane, and has the crico-thyroideus attached to its surface), but deep behind, where it fills up a part of the space left between the posterior borders of the thyroid. The upper border of the deep portion presents two oval articular surfaces for the arytænoid cartilages, external to which are the origins of the crico-arytænoidei laterales.

On each side, and near the lower border of the cartilage, are two small facets for articulation with the inferior cornua of the thyroid cartilage. The posterior surface is divided in the middle line by a vertical ridge, to which some of the fibres of the œsophagus are attached, the concave surface on each side giving origin to the crico-arytænoidei postici muscles.

The **Arytænoid Cartilages** (Fig. 219) (*ἀρυταίνα*, a pitcher*) are two in number, and are of a pyramidal shape. The base of each cartilage is triangular, and articulates with the upper border of the cricoid cartilage; its anterior angle gives attachment to the true vocal cord, and its external angle to the crico-arytænoideus posticus and crico-arytænoideus lateralis. The apex is curved backwards and inwards, and is surmounted by the corniculum laryngis.

The posterior surface of the cartilage is concave, and gives attachment to the arytænoideus muscle; the anterior surface presents a small tubercle for the attachment of the false vocal cord,

* This derivation has reference to the appearance of both cartilages taken together and covered by mucous membrane. In animals, which were the principal subjects of dissection among the ancients, the opening of the larynx, with the arytænoid cartilages, bears a curious resemblance to the mouth of a pitcher with a large spout (Wilson)

and also gives attachment to the thyro-arytænoideus muscle; the internal surface is smooth, and covered with mucous membrane.

The **Cornicula Laryngis** or **Cartilages of Santorini** are two small conical cartilages, connected with the apices of the arytænoid cartilages and with the arytæno-epiglottidean folds. They are composed of yellow fibro-cartilage.

The **Cuneiform Cartilages** or **Cartilages of Wrisberg** are two small bodies found in the arytæno-epiglottidean folds of mucous membrane, and are sometimes wanting. They are composed of yellow fibro-cartilage.

The **Epiglottis** (Fig. 221, 2) is composed of yellow fibro-cartilage, shaped like a cordate leaf, and has been seen to be connected with the thyroid cartilage and the hyoid bone. It is covered with mucous membrane, upon removing which it will be found to be perforated, especially in the posterior aspect, by numerous holes, in which mucous glands are lodged.

The large cartilages of the larynx are very apt to undergo calcareous degeneration in advanced life, and the epiglottis is not unfrequently thickened by disease or injured by ulceration.

Ligaments of the Cervical Vertebræ.

The ligaments uniting the cervical vertebræ together are, except in the case of the first two, similar to those found in other parts of the spinal column, and their description will be found at the end of that of the thorax. The student would do well to refer to this description in order to observe the slight differences between these ligaments in the cervical and dorsal regions.

Ligaments of the Atlas, Axis, and Occiput.

[In order to examine the special ligaments of the first two cervical vertebræ and the occipital bone, it will be convenient to separate the whole of the cervical from the dorsal spine.]

The ligaments of the first two vertebræ and the occipital bone may be conveniently divided into (1) those external to, and (2) these internal to the vertebral canal. The external ligaments more or less resemble the ligaments common to the vertebral column, but the internal ligaments have special relation to the movements of nutation and rotation, which are peculiar to this region.

1. The *External ligaments* are the Anterior, Posterior, and Lateral

Occipito-Atlantal, and the Anterior and Posterior Atlanto-axial ligaments; besides Capsular ligaments for the articular processes of the vertebræ and the condyles of the occipital bone.

The **Anterior Occipito-Atlantal Ligament** (Fig. 223) consists of a superficial and a deep portion. The superficial portion (1) is round, and is attached to the basilar process of the occipital bone above, and to the anterior tubercle of the atlas below. The deep

Fig. 223.

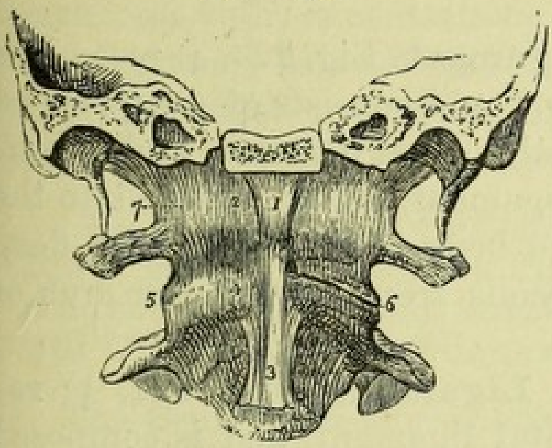
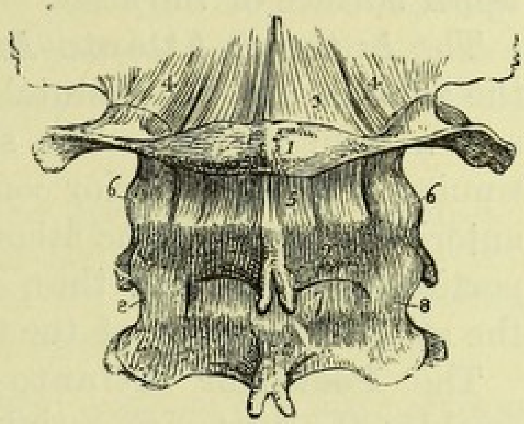


Fig. 224.



portion (2) is broad and membranous, and is attached to the occipital bone close to the foramen magnum above, and to the upper margin of the anterior arch of the atlas below.

The **Posterior Occipito-Atlantal Ligament** (Fig. 224, 3) resembles the ligamenta subflava, but is composed of white fibrous tissue. It is thin and membranous, and is attached above to the

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Fig. 223.—Anterior view of the ligaments connecting the atlas, axis, and occipital bone (from Wilson).

1. Anterior round occipito-atlantal ligament.
2. Anterior broad occipito-atlantal ligament.
3. Commencement of the anterior common ligament.
4. Anterior atlanto-axial ligament, continuous inferiorly with the commencement of the anterior common ligament.
5. One of the atlanto-axial capsular ligaments; that on the opposite side has been removed to show the approximated surfaces of the articular processes (6).
7. One of the occipito-atlantal capsular ligaments. The most external of these fibres constitute the lateral occipito-atlantal ligament.

Fig. 224.—Posterior ligaments of the occipito-atlantal and atlanto-axial articulations (from Wilson).

1. Atlas.
2. Axis.
3. Posterior occipito-atlantal ligament.
4, 4. Capsular and lateral occipito-atlantal ligament.
5. Posterior atlanto-axial ligament.
6, 6. Its capsular ligaments.
7. The first pair of ligamenta subflava.
8, 8. Capsular ligaments of the 2nd and 3rd vertebræ.

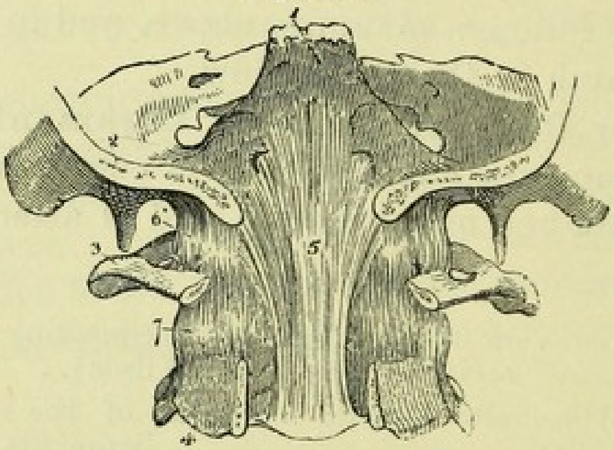
posterior margin of the foramen magnum, and below to the posterior arch of the atlas. On each side, this ligament is perforated by the vertebral artery and suboccipital nerve, over which some of its fibres arch.

The **Lateral Occipito-Atlantal Ligaments** (Fig. 224, 4) are short strong bands, passing between the roots of the transverse processes of the atlas and the jugular processes of the occipital bone, which serve to strengthen the *capsular ligaments* uniting the condyles of the occipital bone with the corresponding articular facets on the upper surface of the atlas.

The **Anterior Atlanto-Axial Ligament** (Fig. 223, 4) resembles the anterior occipito-atlantal ligament, and consists of a superficial and a deep portion. The superficial portion is round, and is continuous with the anterior common ligament, being attached to the anterior tubercle of the atlas and the body of the axis. The deep portion is broad and thin, and extends from the anterior arch of the atlas to the body of the axis.

The **Posterior Atlanto-Axial Ligament** (Fig. 224, 5) resembles the posterior occipito-atlantal ligament, and is composed

Fig. 225.



of white fibrous tissues, lined by a layer of yellow elastic tissue. It extends between the posterior arch of the atlas and the laminæ of the axis.

Fig. 225.—The occipito-axial ligament (from Wilson).

1. Basilar portion of the sphenoid bone.
2. Section of the occipital bone.
3. Atlas, its posterior arch removed.
4. Axis, its posterior arch removed.
5. Occipito-axial ligament, rendered prominent at its middle by the projection of the odontoid process.
6. Lateral and capsular ligament of the occipito-atlantal articulation.
7. Capsular ligament of the articular process of the atlas and axis.

2. The *Internal Ligaments* are the Occipito-Axial, the Cruciform, and the Odontoid ligaments.

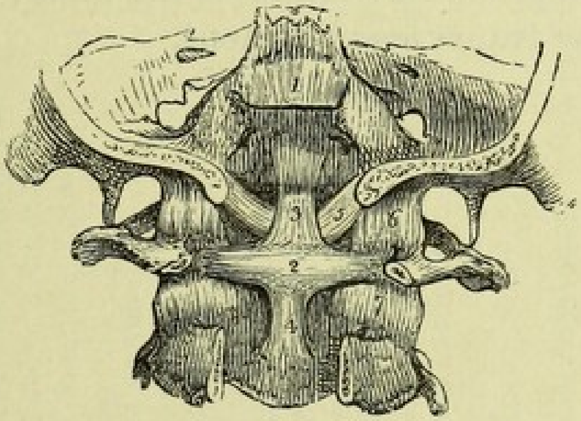
[To expose these ligaments it will be necessary to saw through the occipital bone obliquely on each side of the foramen magnum. The posterior part of the bone being removed, the arches of the atlas and axis are to be cut through on each side and removed, and any remains of the spinal cord dissected away with the dura-mater, when the occipito-axial ligament will be exposed.]

The **Occipito-Axial Ligament** (Fig. 225, 5) (apparatus ligamentosus colli) is continuous with the posterior common ligament. It is attached below to the back of the body of the axis, and above to the basilar groove of the occipital bone above the foramen magnum, through which it passes.

[The occipito-axial ligament is to be divided and turned up and down, when the cruciform ligament of the atlas and axis will be brought into view, and immediately above the transverse portion will be seen the two oblique odontoid ligaments.]

The **Cruciform Ligament** (Fig. 226) consists of a strong transverse ligament and two small vertical slips.

Fig. 226.



The **Transverse Ligament of the Atlas** (Fig. 226, 2) is attached to a tubercle on the inner surface of the articular process

Fig. 226.—Posterior view of the ligaments connecting the atlas, axis, and occipital bone (from Wilson).

1. Superior part of the occipito-axial ligament, which has been cut away in order to show the ligaments beneath.
2. Transverse ligament of the atlas.
3, 4. Ascending and descending slips of the transverse ligament, which complete the cruciform arrangement.
5. One of the odontoid ligaments, the fellow ligament is seen on the opposite side.
6. One of the occipito-atlantal capsular ligaments.
7. One of the atlanto-axial capsular ligaments.

of each side, and thus forms a ring with the anterior arch of the atlas, in which the odontoid process of the axis is firmly held. The vertical slips of the cruciform ligament pass from the transverse ligament to the basilar process of the occipital bone and the body of the axis respectively, and by detaching the upper one the odontoid ligament will be fully seen.

The **Odontoid** or **Check Ligaments** (Fig. 226, 5), are two strong bands of fibres, which pass obliquely from the apex of the odontoid process to the margin of the foramen magnum on each side, and they thus check the rotation of the cranium and atlas upon the odontoid process. Between these is a *central odontoid ligament* (*ligamentum suspensorium dentis*), passing vertically between the margin of the foramen magnum and the top of the odontoid process.

On cutting all the ligaments of the articulation except the transverse ligament of the atlas, the odontoid process will be found to be still firmly held in position, owing to the fact that the ligament surrounds the contracted neck of the odontoid process, which is considerably smaller than the head. There are two *synovial membranes* in connection with the odontoid process, one in front, between it and the posterior surface of the atlas; the other behind, between it and the transverse ligament.

TABLE 4.
MUSCLES OF THE HEAD AND NECK.

Muscle.	Origin.	Insertion.	Nerve.
Occipito-frontalis	Fibres of orbicularis palpebrarum and pyramidalis nasi; Superior occipital line, mastoid process	Aponeurosis over skull	Facial (7th).
Attollens aurem	Aponeurosis of occipito-frontalis	Helix of pinna	Facial (7th).
Attrahens aurem	Aponeurosis of occipito-frontalis	Back of pinna	Facial (7th).
Retrahens aurem	Mastoid process	Back of concha	Facial (7th).
Levator palpebræ sup.	Margin of optic foramen	Upper tarsal cartilage	Third.
Obliquus superior	Margin of optic foramen	Eyeball, outer side	Fourth.
Rectus superior	Margin of optic foramen	Eyeball, upper side	Third.
Rectus internus	Margin of optic foramen	Eyeball, inner side	Third.
Rectus inferior	Margin of optic foramen	Eyeball, lower side	Third.
Rectus externus	Common origin and sphenoidal fissure; Upper part of optic foramen	Eyeball, outer side	Sixth.
Obliquus inferior	Superior maxilla behind lacrymal groove	Eyeball, outer side	Third.
Orbicularis palpebrarum	Frontal, inner angle; tendo oculi; superior maxilla, nasal process	Skin; malar bone and external tarsal ligament	Facial (7th).
Corrugator supercilii	Frontal, superciliary ridge	Orbicularis palpebrarum	Facial (7th).
Pyramidalis nasi	Orbicularis palpebrarum	Fascia over nose	Facial (7th).
Levator labii superioris alæque nasi	Superior maxilla, nasal process	Alar cartilage; upper lip	Facial (7th).
Compressor naris	Superior maxilla, canine fossa	Fascia over bridge of nose	Facial (7th).
Depressor alæ nasi	Superior maxilla, myrtiform fossa	Columna and ala nasi	Facial (7th).
Orbicularis oris	Septum nasi; alveoli of both jaws	Surrounds the mouth	Facial (7th).
Levator labii proprius	Sup. maxilla (and malar) above foramen	Orbicularis oris	Facial (7th).
Levator anguli oris	Sup. maxilla below infra-orbital foramen	Orbicularis oris	Facial (7th).
Zygomaticus major	Malar bone and Zygoma	Orbicularis oris	Facial (7th).
Zygomaticus minor	Malar bone	Levator labii superioris	Facial (7th).
Depressor anguli oris	Lower jaw below mental foramen	Orbicularis oris	Facial (7th).

TABLE 4.

MUSCLES OF THE HEAD AND NECK—*continued.*

Muscle.	Origin.	Insertion.	Nerve.
Depressor labii inferioris	Lower jaw, near symphysis	Orbicularis oris	Facial (7th).
Levator menti	Lower jaw, incisive fossa	Skin of chin	Facial (7th).
Platysma	Front of clavicle; fascia	Lower jaw, side of, skin and fascia	Facial (7th).
Sterno-mastoid	Sternum, top of; clavicle, inner $\frac{1}{3}$	Mastoid process; occipital line, outer $\frac{1}{2}$.	Spinal accessory (8th).
Sterno-hyoid	Sternum; 1st costal cartilage; clavicle	Hyoid bone, body	Descendens noni (9th).
Sterno-thyroid	Sternum; 1st costal cartilage	Thyroid cartilage, oblique line	Descendens noni (9th).
Thyro-hyoid	Thyroid cartilage, oblique line	Hyoid bone, body, and great cornu	Special branch (9th).
Omo-hyoid	Scapula, upper margin and transverse ligament.	Hyoid bone, body	Descendens noni (9th).
Digastricus	Groove on mastoid process	Lower jaw, close to symphysis	Facial (7th). Mylo-hyoid (5th).
Stylo-hyoid	Styloid process, outer side	Hyoid bone, body	Facial (7th).
Masseter	Zygomatic arch and superior maxilla	Lower jaw, angle and ramus	3rd division of 5th.
Temporal	Temporal fossa and fascia	Lower jaw, coronoid and ramus	3rd division of 5th.
Pterygoideus externus	Pterygoid plate, tuberosity of palate and maxilla Great wing of sphenoid	Lower jaw, interarticular cartilage	3rd division of 5th.
Pterygoideus internus	Pterygoid plate, tuberosity of palate and maxilla	Lower jaw, inner surface of angle	3rd division of 5th.
Buccinator	Maxillæ, alveolar borders; pterygo-maxillary ligament	Orbicularis oris	7th and 3rd div. of 5th.
Mylo-hyoid	Ridge on inner side of lower jaw	Hyoid bone, body; median line	Inferior dental (5th).
Hyo-glossus	Hyoid bone, body and cornua	Tongue, side of	Hypoglossal (9th).
Stylo-glossus	Styloid process, tip; stylo-maxillary ligament	Tongue, side of	Hypoglossal (9th).
Stylo-pharyngeus	Styloid process, root	Bag of pharynx; thyroid cartilage	Glosso - pharyngeal (8th).
Genio-hyoid	Lower mental tubercle	Hyoid bone, body	Hypoglossal (9th).
Genio-hyo-glossus	Upper mental tubercle	Hyoid bone, body; tongue, median line	Hypoglossal (9th).
Scalenus anticus	1st rib, tubercle	Cervical vertebræ, 3, 4, 5, 6, anterior transverse processes	Brachial nerves,

Scalenus medius	1st rib, upper surface	Cervical vertebræ, lower 6, posterior transverse processes	Brachial nerves.
Scalenus posticus	2nd rib	Cervical vertebræ, lower 3, posterior transverse processes	Brachial nerves.
Rectus capitis anticus major	Cervical vertebræ, 3, 4, 5, 6, anterior transverse processes	Occipital, basilar process	1st cervical, anterior.
Rectus capitis anticus minor	Atlas, lateral mass and transverse process	Occipital, basilar process	1st cervical, anterior.
Rectus capitis lateralis	Atlas, transverse process	Occipital, jugular process	1st cervical, anterior.
Longus colli	Dorsal vertebræ, 1st and 2nd bodies Cervical vertebræ, 3, 4, 5, transverse processes Cervical vertebræ, 5, 6, 7; dorsal, 1, 2, 3, bodies	Cervical vertebræ, 5th and 6th transverse processes Atlas, anterior tubercle Cervical vertebræ, 2, 3, 4, bodies	Brachial nerves.
Inferior constrictor	Cricoid cartilage; thyroid cartilage behind line.	Median raphé	Pharyngeal plexus.
Middle constrictor	Hyoid bone, great and lesser cornua; stylo-hyoid ligament	Median raphé	
Superior constrictor	Internal pterygoid plate; pterygo-maxillary ligament; mylo-hyoid ridge	Median raphé; basilar process	
Levator palati	Petrous bone; Eustachian tube	Soft palate	Meckel's ganglion.
Circumflexus palati	Scaphoid fossa; Eustachian tube	Soft palate and palatine ridge	Otic ganglion.
Azygos uvulæ	Posterior nasal spine of palate	Uvula	Meckel's ganglion.
Palato-glossus	Soft palate	Side of tongue	Meckel's ganglion.
Palato-pharyngeus	Soft palate	Pharynx; thyroid cartilage	Meckel's ganglion.
Crico-thyroideus	Cricoid cartilage, ring	Thyroid cartilage, lower border and cornu	External laryngeal.
Arytænoideus	Arytænoid cartilages, concave posterior surfaces	Decussating fibres	Inferior laryngeal.
Crico-arytænoideus posticus	Cricoid cartilage, posterior surface	Arytænoid, base, posterior outer angle.	Inferior laryngeal.
Crico-arytænoid. lat.	Cricoid cartilage, lateral border	Arytænoid, base, anterior outer angle	Inferior laryngeal.
Thyro-arytænoideus	Thyroid cartilage, receding angle	Arytænoid, anterior surface	Inferior laryngeal.

PART V.

THE THORAX.

[The axilla having been completed, the dissectors of the thorax should detach the remains of the pectorales, the serrati, and the abdominal muscles from the outer surfaces of the ribs and their cartilages, and dissect the external intercostal muscles.]

The **External Intercostal Muscles** (Fig. 102, 4), eleven in number, are placed between the ribs, being attached to the lower and upper borders of the adjacent bones, the fibres running obliquely downwards and forwards. The external intercostals extend from the tubercles of the ribs to the line of their junction with the cartilages, beyond which point a thin fascia is prolonged to the sternum, the fibres of which take the same direction as those of the external intercostals. Between the floating ribs the fibres cease at the extremities of the bones.

[By removing the external intercostal in one space, the outer surface of the internal intercostal muscle will be exposed, and the intercostal artery will be found with its accompanying vein and nerve. The artery, which lies at first at the lower border of the rib bounding the space above, will be seen at last to anastomose with one of the intercostal branches of the internal mammary, which runs outwards in the substance of the internal intercostal muscle. A branch of the intercostal artery will be found at the lower part of each space between the muscles, and anastomosing with a corresponding branch of the internal mammary.]

The **Internal Intercostal Muscles** (Fig. 102, 5) take a direction opposite to that of the external muscles, and can now be seen partially near the sternum, where the external muscles are wanting, but are fully seen subsequently from within the thorax.

[The knife is to be carried through the cartilages of all the true ribs except the first, as near the bones as possible, and then along the intercostal space between the 5th and 6th ribs to the lower part of the sternum. The sternum being sawn across between the 1st and 2nd ribs, and between the 5th and 6th ribs, the intervening part is to be removed with the triangularis sterni and the internal mammary vessels, which are necessarily divided in two places, the pleuræ being divided near the median line so as to preserve the anterior mediastinum.]

The **Triangularis Sterni Muscle** (Fig. 227, 3) lies at the back of the sternum, but is ordinarily damaged by the incision made for injecting the subject, and the muscle is therefore best seen on a fresh sternum from a post-mortem examination. It *arises* from the inner surface of the ensiform cartilage and lower part of the sternum, and from the cartilages of the last three or four true ribs; and is *inserted* into the cartilages of the 2nd, 3rd, 4th, and 5th ribs. The triangularis sterni acts as a muscle of expiration by depressing the ribs, and is *supplied* by the intercostal nerves.

[The internal mammary arteries may now be dissected by removing the triangularis sterni.]

The **Internal Mammary Artery** (Fig. 227, 2) passes downwards behind the cartilages of the ribs, about half an inch from the margin of the sternum, superficially to the triangularis sterni, as far as the 7th costal cartilage, where it divides into its terminal branches the superior epigastric and the musculo-phrenic.

a. The *superior epigastric branch*, after passing between the sternal and costal origins of the diaphragm, enters the fibres of the rectus abdominis muscle, and anastomoses with the epigastric branch of the external iliac, thus establishing a communication which becomes of great importance in any case of obstruction of the aorta or iliac arteries.

b. The *musculo-phrenic branch* runs outwards between the lower rib cartilages and the diaphragm, and after perforating the latter opposite the 8th or 9th cartilage, supplies it and anastomoses with the intercostal arteries, as well as with the phrenic branches of the abdominal aorta.

The other branches of the internal mammary are (*c*) *comes nervi phrenici*, a small branch accompanying the phrenic nerve and seldom seen; (*d*) *mediastinal* and (*e*) *pericardiac* branches to those parts, from which small branches pass to form the 'sub-pleural mediastinal plexus' (Turner); (*f*) *anterior intercostals*, two to each of the upper six intercostal spaces, running out in the substance of the internal intercostal muscle, and anastomosing with other intercostal branches; and (*g*) *perforating* branches to the pectoral muscles and to the mamma and the skin.

The *venæ comites* of the internal mammary artery unite to open into the corresponding innominate or brachio-cephalic vein.

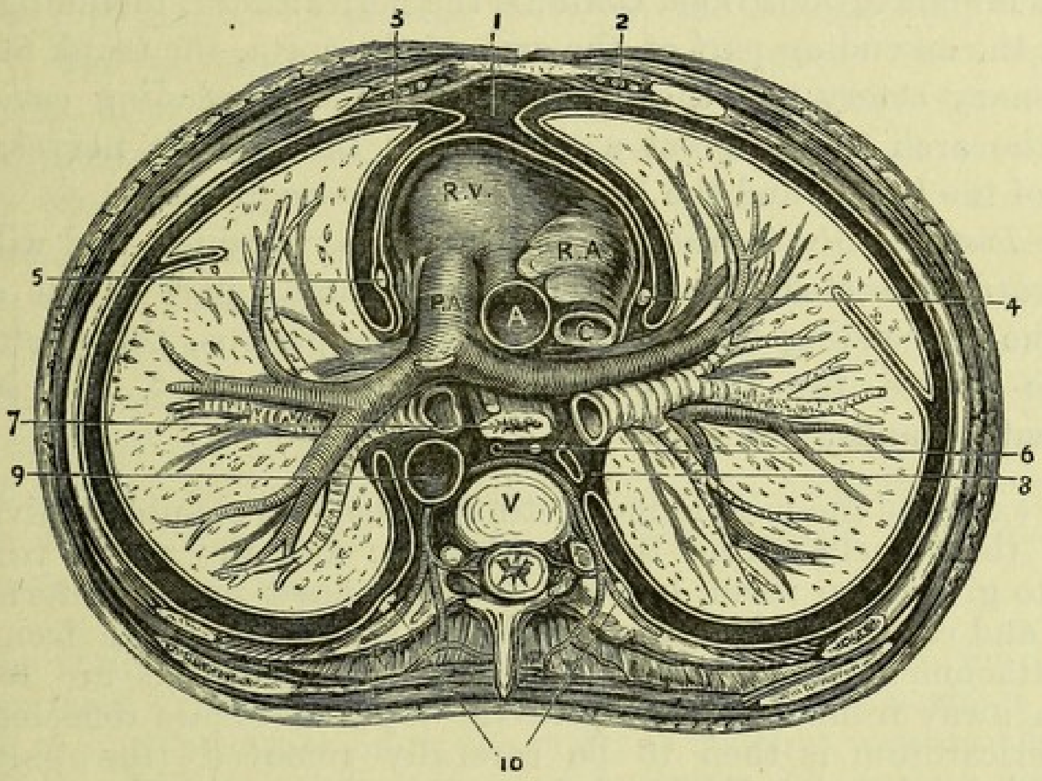
On opening the thorax as directed, the lungs will be exposed by the necessary division of the pleuræ, and will be seen to occupy the sides of the chest, having probably, unless attached by old adhesions, fallen back so as to leave the pericardium exposed. The great vessels of the heart will be seen emerging from the upper part of the pericardium, and if the lungs are fully collapsed, the roots of the lungs will be visible on each side. The pericardium will in all probability have been opened at the upper part to allow of the injection of the body, in which case a portion of the heart may be seen within it, and the opening may be advantageously closed with a stitch.

The **Pleuræ** (Fig. 227) are two shut sacs of serous membrane, lining the thorax and covering the lungs, but have been opened in removing the sternum. One of the lungs is to be drawn forward, when its pleura can be readily traced over the inner surface of the sternum and ribs (costal layer) on to the back of the lung; thence over the lung (pulmonary layer) to the front of the root of the lung, by which it is directed to the pericardium, and carried forward to the sternum a little to one side of the median line. Frequently it will be impossible to trace the pleura in this manner, owing to the adhesions which have formed between the pleura costalis and pleura pulmonalis as the result of inflammation. When the lung is drawn forward, below its root will be found a fold of pleura connecting the lower lobe with the side of the pericardium, which is called the *ligamentum latum pulmonis*. The pleura will be seen to be reflected on the upper surface of the diaphragm below, and to be prolonged in a conical form above the first rib, where it may be felt in relation with the subclavian artery. The visceral layer of the pleura is that which covers the lung, the parietal layer includes the costal layer as well as that part which covers the diaphragm and the sides of the pericardium, and enters into the formation of the mediastinum. The diaphragm rises higher on the right side than on the left, owing to the presence of the liver, and the heart has a direction to the left; hence the right bag of the pleura is the wider, whilst the left is the longer of the two, and the lungs correspond in shape.

The **Mediastinum** * is the space between the pleuræ, and is best understood by dividing it into four parts.

The *Superior Mediastinum* is bounded in front by the manubrium sterni and behind by the bodies of the upper four dorsal vertebræ; its upper limit is the upper aperture of the thorax, its lower a plane drawn through the lower part of the body of the fourth dorsal

Fig. 227.



vertebra and the junction of the manubrium with the body of the sternum. It contains the trachea, the œsophagus, and the thoracic duct; the transverse part of the arch of the aorta and its

* The following description is a modification of one first suggested by Struthers.

Fig. 227.—Diagram of a transverse section of the thorax (altered from Wilson and Carter, by J. T. Gray).

1. Anterior mediastinum.
2. Internal mammary vessels.
3. Triangularis sterni muscle.
4. Right phrenic nerve between pleura and pericardium.
5. Left phrenic nerve between pleura and pericardium.
6. Thoracic duct in posterior mediastinum.
7. Œsophagus with left vagus in front and right vagus behind.
8. Vena azygos major.
9. Thoracic aorta, giving off intercostal arteries.
10. Gangliated cord of sympathetic.

R. V. Right ventricle. R. A. Right auricle of heart in middle mediastinum.
P. A. Pulmonary Artery.
A. Aorta.
C. Vena cava superior.
V. Dorsal vertebra.

three great branches, the innominate veins and part of the vena cava; the phrenic and pneumogastric nerves, the left recurrent and some cardiac nerves, with some lymphatic glands and the remains of the thymus gland.

The space below is divided into three parts, the *Anterior mediastinum* is the space in front of the pericardium, and contains some cellular tissue and lymphatic glands, and the left triangularis sterni.

The *Middle Mediastinum* contains the pericardium, including the heart, the ascending part of the arch of the aorta, the trunk of the pulmonary artery and the lower part of the descending cava, as well the arch of the great azygos vein; the phrenic nerves, the roots of the lungs, and the bronchial lymphatic glands.

The *Posterior Mediastinum* is behind the pericardium and will be afterwards dissected; it contains the descending part of the arch and the descending thoracic aorta, the œsophagus, the pneumogastric nerves, the azygos veins, the thoracic duct, and some lymphatic glands.

[To examine the middle mediastinum, the ribs should be divided about three inches from their cartilages, and the pieces turned back to give more room, but the first rib must not be interfered with, and care should be taken to divide the second rib in front of the attachment of the scalenus posticus. The lungs are to be drawn away from the heart, and the layer of pleura reflected on the pericardium is then to be carefully removed (the phrenic nerves lying between the two being preserved), and the roots of the lungs cleaned without injuring the pericardium. After observing the external surface of the pericardium, an oblique incision, from above downwards and to the left, may be made in it, in order to study its interior.]

The **Pericardium** (Fig. 227) is a fibro-serous membrane inclosing the heart, and is of conical shape, the base being at the diaphragm and the apex lost on the great vessels, where it is incorporated with a process of the deep cervical fascia, which serves to maintain the position of the heart. The fibrous layer is pierced by and gives an investment to all the vessels connected with the heart, except the inferior vena cava, which pierces the central tendon of the diaphragm within the line at which the fibres of the pericardium are incorporated with those of the central tendon of the diaphragm. The serous lining consists of a parietal and a visceral layer, the former being inseparably united with the fibrous layer, and the latter covering the heart and being reflected on all the vessels for a short distance, but binding the aorta and the pulmonary artery together in a single tube of membrane.

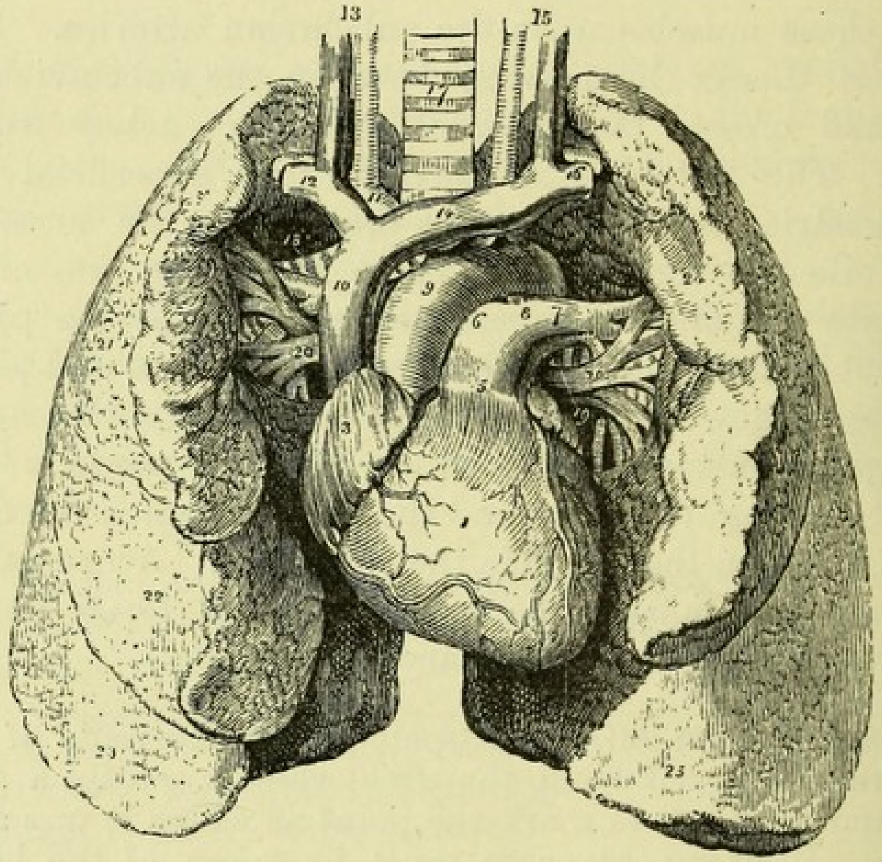
The **Phrenic Nerves** (Fig. 227, 4, 5) will be seen in the whole of their course, if the dissection of the neck is sufficiently advanced, and should be carefully preserved. Arising from the 4th and 5th cervical nerves, and frequently by a small branch from the 3rd, they lie on the scaleni antici in the neck, and then to the inner sides of those muscles upon the subclavian arteries. Each nerve enters the thorax by passing between the subclavian vein and artery, and crosses the internal mammary artery from without inwards. The left phrenic nerve is then superficial to the left pneumogastric nerve, and crosses the arch of the aorta internally to it, while the right nerve lies to the outer side of the right innominate vein and the superior cava. Both nerves pass in front of the root of the lungs, and between the pleuræ and pericardium, to the diaphragm, which they pierce and supply, the right having a small ganglion connected with it. The left nerve is longer than the right, having to pass round the heart to reach the diaphragm, which is lower on the left than the right side. Accompanying each nerve may occasionally be seen the small *comes nervi phrenici* artery from the internal mammary.

[The pericardium is to be dissected from the roots of the lungs and entirely removed from the great vessels, except a small piece which should be left to mark the point at which it was attached to the aorta. In doing this, care must be taken of the left phrenic and left pneumogastric nerves, as well as of some small cardiac nerves and the left superior intercostal vein, which cross the arch of the aorta.]

The **Roots of the Lungs** (Figs. 227 and 228) are situated about midway between the base and the apex, and at the junction of the posterior with the middle third of the inner surface of the lung; they are each formed by a pulmonary artery, two pulmonary veins, and a bronchus, bound together by cellular tissue; together with the small bronchial vessels, the pulmonary plexuses of the pneumogastric nerve, and some lymphatics. The order of the vessels from before backwards on both sides of the body is the same, viz. veins, artery, and bronchus; from above downwards on the right side the order is the reverse, viz. bronchus, artery, veins; but on the left side it is artery, bronchus, veins. The reason of this difference is, that in the lung itself the artery is applied to the back of the main bronchus, to reach which position it crosses the air tube, and in doing so passes below the bronchus which goes to the upper lobe of the right lung, to which there is no corresponding branch on the left side.*

The **Lungs** (Fig. 228) will vary very much in condition in different bodies. If perfectly healthy their surfaces will be smooth,

Fig. 228.



and they will be somewhat contracted, but crepitant throughout. Every variety of disease may be found, the most common being

* It may be noticed that the order of structures from before backwards in the root of the lung corresponds to the arrangement in the hilum of the kidney, viz. vein, artery, ureter.

Fig. 228.—The heart and lungs (from Wilson).

1. Right ventricle.
2. Left ventricle.
3. Right auricle.
4. Left auricular appendix.
5. Pulmonary artery.
6. Right pulmonary artery.
7. Left pulmonary artery.
8. Remains of the ductus arteriosus.
9. Arch of the aorta.
10. Superior vena cava.
11. Innominate artery, and in front of it the right innominate vein.
12. Right subclavian vein, and behind it, the corresponding artery.
13. Right common carotid artery and jugular vein.
14. Left innominate vein.
15. Left carotid artery and jugular vein.
16. Left subclavian vein and artery.
17. Trachea.
18. Right bronchus.
19. Left bronchus.
20, 20. Pulmonary veins.
21. Superior lobe of the right lung.
22. Middle lobe.
23. Inferior lobe.
24. Superior lobe of the left lung
25. Inferior lobe.

tubercle and abscess in the upper lobes, with adhesion to the wall of the thorax, or pneumonic condensation through more or less of the organ. The lungs of subjects dying in large cities not unfrequently present black pigment in the lung tissue and the lymphatic glands. Each lung has a thin anterior margin and a thicker posterior one, which lies against the spinal column, and is longer than the anterior border. The anterior margin of the left lung is notched so as to leave the apex of the heart uncovered. The outer surface of the lung is convex and the inner concave; about the middle of this latter surface from above down, and nearer the posterior than the anterior border is a slit, the hilum, at which the root of the lung enters, whilst in front of it is a hollow corresponding to the heart, and larger in the left lung than the right. The base of the lung is moulded to the diaphragm, and is, therefore, lower behind than in front; whilst the apex is rounded and reaches into the neck above the first rib, extending to a point, varying from half an inch to an inch and a half, above the clavicle. The right lung is the larger, owing to the direction of the heart to the left, but is shorter than the left, owing to the position of the liver. The left lung is divided into two lobes (upper and lower) by a fissure running obliquely across the external surface, from near the apex to the anterior border; but the right has three lobes, owing to the existence of a second fissure running horizontally forward, from the middle of the first fissure to the anterior margin of the lung.

The **Heart** (Fig. 228) is placed obliquely between the lungs, the base being directed backwards to the right, and the apex to the left side; and resting on the diaphragm, which is now convex (the position of expiration), the apex looks almost horizontally outwards. The base corresponds to the interval between the 5th and 8th dorsal vertebræ, and the apex beats between the 5th and 6th ribs, the larger portion of the organ being to the left of the median line. The right border is situated an inch and a half from the middle line, the apex, which for purposes of auscultation is described as being about two inches below the nipple and one to the sternal side, is placed three inches from the middle of the sternum. The base reaches as high as the lower borders of the second costal cartilages, the lower limit is marked by a line drawn from the 7th right chondro-sternal articulation to the apex of the heart. The right auriculo-ventricular opening (tricuspid valve) lies behind the middle of the sternum, about the level of the fourth intercostal space. The left auriculo-ventricular opening (mitral valve) lies behind the left half of the sternum opposite the fourth cartilage. The pulmonary semilunar valves lie behind the junction of the third rib-cartilage of the left side with the sternum. The aortic semilunar valves lie behind the sternum close to the lower border of the third left cartilage, and are thus slightly below and

Fig. 229.

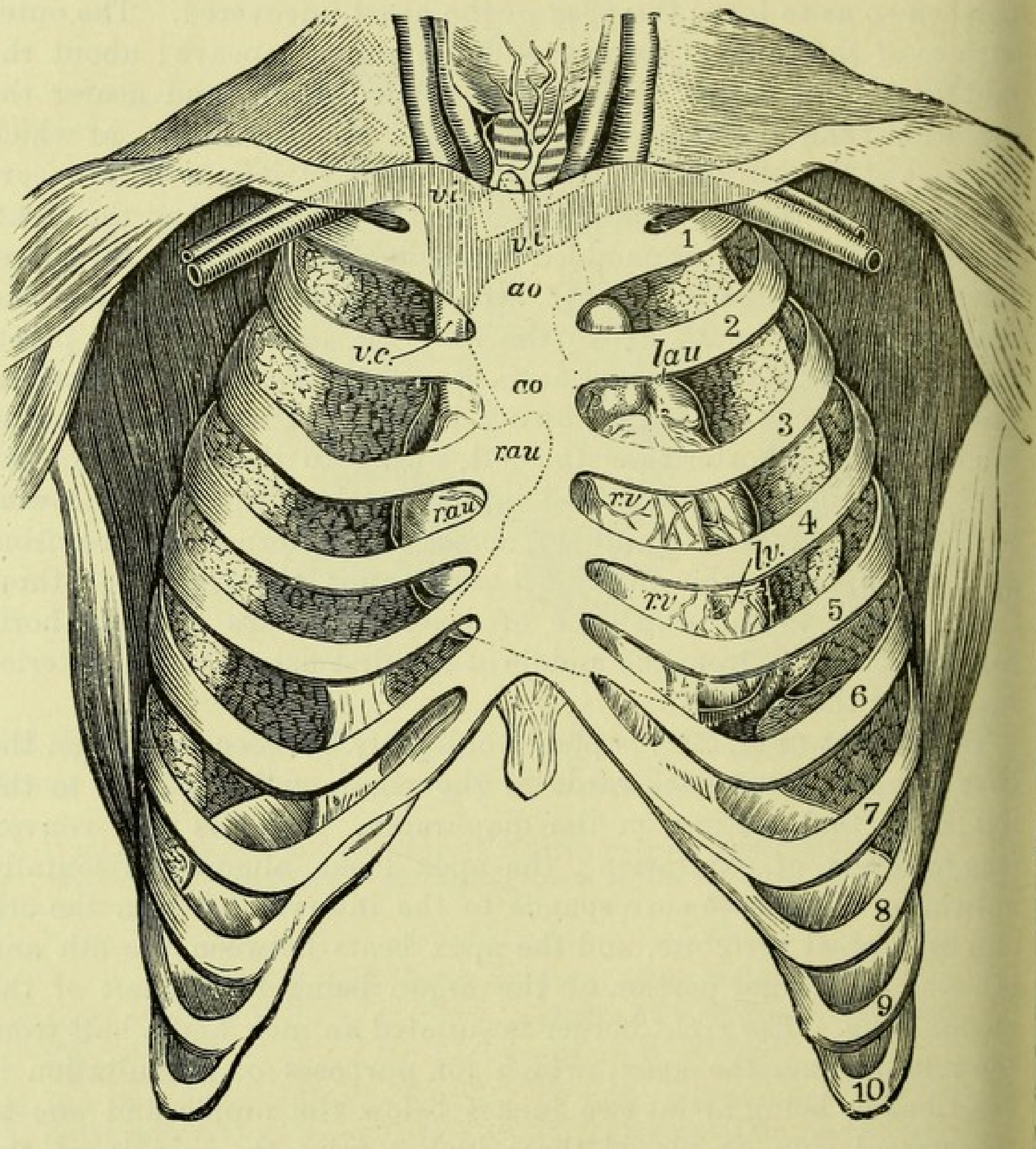


Fig. 229.—Diagram of the relations of the heart and great vessels to the wall of the thorax. The collapsed lungs are drawn aside slightly, to expose the parts more clearly (from Luschka).

v.i. Innominate veins.
ao. Aorta.
v.c. Vena cava superior.
r.au. Right auricle.
l.au. Left auricle.
r.v. Right ventricle.
l.v. Left ventricle.

internal to the pulmonary orifice. The weight of the healthy heart averages 11oz. in the male and 9oz. in the female.

The anterior surface of the heart is convex, and is formed almost entirely by the right ventricle and auricular appendage, but a small portion of the right auricle is seen at the right side, and a part of the left ventricle at the apex and the left border, while the irregular border of the left auricular appendage appears to the left of the pulmonary artery. The posterior surface of the heart is flattened, and is formed by part of the right auricle, and by the left auricle and ventricle, which last forms the apex of the heart. Each surface of the heart is grooved vertically and horizontally, marking the divisions between the auricles and ventricles. The anterior inter-ventricular groove is near the left border of the heart, whilst the posterior inter-ventricular groove is to the right, and they thus indicate the oblique position of the septum. In these grooves will be seen the descending branches of the coronary vessels.

The **Coronary Arteries** (right and left) are the first branches of the aorta, and supply the substance of the heart. They are to be found one on either side of the pulmonary artery, with a plexus (*coronary*) of nerves accompanying each.

The *left coronary artery* runs from right to left in the auriculo-ventricular groove, and gives a large branch to the front of the heart, which appears to the left of the pulmonary artery and runs down the anterior inter-ventricular groove to the apex.

The *right coronary artery* runs from left to right in the auriculo-ventricular groove, and gives a large branch to the back of the heart, which runs along the septum to the apex. The coronary arteries supply branches freely to the substance of the heart, and anastomose by means of small vessels, but the larger branches do not anastomose with one another.

The **Veins** of the heart do not correspond precisely to the arteries. The *great cardiac vein* runs up the anterior inter-ventricular groove with the descending branch of the left coronary artery, but leaves it to pass along the horizontal auriculo-ventricular groove to the back of the heart. It becomes considerably enlarged and is then called the *coronary sinus*, which lies between the left auricle and ventricle, and after receiving the *posterior cardiac veins* from the back of the heart, the *middle cardiac vein* which follows the inter-ventricular groove behind, the *right coronary vein* which enters it near its termination, and small branches from the auricles, including the *oblique vein* of Marshall which runs downwards and inwards over the back of the left auricle, the sinus opens into the back of the right auricle.

Some small *anterior cardiac veins*, and other small veins called the *venæ cordis minimæ*, pass directly into the right auricle.

The *superficial cardiac plexus* of the sympathetic is situated immediately below the arch of the aorta, and gives branches to the front and back of the heart, which are seldom seen. To it may be traced the left superficial cardiac nerve of the sympathetic, a cardiac branch from the left pneumogastric, and branches from the deep cardiac plexus.

The **Great Vessels of the Heart** (Fig. 228) have the following positions. The vena cava superior is to the right, and the pulmonary artery to the left, whilst between them the arch of the aorta is seen. The inferior vena cava can be seen piercing the diaphragm at the back of the heart, by drawing the organ upwards.

The **Cavities** of the heart are to be opened *in situ*, and in the order in which the blood enters them.

[The right auricle is to be opened by one incision from the superior to the inferior vena cava, and another at right angles to it into the auricular appendage.]

Right Auricle (Fig. 230, 1).—The main cavity of the auricle is smooth internally, but in the appendix are the *musculi pectinati*, or muscular bands "resembling a comb." The *endocardium*, or lining membrane of the heart, is seen to be continuous with the lining membrane of the veins, and will be traced subsequently into the arteries.

The large openings into the right auricle are (1) the *superior vena cava* (3), which enters at the upper and anterior part; (2) the *inferior vena cava* (4), which enters at the lower and back part; and (3) the *coronary sinus* (7), which enters close above (4) the *auriculo-ventricular* opening (9) and below the Eustachian valve.

The *foramina Thebesii* are numerous small openings which are found in the wall of the auricle, corresponding to the anterior cardiac veins and the venæ cordis minimæ.

The *tubercle of Lower* is a projection which is occasionally found in the wall of the auricle, between the superior and inferior venæ cavæ.

The *coronary valve* (8) (valve of Thebesius) is a thin fold at the orifice of the coronary sinus, which serves to prevent regurgitation into it.

The *Eustachian valve* (6) is a semilunar fold placed in front and to the left of the vena cava inferior, and extending between it and the annulus ovalis immediately above the opening of the coronary sinus; it served in the fœtus to direct the current of blood from the inferior vena cava through the foramen ovale. In the adult it is generally cribriform and often very imperfect.

The *fossa ovalis* and *annulus ovalis* (5) are remains of fœtal structure, found on the inner wall of the right auricle, in the

Fig. 230.

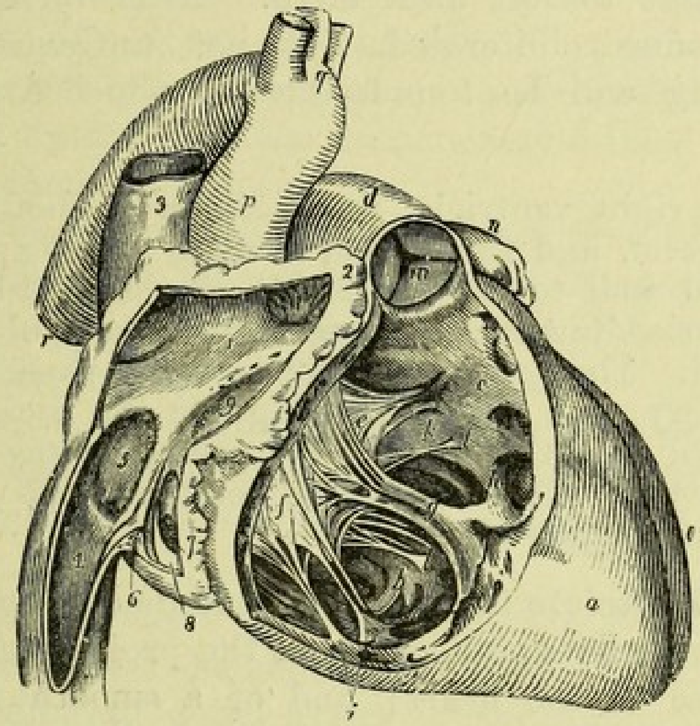


Fig. 230.—Right side of the heart laid open (from Wilson).

1. Cavity of right auricle.
2. Auricular appendix: in its cavity are seen the musculi pectinati.
3. Superior vena cava, opening into the upper part of the right auricle.
4. Inferior vena cava.
5. Fossa ovalis; the prominent ridge surrounding it is the annulus ovalis.
6. Eustachian valve.
7. Opening of the coronary sinus.
8. Coronary valve.
9. Entrance of the auriculo-ventricular opening. Between the figures 1 and 9, two or three foramina Thebesii are seen.

a. Right ventricle.
b. Cavity of right ventricle.
c. Conus arteriosus or infundibulum.
d. Pulmonary artery.
e, *f*. Tricuspid valve; *e* is placed on the left curtain, *f* on the anterior curtain.
g. One of the musculi papillares, to the apex of which the anterior and right curtains are connected by chordæ tendineæ.
h. Columnæ carneæ.
i. Two musculi papillares of the right curtain.
k. Attachment by chordæ tendineæ of the left limb of the anterior curtain.
l, *l*. Chordæ tendineæ.
m. Semilunar valves of the pulmonary artery.
n. Apex of left auricular appendix.
o. Left ventricle.
p. Ascending aorta.
q. Its transverse portion, with the three arterial trunks which arise from the arch.
r. Descending aorta.

position of the *foramen ovale*, the name applied to a communication between the two auricles which existed in the fœtus.

The *annulus ovalis* is a muscular ring, which is generally well marked, and which surrounds the shallow *fossa ovalis*, formed by a thin membrane thrown across the foramen ovale. This membrane is produced from the posterior margin of the foramen from about the fourth month of fœtal life, and gradually overlaps the anterior margin, so as to form an oblique opening for the passage of the blood from right to left until birth. After birth the aperture gradually becomes obliterated, but not unfrequently a small oblique opening will be found, through which a probe can be introduced.

[To open the right ventricle, its flaccid wall should be grasped with the left hand, and the scalpel made to transfix it about half-way down, and well to the right side of the septum; the knife being then carried towards the apex, the cavity of the ventricle will be opened. The left forefinger is to be passed up into the pulmonary artery, and will serve to guide the incision, which is to be prolonged into that vessel, if possible, *between* two of the semilunar valves. All clots being removed, the whole of the ventricle will be displayed.]

The **Right Ventricle** (Fig. 230, *a*) consists of a main cavity, the walls of which are irregular, owing to the projections of the muscular substance of the heart; and of a smooth funnel-shaped portion (*infundibulum* or *conus arteriosus*) leading upwards and to the left into the pulmonary artery. The projections on the wall of the ventricle are the *columnæ carneæ* (*h*) (fleshy columns), of which three varieties are described: one in which the column merely stands out in relief, being attached to the wall of the ventricle in its whole length; a second in which the column is attached at both ends but is free in the middle, so that a probe may be passed between it and the wall; and a third variety called the *musculi papillares* (*g*). These last project into the cavity of the ventricle and give attachment by their extremities to the *chordæ tendineæ*, or fibrous cords attached to the flaps of the auriculo-ventricular valve.

The right auriculo-ventricular valve (*e*) consists of three portions, and is hence called *tricuspid*. The flaps are formed by a reduplication of the *endocardium* or lining membrane of the heart, between the layers of which are some tendinous and muscular fibres, the former being continuous with the chordæ tendineæ. The entire valve is attached above to a fibrous ring (zona tendinosa), which bounds the auriculo-ventricular opening, and is divided below into three portions, anterior, posterior, and internal.*

The anterior division of the valve is the largest and is in contact with the anterior wall, whilst the posterior flap lies against the posterior wall, which is formed by the posterior part of the septum ventriculorum. The internal or left flap, which is the smallest of the three, shuts off the infundibulum from the general cavity of the ventricle.

The auricular surface of the tricuspid valve is extremely smooth, for the purpose of facilitating the flow of blood into the ventricles; whilst the surface which corresponds to the walls of the ventricle is remarkably rough, from the prominences formed by the attachments of the chordæ tendineæ.

The tricuspid valve acts during contraction of the ventricle (systole), and prevents the regurgitation of blood into the auricle; though even in health there is said to be a slight reflux, which has been termed the 'safety-valve action' (King).

The internal division of the tricuspid valve serves to prevent the blood from flowing into the pulmonary artery, until the ventricle is fully distended and able to contract forcibly on its contents.

The *pulmonary artery* is attached to a fibrous ring, which intervenes between it and the muscular substance of the heart, but the lining membrane of the artery is continuous with that of the ventricle.

The *semilunar valves* (*m*) of the pulmonary artery, two anterior and one posterior, are three reduplications of the lining membrane, strengthened by fibrous tissue which is collected principally at the attached border of each valve. The attached border is convex, and is fixed to the wall of the artery; the free border is sub-divided into two slightly concave portions by a little fibro-cartilaginous body, called the *corpus Arantii;* on each side of this are two crescentic portions, termed *lunulæ* from their shape, which are more transparent than the rest of the valve from the fact of the fibrous elements of the valve being absent.

The semilunar valves act during dilatation of the ventricle (diastole), and prevent the regurgitation of the blood from the pulmonary artery.

The blood (which is venous or dark-coloured) is carried by the

* The tricuspid valve is very irregular in its divisions, sometimes consisting of only two flaps like the mitral valve, and at others being divided into four or even six small portions.

pulmonary artery to its bifurcation, and then by the right and left pulmonary arteries to the lungs, where it is aerated; and is brought back to the heart by the four pulmonary veins as arterial or red blood. The pulmonary veins open into the left auricle.

[The left auricle is to be opened by one incision on its posterior aspect, placed vertically midway between the pulmonary veins, and another into the auricular appendage. The heart must be drawn well upwards and to the right side to expose the cavity properly.]

The **Left Auricle** (Fig. 231, 1) closely resembles the right auricle, but is altogether on a smaller scale, and the auricular

Fig. 231.

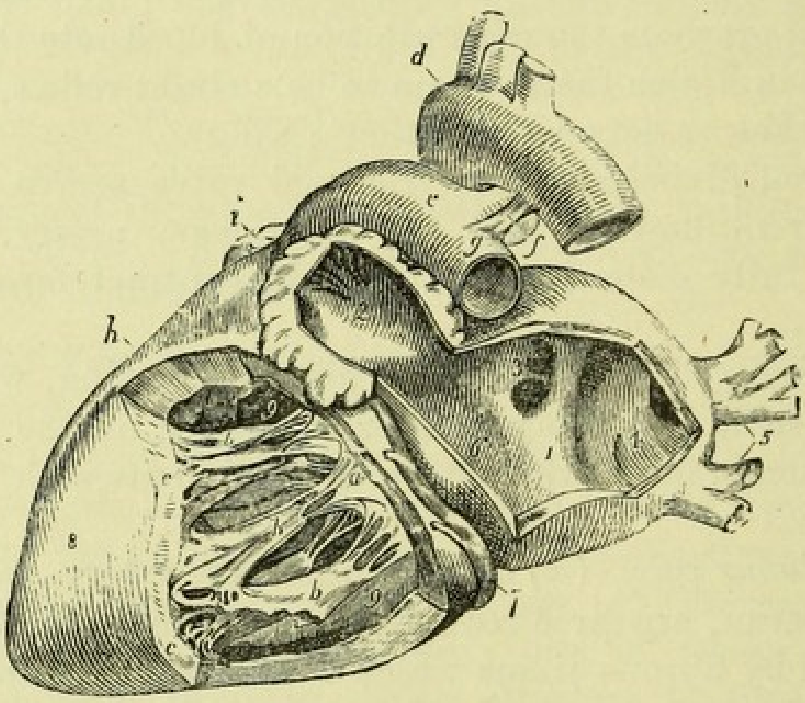


Fig. 231.—Left side of the heart laid open from behind (from Wilson).

1. Cavity of the left auricle.
2. Cavity of the appendix auriculæ, near the apex of which are seen musculi pectinati.
3. Opening of the two right pulmonary veins.
4. The sinus, into which the left pulmonary veins sometimes open.
5. Left pulmonary vein.
6. Auriculo-ventricular opening.
7. Coronary sinus, lying in the auriculo-ventricular groove.
8. Left ventricle.
9, 9. Cavity of the left ventricle; the figures rest on the septum ventriculorum.

a. Mitral valve; its flaps are connected by chordæ tendineæ to *b*, *b*, musculi papillares.
c, *c*. Fixed columnæ carneæ, forming part of the internal surface of the ventricle.
d. Arch of the aorta.
e. Pulmonary artery.
f. Obliterated ductus arteriosus.
g. Left pulmonary artery.
h. Right ventricle.
i. Apex of the appendix of right auricle.

appendix is longer and thinner and more "crenate" than on the opposite side. The openings into it are those of the four pulmonary veins, two on each side, and the left auriculo-ventricular opening.

The *musculi pectinati* of the auricular appendix are like those of the right side but smaller, and on the septum of the auricles will be seen the *annulus ovalis* and *fossa ovalis* corresponding to those on the right side, but the ring of muscular fibre is not so well developed.

[To open the left ventricle, the left forefinger should be introduced through the auriculo-ventricular opening, and the knife thrust through the wall of the ventricle near the apex to meet it. The knife is then guided upwards between the flaps of the mitral valve, and an incision made through the front of the ventricle into the auriculo-ventricular opening. The finger is next to be passed from below into the aorta, followed by the knife, which is to be carried through the front wall of the ventricle close to the septum, thus isolating the right flap of the mitral valve. The incision is to be prolonged into the aorta between two of the semilunar valves, and it will be found to be necessary to divide the pulmonary artery, which lies in front of the aorta, but care should be taken to do so above the pulmonary semilunar valves.]

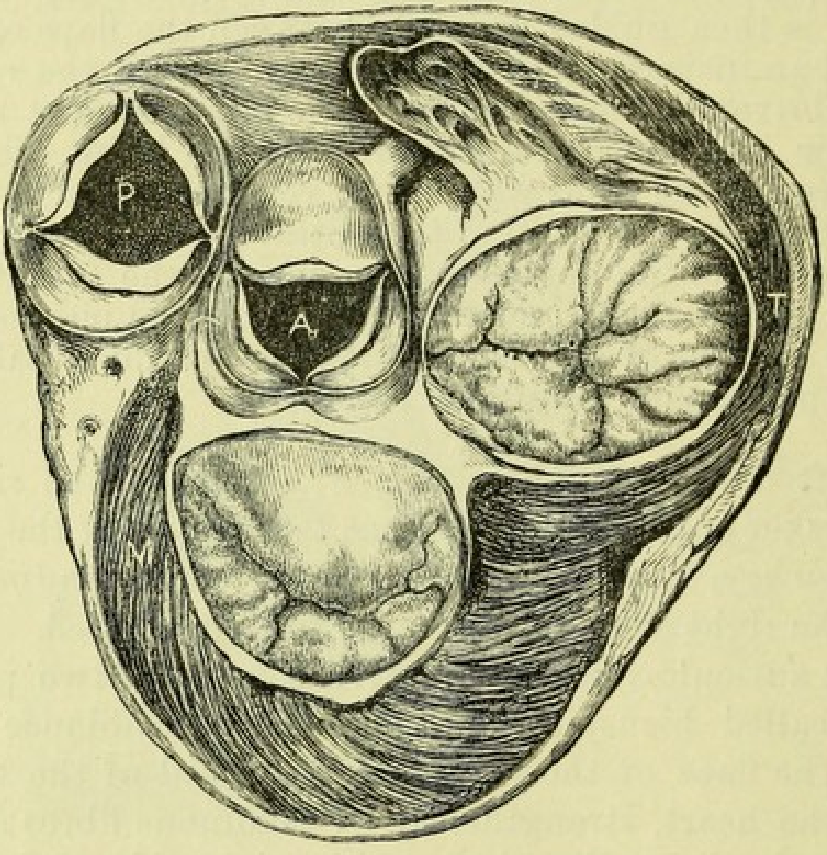
The **Left Ventricle** (Fig. 231, 8) resembles the right, but its wall is thicker and its cavity reaches to the apex of the heart. The *columnæ carneæ*, *musculi papillares*, and *chordæ tendineæ* resemble those of the right side, but are more fully developed.

The left auriculo-ventricular valve consists of two portions, and is hence called bicuspid, or (from the resemblance to a mitre) mitral. The flaps of the valve are composed of the lining membrane of the heart, strengthened by tendinous fibres derived from the chordæ tendineæ like those on the right side, and are attached to the fibrous ring bounding the auriculo-ventricular opening. The right flap of the valve is anterior to the left flap, and is placed between the cavity of the ventricle and the orifice of the aorta, against which it lies during diastole of the ventricle. It is perfectly smooth on both surfaces, so as not to impede the current of blood into the aorta, thus differing from the left flap, of which the surface next to the wall of the heart is rough (Power). Between the anterior flap of the mitral valve and the aortic valves is a small space with aponeurotic walls—the *intervalvular space* of Sibson—which receives the aortic valves when distended in 'diastole.'

The mitral valve acts during contraction of the ventricle (systole), and prevents the regurgitation of blood into the auricle. The anterior division of the mitral valve prevents the blood from flowing into the aorta, until the ventricle is fully distended and able to contract forcibly on its contents; and the pressure of the blood in the intervalvular space, on the anterior flap of the mitral valve, keeps the latter closed up to the end of the 'systole' or contraction of the ventricle.

The closure of the mitral valve accompanies the 'first sound' of the heart, which is best heard at the apex. A *bruit* caused by

Fig. 232.



disease of the valve would be heard in the same situation (Fig. 229, *l.v.*), and if systolic, depends upon regurgitation through the valve, if diastolic, upon roughness of the surface over which the blood passes from the auricle.

A fibrous ring intervenes between the muscular tissue of the heart and the aorta, the lining membrane of which is continuous with the endocardium.

The *Aortic semilunar valves* resemble those of the pulmonary

Fig. 232.—A section of the heart at the level of the valves, seen from above (from Sibson's Medical Anatomy).

P. Pulmonary artery. M. Mitral valve.
A. Aorta. T. Tricuspid valve.

artery but are more fully developed, and the *corpora Arantii* are better seen than on the right side. The aortic valves occupy a position the converse of those of the pulmonary artery, viz., one in front and two behind; and above each of the three valves there is a dilatation of the aorta, called the *aortic sinus*, or *sinus of Valsalva*. At the bottom of the anterior and left posterior sinuses will be seen the orifices of the coronary arteries, the first branches of the aorta.

The aortic valves act during dilatation of the ventricle (diastole), and prevent regurgitation into the ventricle, their closure accompanying the 'second sound' of the heart, which is best heard over the base of the heart and on the sternum opposite the second intercostal space (Fig. 229, *ao.*). If from disease of the valves their closure is not perfect and regurgita-

Fig. 233.

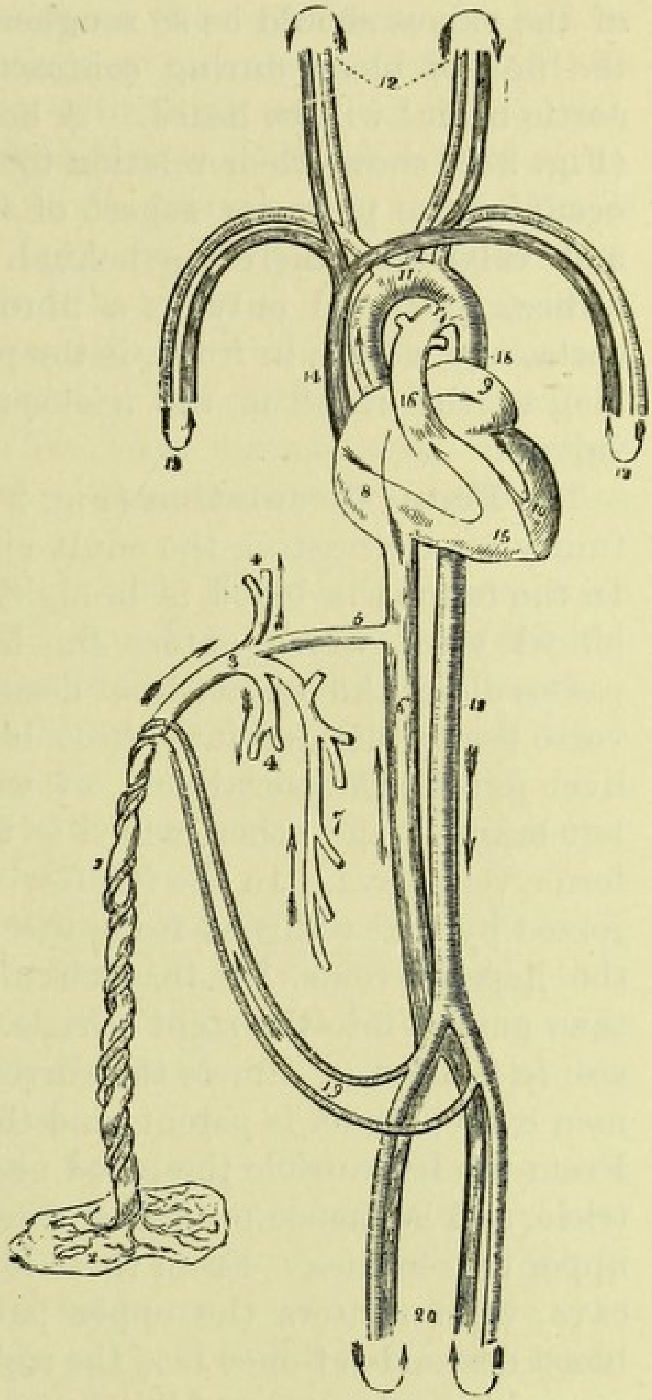


Fig. 233.—Diagram of the Fœtal circulation (from Wilson).

1. Umbilical vein proceeding from the placenta (2).
3. Umbilical vein, dividing into branches; two (4, 4), to be distributed to the liver; and one (5), the ductus venosus, which enters the inferior vena cava (6).
7. Portal vein, communicating with the right hepatic branch.
8. Right auricle.
9. Left auricle.
10. Left ventricle.
11. The arch of the aorta.

The arrows 12 and 13, represent the return of the blood from the head and upper extremities through the jugular and subclavian veins.

14. Superior vena cava.
15. Right ventricle.
16. Pulmonary artery.
17. Ductus arteriosus.
18, 18. Descending aorta.
19. Hypogastric arteries.
20. External iliac.

tion occurs, a 'diastolic aortic bruit' is produced: if the surfaces of the valves should be so roughened as to offer an obstruction to the flow of blood during contraction of the ventricle, a 'systolic aortic bruit' will be heard. A horizontal section above the valves (Fig. 232) shows their relation to one another. The left ventricle occupies the posterior aspect of the heart, and the mitral orifice and valve are therefore behind. In front of this is the aortic orifice, separated only by a fibrous septum. To the left of the aorta, and a little in front, is the pulmonary artery with its valves, and to the right is the tricuspid or right auriculo-ventricular valve.

The **Fœtal Circulation** (Fig. 233).—This will be the best opportunity for contrasting the adult circulation with that of the fœtus. In the fœtus the blood is brought from the placenta by the umbilical vein, which enters the body at the umbilicus. It then passes along the longitudinal fissure of the liver, and at the transverse fissure divides into three branches, two of which enter the liver joining the portal vein, of which they form in the adult the left branch; the other, which is the *ductus venosus*, joins the inferior vena cava. In the inferior vena cava the placental blood is joined by that returned from the lower extremities, and, through the hepatic veins, by that circulated through the liver; and is then poured into the right auricle. The Eustachian valve, of large size in the fœtus, directs the current across the auricle to the foramen ovale, which is patent, and the blood enters the left auricle. From the left auricle the blood necessarily passes into the left ventricle, and is thence propelled through the aorta to the head and upper extremities. From these it is returned by the superior vena cava, which enters the upper part of the right auricle, and the blood descends at once into the right ventricle, thus taking a course at right angles to, and in front of, the former one. From the right ventricle the blood is propelled into the pulmonary artery, and a small portion reaches the lungs through the right and left pulmonary arteries, but by far the larger portion passes through the *ductus arteriosus* (a short tube connected with the pulmonary artery close to the bifurcation), and enters the descending portion of the arch of the aorta. Through the aorta the blood passes to the trunk and viscera, and then reaches the iliac arteries; a small portion passes by the external iliacs to the lower extremities, but the rest passes by the internal iliacs to the hypogastric arteries, which run to the umbilicus and then wind round the umbilical vein to the placenta, under the name of *umbilical arteries*.

The **Pulmonary Artery** (Fig. 234, 28) is about two inches long; it has already been seen to arise from the right ventricle and to lie in front of the aorta, having the two coronary arteries and the auricular appendages in contact with it at the commencement. It then passes upwards and backwards to the left side of the aorta, lying in front of the left auricle, and after reaching the hollow of the aortic arch it bifurcates into right and left pulmonary arteries, which go to their respective lungs; the right being the longer of the two and necessarily passing beneath the arch of the aorta, and the left crossing the descending aorta. The position of each of the arteries in the root of the lung has been already seen, the right being below and the left above the bronchi passing to the upper lobes of the corresponding lungs.

Connecting the pulmonary artery with the descending portion of the arch of the aorta is a fibrous cord, externally to which the recurrent laryngeal nerve of the left side passes from the trunk of the pneumogastric. This is the obliterated *ductus arteriosus*, which in the fœtus is a vessel nearly as large as the aorta, passing from the bifurcation of the pulmonary artery to the arch of the aorta, just beyond the origin of the left subclavian.

The **Pulmonary Veins** are four in number, two to each lung. Their positions in the roots of the lungs have been seen, and they have been traced to the left auricle of the heart. The right veins are the longer and pass beneath the arch of the aorta, the left veins crossing the descending aorta.

The **Arch of the Aorta** (Fig. 234, 26).—The aorta has been seen to arise from the left ventricle, and it at first takes a course upwards and to the right side, but then backwards and to the left, thus forming an arch with a convexity upwards and to the left. For convenience of description the arch is divided into three portions—ascending, horizontal or transverse, and descending.

1. The *ascending portion*, beginning behind the sternum close to the lower border of the third costal cartilage of the left side, reaches as high as the upper border of the second costal cartilage of the right side close to the sternum. It is almost entirely enclosed within the pericardium, and is crossed at first by the pulmonary artery. *In front* of the pericardium are the sternum and both pleuræ; *behind* the ascending aorta is the right pulmonary artery; to its *right* side are the vena cava and right auricular appendix; and to its *left* side is the trunk of the pulmonary artery. Its branches are the two coronary arteries, which have been already traced.

2. The *horizontal* or *transverse portion* has a direction backwards

Fig. 234.

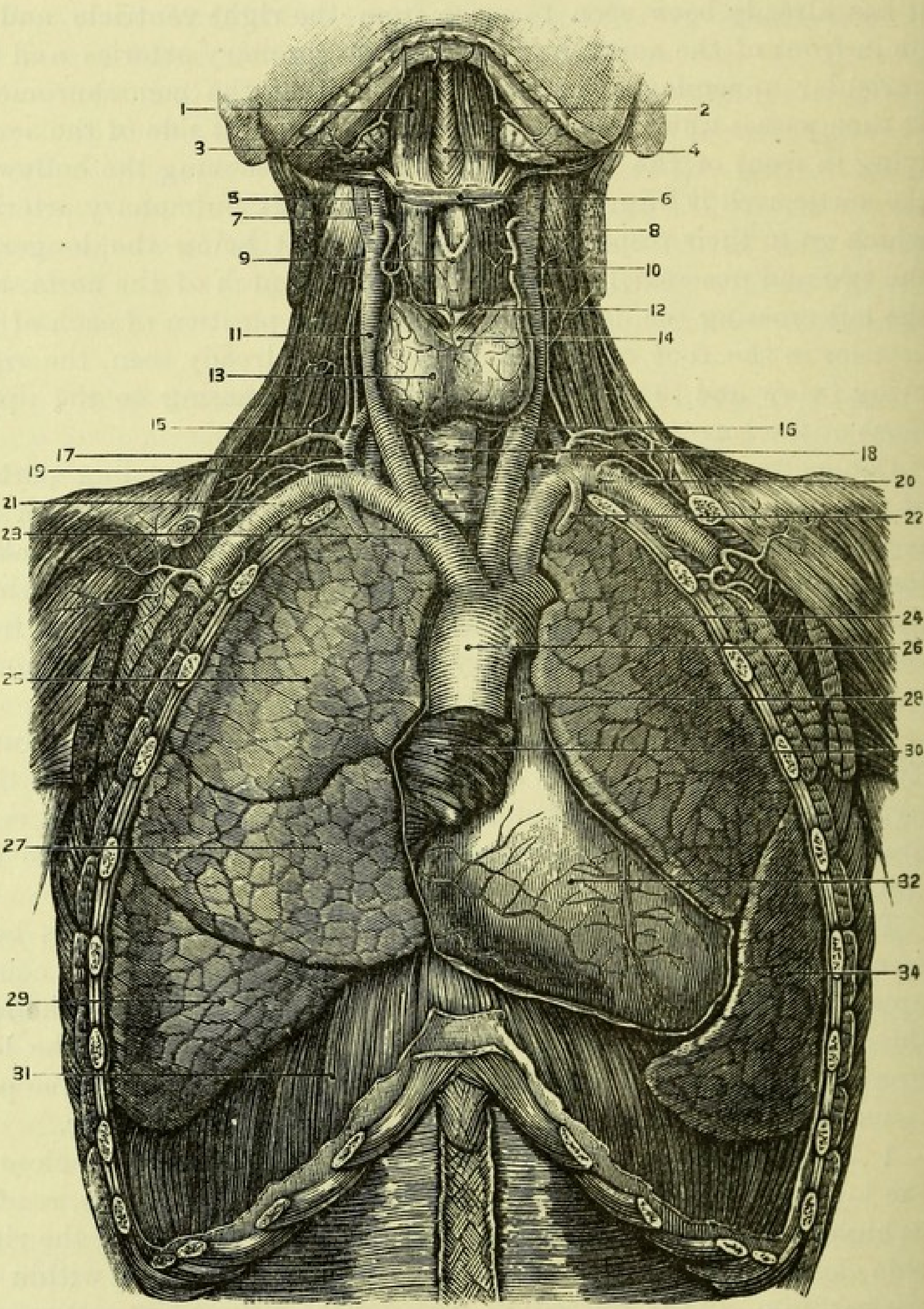


Fig. 234.—Heart and large vessels (from Bonamy and Beau).

1. Digastric.
2. Submental artery (facial).
3. Submaxillary gland.
4. Mylo-hyoid.
5. External carotid.
6. Hyoid bone.
7. Internal carotid.
8. Thyro-hyoid.
9. Thyroid cartilage.
10. Superior thyroid artery.
11. Right common carotid.
12. Crico-thyroid.

and to the left side, reaching from the second costal cartilage of the right side to the left side of the fourth dorsal vertebra. In *front* of this portion are the sternum and left pleura, and, from left to right, the left pneumo-gastric with the small cardiac nerves, the left phrenic nerve, and the left superior intercostal vein; *behind* are the trachea, the œsophagus and thoracic duct, and the left recurrent laryngeal nerve. *Above* is the left innominate vein; and *below* are the left bronchus and the bifurcation of the pulmonary artery, the left recurrent laryngeal nerve and the obliterated ductus arteriosus. The branches of this portion are the innominate, the left carotid, and the left subclavian arteries.

3. The *descending portion* extends to the lower border of the fifth dorsal vertebra, where the descending thoracic aorta begins, but the division between these two parts of the vessel is arbitrary. It is invested almost entirely by the left pleura, which binds it to the side of the vertebræ.

The **Vena Cava Superior** (Fig. 229, *v.c.*) is formed by the junction of the right and left brachio-cephalic or innominate veins, on the right of the innominate artery. The vena cava receives the vena azygos major just above the pericardium, and then, piercing the pericardium, passes in front of the root of the right lung to enter the upper part of the right auricle.

Note.—The levels of the aorta here given are lower than those ordinarily laid down, but are the result of numerous independent observations by the author, and by Professor Wood, who originally investigated the subject, and whose paper in the *Journal of Anatomy* for December, 1868, may be consulted with advantage.

Great Vessels of the Root of the Neck.

The three great branches of the second part of the arch of the aorta are the Innominate, the Left Carotid, and the Left Subclavian arteries.

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13. Thyroid body.
14. Cricoid cartilage.
15. Inferior thyroid artery.
16. Left common carotid.
17. Thyroid axis.
18. Trachea.
19. Vertebral artery.
20. Left subclavian artery.
21. Right subclavian artery.
22. Internal mammary artery.
23. Innominate artery.
24. Left lung (upper lobe).
25. Right lung (upper lobe).
26. Arch of aorta.
27. Right lung (middle lobe).
28. Pulmonary artery.
29. Right lung (lower lobe).
30. Right auricle.
31. Diaphragm.
32. Front of right ventricle.
34. Left lung (lower lobe).

The **Innominate Artery** (Fig. 234, 23) begins in the middle line of the body behind the centre of the manubrium sterni, and passes upwards and to the right side, dividing at the sterno-clavicular articulation into the right common carotid and right subclavian arteries; it is from one to two inches long. It has *in front* of it the upper piece of the sternum, with the remains of the thymus gland, and the origins of the sterno-hyoid and sterno-thyroid muscles; and is crossed nearly at right angles by the left brachio-cephalic or innominate vein, and obliquely by the right inferior thyroid vein. *Behind* it at first is the trachea, but afterwards the prolongation of the right pleura into the neck. To the *right* side are the right innominate vein and right phrenic nerve; to the *left* side, the origin of the left common carotid, and afterwards the trachea.

The innominate artery ordinarily gives off no branch, but occasionally a small branch (*thyroidea ima*), (middle thyroid artery of Harrison) arises from it or from the aorta close to it, and runs up the front of the trachea to the thyroid body.

The **Left Common Carotid Artery** (Fig. 234, 16) leaves the arch just to the left of the middle line, and runs upwards and to the left side, at a level anterior to that of the left subclavian artery, and beyond the left sterno-clavicular articulation its relations correspond to those of the right carotid artery (p. 358).

The *thoracic portion* has *in front* of it the upper piece of the sternum, with the remains of the thymus gland, and the origins of the sterno-hyoid and sterno-thyroid muscles; and is crossed by the left innominate vein. It lies *against* the trachea at first, and then upon the œsophagus and thoracic duct; having at first the innominate artery, and then the trachea with the left recurrent laryngeal nerve to its *right* side; and the left pneumo-gastric nerve with its cardiac branches, the left subclavian artery and the pleura to its *left* side.

The **Left Subclavian Artery** (Fig. 234, 20), arising near the end of the transverse part of the arch and thus somewhat behind the left common carotid, extends to the lower border of the first rib, and may be conveniently divided into a thoracic and a cervical portion. The thoracic portion is nearly vertical in its direction, and lies to the left side of, but in a plane posterior to that of, the left carotid artery. It is *crossed* by the left innominate vein and by the left pneumo-gastric and cardiac nerves; to the *inner* side and *behind* are the trachea, the œsophagus, the thoracic duct, and the spine covered by the longus colli muscle; on the *outer* side it is covered by the pleura.

Irregularities of the Great Vessels.—The number and position of the branches of the arch of the aorta are subject to variation. The commonest variety is for the *left* carotid to arise from the innominate, thus reducing the branches to two; but there may be *four* branches from the arch of the aorta, owing to the right carotid and subclavian arising separately. Occasionally, when four branches are present, the *right* subclavian arises from the extreme left of the arch, and passes to the right side in front of or behind the œsophagus. The left vertebral artery not unfrequently arises from the aorta between the left carotid and left subclavian; and the thyroidea ima may occasionally arise from the arch.

The **Right Innominate Vein** (Fig. 229) commences at the inner end of the clavicle by the junction of the subclavian and internal jugular veins, and then descends on the outer side of the innominate artery to join the vein of the opposite side, the junction of the two forming the vena cava superior. It is closely invested by the right pleura, and has the phrenic nerve on its outer side.

The **Left Innominate Vein** (Fig. 229) commencing at a corresponding point on the left side, and in the same way as the right vein, runs obliquely downwards and to the right, lying just above the level of the arch of the aorta and crossing its large branches It unites with the right innominate vein on the right of the sternum, between the cartilages of the first and second ribs, to form the vena cava superior (p. 481).

Branches.—Each innominate vein receives the internal mammary, the inferior thyroid, and the superior intercostal branches. The left vein receives, in addition, small thymic and pericardiac branches.

[The ascending portion of the arch of the aorta and the venæ cavæ are to be divided, and the remains of the heart removed with the pulmonary vessels, which are to be cut close to the lungs. The arch of the aorta is to be held to one side by hooks, and the bifurcation of the trachea with the deep cardiac plexus dissected out.]

The **Deep Cardiac Plexus** (Fig. 235) is situated on each side of the trachea close to its bifurcation. The *right half* of the plexus receives all the cardiac nerves of that side, viz., three cardiac nerves

Fig. 235.

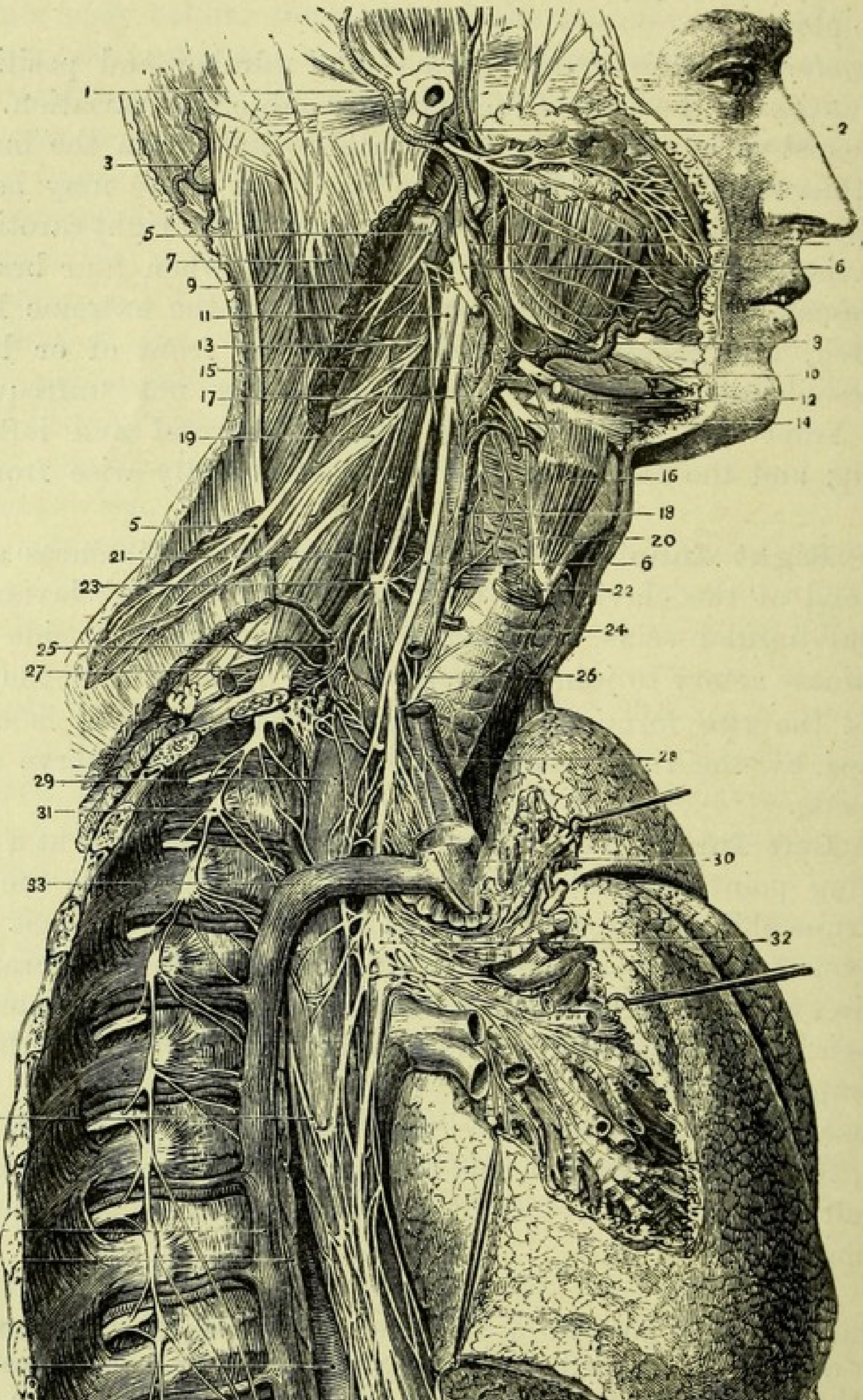

Fig. 235.—Distribution of the eighth pair of nerves of the right side (from Hirschfeld and Leveillé).

1. Posterior auricular artery.
2. Temporal artery.
3. Occipital artery.
4. Glosso-pharyngeal nerve.
5, 5. Spinal-accessory nerve.
6, 6. Pneumo-gastric nerve.

from the three cervical ganglia of the sympathetic, the three cardiac branches of the pneumo-gastric, and the cardiac branch of its recurrent laryngeal nerve. The branches of this half of the plexus are distributed to the right side of the heart and the right lung, and many of them have been necessarily destroyed. The *left half* (Fig. 236) of the plexus receives the same nerves as the right, with the exception of the superior cardiac nerve of the sympathetic and the inferior cardiac branch of the pneumo-gastric, which have been already traced to the superficial cardiac plexus (p. 470). The branches of this half of the plexus are distributed to the left side of the heart and the left lung, and also communicate with the superficial cardial plexus.

The **Trachea** (Fig. 234, 18) in the thorax has in front of it the sternum with the remains of the thymus gland; the arch of the aorta and the nerves crossing it; the innominate and left carotid arteries (for a very short distance); and the left innominate vein. It rests upon the œsophagus and on each side is in contact with the pleura and the pneumo-gastric nerves; on the left side there are in addition the left carotid artery and the left recurrent laryngeal nerve. It bifurcates into the bronchi opposite the fifth dorsal vertebra.

The **Right Bronchus** (Fig. 235) is larger than the left, and its course is more vertical. It thus follows more closely the direction of the trachea than the left. At a distance of about one inch is given off the large branch to the upper lobe of the lung, *beneath* which the pulmonary artery passes backwards to reach the posterior surface of the main bronchus. The vena azygos major hooks round the right bronchus to open into the vena cava.

7. Sterno-mastoid (cut).
8. Facial artery.
9. Hypoglossal nerve with communication from 2nd cervical nerve.
10. Lower end of ditto.
11. Superior cervical ganglion of sympathetic.
12. Digastric.
13. Third cervical nerve.
14. Superior laryngeal nerve.
15. Internal carotid.
16. Thyro-hyoid.
17. External carotid.
18. Common carotid.
19. Fourth cervical nerve.
20. Inferior constrictor of pharynx.
21. Phrenic nerve on scalenus anticus.
22. Crico-thyroideus.
23. Middle cervical ganglion.
24. Trachea.
25. Thyroid axis.
26. Recurrent laryngeal nerve.
27. Subclavian artery.
28. Innominate artery.
29. Œsophagus.
30. Vena cava superior (cut).
31. Gangliated cord of sympathetic.
32. Posterior pulmonary plexus.
33. Phrenic nerve (cut).
35. Œsophageal plexus.
37. Vena azygos major.
39. Thoracic duct.
41. Thoracic aorta.
43. Great splanchnic nerve.

Fig. 236.

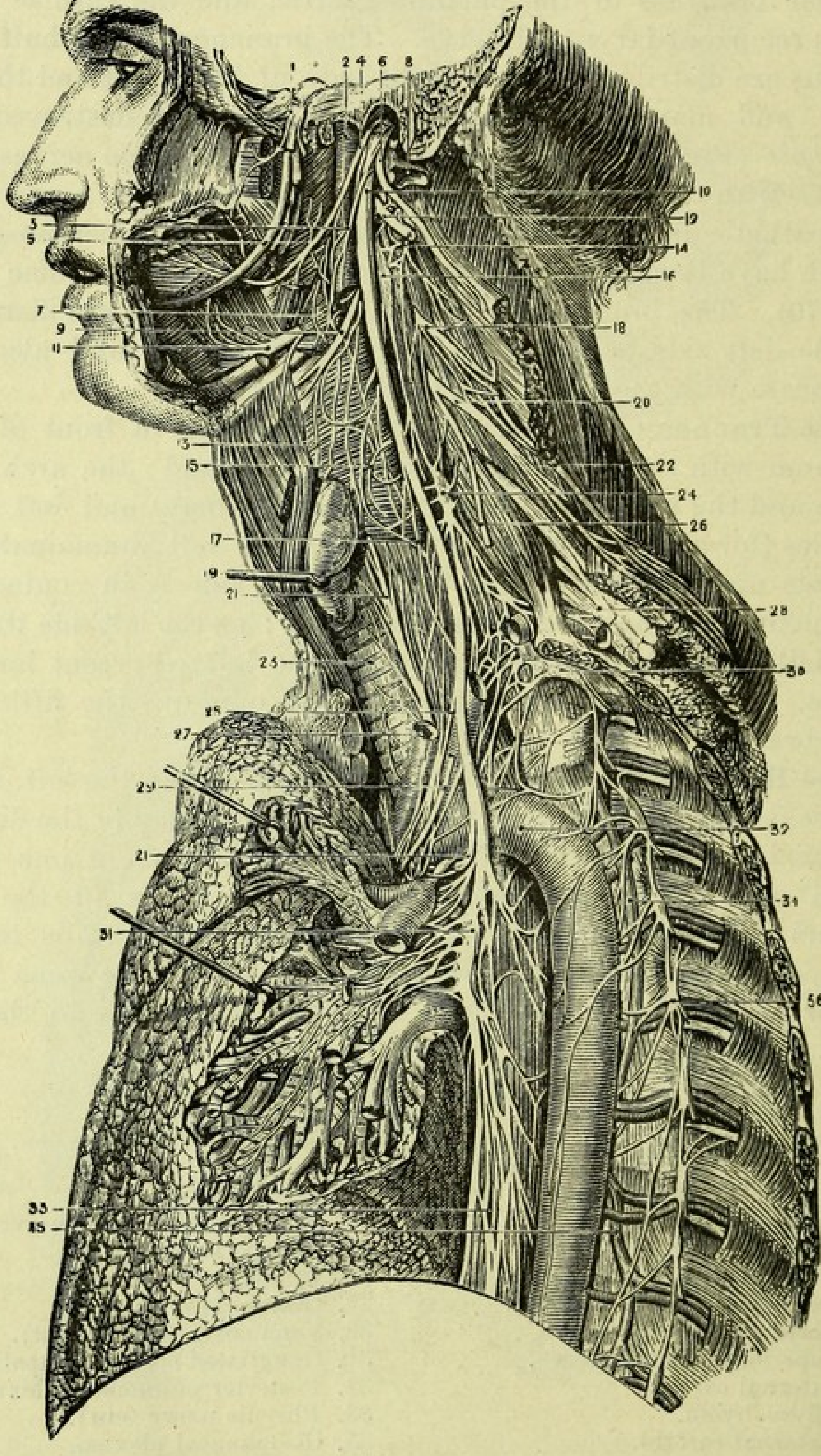

Fig. 236.—Distribution of the eighth pair of nerves on the left side (from Hirschfeld and Leveillé).

1. Gasserian ganglion of fifth nerve. 2. Internal carotid artery.

The **Left Bronchus** (Fig. 236) takes a more oblique course beneath the arch of the aorta, crossing the œsophagus and the descending aorta. It is described as being nearly twice as long as the right bronchus, because the branch to the upper lobe of the lung comes off at a lower level (nearly two inches), the pulmonary artery passing *above* it to reach the back of the main bronchus.

[The right lung is to be drawn forward, and the pleura divided where it is reflected from the lung to the wall of the thorax, and the parts in the posterior mediastinum are to be cleaned.

The muscular œsophagus will be at once seen, and the right pneumo-gastric nerve is to be traced to it and to the back of the right bronchus. On displacing the œsophagus, the side of the descending thoracic aorta will come into view, but it will be better seen in the dissection of the left side.

The vena azygos major will be seen to the right of the aorta, and between the two will be found the slender and collapsed thoracic duct. The intercostal vessels will be seen crossing the back of the space, and near the diaphragm will be found the splanchnic nerves from the sympathetic cord, which is itself outside the mediastinum.]

The **Posterior Mediastinum** (Fig. 227) is the interpleural space behind the pericardium, bounded by the vertebræ behind,

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3. Pharyngeal branch of pneumo-gastric.
4. Glosso-pharyngeal nerve.
5. Lingual nerve (5th).
6. Spinal-accessory nerve.
7. Middle constrictor of pharynx.
8. Internal jugular vein (cut).
9. Superior laryngeal nerve.
10. Ganglion of trunk of pneumo-gastric nerve.
11. Hypoglossal nerve on hyo-glossus.
12. Ditto communicating with eighth and first cervical nerve.
13. External laryngeal nerve.
14. Second cervical nerve looping with first.
15. Pharyngeal plexus on inferior constrictor.
16. Superior cervical ganglion of sympathetic.
17. Superior cardiac nerve of pneumo-gastric.
18. Third cervical nerve.
19. Thyroid body.
20. Fourth cervical nerve.
21, 21. Left recurrent laryngeal nerve.
22. Spinal-accessory, communicating with cervical nerves.
23. Trachea.
24. Middle cervical ganglion of sympathetic.
25. Middle cardiac nerve of pneumo-gastric.
26. Phrenic nerve (cut).
27. Left common carotid artery
28. Brachial plexus.
29. Phrenic nerve (cut).
30. Inferior cervical ganglion of sympathetic.
31. Posterior pulmonary plexus of pneumo-gastric.
32. Thoracic aorta.
33. Œsophageal plexus.
34. Vena azygos superior.
35. Vena azygos minor.
36. Gangliated cord of sympathetic.

the pericardium in front, and the reflection of the pleura on each side. Its contents have been enumerated at p. 464.

The **Œsophagus** (Fig. 235, 29) is a muscular tube continuous

Fig. 237.

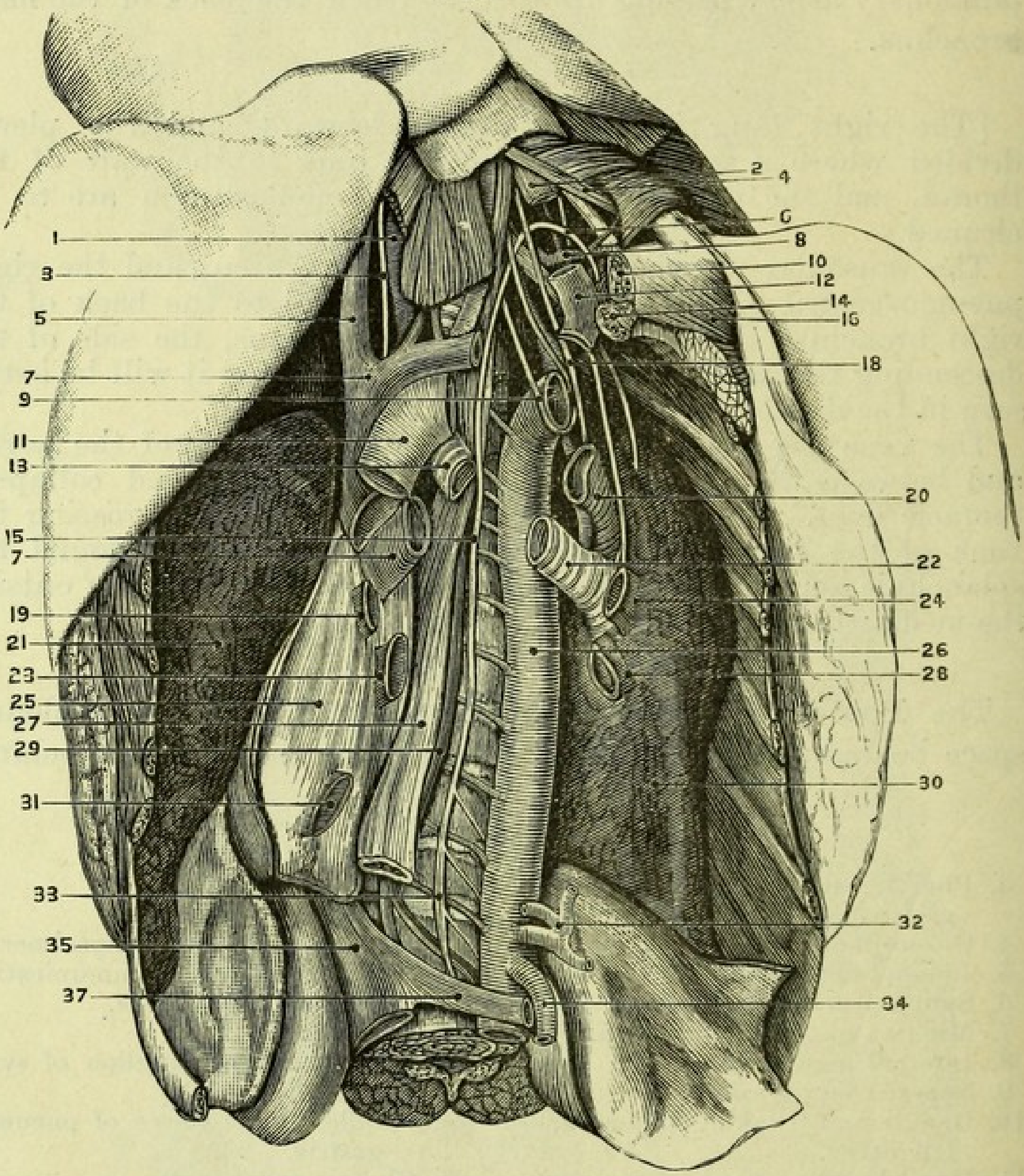

Fig. 237.—The thoracic duct (drawn by H. E. Browne).

1. Right common carotid.
2. Left internal jugular vein (cut).
3. Right vagus.
4. Left omohyoid.
5. Right innominate vein.
6. Thoracic duct.
7. Commencement of superior cava.
8. Left thyroid axis.
9. Left recurrent laryngeal nerve.
10. Clavicle.
11. Arch of aorta.
12. Junction of left internal jugular and subclavian veins.
13. Commencement of left bronchus.
14. Left first rib.
15. Thoracic duct.
16. Pectoralis major.
17. Right pulmonary artery.

with the pharynx. It begins opposite the 5th cervical vertebra, and lies slightly to the left side of the median line in the neck, as it passes through the superior aperture of the thorax. About the 5th dorsal vertebra it regains the middle line and follows the curve of the spine down to the level of the 9th or 10th dorsal vertebra, at which point it bends forward and rather sharply to the left to enter the stomach by passing through the œsophageal opening in the diaphragm. In front of it are the trachea, the left bronchus, and the pericardium, the arch of the aorta crossing it at some distance, but the descending aorta lies to its left side except at the lower end where it is behind the œsophagus. To the left side are also found the left common carotid artery and the left pleura. To the right are the right pleura, which touches it more extensively, and the vena azygos major which, with the thoracic duct and the right intercostal arteries, lies somewhat behind the gullet. The vagi form plexuses around it, the right being situated behind and the left in front.

The œsophagus is from nine to ten inches in length, and consists of two layers of *muscular* fibres, the outer longitudinal and the inner circular, which are of the striped variety in the upper part, but of the unstriped variety in the lower part of the tube. Within the muscular coats are a delicate *fibrous* coat and a simple *mucous membrane* with tesselated epithelium, which is thrown into longitudinal folds when the œsophagus is not distended with food. The long meshes of nerve upon the œsophagus are derived from the two pneumo-gastrics, and form the *plexus gulæ*.

The **Thoracic Duct** (Fig. 237, 15) is a delicate tube about eighteen inches long, embedded in loose tissue between the aorta and the vena azygos major. By cutting away the remains of the diaphragm carefully, if the abdomen has been dissected, it may be traced from the *receptaculum chyli* (33) opposite one of the upper three lumbar vertebræ, and will be found to pass through the aortic

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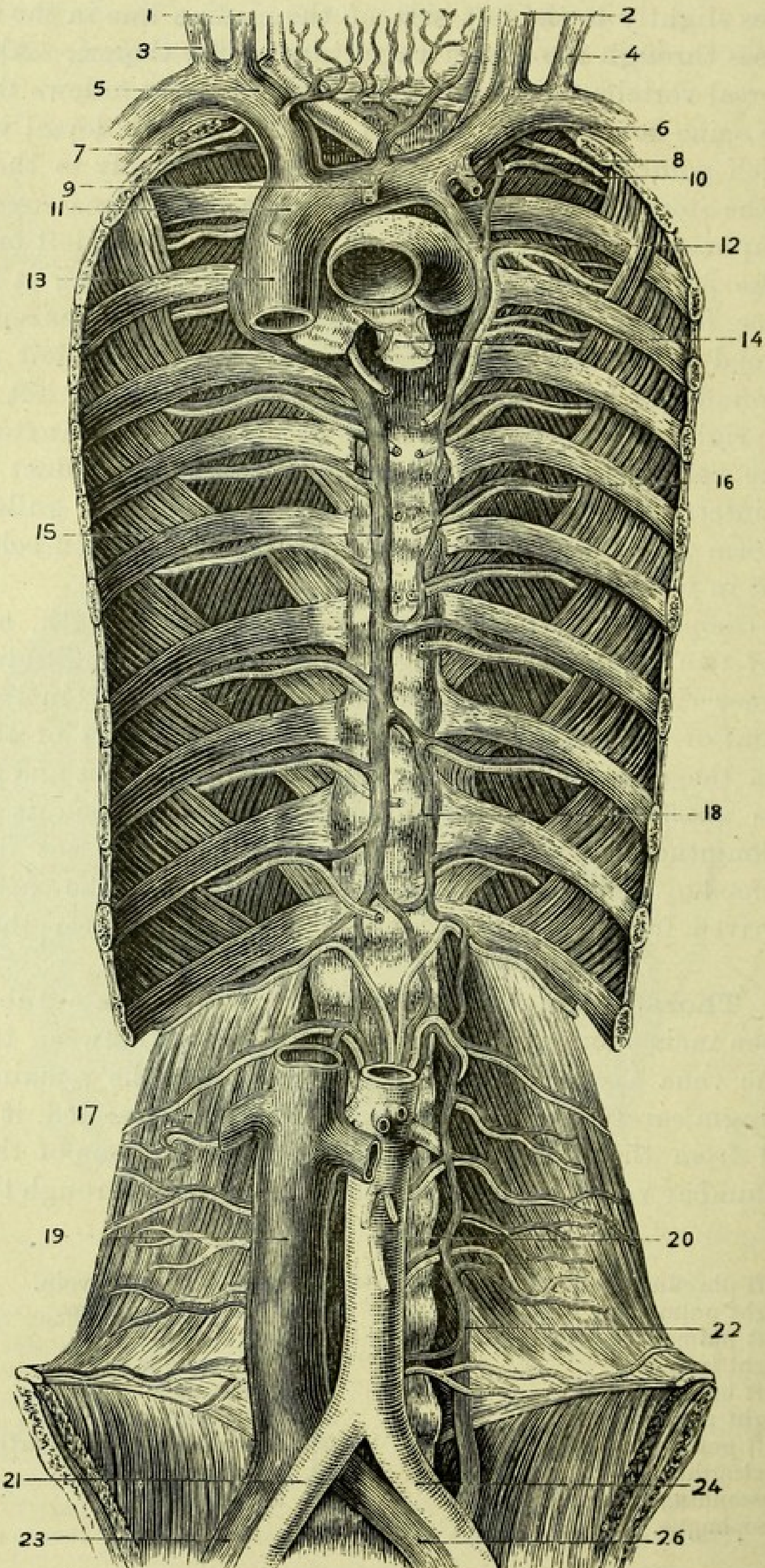
18. Left phrenic nerve.
19. Right pulmonary vein.
20. Left pulmonary artery.
21. Right lung.
22. Left bronchus.
23. Right pulmonary vein.
24. Left pulmonary vein.
25. Pericardium.
26. Descending thoracic aorta.
27. Œsophagus.
28. Left pulmonary vein.
29. Vena azygos major.
30. Left lung.
31. Vena cava inferior.
32. Cœliac axis.
33. Receptaculum chyli.
34. Superior mesenteric artery.
35. Vena cava inferior.
37. Left renal vein.

Fig. 238.



opening to the right side of the aorta. It continues to the right of the aorta, lying between it and the vena azygos, and superficial to the intercostal arteries as high as the fourth dorsal vertebra; and then crosses obliquely to the left of the spine behind the arch of the aorta, and runs along the left side of the œsophagus through the superior aperture of the thorax. In the neck the duct reaches as high as the sixth cervical vertebra, and then, crossing the left vertebral artery and thyroid axis, curves downwards in front of the scalenus anticus and phrenic nerve, to enter the left subclavian vein at its junction with the left internal jugular (6) (*vide* p. 368). The duct occasionally passes higher in the neck, and opens into the jugular at the point where some irregular vein joins it. The duct is dilated near its termination, and is often double both there and in the thorax. It has valves at various points, and, by opening the subclavian vein, a pair may be found at its entrance into the vein, which prevents the reflux of blood into the duct.

Between the ribs close to the vertebræ, some intercostal *lymphatic glands* may be found, which open into the duct. Œsophageal and bronchial glands may also be seen in connection with the tubes of the same name.

The **Vena Azygos Major** (Fig. 238, 15) commences in one of the lumbar veins, and is to be traced through the aortic orifice of the diaphragm. It lies to the right of the thoracic duct upon the vertebræ, crossing the right intercostal arteries, and receiving directly or indirectly all the right intercostal veins, except the first. About the level of the seventh dorsal vertebra, it receives the *vena azygos minor* (18), passing from the left side behind the aorta, and very generally a vertebra or two higher receives the *vena azygos*

Fig. 238.—Veins of the trunk and neck (from Cruveilhier).

1. Right internal jugular vein.
2. Left internal jugular vein.
3. Right external jugular vein.
4. Left external jugular vein.
5. Right innominate vein.
6. Left innominate vein.
7. Right superior intercostal vein.
8. Left superior intercostal artery.
9. Thymic vein.
10. Left internal mammary vein.
11. Right internal mammary vein.
12. Left superior intercostal vein.
13. Vena cava superior, receiving the vena azygos major.
14. Left bronchus.
15. Vena azygos major.
16. Vena azygos superior.
17. Quadratus lumborum.
18. Vena azygos minor.
19. Vena cava inferior.
20. Abdominal aorta.
21. Right common iliac artery.
22. Ascending lumbar vein.
23. Right common iliac vein.
24. Left common iliac artery.
26. Left common iliac vein.

superior (16) from the left side. It lastly arches forward over the right bronchus, and after receiving the right bronchial vein, opens into the superior vena cava just outside the pericardium. The superior intercostal vein enters the vena azygos major at the commencement of its arch over the root of the lung.

The azygos veins contain some imperfect valves, and form an important communication between the superior and inferior venæ cavæ.

The **Right Pneumo-Gastric Nerve** (Fig. 235, 6) has been seen to enter the thorax between the subclavian artery and right innominate vein (p. 368). It is now seen to run backward to the right side of the trachea, along which it passes to the bifurcation, to form the *posterior pulmonary plexus* at the back of the right bronchus. From this it emerges as two cords, which supply the œsophagus, forming with the nerve of the opposite side a plexus of long meshes, which has been called the *plexus gulæ*. Lastly, the right nerve is again a single trunk which reaches the back of the stomach.

Cardiac branches from the trunk of the pneumo-gastric nerve and from its recurrent laryngeal branch arise in the thorax; the cervical cardiac branches may also be traced out, and will be afterwards seen to join the deep cardiac plexus.

[The left lung is now to be drawn forward, and the pleura removed in the same manner as on the right side. The œsophagus with branches from the left pneumo-gastric will be seen near the diaphragm, and upon displacing it, the descending thoracic aorta will be brought into view, with the left splanchnic nerves and vena azygos minor.]

The **Left Pneumo-Gastric Nerve** (Fig. 236, 31) enters the thorax between the left carotid and subclavian arteries, and passes behind the left innominate vein. It then crosses the arch of the aorta, around which it gives its *recurrent branch* (21), and can now be traced to the back of the left bronchus, where it breaks up into numerous branches to the left lung and, after giving branches to the œsophagus which unite with those of the opposite side in the *plexus gulæ*, terminates on the anterior surface of the stomach. From the left recurrent branch *cardiac nerves* pass to the deep cardiac plexus.

The **Descending Thoracic Aorta** (Fig. 237, 26) is the continuation of the arch of the aorta, and extends from the lower border of the fifth dorsal vertebra to the twelfth dorsal vertebra, opposite which it passes through the aortic opening in the diaphragm to become the abdominal aorta. In its course it lies at first to the left, but afterwards in front of the bodies of the vertebræ, crossing the vena azygos minor. It is crossed by the root of the left lung and by the œsophagus, which at first lies to its right side, but reaches the front of the vessel close to the diaphragm. The pericardium also touches it in part. The artery has the thoracic duct and the vena azygos major to its right side, and is closely invested by the pleura on the left side.

Branches.—From the front of the aorta *pericardiac*, *bronchial*, *œsophageal*, and *mediastinal* branches are given off, which can now be seen. From the back part of the aorta the right and left *intercostal* arteries arise, which will be afterwards traced.

a. The *pericardiac* branches are small and irregular.

b. The *bronchial* arteries, one or two to each lung, run on the posterior surface of each bronchus, and supply blood to the tissues of the lungs. A *bronchial vein* accompanies each artery; the right opening into the vena azygos major, and the left into the left superior intercostal vein.

c. The *œsophageal* arteries are four or five small branches to the gullet.

d. The *mediastinal* are small twigs to the cellular tissue and glands of the posterior mediastinum. They anastomose with the pericardiac and œsophageal arteries, and form part of the subpleural mediastinal plexus of Turner.

[The trachea is to be cut just above the bifurcation, and the lungs are then to be removed from the chest and kept for subsequent examination. The intercostal vessels, the azygos veins, and the gangliated cord of the sympathetic, with its branches, are now to be dissected out by removing the pleuræ, and opportunity may be taken to follow out the thoracic duct, if this was not done satisfactorily before.]

The **Aortic Intercostal Arteries** (Fig. 238) are nine or ten in number on each side, and arise from the back part of the aorta. They supply the nine lower intercostal spaces, anastomosing with the superior intercostal artery above; and the arteries of the right side are necessarily longer than those of the left, owing to the position of the aorta to the left side of the median line. The upper arteries necessarily ascend to reach their proper intercostal spaces, but the lower ones run transversely, passing beneath the œsophagus, thoracic duct, vena azygos major, and gangliated cord of the sympathetic on the right side; and beneath the vena azygos minor and the gangliated cord of the sympathetic on the left side.

Each artery gives off a *posterior branch* close to the vertebræ, which passes backwards between the transverse processes to the muscles of the back, giving off a small spinal branch through the intervertebral foramen to the spinal cord and body of each vertebra (Fig. 227).

The intercostal arteries lie against the external intercostal muscles at first, and are only covered by pleura. A vein and nerve are in relation with each artery, the vein being highest and the nerve lowest in most of the spaces, but the artery being below the nerve at first in the three or four upper spaces. The arteries then disappear beneath the internal intercostals, by the removal of one or two of which the vessels and nerves can be traced out. The artery soon reaches the lower border of the adjacent rib, along the groove in which it runs, being thus protected from injury in the operation of paracentesis thoracis. Lateral cutaneous branches are given off by both arteries and nerves, which have been already seen. Ultimately the artery divides into two branches, which anastomose with the intercostal branches of the internal mammary.

The **Intercostal Veins** (Fig. 238), with the exception of those from the upper two or three spaces on the left side, open into the azygos veins on each side. The vena azygos major of the right side has been already seen.

The **Vena Azygos Minor** (Fig. 238, 18) commencing in the left lumbar veins (and often in the renal), pierces the left crus of the diaphragm and receives the lower intercostal veins of the left side; it has been seen to pass behind the aorta and open into the vena azygos major. The upper intercostal veins of the left side either open into the *superior intercostal vein* (12), or form a separate vein (vena azygos minor superior) which, communicating with the superior intercostal vein above, either terminates below in the vena azygos minor, or crosses the spine separately to open into the vena azygos major.

The **Intercostal Nerves** (Fig. 236) are twelve in number and, with the exception of the first, accompany the intercostal arteries, and are distributed to the front and sides of the chest and abdomen, supplying muscular and cutaneous branches. The lateral cutaneous branches have been already seen, the posterior will be exposed in the dissection of the back. The first nerve gives only a small branch to the first intercostal space, and then passes through the superior aperture of the thorax to join the brachial plexus.

The **Gangliated Cord of the Sympathetic** (Fig. 235, 31) is placed over the heads of the ribs on each side of the thorax, just outside the posterior mediastinum and beneath the pleura, being continuous with the cervical portion of the sympathetic, the inferior cervical ganglion of which should now be dissected on the neck of the first rib. The thoracic ganglia are generally said to correspond to the ribs in number, but there is seldom a distinct ganglion for the first rib, it being united with the inferior cervical ganglion; and occasionally two of the lower ganglia are united.

The *inferior cervical ganglion* has branches of communication with the two lowest cervical nerves, and gives branches upon the vertebral artery, and an *inferior cardiac nerve* to the deep cardiac plexus (Fig. 236).

The *thoracic ganglia* may be divided into two sets, upper and lower. From the six upper ganglia communicating branches are given to the six upper intercostal nerves, and to the pulmonary and aortic plexuses. From the six lower ganglia branches of communication are given to the six lower intercostal nerves, and the three splanchnic nerves arise. There are generally two branches of communication between each ganglion and an intercostal nerve, one grey and one white.

Splanchnic Nerves (Fig. 235, 43).—The *great splanchnic nerve* is derived from four ganglia, (6th, 7th, 8th, 9th, 10th) by separate fibres. The nerve runs inwards and, after piercing the crus of the diaphragm, joins the solar plexus in the abdomen.

The *lesser splanchnic nerve* is derived from the 10th and 11th ganglia, and also pierces the crus of the diaphragm to join the solar or renal plexus.

The *least splanchnic nerve* is derived from the 12th ganglion, and goes to the renal plexus. It is seldom found, because the lesser nerve is connected with the lowest ganglion.

The **Internal Intercostal Muscles** (Fig. 238) can be seen beneath the pleura without any further dissection. Beginning at the sternum the muscles reach as far as the angles of the ribs, at which points the intercostal vessels and nerves lying against the external intercostals are visible. The fibres of the internal intercostals take a direction contrary to that of the external intercostal muscles, *i.e.*, they run forwards and upwards.

The relation of the parts passing through the **Superior Aperture of the Thorax** can be now fully understood, and will be found in the accompanying table (p. 496) and the diagram taken from nature (Fig. 239).

The **Upper Surface of the Diaphragm** (Fig. 240) will now also be thoroughly exposed, the structures in relation with it having been already dissected; but these should be again carefully studied in connection with the muscle.

Fig. 239.

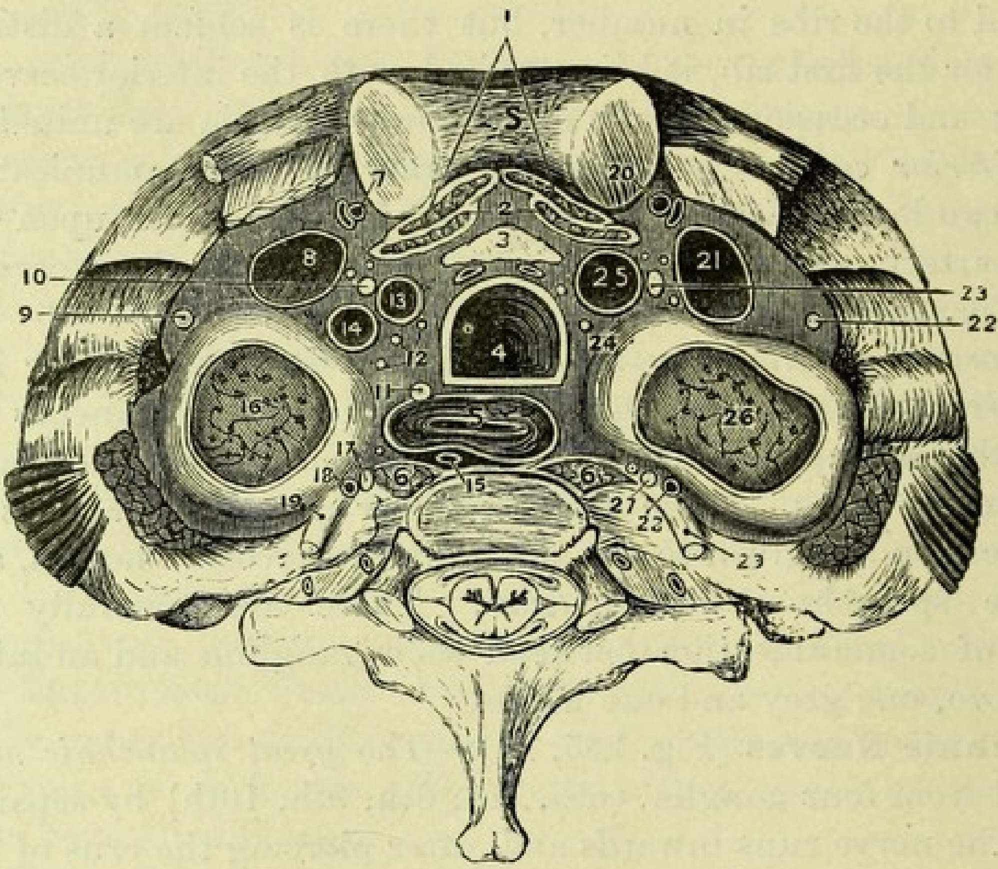


Fig. 239.—The superior aperture of the thorax (drawn by G. E. L. Pearse).

MEDIAN LINE.

1. Sterno-hyoid muscles.
2. Sterno-thyroid muscles.
3. Remains of thymus gland.
4. Trachea.
5. Œsophagus.
6. Longi colli muscles.

LEFT SIDE.

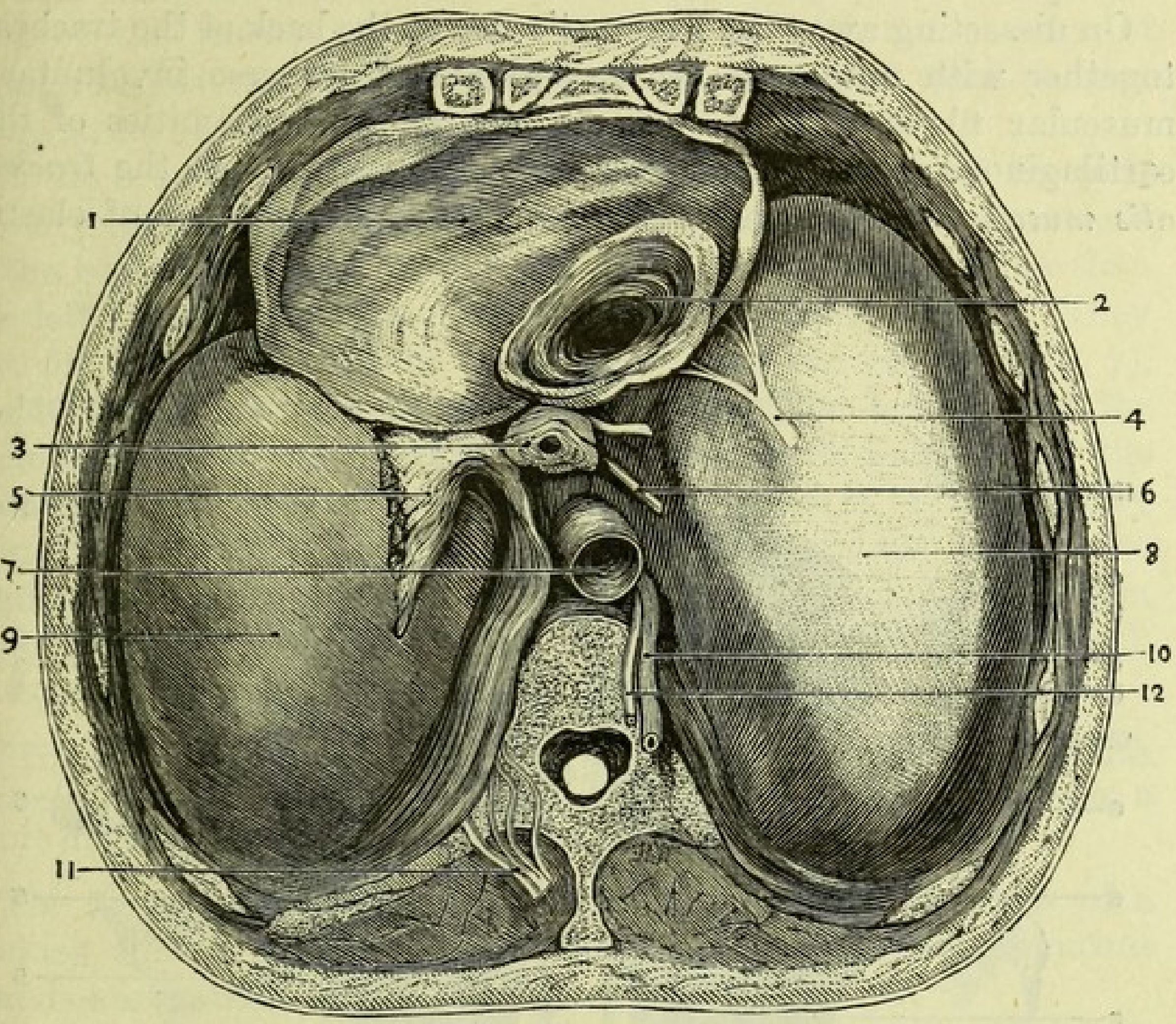
7. Internal mammary artery.
8. Innominate vein.
9. Phrenic nerve.
10. Pneumo-gastric nerve.
11. Recurrent laryngeal nerve.
12. Cardiac nerves.
13. Left carotid artery
14. Left subclavian artery
15. Thoracic duct.
16. Apex of lung and pleura.
17. Sympathetic.
18. Superior intercostal artery.
19. First dorsal nerve.

RIGHT SIDE.

20. Internal mammary artery.
21. Innominate vein.
22. Phrenic nerve.
23. Pneumo-gastric nerve.
24. Cardiac nerves.
25. Innominate artery.
26. Apex of lung and pleura.
27. Sympathetic.
28. Superior intercostal artery.
29. First dorsal nerve.

[The lungs, which have been removed and laid aside, are now to be dissected, and the structure of the trachea and lungs is to be examined.]

Fig. 240.



The **Trachea** is about four inches and a half in length, and is convex in front, but flattened posteriorly, being composed of a series of cartilages, the extremities of which are connected behind by fibrous and muscular tissue. There are from sixteen to twenty cartilages, each measuring about two lines in depth, but decreasing

Fig. 240.—The upper surface of the diaphragm (from University College Museum).

1. Pericardium.
2. Vena cava inferior opening into right auricle.
3. Œsophagus with left pneumo-gastric nerve in front.
4. Right phrenic nerve (left nerve hidden by the pericardium).
5. Ligamentum latum pulmonis.
6. Right pneumo-gastric nerve.
7. Aorta.
8. Tendinous centre of right muscle.
9. Pleura, covering left muscle.
10. Vena azygos major.
11. Sympathetic with splanchnics.
12. Thoracic duct.

in depth from above downwards. The last cartilage is peculiar in being cut obliquely on each side, so as to be adapted to the commencement of the bronchi. The cartilages are connected together by fibrous tissue, and the first is similarly connected to the cricoid cartilage.

On dissecting away the fibrous tissues at the back of the trachea, together with numerous mucous glands, transverse involuntary muscular fibres will be seen connecting the extremities of the cartilaginous rings, constituting what has been termed the *trachealis muscle*. Within this again is a longitudinal layer of elastic

Fig. 241.

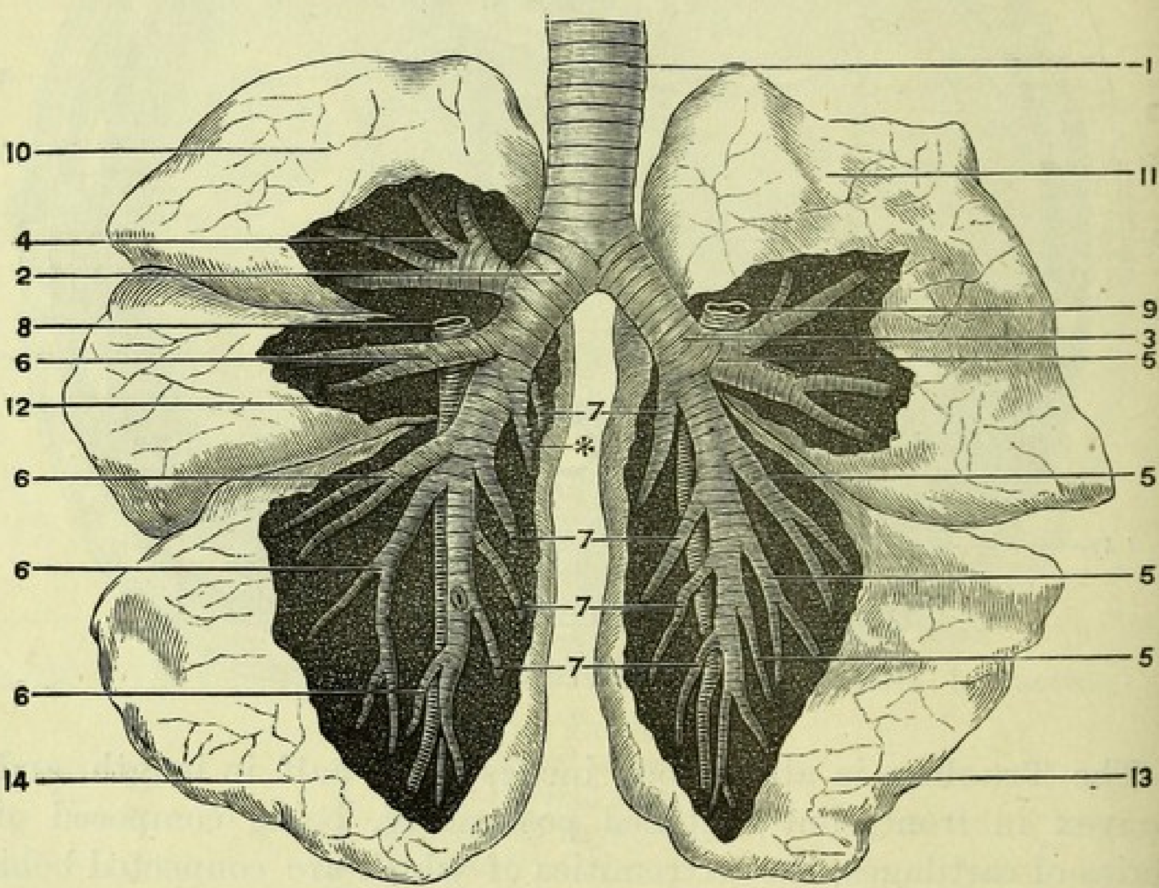


Fig. 241.—Trachea and bronchi seen from the front (modified from Aeby).

1. Trachea.
2. Right bronchus.
3. Left bronchus.
4. Bronchus to right upper lobe, above pulmonary artery; no corresponding branch on left side.
5, 5, 5, 5. Left ventral branches, four in number, the upper going to upper lobe.
6, 6, 6, 6. Right ventral branches, four in number.
7, 7, 7, 7. Dorsal branches, right and left, four in number, the upper going to the middle lobe.

* A branch found only on the right side, corresponding to that going to the azygos lobe of most animals.

8. Right pulmonary artery.
9. Left pulmonary artery.
10. Right upper lobe.
11. Left upper lobe.
12. Right middle lobe.
13. Left lower lobe.
14. Right lower lobe.

fibres, closely connected with the mucous membrane, the epithelium of which is columnar and ciliated.

On looking into the lower end of the trachea, a slight septum will be seen between the two bronchi, but placed to the left of the median line, because the right bronchus is a more direct continuation of the trachea than the left; this favours the passage of foreign bodies into the right bronchus, the orifice of which is seen to be larger than that of the left.

If the bronchi be traced into the lung by dissecting off the pulmonary tissue, it will be found that each main bronchus extends to the base of the lung, the right (Fig. 241, 2) being straighter than the left (3), which forms a sigmoid curve round the heart. They give off lateral branches in two series, dorsal and ventral (5, 6, 7), besides others less regular in arrangement. The branches of the pulmonary artery lie in immediate contact with the back of the bronchi and follow their course accurately; those of the pulmonary veins lie for the most part on the ventral aspect, and are not quite so regular. The pulmonary artery crosses the right bronchus (8), from front to back, below the bronchus, coming from the upper lobe (4), but on the left side (9) it is higher than all the lateral branches.

[The trachea and bronchi are to be laid open from behind with scissors, and the divisions of the bronchi should be followed for a short distance into the substance of the lungs.]

The **Lungs.**—The mucous membrane of the air tubes is of a pinkish colour, and has ciliated epithelium. Numerous mucous glands are embedded in the submucous areolar tissue.

On tracing the bronchi they will be found to become cylindrical, the cartilaginous rings becoming merely plates, and at length disappearing when the *bronchia* become less than half a line in diameter. The muscular fibres, which were only at the back of the large bronchi, surround the smaller tubes, and can be traced further than the cartilages. The fibrous and elastic coats may be traced into the smallest ramifications of the air-tubes, which thus become eventually membranous. The minute *bronchia* terminate in *intercellular passages*, in which the mucous membrane is covered with squamous epithelium. Opening out of the intercellular passages are the *air-cells*, or alveoli, the average diameter of which is $\frac{1}{100}$th of an inch, and the septa between which are formed by reduplications of the lining membrane (Fig. 244).

The air-cells collected around the extremity of each minute bronchial tube form a *lobule* or *infundibulum*, and these aggregated together form the substance of the lung, but the air-cells of one lobule have no connection with those of another (Fig. 242).

Fig. 242.

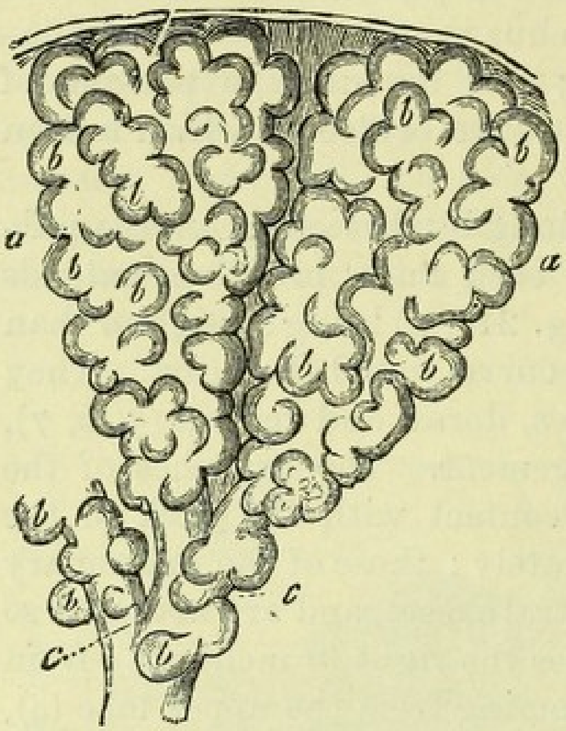
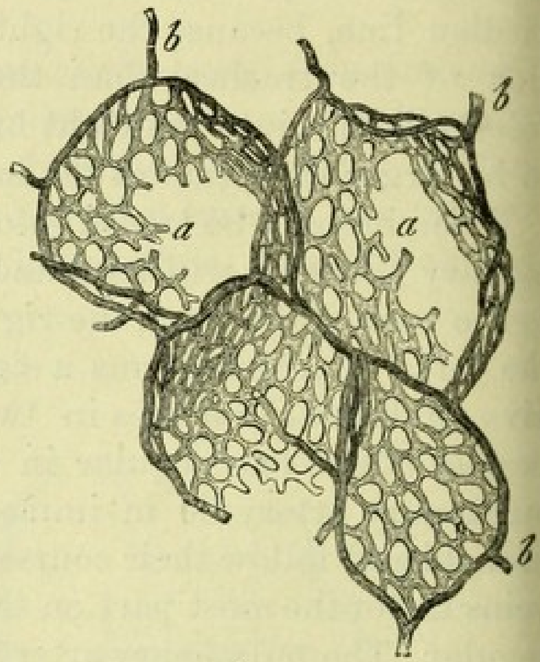
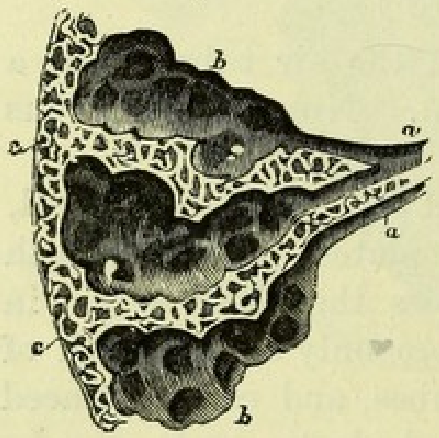


Fig. 243.



The pulmonary artery subdivides like the bronchus which it accompanies, giving a branch to each lobule, which ends in a plexus of capillaries distributed beneath the mucous membrane of the air-cells and their septa, and also on the walls of the inter-cellular passages ; the capillaries of each lobule being distinct (Fig. 243).

Fig. 244.



The pulmonary veins convey the arterialised blood from the lobules, and correspond to the branches of the arteries. They have no valves, and the veins of different lobules anastomose freely.

Fig. 242.—Two primary pulmonary lobuli or infundibula (from Frey).
a, *a*. Exterior of lobuli. *b*, *b*. Pulmonary vesicles. *c*, *c*. Smallest bronchia.

Fig. 243.—Capillary network of a pulmonary vesicle (from Frey).
a. Capillary network.
b. Terminal branches of the pulmonary artery encircling the vesicles.

Fig. 244.—A diagram showing the dilatation of the ultimate bronchial tubes into intercellular passages, and the enlargement of the latter near the surface of the lung (from Wilson).
a, *a*. Bronchial tubes.
b, *b*. Intercellular passages, on the walls of which the air-cells are seen opening.
c, *c*. Air-cells near the surface of the lung.

The bronchial arteries, arising from the thoracic aorta, may be traced upon the bronchial tubes for some distance. They supply the substance of the lung, and their blood is returned partly by the bronchial veins and partly by the pulmonary veins. The bronchial veins open on the right side into the vena azygos, and on the left usually into the superior intercostal vein. The nerves of the lungs are from the anterior and posterior pulmonary plexuses, and are principally derived from the pneumo-gastrics. They can be traced upon the bronchial tubes for some distance, and are said to have minute ganglia developed upon them. The lymphatics of the lung are connected with the bronchial glands found about the bifurcation of the trachea.

Articulation of the Ribs with the Vertebræ.

The ligaments of the ribs may be divided into two sets, (1) those connecting the ribs with the bodies of the vertebræ (costo-vertebral), and (2) those connecting the ribs with the transverse processes (costo-transverse).

1. The Costo-vertebral ligaments are Anterior, Capsular, and Inter-articular.

The **Anterior Costo-vertebral** or **Stellate Ligament** (Fig. 245, 2) consists of three short fasciculi, which radiate from the anterior surface of the head of the rib. The *superior* fasciculus passes to the vertebra above; the *middle* fasciculus to the intervertebral substance; the *inferior* fasciculus to the vertebra below. The whole ligament is closely connected with the anterior common ligament of the vertebræ. This arrangement only holds good in the case of those ribs which articulate with two vertebræ. In the case of the first, tenth, eleventh, and twelfth ribs, which articulate with a single vertebra each, the stellate ligament is attached principally to that vertebra, but sends a few fibres to the vertebra above.

The **Capsular Ligament** is a thin layer of fibres surrounding the articulation where the anterior ligament is wanting.

The **Interarticular Ligament** (Fig. 245, 4) is seen by removing the stellate ligament, and is a short band passing between the ridge on the head of the rib and the intervertebral substance. It divides the articulation into two parts, each of which has a separate *synovial membrane*, but it is absent from the articulations of the first, tenth, eleventh, and twelfth ribs, which have a single synovial membrane.

2. The Costo-transverse ligaments are Anterior, Posterior, and Middle.

The **Anterior Costo-transverse Ligament** (Fig. 245, 3) is attached to the upper border of the neck of all the ribs except the first, and ascends to the lower border of the transverse process of the vertebra above. It separates the anterior from the posterior division of the intercostal nerves.

The **Posterior Costo-transverse Ligament** (Fig. 246, 4) is a short thick band, passing obliquely upward from the apex of the

Fig. 245.

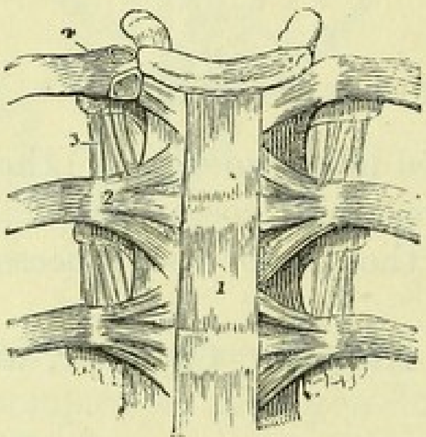
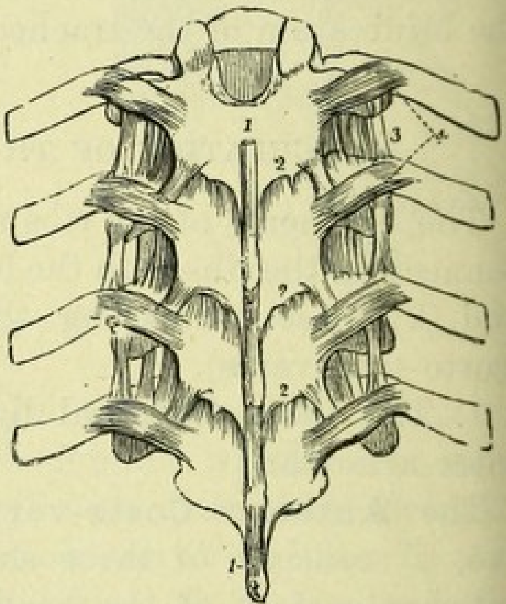


Fig. 246.



transverse process of the vertebra to the rough non-articular portion of the tubercle of the rib (Fig. 247, 5).

[In order to see the middle costo-transverse ligament it will be necessary to make a horizontal section through the transverse process of a vertebra and the neck of the corresponding rib, when the short ligament will be found between the two.]

Fig. 245.—Anterior ligament of the vertebræ, and ligaments of the ribs (from Wilson).

1. Anterior common ligament.
2. Anterior costo-vertebral or stellate ligament.
3. Anterior costo-transverse ligament.
4. Interarticular ligament connecting the head of the rib to the intervertebral substance, and separating the two synovial membranes of this articulation.

Fig. 246.—Posterior view of part of the dorsal vertebral column, showing the ligaments connecting the vertebræ with each other, and the ribs with the vertebræ (from Wilson).

1, 1. Supraspinous ligament.
2, 2. Ligamenta subflava, connecting the laminæ.
3. Anterior costo-transverse ligament.
4. Posterior costo-transverse ligament.

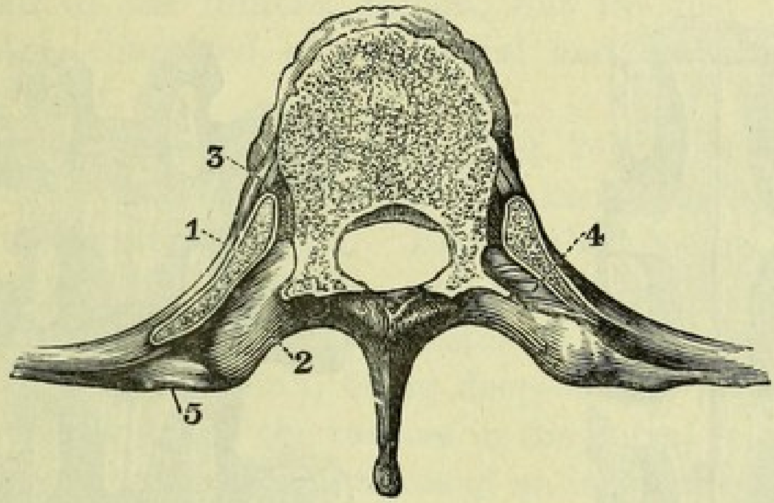
The **Middle Costo-transverse Ligament** (Fig. 247, 4) consists of short strong fibres, passing between the posterior surface of the neck of the rib and the corresponding transverse process.

A *synovial membrane* exists between the facet upon each of the transverse processes of the ten upper dorsal vertebræ and the articular tubercle of the corresponding rib.

The anterior extremity of each rib has a hollow into which the costal cartilage fits, being firmly united by the periosteum.

Chondro-Sternal Articulation.—The cartilages of the true ribs fit into depressions on the side of the sternum, and are

Fig. 247.



attached by *anterior* and *posterior* ligaments. A band attaching the seventh rib to the xiphoid cartilage is called the costo-xiphoid ligament.

The fifth, sixth, seventh, eighth, ninth and tenth cartilages are connected by fibrous bands.

Synovial Membranes.—The first costal cartilage is continuous with the sternum, and has no synovial cavity. The second and third cartilages have a double synovial membrane, owing to the existence of an interarticular ligament. The fourth, fifth, sixth, and seventh cartilages have a single synovial membrane at the external articulation, and there are, in addition, three synovial membranes between the sixth, seventh, eighth, and ninth costal cartilages respectively.

Fig. 247.—Transverse section of dorsal vertebra and ribs (Quain).

1. Head of rib.
2. Transverse process of vertebra.
3. Anterior costo-vertebral or stellate ligament.
4. Middle costo-transverse ligament.
5. Posterior costo-transverse ligament.

Ligaments of the Vertebræ.

[The ligaments of the spinal column are to be examined by removing all the remaining muscular fibres.]

The ligaments of the *Bodies* of the vertebræ are—1, the Anterior Common Ligament; 2, the Posterior Common Ligament; and 3, the Intervertebral Substance or Fibro-cartilage.

The **Anterior Common Ligament** (Fig. 245, 1) is a broad band of fibres extending down the front of the vertebral column, from the axis to the sacrum. The fibres are attached principally

Fig. 248

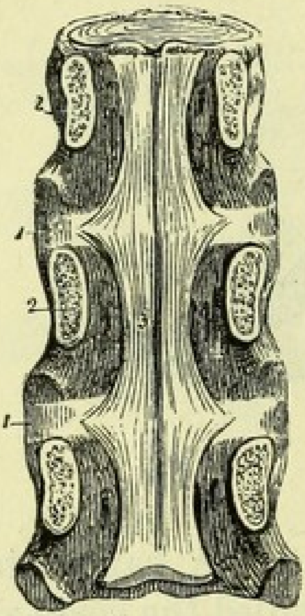
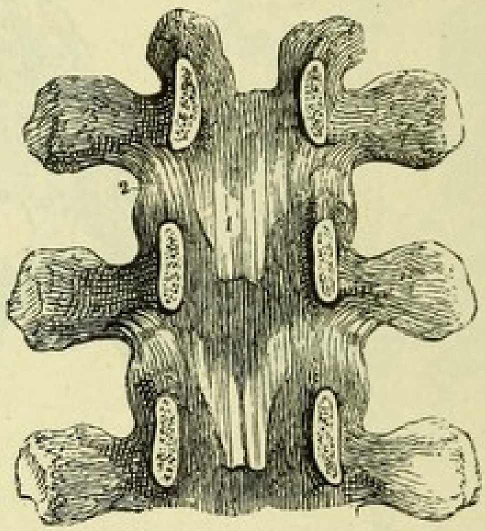


Fig. 249



to the intervertebral substances, and only slightly to the upper and lower margins of the vertebræ; the deep fibres passing between the adjacent bones, but the superficial crossing three or more vertebræ. The ligament, when divided, will be seen to be thicker opposite the bodies of the vertebræ than on the intervertebral substances; and it is broader in the lumbar than in the cervical region.

[To see the posterior common ligament it will be necessary to remove the spinal cord, if this has not been already done, as

Fig. 248.—Posterior ligament of the vertebræ (from Wilson).

1, 1. Intervertebral substances. 3. Posterior common ligament.
2. Pedicles of vertebræ sawn through.

Fig. 249.—Internal view of the arches of three vertebræ (from Wilson).

1. One of the ligamenta subflava. 2. The capsular ligament of one side.

follows: the saw is to be applied over the pedicles of, say, six dorsal vertebræ, and these being divided on each side, the remains of the spinal cord can be removed, when the posterior ligament will be seen on the backs of the bodies of the vertebræ; and the ligamenta subflava can be dissected upon the vertebral arches which have been removed.]

The **Posterior Common Ligament** (Fig. 248, 3) is found upon the posterior aspect of the bodies of the vertebræ from the axis to the sacrum. It is remarkable in being broad opposite the intervertebral substances, with which it is closely connected, and narrow opposite the bodies of the vertebræ, over which it stretches to allow of the passage of vessels to the bone. It is broader in the cervical than in the lumbar region, but thickest in the dorsal region, and is composed of superficial and deep fibres like the anterior ligament.

The **Intervertebral Substance** (Fig. 248, 1) is found between the bodies of all the vertebræ from the axis to the sacrum, and is largest in the lumbar region. Each substance is composed of fibrous tissue and fibro-cartilage externally, but has a soft elastic material in the centre. The substances vary according to the curves of the spinal column, being deepest in front in the cervical and lumbar regions, and the reverse in the dorsal region.

On dissecting the superficial fibres of an intervertebral substance, they will be found to pass obliquely between the adjacent vertebræ, alternate layers taking opposite directions. By cutting through the attachment to one of the vertebræ with a strong knife, the pulpy material in the centre will be shown, and will expand considerably above the level of the fibro-cartilaginous rings around it.

On making a vertical section of two or more vertebræ with their intervertebral substances, the structure of the intervertebral substance will be best seen, and will be found to consist of fibro-cartilaginous plates placed in front of and behind the central pulpy material. The plates of both series are arranged one within another, the superficial ones being slightly bent towards the surface, and the deeper ones towards the centre.

The *Articular Processes* are surrounded by **Capsular Ligaments** (Fig. 249, 2), which are looser in the cervical than in the dorsal and lumbar regions; they permit a simple gliding movement (arthrodia) between the processes, which are invested by a simple synovial membrane.

The *Arches* are united by the **Ligamenta Subflava** (Fig. 249, 1).

These are to be seen on the internal surfaces of the arches which have been removed, and will be found to consist of a series of yellow elastic ligaments, extending between the arches of the vertebræ on each side of the middle line, from the axis to the sacrum. Owing to the overlapping of the vertebræ, the ligaments are attached to the posterior surface of the arch below and to the anterior surface of the arch above, extending from the articular process to the root of the spinous process on each side (Fig. 246, 2).

The *Spinous Processes* are united by (1) the Interspinous and (2) the Supraspinous ligaments.

The **Interspinous Ligaments** are placed between the spinous processes of the vertebræ, extending from the root to the tip of each, and being stronger in the lumbar than in the dorsal, and in the dorsal than in the cervical region.

The **Supraspinous Ligament** (Fig. 246, 1) is a fibrous cord extending along the tips of the spinous processes, from the last cervical vertebra to the sacrum. It is continuous with the *ligamentum nuchæ*, and is thicker in the lumbar than in the dorsal region. It is composed of superficial and deep fibres, which have the same arrangement as those of the anterior and posterior common ligaments.

The *Transverse Processes* are connected by **Intertransverse Ligaments,** which are frequently absent in the cervical region, but are round and thick in the dorsal, and thin and membranous in the lumbar region.

PART VI.

DISSECTION OF THE BACK AND SPINAL CORD.

In dissecting the back it is customary for the dissectors of the arms to take the first two layers of muscles, the dissectors of the head and neck taking such of the superficial muscles as are contained in their part, and then completing the dissection of the remainder of the region, including the spinal cord.

[An incision is to be made from the occiput to the sacrum in the median line, and another along each crest of the ilium at right angles to it. The dissectors should then raise the skin with all the infiltrated fascia, going at once down to the superficial muscles, through which the cutaneous nerves appear, and then dissecting them out of the superficial fascia. On the left side of the subject the arm is to be drawn forward so as to put the latissimus dorsi on the stretch, and the dissector should begin to clean the lower part of that muscle, and work upwards to the trapezius; on the right side the arm should be pulled down at first, and the head drawn over to the opposite side with hooks, to put the upper fibres of the trapezius on the stretch, and the dissector must begin at the upper border of that muscle (already exposed in the posterior triangle) and work downwards to the latissimus dorsi. On both sides, the arm and scapula will require to be moved from time to time to put the different sets of fibres on the stretch in turn.]

The **Cutaneous Nerves** (Fig. 253) are derived from the posterior divisions of the spinal nerves, and are mostly of small size; but the upper dorsal nerves reach the shoulder, and the lumbar the buttock. The cervical and upper six dorsal nerves pierce the trapezius close to the spine, the second and third cervical turning up to the occiput, the third nerve being much smaller than the second, and lying internally to it. There are no cutaneous branches from the 1st, 6th, 7th, and 8th cervical nerves. The lower six dorsal and three lumbar nerves appear near the angles of the ribs, and pierce the latissimus dorsi along the oblique line at which the muscular fibres commence; and the sacral nerves give usually two small branches through the tendinous expansion near the spine.

Fig. 250.

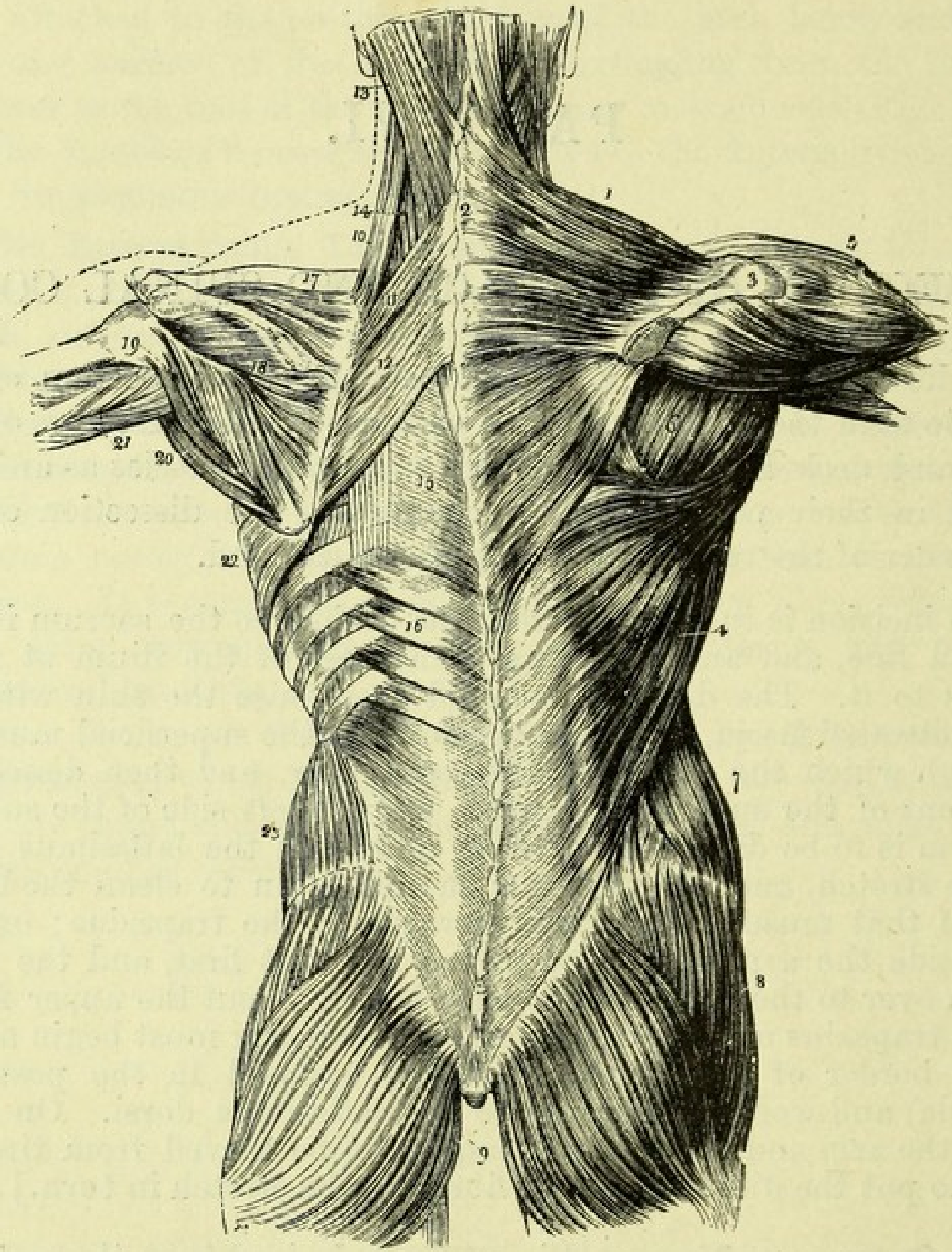


Fig. 250.—First, second, and part of the third layer of muscles of the back: the first layer occupies the right; the second the left side (from Wilson).

1. Trapezius.
2. Ligamentum nuchæ.
3. Acromion process and spine of the scapula.
4. Latissimus dorsi.
5. Deltoid.
6. Muscles of the dorsum of the right scapula: infraspinatus, teres minor, and teres major.
7. Obliquus externus.
8. Gluteus medius.
9. Glutei maximi.
10. Levator anguli scapulæ.
11. Rhomboideus minor.
12. Rhomboideus major.
13. Splenius capitis; the muscle internal to, and overlaid by, the splenius, is the complexus.

The **First Layer of Muscles** (Fig. 250) consists of the Trapezius and Latissimus Dorsi. The Trapezius partially overlaps the latissimus, but between them and the base of the scapula is a small triangular interval, in which the lower fibres of the rhomboideus major can be seen, and also, below that muscle, the posterior surfaces of two or three ribs and their intercostal muscles.

The **Trapezius** (Fig. 250, 1) of one side is triangular, but the two muscles together resemble a trapezium. It *arises* from the external occipital protuberance and inner third of the superior curved line of the occipital bone; from the ligamentum nuchæ and seventh cervical spinous process; and from the spinous processes of all the dorsal vertebræ. The fibres converge to be *inserted* into the outer third of the posterior border of the clavicle, and into the inner border of the acromion process and the upper border of the spine of the scapula. The fibres thus have different directions, and the action of the muscle upon the scapula is said to vary according to the fibres brought into use. The action of the entire muscle is to draw the scapula towards the spine, and thus the two trapezii throw back the shoulders. When the scapulæ are fixed by other muscles, the two trapezii throw the head back, or one muscle acting by itself would draw the head and spine to that side.

The trapezius has been seen to be *supplied* by the spinal-accessory nerve and branches of the deep cervical plexus, it also receives branches from the posterior divisions of the nerves which pierce it.

The *Ligamentum Nuchæ* is a band of white fibrous tissue, which extends from the prominent spinous process of the seventh cervical vertebra to the external occipital protuberance, being connected by small slips with the spines of the intervening vertebræ. It intervenes between, and gives origin to, the muscles of the two sides of the neck, and in some of the lower animals, being composed of yellow elastic tissue, it gives an important support to the head.

The **Latissimus Dorsi** (Fig. 250, 4) *arises* by a tendinous origin from the posterior half of the outer lip of the crest of the ilium, and the back of the sacrum; from all the lumbar and the six lower dorsal spines; and from the outer surfaces of the three lower ribs,

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14. Splenius colli, partially seen: the common origin of the splenius is seen attached to the spinous processes below the origin of rhomboideus major.
15. Vertebral aponeurosis.
16. Serratus posticus inferior.
17. Supra-spinatus.
18. Infra-spinatus.
19. Teres minor.
20. Teres major.
21. Long head of triceps.
22. Serratus magnus.
23. Obliquus internus.

interdigitating with the external oblique muscle of the abdomen. The broad muscular fibres become collected together as they wind round the inferior angle of the scapula, to which they sometimes have a slight attachment, and then pass forward and upward in front of the teres major, to be *inserted* into the bottom of the bicipital groove of the humerus. The fibres of the muscle are twisted, so that those which were highest at their origin are lowest at the insertion, and *vice versâ*.

The latissimus dorsi, when taking its fixed point below, rotates the humerus inwards and then draws it behind the back, the two muscles, when acting together, crossing the arms behind. When the humerus is fixed, the muscle would draw up the trunk as in climbing, and may act as an extraordinary muscle of inspiration upon the lower ribs. It is *supplied* by the long subscapular nerve, and by the dorsal nerves which pierce it.

[The trapezius is to be divided by a vertical incision near the spine, care being taken not to divide the subjacent tendinous origins of the rhomboidei in the cervical region. In reflecting the trapezius, its tendon will be seen to glide over the smooth triangular surface at the inner end of the spine of the scapula. Care must be taken of the spinal-accessory nerve and the accompanying branches of the superficial cervical artery. The posterior surface of the levator anguli scapulæ and the two rhomboidei muscles are now to be cleaned.]

Second Layer of Muscles.

The **Levator Anguli Scapulæ** (Fig. 250, 10) *arises* from the posterior tubercles on the transverse processes of the upper four cervical vertebræ, and is *inserted* into the base of the scapula opposite the supra-spinal fossa. The anterior surface of this muscle has been seen in the posterior triangle of the neck, where the levator covers the splenius colli muscle.

The **Rhomboideus Minor** (Fig. 250, 11) is a narrow muscle, *arising* from the ligamentum nuchæ, and from the spines of the seventh cervical and first dorsal vertebræ. It is *inserted* into the base of the scapula opposite the spine.

The **Rhomboideus Major** (Fig. 250, 12) *arises* from the spinous processes of the upper four or five dorsal vertebræ, except the first, being often united with the minor ; and is *inserted* into the base of the scapula opposite the infra-spinal fossa, the middle fibres being attached to a fibrous arch, which is connected with the bone at its extremities.

The three muscles of the second layer act upon the scapula, the levator drawing up the superior angle, and the rhomboidei drawing the lower part of the bone towards the spine, and thus tending to rotate the scapula and depress the glenoid cavity. The muscles are *supplied* by branches from the upper part of the brachial plexus and twigs from the cervical plexus.

[The posterior belly of the omo-hyoid is to be traced out to the scapula, and the levator, rhomboidei, and the upper half of the latissimus dorsi are then to be divided, when the scapula can be drawn away from the ribs, and the inner surface of the serratus magnus muscle, with a quantity of loose cellular tissue between it and the ribs, will be brought into view. This muscle is to be divided by a vertical incision, and the clavicle being sawn through (if this has not already been done), the arm will be attached only by the vessels and nerves, which may be cut through and the limb removed. Between the rhomboidei and the serratus will be seen an artery, which is the posterior scapular. The dissector of the arm will proceed at once with the dissection of the scapular muscles. The tendinous origin of the latissimus is then to be removed, and the serratus posticus superior and the serratus posticus inferior are to be defined.]

The **Third Layer of Muscles** (Fig. 250) consists of two thin muscles, the Serratus posticus superior and the Serratus posticus inferior, and of the Splenius, which is divided into splenius capitis and splenius colli.

The **Serratus Posticus Superior** *arises* from the ligamentum nuchæ, and the spinous processes of the seventh cervical and upper two dorsal vertebræ; it passes downwards to be *inserted* into the superior borders of the second, third, fourth, and fifth ribs, externally to their angles.

The **Serratus Posticus Inferior** (Fig. 250, 16) *arises* from the spinous processes of the last two dorsal and upper two lumbar vertebræ; it passes upwards to be *inserted* into the lower borders of the last four ribs, externally to their angles.

The serrati postici are antagonistic muscles, the superior raising the ribs, and being therefore a muscle of inspiration, the inferior depressing the ribs, and being therefore a muscle of expiration.

[The serrati are to be divided and turned aside, and the splenius capitis and splenius colli are to be cleaned, when the posterior portion of the *fascia lumborum* covering the deeper muscles, and united more or less with the origins of the latissimus dorsi and serratus posticus inferior, as well as with the subjacent muscles, will be seen. The name of *vertebral aponeurosis* has been given to the continuation of this structure beneath the serratus posticus superior and the splenius, and over the deep muscles; this is to be defined, and afterwards must be removed.]

The **Splenius** (Fig. 250) is single at its *origin*, which is from the lower half of the ligamentum nuchæ, and from the spinous processes of the seventh cervical and upper six dorsal vertebræ.

The *splenius capitis* (13), or upper portion, is *inserted* across the mastoid process and into the outer third of the superior curved line of the occipital bone, immediately beneath the sterno-mastoid muscle.

The *splenius colli* (14), or lower portion, is *inserted* into the posterior tubercles on the transverse processes of the upper four cervical vertebræ.*

The splenii draw the head and neck backward, and thus assist in maintaining the erect posture. One muscle acting alone, draws the head over to the same side, *i.e.*, it antagonises the sterno-mastoid.

The splenius capitis was seen in the posterior triangle of the neck, but the splenius colli was hidden by the levator anguli scapulæ. At the upper border of the splenius the nearly vertical fibres of the complexus appear.†

[The splenius must be reflected in order to show the complexus, which lies beneath it. In order to define the parts of the erector spinæ, an interval is to be sought opposite the last rib, separating it into two parts. The outer of these is to be turned outwards and its attachment to the ribs and cervical transverse processes defined; it consists of the sacro-lumbalis, the accessorius, and the cervicalis ascendens. The inner part can only be turned aside, after separating it from a few muscular and tendinous bands passing between some of the dorsal and lumbar spines, and called the spinalis dorsi; this inner part consists of the longissimus dorsi and its two prolongations upwards into the neck. The aponeurosis from which the erector spinæ and the subjacent multifidus arise is to be divided by an oblique incision following the line of separation between the muscles. In making this dissection the inner branches of the posterior divisions of the intercostal vessels and nerves will be found internal to the longissimus dorsi, and the external branches between the longissimus dorsi and the sacro-lumbalis. The occipital artery will also be shown in the neck.]

The **Fourth Layer of Muscles** (Fig. 251) consists of the Spinalis dorsi, the Erector spinæ with its subdivisions, and the Complexus.

* The splenius is inserted into the posterior tubercles of the vertebræ which give origin to the levator anguli scapulæ.

† The student is advised not to burden his memory with the *attachments* of the remaining muscles of the back, with the exception of the small muscles of the suboccipital region. He should, however, dissect the principal ones so as to be able to identify them, and to know their general positions.

The **Spinalis Dorsi** (Fig. 251, 4) lies close to the spinous processes, *arising* from the last two dorsal and upper two lumbar spinous processes, and being *inserted* into the spinous processes of the upper six dorsal vertebræ.

The **Erector Spinæ** (Fig. 251, 1) is the great muscle filling up the hollow at the back of the sacrum and lumbar vertebræ. It *arises* from the posterior fifth of the inner lip of the crest of the ilium; from the posterior surface of the sacrum; from the transverse and spinous processes of all the lumbar vertebræ; as well as from the aponeurosis covering the muscle.

Opposite the last rib the erector divides into the sacro-lumbalis and longissimus dorsi muscles, of which the sacro-lumbalis is the further from the median line.

The **Sacro-Lumbalis** (Fig. 251, 2) is the smaller of the two divisions, and passes upwards and outwards to be *inserted* into the angles of the six lower ribs, and is directly prolonged upwards by the two following muscles.

The **Accessorius** (musculus accessorius ad sacro-lumbalem) is placed internally to the sacro-lumbalis, and consists of muscular slips which pass *from* the lower six *to* the upper six ribs, near their angles.

The **Cervicalis Ascendens** (Fig. 251, 5) is placed internally to the accessorius, of which it is the continuation, *arising* from the upper four ribs, and being *inserted* into the posterior tubercles on the transverse processes of the lower four cervical vertebræ, with the exception of the seventh.*

The **Longissimus Dorsi** (Fig. 251, 3), the inner division of the Erector spinæ, has two sets of insertions; an inner by tendinous slips into the transverse processes of all the dorsal vertebræ, and an outer by fleshy slips into the ten lower ribs externally to their angles. It is prolonged into the neck by the two following muscles.

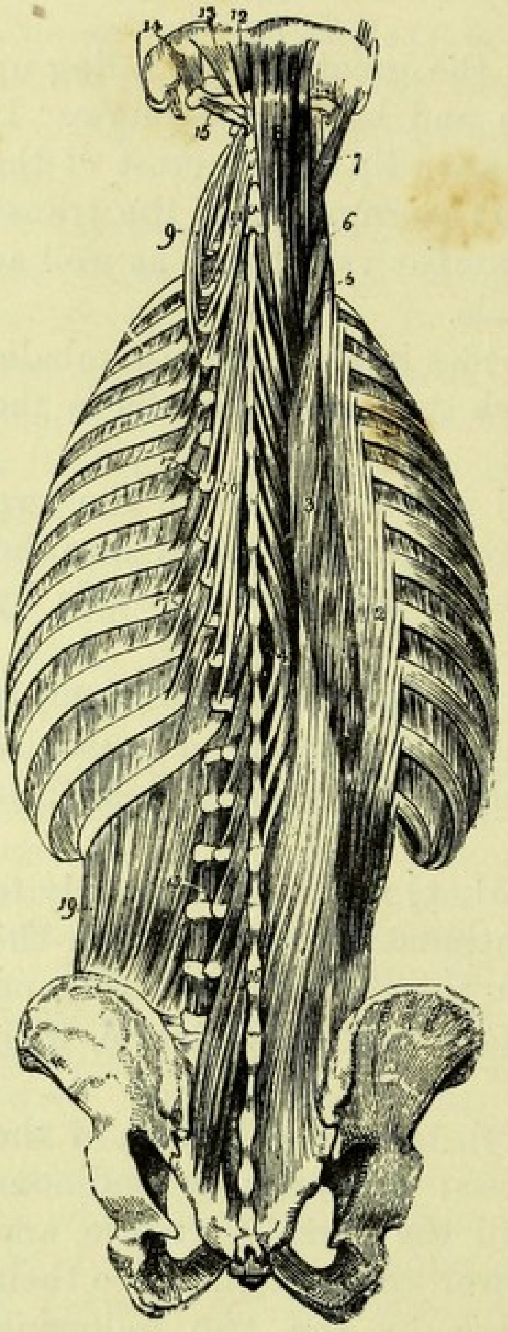
The **Transversalis Cervicis** (Fig. 251, 6) is the continuation of the longissimus, and lies to its inner side, *arising* from the transverse processes of the upper six dorsal vertebræ. It is *inserted* into the posterior tubercles on the transverse processes of the lower six cervical vertebræ.

The **Trachelo-mastoideus** (Fig. 251, 7) is to the inner side of the transversalis, and between it and the complexus. It *arises*,

* The muscles forming the outer division of the erector spinæ may be remembered by the first syllable of SACro-lumbalis, thus—Sacro-lumbalis, Accessorius, Cervicalis ascendens.

with the transversalis, from the transverse processes of the upper four dorsal vertebræ, and also from the articular processes of the lower four cervical vertebræ; and is *inserted* into the posterior part of the apex of the mastoid process beneath the splenius capitis.

Fig. 251.



The **Complexus** (Fig. 251, 8) is a large muscle placed close to the vertebræ and reaching to the occiput, and is remarkable for a tendinous intersection about the middle of its inner part, and for being pierced by the great occipital and third nerves. It *arises* from the transverse processes of the upper six dorsal and last cervical vertebræ, and from the articular processes of the 4th, 5th, and 6th cervical vertebræ. Its fibres ascend nearly vertically to be *inserted* into the occipital bone between the curved lines.

The most internal and superficial part of the complexus has been called the **Biventer Cervicis**, from the fact that it consists of two fleshy portions or bellies with an intervening tendon.

The erector spinæ is one of the most important muscles for main-

Fig. 251.—Fourth and fifth, and part of the sixth layer of the muscles of the back (from Wilson).

1. Common origin of the erector spinæ.
2. Sacro-lumbalis.
3. Longissimus dorsi.
4. Spinalis dorsi.
5. Cervicalis ascendens.
6. Transversalis cervicis.
7. Trachelo-mastoideus.
8. Complexus.
9. Transversalis cervicis, showing its origin.
10. Semispinalis dorsi.
11. Semispinalis colli.
12. Rectus posticus minor.
13. Rectus posticus major.
14. Obliquus superior.
15. Obliquus inferior.
16. Multifidus spinæ.
17. Levatores costarum.
18. Intertransversales.
19. Quadratus lumborum.

taining the erect position of the trunk, and the complexus in addition draws back the head.

Occipital Artery (Fig. 252, 3).—The second portion of the occipital artery is now exposed in its course between the muscles attached to the occipital bone. It was traced along the lower border of the digastric in the neck, and, leaving that muscle, it now runs beneath the splenius capitis and over or under the trachelo-mastoid, lying above the border of the superior oblique muscle, and then getting on to the complexus close to its insertion. It lastly pierces the trapezius to reach the back of the scalp, being accompanied by the great occipital nerve, which appears through the trapezius (1).

The *Arteria princeps cervicis* is given off from this portion of the occipital artery, and divides into a branch to the trapezius and a descending larger one, which latter passes beneath the complexus to anastomose with the profunda cervicis artery on the semispinalis.

[The complexus is to be divided transversely, at the point where the great occipital nerve pierces it, so as to preserve the nerve uninjured, and the muscle is then to be dissected up from the condensèd cellular tissue beneath it and turned outward. The small muscles, with the vessels and nerves, of the suboccipital region are then to be dissected out, together with the semispinalis muscle, which fills the vertebral groove in the cervical and dorsal regions. All vessels and nerves are to be carefully preserved.]

The **Fifth Layer of Muscles** (Fig. 252) consists of the two Recti, the two Obliqui, and the Semispinalis muscles.

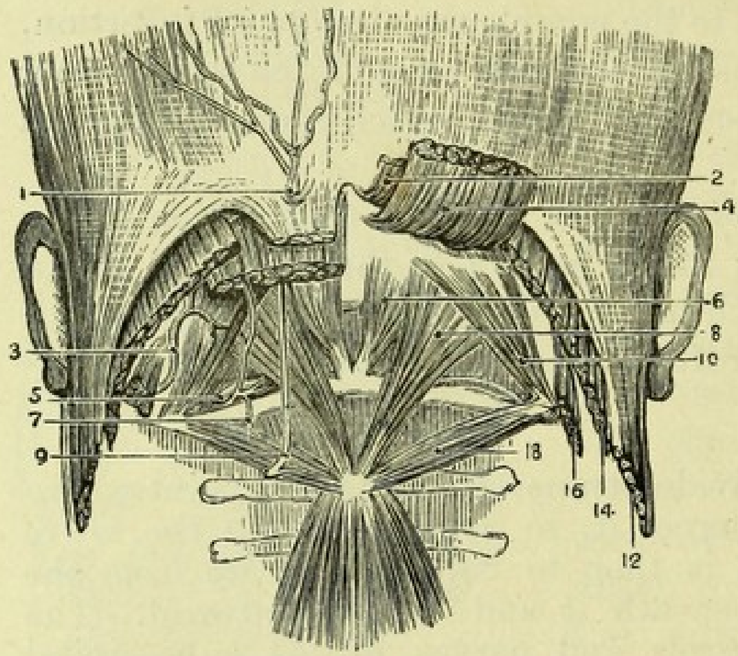
The **Rectus Capitis Posticus Major** (Fig. 252, 8) *arises* from the spinous process of the axis, and passes upward and outward to be *inserted* into the outer part of the inferior curved line upon the occipital bone, and into a small portion of the space below it.

The **Rectus Capitis Posticus Minor** (Fig. 252, 6) is placed close to the median line, and is slightly overlapped by the preceding muscle. It *arises* from the posterior tubercle of the atlas, and is *inserted* by fleshy fibres into the space below the inferior curved line on the occipital bone, close to the median line and to its fellow muscle of the opposite side.

The **Obliquus Inferior** (Fig. 252, 18) *arises* from the spinous process of the axis, and is *inserted* into the posterior tubercle of the transverse process of the atlas. Around the lower border of this muscle the great occipital nerve makes its appearance.

The **Obliquus Superior** (Fig. 252, 10) is the continuation upwards of the preceding muscle. It *arises* from the transverse process of the atlas, and is *inserted* into a mark above or outside the outer part of the inferior curved line of the occipital bone, externally to the complexus and overlapping the rectus major. The occipital artery has been seen to run along the upper border of this muscle.

Fig. 252.



The recti muscles draw the head backward, and the rectus major, owing to its oblique direction, assists slightly in producing rotation. The obliqui produce rotation, the inferior oblique rotating the atlas upon the axis, and the muscle of one side acting with the superior oblique of the other, which latter acts slightly upon the skull.

Vertebral Artery (Fig. 252, 5). — The horizontal portion of the vertebral artery will be found in the triangle formed by the rectus posticus major and the two oblique muscles. It ascends through the foramina in the transverse processes of the vertebræ, beginning at the sixth, and, having perforated the atlas, is seen to wind in the groove behind the superior articular process of that bone, and pierce the posterior occipito-atlantal ligament to enter the vertebral canal. Lastly, it reaches the interior of the skull through the foramen magnum. While in the transverse processes the artery gives small branches to the muscles and to the spinal cord, and in its horizontal portion

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Fig. 252.—Suboccipital region (drawn by J. T. Gray).

1. Occipital artery and nerve piercing trapezius.
2. Trapezius.
3. Occipital artery.
4. Complexus.
5. Vertebral artery.
6. Rectus capitis posticus minor.
7. Suboccipital nerve.
8. Rectus capitis posticus major.
9. Great occipital nerve.
10. Obliquus superior.
11. Semispinalis colli.
12. Sterno-mastoid.
14. Splenius capitis.
16. Trachelo-mastoideus.
18. Obliquus inferior.

it occasionally gives off a branch to the back of the skull to supply the muscles.

The *Vertebral vein* does not accompany the artery in this part of its course, but only commences close to the transverse process of the atlas by the junction of one or two minute radicles. The vein accompanies the artery through the transverse processes of the vertebræ, and ends in the subclavian vein.

The posterior division of the **Suboccipital Nerve** (Fig. 252, 7) (1st cervical) emerges between the occiput and atlas, and generally beneath the vertebral artery. It is of small size, and supplies branches to the recti and obliqui muscles, and one to the complexus.

The **Great Occipital Nerve** (Fig. 252, 9) is the posterior division (internal branch) of the second cervical nerve, and leaves the vertebral canal between the atlas and axis. It winds below the inferior oblique, giving a branch to that muscle, and then turns upward to pierce the complexus and trapezius muscles and supply the skin of the occipital region. Its external branch is of small size.

The *posterior division of the third nerve* gives a branch, which takes the same direction as the great occipital nerve but internally to it, and is joined with it.

The suboccipital nerve often joins the internal branch of the 2nd, and the latter the internal branch of the 3rd (Posterior Cervical plexus).

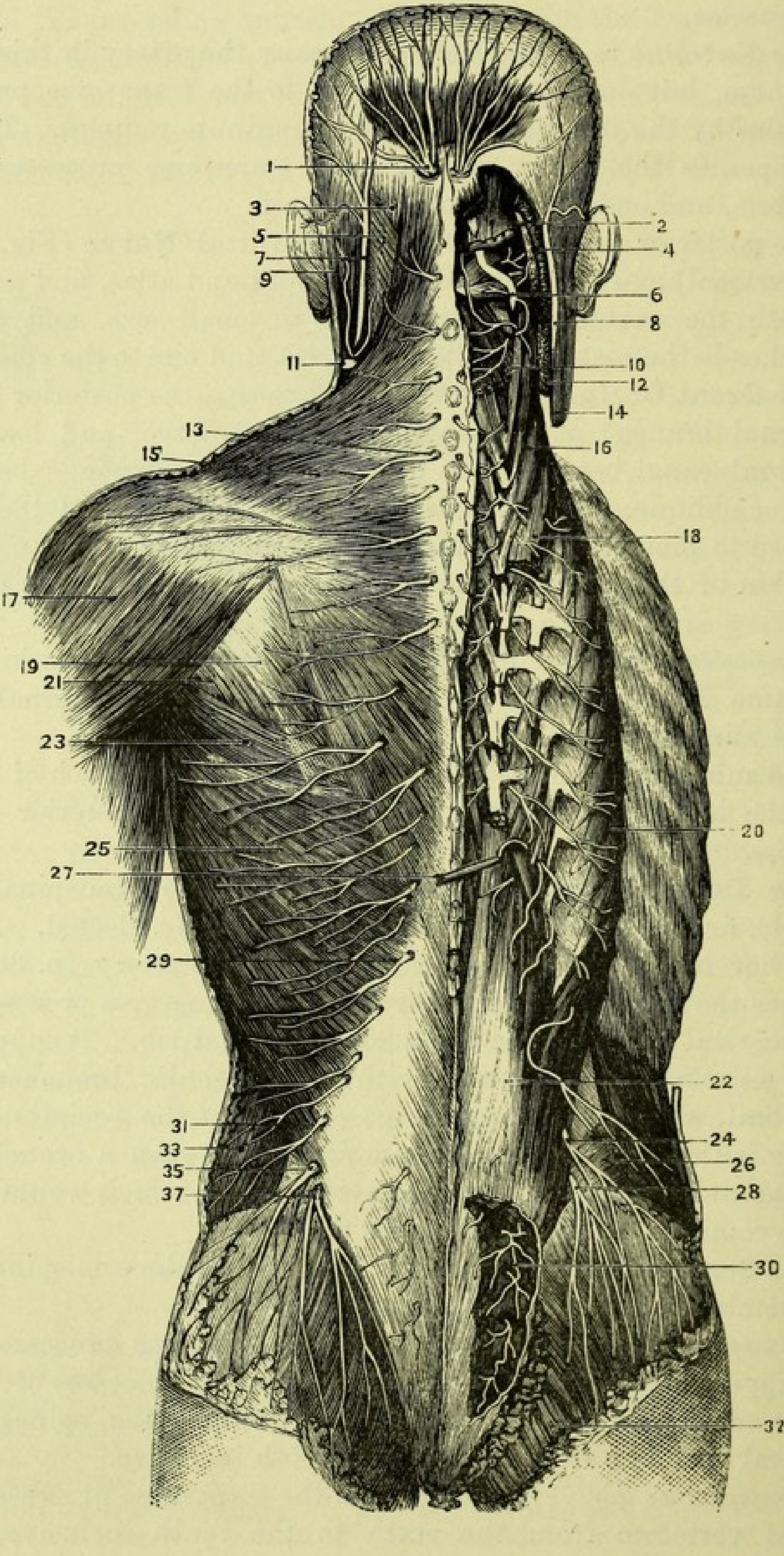
The **Deep Cervical Artery** lies upon the semispinalis colli muscle, and is exposed when the complexus is reflected. It is the posterior branch of the superior intercostal artery (p. 366), and reaches the back by passing between the transverse process of the last cervical vertebra and the neck of the first rib. It supplies the deep muscles, anastomosing with the muscular branches of the vertebral, and with the princeps cervicis of the occipital artery. There is thus an anastomosis established between a branch of the carotid and a branch of the subclavian artery, which would enlarge if the common carotid artery were tied.

The **Semispinalis** (Fig. 251) is divided into the semispinalis colli and semispinalis dorsi.

Semispinalis colli (11) *arises* from the transverse processes of the six upper dorsal vertebræ and the articular processes of the four lower cervical vertebræ, and is *inserted* into the spines of the cervical vertebræ from the 2nd to the 5th inclusive.

Semispinalis dorsi (10) *arises* from the transverse processes of the dorsal vertebræ from the sixth to the tenth inclusive, and is

Fig. 253.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37
37

inserted into the spinous processes of the last two cervical and upper four dorsal vertebræ.

Spinal Nerves (Fig. 253).—The Posterior Divisions of all the spinal nerves (with the exception of the first cervical and fourth and fifth sacral and the coccygeal) divide into internal and external branches, which supply all the muscles of the back, and give the following cutaneous branches:—

The Internal branches of all the cervical nerves (except the first, sixth, seventh, and eighth) and of the upper six dorsal nerves become cutaneous near the spinous processes.

The External branches of the lower six dorsal and of the upper three lumbar nerves become cutaneous at an oblique line, corresponding to the margin of the aponeurosis of the latissimus dorsi.

The External branches of the upper sacral nerves become cutaneous near the median line. The fourth and fifth sacral nerves are very small and join with the coccygeal nerve.

The *Coccygeal nerve* emerges from the lower end of the vertebral canal and is distributed over the coccyx.

The Posterior Divisions of the **Intercostal and Lumbar Arteries** divide like the nerves into internal and external branches, which accompany the nerves to the muscles of the back.

The **Sixth Layer of Muscles** (Fig. 251) consists of the Interspinales, Intertransversales, Multifidus Spinæ, and Levatores Costarum, which will not repay the trouble of dissection.

The position of the Interspinales and Intertransversales is sufficiently indicated by their names.

The Multifidus Spinæ (16) fills up the vertebral groove beneath the erector spinæ, *arising* from the articular processes of the cervical

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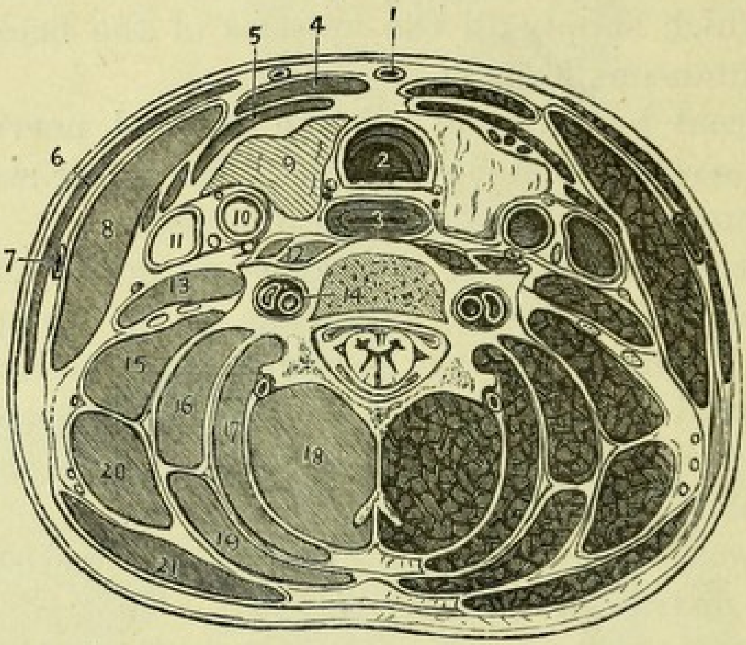
Fig. 253.—The nerves of the back (from Hirschfeld and Leveillé).

1. Great occipital nerve.
2 & 3. Complexus muscle.
4 & 5. Splenius capitis.
6. Great occipital nerve.
7 & 8. Small occipital nerve.
9. Sterno-mastoid.
10. Semispinalis colli.
11. Superficial cervical nerve.
12. Levator anguli scapulæ (cut).
13. Eighth cervical nerve.
14. Sterno-mastoid (cut).
15. Trapezius.
16. Trachelo-mastoideus.
17. Deltoid.
18. Transversalis colli.
19. Infra-spinatus.
20. Sacro-lumbalis.
21. Teres minor.
22. Erector spinæ.
23. Teres major.
24. Lateral cutaneous of last dorsal.
25. Latissimus dorsi.
26. Obliquus internus.
27. Longissimus dorsi.
28. Lateral cutaneous of first lumbar.
29. Posterior division of first lumbar.
30. ,, ,, of sacral nerves.
31. ,, ,, of fifth lumbar.
32. Gluteus maximus.
33. Obliquus externus.
35. Lateral cutaneous of last dorsal.
37. ,, ,, of first lumbar.

and lumbar vertebræ, and from the transverse processes of the dorsal vertebræ and sacrum. The muscle is *inserted* into the spinous processes of all the vertebræ except the atlas.

Fig. 254.



The Levatores Costarum are twelve fan-shaped muscles passing between the dorsal transverse processes and the upper borders of the ribs.

The Spinal Cord and Membranes.

[To open the spinal canal, the remains of the muscles of the back should be cleared away as far as possible, when some part of the plexus of *dorsi-spinal veins* may be seen upon the vertebræ. A

Fig. 254.—Section of neck at the fourth cervical vertebra (altered from Béraud).

1. Anterior jugular vein.
2. Trachea.
3. Œsophagus.
4. Sterno-hyoid muscle.
5. Sterno-thyroid muscle.
6. Platysma myoides.
7. External jugular vein.
8. Sterno-mastoid.
9. Thyroid gland.
10. Common carotid artery.
11. Internal jugular vein. The descendens noni nerve is seen in front of these vessels, the pneumo-gastric between them, and the sympathetic behind them.
12. Longus colli, with rectus capitis anticus major to outer side.
13. Scalenus anticus with phrenic nerve.
14. Vertebral vessels in transverse process.
15. Scalenus medius with brachial cords in front.
16. Splenius colli.
17. Complexus.
18. Semispinalis colli.
19. Splenius capitis.
20. Levator anguli scapulæ.
21. Trapezius.

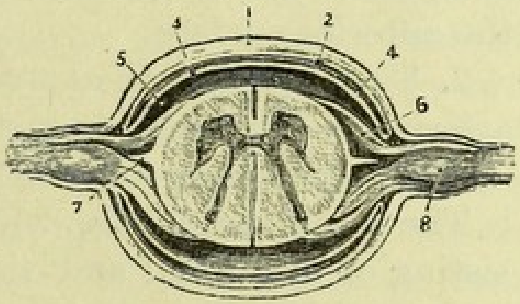
block then being placed beneath the thorax so as to make the dorsal region prominent, a cut is to be made with the saw on each side of the middle line, so as to divide the laminæ of the vertebræ as far out as possible. Two or three of the arches being now removed with the chisel, the point of a spine-chisel or rachet is to be introduced into the canal, and the rachet carefully hammered through the arches of the vertebræ for the whole length of the spine, except the upper two cervical vertebræ. The operation being repeated on the opposite side, the arches can be removed with the bone-forceps, and the canal will be thoroughly opened. On the inner surface of the arches will be seen the *ligamenta subflava*, which are described with the other vertebral ligaments, (p. 505).]

Upon opening the Spinal Canal some loose tissue and fat will be seen, together with the *meningeo-rachidian veins*, which are occasionally full of blood. These extend for the whole length of the spinal cord under the name of *posterior longitudinal spinal veins*, and communicate both with the veins outside the vertebræ, and with the *anterior longitudinal spinal veins* at the backs of the bodies of the vertebræ.

By removing the fat and veins the dura mater will be exposed.

The **Dura Mater** (Fig. 255, 1) of the spinal cord, or *theca*, differs from the dura mater of the brain, in being comparatively smooth on its exterior, and in not forming the periosteum of the vertebræ. It also does not send processes into the spinal cord, nor has it any sinuses formed in it, but has numerous large veins on its outside.

Fig. 255.



The dura mater, being opened by a longitudinal incision, will be found to be a tube firmly connected with the margin of the foramen magnum, where it is continuous with the dura mater of the skull. The tube is largest in the cervical and lumbar regions, but at the top of the sacrum it becomes impervious, and is continued to the coccyx by a small

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Fig. 255.—Transverse section of the spinal cord and its membranes (from Hirschfeld and Leveillé).

1. Dura mater.
2. Parietal layer of arachnoid.
3. Visceral layer of arachnoid.
4. Cavity of arachnoid.
5. Subarachnoid space.
6. Anterior root of nerve.
7. Ligamentum denticulatum.
8. Ganglion on posterior root of nerve.

fibrous process. Sheaths are given to all the spinal nerves, and take corresponding directions, being nearly horizontal in the cervical region and gradually becoming more vertical below. In the sacral canal the sheaths of the nerves lie side by side, with the fibrous continuation of the dura mater between them.

By removing the transverse processes of two or three of the dorsal vertebræ, the tubes of dura mater may be traced upon the nerves to the intervertebral foramina, and will be found to be lost upon the nerves themselves, and to be attached to the foramina by connective tissue.

[By opening one of the tubes of dura mater, the position of the ganglion upon the posterior root in the intervertebral foramen will be seen. The cord is next to be removed by carrying the knife along the outside of the dura mater so as to divide the nerves as far out as possible, those which have been thoroughly exposed by the above dissection being divided beyond the ganglion. The cord attaching the dura mater to the coccyx is to be divided, and the sacral nerves cut as long as possible, and lastly the dura mater divided transversely at the level of the axis. The cord when removed is to be laid out on a table with the posterior surface uppermost.]

The anterior and the posterior surfaces of the spinal cord, when removed from the body, may always be distinguished as follows:—

1. There is a bright shining cord (linea splendens) running down the anterior surface.

2. There is one spinal artery on the anterior, but there are two arteries on the posterior surface.

3. The posterior roots of the nerves are ganglionic.

The **Arachnoid** (Fig. 255, 2, 3) was formerly described as consisting of a parietal and visceral layer like the arachnoid of the brain, with which it is continuous. The parietal layer, now usually called the epithelial layer of the dura mater, is seen on the inner surface of the dura mater, to which it is firmly attached; the visceral layer is reflected loosely upon the spinal cord, giving to the several nerves loose sheaths, which are reflected on to the parietal layer at the points where the nerves pierce the dura mater. The space between the two layers of the arachnoid, or rather between the dura mater and the arachnoid, was formerly called the *sac of the arachnoid*, but is now usually described as the *subdural space*.

The **Subarachnoid Space** (Fig. 255, 5) is between the visceral layer of the arachnoid and the pia mater of the spinal cord, and is of considerable extent; it can be shown by lifting up the arachnoid with forceps, or by inserting a blow-pipe and forcing air beneath the membrane. This space is crossed by fine trabeculæ and membranous expansions of delicate connective tissue; it communicates with the interior of the brain by an opening at the lower extremity of the fourth ventricle. It lodges the *subarachnoid fluid*, which also enters the ventricles, and is hence called *cerebro-spinal fluid*.*

[The cord is to be turned over so as to expose its anterior surface, and an incision is to be made through the dura mater to expose the arachnoid and subarachnoid space, as was done behind. The pia mater is then to be examined both on the front and back of the cord.]

The **Pia Mater** encloses the spinal cord, giving prolongations upon the roots of the nerves. It is continuous with the pia mater of the brain, but is more fibrous and less vascular than it. It sends a process into the anterior median fissure of the cord, opposite to which is a fibrous band called *linea splendens*, and at the first lumbar vertebra (termination of the spinal cord) ends in the *filum terminale* or *central ligament* of the cord, which lies within the prolongation of the dura mater, to be attached with it to the coccyx.

The **Ligamentum Denticulatum** (Fig. 256, 16) is found on each side of the cord, between the anterior and posterior roots of the nerves. It is formed by a series of twenty-one or twenty-two serrations, connected with the pia mater and with the inner surface of the dura mater midway between the apertures of exit for the nerves, each denticulation being covered by a funnel-shaped sheath of arachnoid. It serves to sling the cord and secure it from shocks.

The *Anterior Spinal Artery* and the two *Posterior Spinal Arteries* may be traced upon the cord, if well-injected. They are branches of the vertebral arteries, the anterior being formed by the junction of a branch from each side. The arteries ramify in the pia mater, anastomosing with the spinal branches which enter the vertebral canal through the intervertebral foramina.

* It has been supposed that a distinct serous membrane existed beneath the true arachnoid, in which the subarachnoid fluid was contained. Mr. Hilton has given prominence to this view in his "Lectures on Rest and Pain" (1863), but the question was decided some years since by Dr. Sharpey, who found that microscopically there was no evidence of a second serous membrane.

The *Veins* of the cord are small and tortuous, forming an irregular network, but one branch larger than the rest accompanies the anterior spinal artery. They communicate with the spinal veins by branches that accompany the nerves to the intervertebral foramina, and above join the inferior cerebellar vein or the inferior petrosal sinus.

The **Spinal Cord** (Figs. 256, 257) extends from the termination of the medulla oblongata, at the level of the upper border of the atlas, to the first lumbar vertebra. It is cylindrical in shape, but presents two flattened enlargements, one the *brachial*, which extends from the third cervical to the first dorsal vertebra, and the lower or *lumbar* enlargement near the lower extremity of the cord. From the upper enlargement the nerves to the upper extremity have their origins; from the lower enlargement the lumbar and sacral nerves arise, which, lying side by side before they leave the vertebral canal, form the *cauda equina*.

The cord presents an *anterior median fissure*, which extends for its whole length, and a *posterior median fissure*, which is most dis-

Fig. 256.

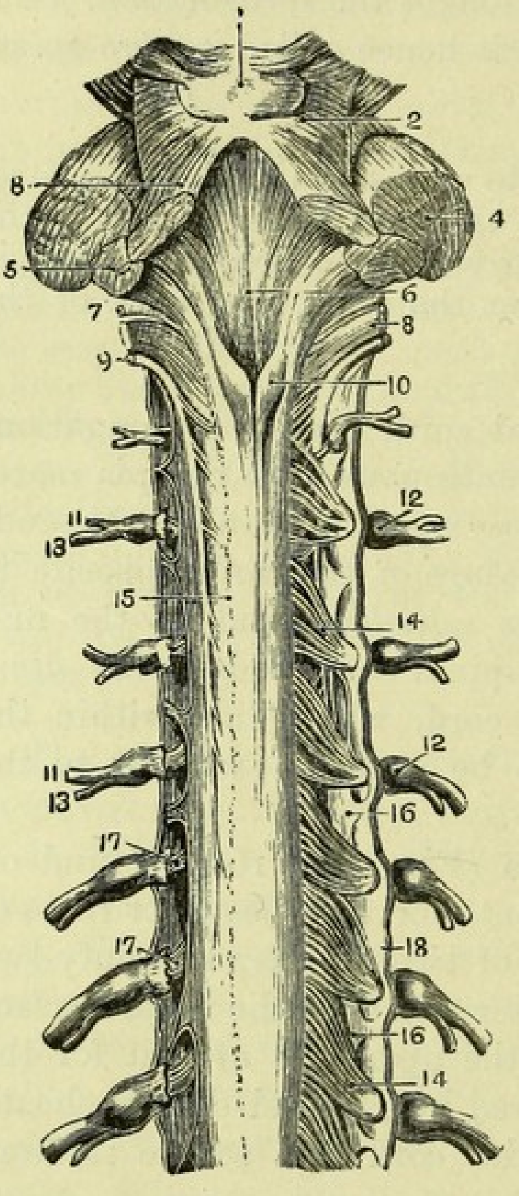


Fig. 256.—Fourth ventricle and upper part of spinal cord and membranes. The posterior roots of the nerve are removed on the left side (from Hirschfeld and Leveillé).

1. Corpora quadrigemina.
2. Fillet of the olivary body.
3. Processus a cerebello ad testes.
4. Processus a cerebello ad pontem.
5. Processus a cerebello ad medullam.
6. Floor of fourth ventricle.
7. Glosso-pharyngeal nerve.
8. Pneumo-gastric nerve.
9. Spinal-accessory nerve.
10. Posterior columns of spinal cord.

11, 11. Anterior divisions of spinal nerves.
12, 12. Ganglia of nerves.
13, 13. Posterior divisions of spinal nerves.
14, 14. Posterior roots of spinal nerves.
15. Line of origin of posterior roots of left side.
16, 16. Ligamentum denticulatum.
17, 17. Anterior roots of spinal nerves.
18. Dura mater.

tinct at the upper and lower parts of the cord.

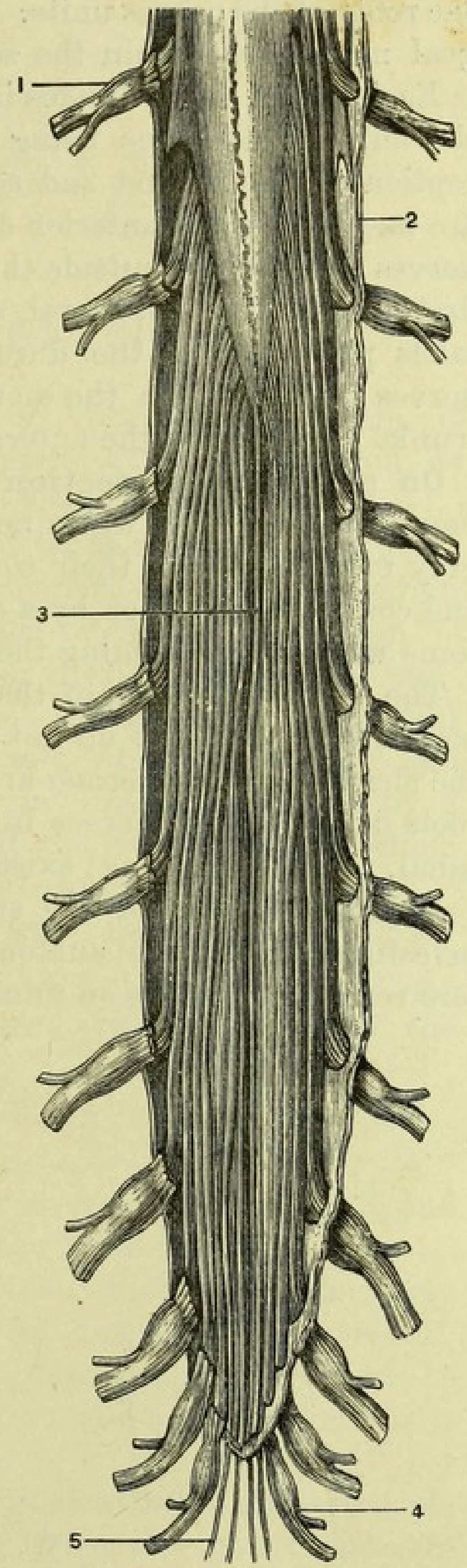
A *lateral fissure* extends along the line of attachment of the posterior roots of the spinal nerves, thus dividing each half of the cord into an *antero-lateral* and a *posterior column.*

The anterior roots of the nerves emerge from the antero-lateral columns, and these are sometimes considered to mark a further subdivision into *anterior* and *lateral* columns. At the bottom of the median fissures is the *commissure*, which is nearer to the anterior than the posterior surface of the cord.

The **Spinal Nerves** (Fig. 256) are thirty-one in number on each side of the cord. Each nerve has been seen to arise by two roots, the posterior (with the exception of the first nerve) being larger than the anterior. The posterior roots, with the exception probably of the first nerve, have each a ganglion which is generally placed in the intervertebral foramen, at which point and immediately beyond the ganglion, the anterior (motor) and posterior (sensory) roots unite to form a *spinal nerve* of mixed endowments.

The first two cervical, with the sacral and coccygeal nerves, are exceptions to the general rule as regards the position of the ganglia. The ganglia of the two cervical

Fig. 257.



257—The cauda equina, seen from behind (from Hirschfeld and Leveillé).

1. Root of 12th dorsal nerve.
2. Dura mater laid open.
3. Filum terminale.
4. Fourth sacral nerve.
5. Fifth and sixth sacral nerves.

nerves lie upon the arches of the atlas and axis, at which point the roots of the nerves unite. The ganglia of the sacral and coccygeal nerves are within the sacral canal.

Each spinal nerve divides into an anterior and a posterior trunk, the anterior divisions being the larger throughout, with the exception of the 1st and 2nd cervical nerves, of which the posterior are larger than the anterior divisions. The majority of the spinal nerves divide just outside the intervertebral foramina, but in the first cervical, the last sacral, and the coccygeal nerves, the division takes place within the dura mater; and the upper four sacral nerves divide within the sacral canal, the anterior and posterior trunks emerging at the anterior and posterior sacral foramina.

On a transverse section (Fig. 255) the spinal cord will be found to consist of white nervous matter, in which are seen two grey crescents, with their convexities turned toward one another and connected together by a *grey commissure*, in front of which are some white fibres forming the *white commissure*.

The *anterior cornua* of the grey crescents are larger than the posterior cornua, but do not reach to the periphery of the cord; the slender *posterior cornua* are closely connected with the posterior roots of the spinal nerves in the lateral fissure. A small central canal, (canal of Stilling) exists throughout the cord.

It is impossible for the student in his ordinary dissection to investigate the minute anatomy of the spinal cord, and he is therefore referred to works on minute anatomy for fuller details.

PART VII.

DISSECTION OF THE BRAIN.

Before dissecting the Membranes or Vessels of the Brain, it will be well to recognise the several parts of the Encephalon, as this will assist the student in following the description.

The upper part of the brain is formed by the Cerebrum or great brain, which is divided into two symmetrical halves by a median *longitudinal fissure.* The under surface or *base* of the brain is much more complicated than the upper surface, and will be subsequently examined more particularly. At the posterior part will be seen the Cerebellum or smaller brain, which consists of two symmetrical halves, like the great brain; these are united by a convex white body, the Pons Varolii, at the lower border of which is the upper part of the spinal cord or Medulla Oblongata.

These parts will be readily recognised by referring to Fig. 260.

[The brain is to be placed in a plate with the base upward, for the examination of the membranes and the dissection of the vessels.]

The **Membranes of the Brain** are the Dura Mater, the Arachnoid, and the Pia Mater.

The **Dura Mater** has been already seen lining the skull and giving off processes for the support of the brain (p. 325).

The **Arachnoid** is a serous membrane, which it was formerly the custom to describe as consisting of two layers—a *parietal,* which lines the dura mater, and is usually considered to be merely the epithelial layer of the latter; and a *visceral,* which is now to be examined.

The *Visceral layer* is more or less united with the subjacent pia mater, but differs from it in passing from one convolution to another without dipping into the sulci. It passes into the great longitudinal fissure between the hemispheres of the cerebrum, but does not quite reach the corpus callosum, and may be conveniently traced from the anterior termination of this over the base of the cerebrum (the lobes of which it binds together), to the cerebellum and medulla oblongata, where it becomes continuous with the arachnoid of the spinal cord. It gives sheaths to the cranial nerves, which extend as far as their foramina of exit, and are then reflected to join the so-called parietal layer of arachnoid.

Between the arachnoid and the pia mater is the **Subarachnoid Space**, which contains the cerebro-spinal fluid, and which, though existing all over the brain, is only easily made out at the bottom of the great longitudinal fissure and in the following places:—

The *Anterior Subarachnoid Space* (diamond-shaped space) is immediately in front of the pons Varolii, and is formed by the stretching of the arachnoid from one middle lobe of the cerebrum to the other, as far forward as the optic commissure.

The *Posterior Subarachnoid Space* will be found beneath the cerebellum, on lifting up the medulla oblongata. This communicates with the subarachnoid space of the spinal cord, and with the interior of the brain by means of an aperture into the fourth ventricle, the foramen of Magendie, which may now be seen by removing the layer of arachnoid.

The **Pia Mater** is a vascular membrane closely investing the brain and passing into the sulci between the convolutions, besides giving processes into the interior of the brain, which will be subsequently examined. It becomes more tough and fibrous as it approaches the spinal cord, and while investing the latter its vascularity almost entirely disappears.

[The arachnoid is to be removed from the arteries at the base of the brain, which are to be cleaned and the branches followed. It will now be possible to show the longitudinal fissure between the two anterior lobes of the cerebrum more clearly than before, and also the fissure of Sylvius between the anterior and middle lobes of each side, into which a large artery may be traced.]

The **Arteries of the Brain** (Fig. 258) are derived from four great trunks—the two vertebral and the two internal carotid arteries.

The **Vertebral Artery** (1) has been seen to be a branch of the subclavian artery, and has been traced through the transverse processes of the cervical vertebræ to the atlas. The artery pierces the dura mater between the occiput and the atlas, and enters the skull through the foramen magnum by the side of the medulla oblongata. At the lower border of the pons Varolii the two vertebrals unite in the **Basilar Artery** (6), which passes along the middle line of the pons Varolii to bifurcate at its anterior border into the *posterior cerebral arteries* (8).

The *Branches* of the *Vertebral Artery* are :—

1. A small *Posterior Spinal artery* (3), which runs down the posterior surface of the spinal cord with its fellow of the opposite side.

2. A small *Anterior Spinal artery* (2), which joins its fellow of the opposite side to form a small trunk running down the anterior surface of the spinal cord.

3. A small *Posterior Meningeal artery* (4) to the dura mater.

4. The *Posterior Inferior Cerebellar artery* (5), which passes backward to the posterior part of the inferior surface of the cerebellum, and anastomoses with the other cerebellar arteries.

The *Branches* of the *Basilar Artery* are :—

1. The *Anterior Inferior Cerebellar arteries*, a pair of small branches passing to the anterior part of the inferior surface of the cerebellum on each side, and anastomosing with the other cerebellar arteries. These are only two of the following.

2. *Transverse arteries of the Pons*, four or five on each side, which supply the pons Varolii, and one of which, the *auditory*, accompanies the auditory nerve into the temporal bone.

3. The *Superior Cerebellar arteries* (7), which arise close to the bifurcation, the third pair of nerves occupying the interval between these vessels and the posterior cerebral arteries. Each artery winds round the crus cerebri, parallel to the fourth nerve, to the upper surface of the cerebellum, where it anastomoses with its fellow and with the inferior cerebellar arteries.

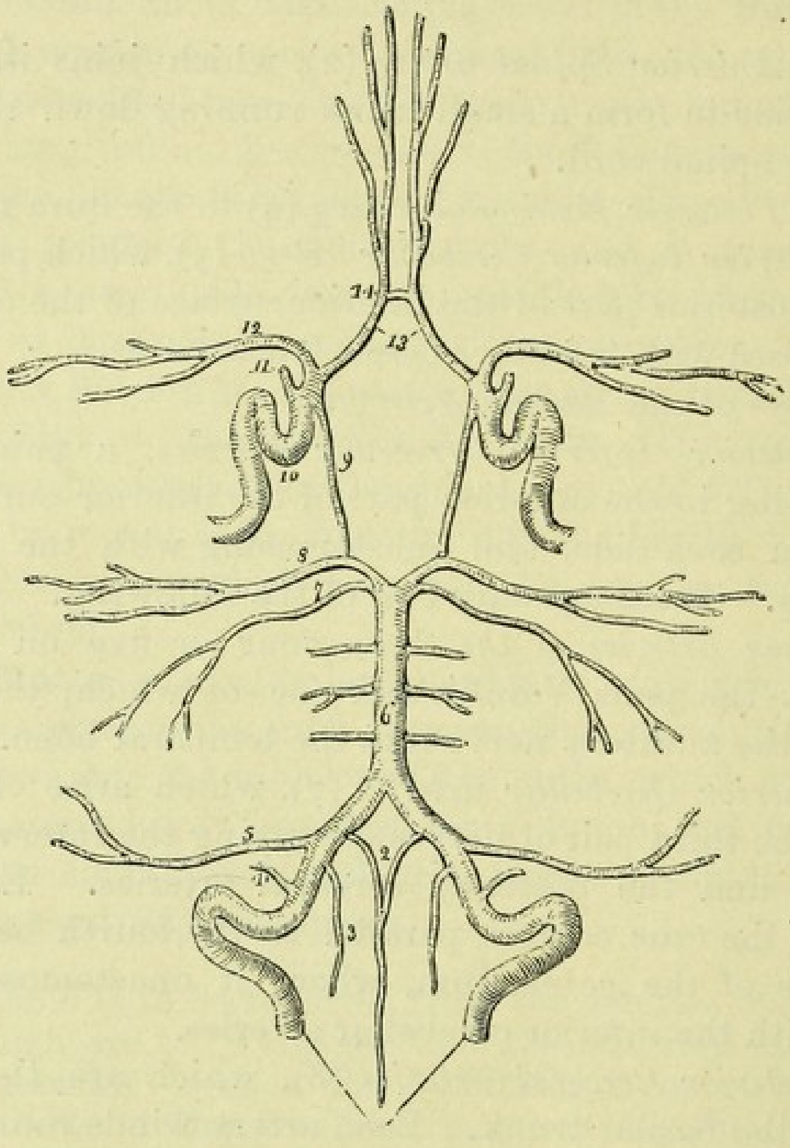
4. The *Posterior Cerebral arteries* (8), which are the terminal branches of the basilar trunk. Each artery winds round the crus cerebri, parallel to the superior cerebellar artery but separated from it by the third nerve, and is distributed to the under surface of the posterior part of the cerebrum, where it anastomoses with the middle cerebral artery. It gives off small branches to the *locus perforatus posticus* which enter the optic thalamus, and also a *choroid* artery to the *velum interpositum*.

The **Internal Carotid Artery** (Fig. 258, 10) has been traced to the anterior clinoid process of the sphenoid bone, close to which it was divided in removing the brain. The artery reaches the base of the brain close to the outer side of the optic commissure, and at once breaks up into three branches—the anterior and middle cerebral, and the posterior communicating arteries.

1. The *Anterior Cerebral artery* (13) runs forward in the longitu-

dinal fissure, and, turning round the corpus callosum, is distributed to the anterior part of the cerebrum, reaching as far back in the longitudinal fissure as the parieto-occipital sulcus. The arteries

Fig. 258.



of the two sides are united at the commencement of the fissure by a short transverse branch, the *anterior communicating artery* (14). At its commencement the anterior cerebral artery sends a few branches

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Fig. 258.—Arteries of the Brain and Circle of Willis (from Wilson).

1. Vertebral arteries.
2. Anterior spinal arteries uniting to form a single vessel.
3. Posterior spinal artery.
4. Posterior meningeal artery.
5. Posterior inferior cerebellar artery.
6. Basilar artery giving off transverse branches.
7. Superior cerebellar artery.
8. Posterior cerebral artery.
9. Posterior communicating branch of the internal carotid.
10. Internal carotid artery, showing its curves within the skull.
11. Ophthalmic artery divided.
12. Middle cerebral artery.
13. Anterior cerebral arteries connected by—
14. Anterior communicating artery.

through the anterior perforated spot to the front of the corpus striatum.

2. The *Middle Cerebral artery* (12) is a larger branch, which runs in the fissure of Sylvius between the anterior and middle lobes, and divides into four or five large branches, which are distributed to the parietal and part of the frontal and temporo-sphenoidal lobes, anastomosing with the anterior and posterior cerebral arteries. It gives off some small branches near its commencement, which pierce the *locus perforatus anticus* on their way to the corpus striatum.

3. The *Posterior Communicating artery* (9) is a long slender branch, which runs backward to join the posterior cerebral artery at a right angle.

A *choroid artery* is given off by either the carotid or the middle cerebral artery, and winds round the crus cerebri to the choroid plexus of the lateral ventricle.

The **Circle of Willis** (Fig. 258) is the name given to the communication between the arteries at the base of the brain, and may be traced on either side from before backward as follows :—Anterior communicating, anterior cerebral, and carotid arteries; posterior communicating, posterior cerebral, and basilar arteries. This free anastomosis is of importance in carrying on and equalising the circulation of the blood in the brain, when an obstruction to one of the main trunks occurs.

Various irregularities of the vessels forming the circle of Willis may be met with, the arteries being much above or below their normal size in various parts of the circle ; but the direct communication between the trunks is almost constant.

The **Veins** of the brain open into the sinuses of the skull, which have been examined (p. 325).

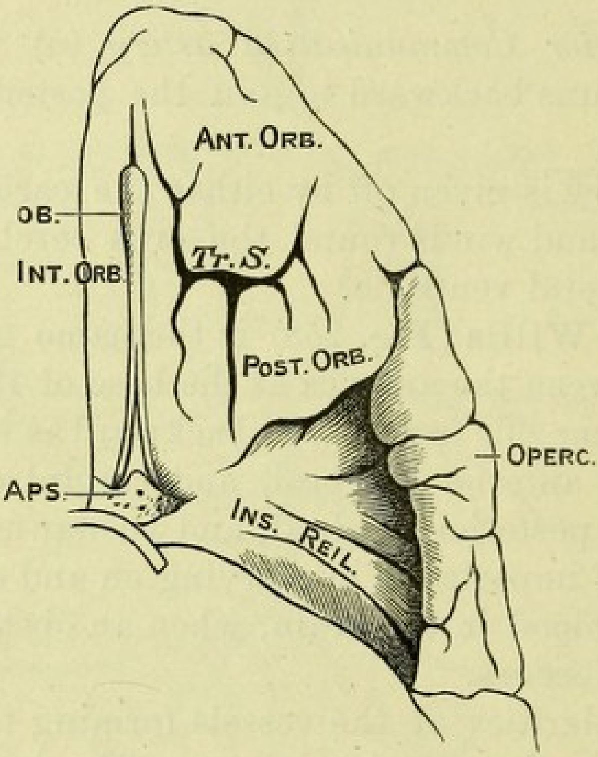
The Base of the Brain.

[The arachnoid and pia mater are to be carefully dissected from the base of the brain, care being taken not to detach any of the nerves. It should be noticed that the pia mater disappears, on the outer side of each crus cerebri, beneath the middle lobe of the cerebrum ; this is the commencement of the *great transverse fissure* of the brain, which opens into the inferior cornu of the lateral ventricle. The pia mater upon the cerebellum and posterior part of the cerebrum should be left undisturbed, so that the velum interpositum may not be damaged.]

The under surface of the great brain or *Cerebrum* is divided into three lobes on each side of the median line.

The **Anterior Lobe** (Fig. 260, 2) of the cerebrum is separated from the middle lobe by the fissure of Sylvius, and from that of the opposite side by the longitudinal fissure. Its under surface is hollowed out in the centre, and fits closely upon the orbital plate of the skull. On this surface (Fig. 259) is seen

Fig. 259.



a *triradiate sulcus* (TRS.) separating three convolutions, named the *anterior* (ANT. ORB.), *posterior* (POST. ORB.), and *internal* (INT. ORB.) *orbital convolutions*. The last, which is continuous with the extremity of the *convolution of the longitudinal fissure* (*marginal convolution*), presents also, half an inch from the longitudinal fissure and parallel to it, the *olfactory sulcus*, lodging the olfactory peduncle and bulb (OB.).

The **Middle Lobe** (Fig. 260, 18) of the cerebrum is separated

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Fig. 259.—Orbital surface of the Frontal lobe, and Island of Reil (after Turner). The tip of the middle (temporo-sphenoidal) lobe is removed.

TRS. Triradiate sulcus.
ANT. ORB. Anterior orbital gyrus.
INT. ORB. Internal ,, ,,
POST. ORB. Posterior ,, ,,
OB. Olfactory bulb occupying the olfactory sulcus.
APS. Anterior perforated spot.
INS. REIL. Island of Reil.
OPERC. Operculum.

from the anterior lobe by the fissure of Sylvius, but is continuous with the posterior lobe, the division between the two being marked only by the border of the cerebellum, the under surface of which is now seen. It occupies the middle fossa of the base of the skull, and presents the convolutions forming the temporo-sphenoidal lobe, to be afterwards described.

The **Posterior Lobe** (Fig. 260, 31) is not divided from the middle lobe by any marked fissure, but is that part of the cerebrum which is above the cerebellum.

It will be most convenient to examine the several structures found in the base of the brain in front of the pons Varolii from before backward, first in the median line and afterwards on each side. In the median line from before backwards are—(1) the longitudinal fissure; (2) the lamina cinerea; (3) the optic commissure; (4) the tuber cinereum (with the infundibulum and pituitary body); (5) the corpora albicantia; (6) the locus perforatus posticus.

On each side from before backward are—(1) the under surface of the anterior lobe of the cerebrum, with (2) the olfactory bulb and the olfactory peduncle resting in the olfactory sulcus; (3) the optic nerve (in front of the commissure), and (4) the optic tract (behind the commissure); (5) the locus perforatus anticus, close to the commencement of (6) the fissure of Sylvius; (7) the crus cerebri diverging from its fellow, with the commencement of the transverse fissure to its outer side; (8) the third nerve appearing between the divergent crura; (9) the fourth nerve winding round the crus; (10) the under surface of the middle lobe of the cerebrum.

The **Longitudinal Fissure** (Fig. 260, 1) is the terminal portion of the fissure which divides the upper surface of the brain into the two hemispheres. It separates the anterior lobes of the cerebrum, and, if these are drawn apart, a white body will be seen at the bottom of the fissure, which is the *corpus callosum.* The anterior part of the corpus callosum, around which the anterior cerebral artery turns, is known as the *genu*, and the central portion continued into the lamina cinerea as the *rostrum.*

The **Lamina Cinerea** (Fig. 260, 4) is a thin grey layer, continuous with the under surface of the corpus callosum and prolonged to the margin of the optic commissure. This is often torn in removing the brain.

The **Optic Commissure** or **Chiasma** (Fig. 260, 7) is the point of communication between the two optic nerves. The fibres of each optic tract are said to have the following arrangement :—The outermost fibres pass to the optic nerve of the same side; the middle fibres mostly decussate with those of the opposite side, forming a figure of X, and pass to the optic nerve of the opposite side; the most internal fibres are reflected back to the brain along the opposite optic tract behind the cross arrangement, and a few fibres of the optic nerve pass in front of it from one eye to the other.

The **Tuber Cinereum** (Fig. 260, 8) is a grey body placed immediately behind the optic chiasma. Projecting from it is the *infundibulum* (funnel), a tube connected with the pituitary body below, and communicating with the third ventricle of the brain by its upper end. The *Pituitary body* is usually torn off in the removal of the brain and left in the Sella Turcica. In the fœtus it is hollow; in the adult it will be seen (if left attached to the brain) to be solid and to consist of two lobes of a reddish colour. The anterior lobe is the larger, and is oblong in shape; the posterior lobe is round.

The relation of the infundibulum and pituitary body to the tuber cinereum will be better understood by referring to the vertical section of the brain (Fig. 260, 20).

The **Corpora Albicantia** or **Mammillaria** (Fig. 260, 10) are two white bodies resembling small peas, which are placed between the two crura cerebri. They are formed by the anterior crura of the *fornix* which, as will be afterwards seen, descend to the base of the brain and there make a sudden twist upon themselves, thus forming the bodies. Upon section grey matter will be found in the interior of each body.

The **Locus Perforatus Posticus** (Fig. 260, 12) (Pons Tarini) is placed in the angle between the two crura cerebri. It is composed of grey matter, and is perforated by numerous small vessels from the posterior cerebral artery going to the thalamus opticus.

The several structures which have been enumerated in the median line, viz., lamina cinerea, optic chiasma, tuber cinereum, corpora albicantia, and locus perforatus posticus, are all included within the area of the circle of Willis, and also form the floor of the third ventricle of the brain, as will be seen on referring to a vertical section (Fig. 271.)

The **Olfactory Peduncle** (First nerve) (Fig. 260, 3) is of a prismatic shape and is very soft, being destitute of neurilemma and only held in its place by a reflection of the arachnoid. The peduncle has three *roots*, two white and one grey. The external root (white) passes in front of the anterior perforated space to the fissure of Sylvius, and may be traced to the corpus striatum; the internal root (white) goes to the inner side of the anterior lobe; the middle root (grey) passes to the papilla of grey matter in the olfactory sulcus.

The **Olfactory Bulb** (Fig. 260, 3) is formed upon the extremity of the olfactory peduncle, and from it the branches of the olfactory

Fig. 260.

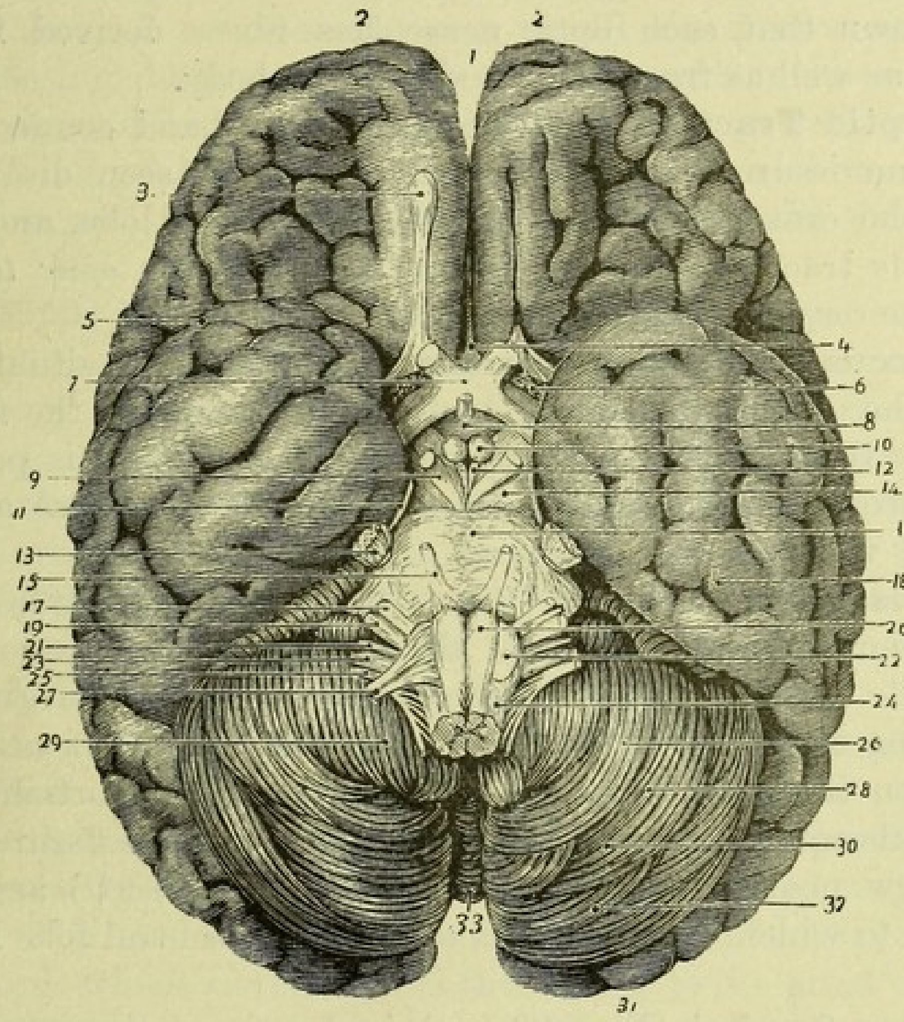


Fig. 260.—The base of the brain (from Hirschfeld and Leveillé).

1. Longitudinal fissure.
2, 2. Anterior lobes of cerebrum.
3. Olfactory peduncle and bulb.
4. Lamina cinerea.
5. Fissure of Sylvius.
6. Locus perforatus anticus.
7. Optic commissure.
8. Tuber cinereum and infundibulum.
9. Third nerve.
10. Corpus albicans.
11. Fourth nerve.
12. Locus perforatus posticus.
13. Fifth nerve.
14. Crus cerebri.
15. Sixth nerve.
16. Pons Varolii.
17. Portio dura of 7th.
18. Middle lobe of cerebrum.
19. Portio mollis of 7th.
20. Anterior pyramid.
21. Glosso-pharyngeal nerve.
22. Olivary body.
23. Pneumo-gastric nerve.
24. Lateral tract.
25. Spinal-accessory nerve.
26. Digastric lobe.
27. Hypoglossal nerve.
28. Cerebellum.
29. Amygdala.
30. Slender lobe.
31. Posterior lobe of cerebrum.
32. Posterior inferior lobe.
33. Inferior vermiform process.

nerve arise which descend to the nose. It contains grey matter, is oval in shape, and rests upon the cribriform plate of the ethmoid bone.

The **Optic** or **Second Nerve** (Fig. 260, 7) passes from the optic commissure to the eye-ball, where it is lost in the retina. It is round and firm, and is invested by a sheath of dura mater. It has been shown that each optic nerve has fibres derived from the opposite as well as from its own side of the body.

The **Optic Tract** (Fig. 260) is a flattened band connecting the optic commissure with the brain. It can be seen disappearing around the crus cerebri and beneath the middle lobe, and will be afterwards traced to the *corpora geniculata*, to the *optic thalamus*, and to the *corpora quadrigemina*.

The **Locus Perforatus Anticus** (Fig. 260, 6) is situated close behind the olfactory nerve, and at the inner end of the fissure of Sylvius. It is composed of grey nervous matter, and is perforated by numerous small branches from the middle cerebral artery on their way to the corpus striatum.

The **Fissure of Sylvius** (Fig. 260, 5) runs outwards between the anterior and middle lobes of the cerebrum, and is occupied by the middle cerebral artery. It corresponds to the margin of the lesser wing of the sphenoid bone when the brain is *in situ*, and is divided on the outer aspect of the brain into two portions, which will be subsequently traced. At the bottom of the fissure will be seen a few nearly straight convolutions (*gyri operti*) aggregated together, to which the name Island of Reil or central lobe has been applied.

The **Crus Cerebri** (Fig. 260, 14) (peduncle of the cerebrum) is one of two large white bodies, which appear at the anterior border of the pons Varolii and diverge to enter the under surface of the cerebrum. It is continuous with the anterior columns of the spinal cord through the pons Varolii. Winding round each crus are the optic tract and the fourth nerve, and between the two crura is the *interpeduncular space* containing the tuber cinereum, the corpora albicantia, and the locus perforatus posticus.

The **Third Nerve** (Fig. 260, 9) (motor oculi) is a good-sized nerve, which appears with its fellow between the crura cerebri in front of the pons Varolii. The fibres are connected with the grey substance of the crura (locus niger), and may be traced to the floor of the fourth ventricle.

The **Fourth Nerve** (Fig. 260, 11) (trochlearis vel patheticus) is the smallest of the cranial nerves, and winds round the crus cerebri. It will be afterwards traced to the valve of Vieussens.

The **Pons Varolii** or **Annular Protuberance** (Fig. 260, 16) is the large white body immediately behind the crura and in front of the medulla oblongata. It is more or less convex from side to side, but is slightly grooved along the middle line by the basilar artery. It is prolonged on each side as a round thick process of white fibres, passing obliquely outwards and backwards to the cerebellum, forming its middle peduncle, known as the *crus cerebelli* or *processus a cerebello ad pontem.* Emerging from the side of the pons is the fifth nerve, and overlying it (in this position) is the sixth pair of nerves.

The **Fifth Nerve** (Fig. 260, 13) (trifacial, trigeminal) is the largest of the cranial nerves, and consists of two portions, motor and sensory, of which the motor is the smaller and the anterior. The nerve arises from the side of the pons Varolii, a few fibres of which intervene between the two roots; but its deep origin can be traced to the floor of the fourth ventricle.

The **Sixth Nerve** (Fig. 260, 15) (abducens oculi) arises from the anterior pyramid of the medulla oblongata close to the posterior border of the pons, and slightly from the pons itself. It may be traced deeply to a nucleus in the floor of the fourth ventricle.

The **Medulla Oblongata** (Fig. 260) is the upper part of the spinal cord, and extends from the upper border of the atlas to the lower border of the pons, being about an inch and a quarter in length. The medulla oblongata contains all the elements of the spinal cord, which are continued through it to the great brain, and has, in addition, a special body, the olive or olivary body, and a number of grey nuclei for the origin of several nerves. It will be impossible to see more than the superficial anatomy of the medulla at this stage, the rest will be taken with the dissection of the cerebellum.

The medulla is divided into two symmetrical halves by an *Anterior Median Fissure,* which is continuous with the anterior fissure of the spinal cord, and ends above, immediately below the pons, in a small depression, called the *foramen cœcum.* On either side of the fissure is the rounded *Anterior Pyramid* (*corpus pyramidale*) (20), which is continuous with the anterior column of the cord; the two anterior pyramids decussate across the median fissure at the lower part of the medulla.

The *Lateral Tract* (24) is continuous with the lateral column of the spinal cord. At the lower part of the medulla it is broad, and is placed between the anterior pyramid and the restiform body, but at the upper part it is narrowed and pushed aside by the projection of the olivary body between it and the anterior pyramid. It may be traced as a slight prominence outside the olive, and a few longitudinal fibres may sometimes be seen in front of this body.

The *Olivary body* (22) is an ovoid projection, close to the anterior pyramid and immediately below the pons, but is separated by a groove from the surrounding parts. Some white fibres arching below and over the olivary body have been called the *arciform fibres.*

The *Restiform body* with its subdivisions, which is prolonged upwards from the posterior column of the cord, is only slightly seen at the side of the medulla in this view, but will be afterwards dissected with the fourth ventricle.

The **Seventh Nerve** (Fig. 260) consists of two portions, the *portio dura* or Facial nerve and the *portio mollis* or Auditory nerve, the facial being anterior and the auditory posterior; and between the two is a minute nerve, which has been named *pars intermedia* and joins the facial nerve.

The *portio dura* (17) is round, and smaller than the portio mollis; it arises from the lateral tract of the medulla oblongata close to the pons, and slightly from the pons itself. The deep origin can be traced to the floor of the fourth ventricle.

The *portio mollis* (19) is flattened and very soft, owing to the absence of neurilemma. It arises from the floor of the fourth ventricle and from the restiform body, around which it winds to join the facial nerve. The deep origin of the nerve is partly from the auditory nucleus in the floor of the fourth ventricle, and partly from the posterior pyramid of the medulla.

The **Eighth Nerve** (Fig. 260) consists of three portions, the Glosso-pharyngeal nerve, the Pneumo-gastric nerve, and the Spinal-accessory nerve, which lie in that order from before backwards.

The *Glosso-pharyngeal nerve* (21) is the smallest of the three nerves, and arises from the lateral tract of the medulla oblongata by three or four fibrillæ.

The *Pneumo-gastric* or *Vagus nerve* (23) arises from the lateral tract below the glosso-pharyngeal, by a number of fibrillæ which unite to form a single nerve. This lies parallel to the glosso-pharyngeal nerve and upon (in this view) a small lobe of the cerebellum, which has therefore been called the *lobe of the pneumo-gastric* or *flocculus.*

The *Spinal-accessory nerve* (25) arises partly from the medulla and partly from the spinal cord. The upper part (accessory to vagus) arises by fine fibrillæ, below the origin of the pneumogastric, for the whole length of the medulla. The spinal portion (Fig. 256, 9) arises by fine fibrillæ from the side of the spinal cord, between the ligamentum denticulatum and the posterior roots of the spinal nerves, as low as the sixth cervical nerve.

The deep origins of the eighth pair may be traced to special nuclei in the floor of the fourth ventricle. The spinal fibres are connected with the grey matter of the spinal cord.

The **Ninth** or **Hypoglossal Nerve** (Fig. 260, 27) arises by numerous fibrillæ from the groove between the anterior pyramid and the olivary body. The nerve consists of two bundles, which pierce the dura mater separately. The deep fibres may be traced to a special nucleus at the lower part of the fourth ventricle.

[By slicing down the pons Varolii, the arrangement of its transverse and longitudinal fibres may be seen. These are in alternate layers, the transverse being continuous with the crura cerebelli, and the longitudinal with the fibres of the cord and the crura cerebri. The superficial fibres are transverse, beneath which is a layer running longitudinally; these are followed by a deep layer of transverse and a still deeper layer of longitudinal fibres. The longitudinal fibres are continued up into the crura cerebri; and, on making a deep long cut into this structure, it will be seen that a grey nucleus of dark colour, the *locus niger*, occupies the interval between the superficial and deep fibres.]

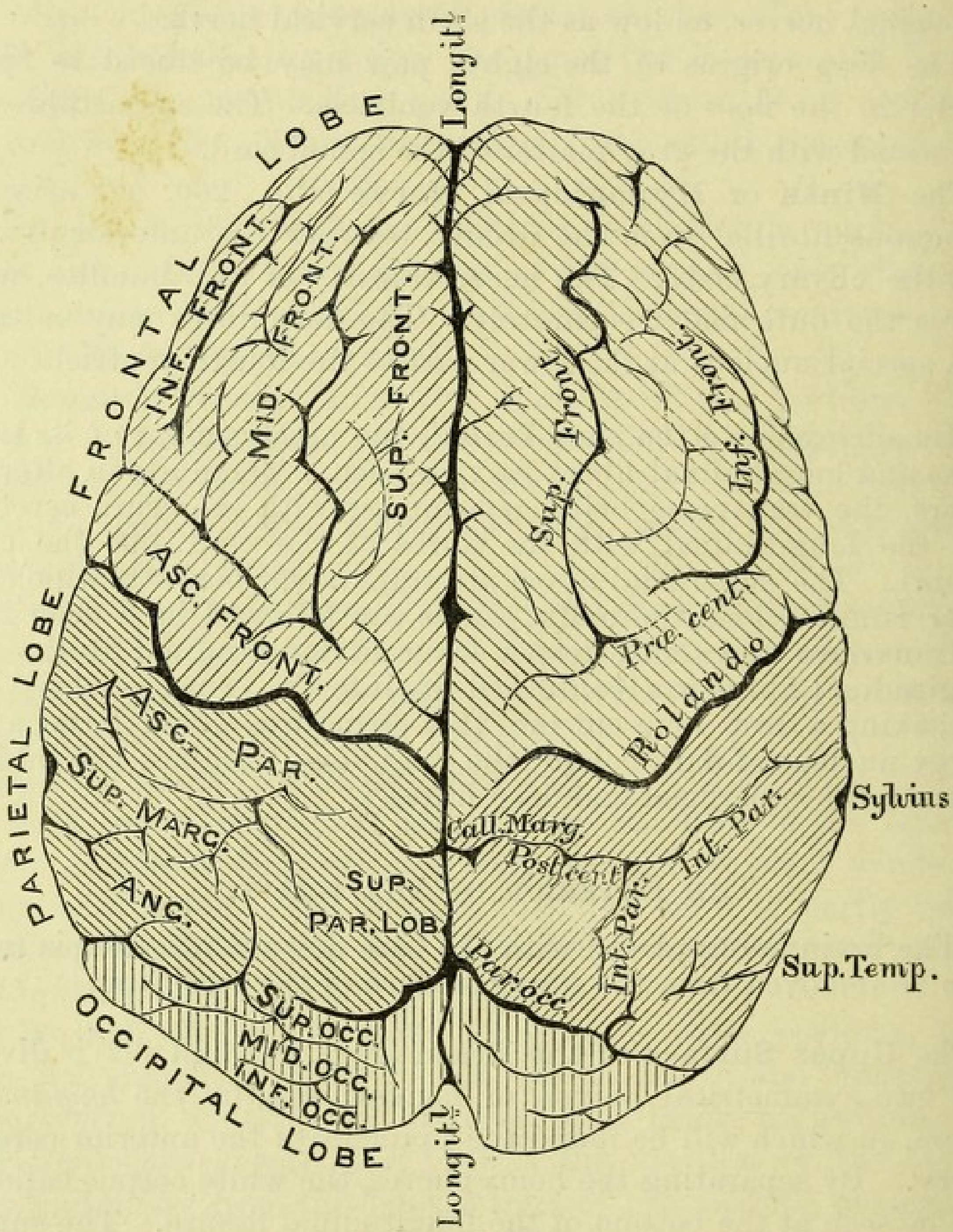
The Exterior of the Brain.

[The brain being placed with the base downwards, the pia mater is to be removed from the upper surface of the cerebrum.]

The **Upper Surface of the Brain** (Figs. 261 and 262) is divided into two symmetrical halves, or hemispheres, by the *longitudinal fissure*, in which will be found the branches of the anterior cerebral artery. By separating the hemispheres, the white corpus callosum will be seen at the bottom of the longitudinal fissure. The surface of the brain is marked by *convolutions*, the intervals between which are called *sulci*, and these have acquired sufficient importance to require individual notice, although the arrangement of the convolutions is not precisely the same in any two brains, or even on both sides of the same brain.

The *Fissure of Sylvius* which was seen at the base of the brain (p. 536), separating the anterior from the middle lobe, can now be traced out, and will be seen to divide into two portions, the posterior or horizontal, which runs between the frontal and temporo-sphenoidal lobes, and the anterior or vertical which ascends between

Fig. 261.



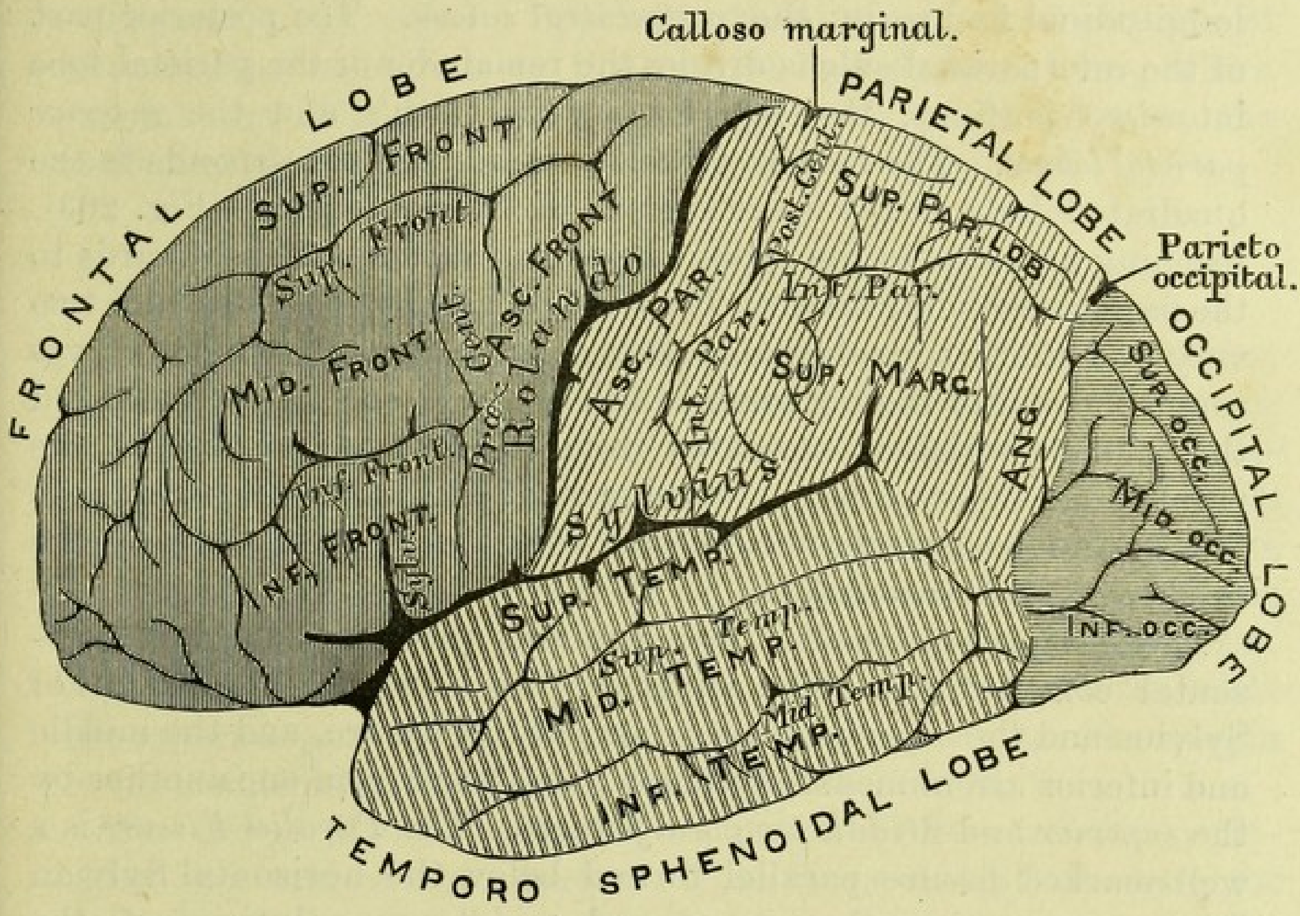
some of the frontal convolutions. Posterior to this portion of the fissure of Sylvius is a well-marked groove, the *fissure of Rolando*, which, beginning close to the margin of the longitudinal fissure,

Fig. 261.—Upper surface of the central hemispheres (modified after Dalton). The Convolutions are marked on the left side and the Sulci on the right.

runs downward and forward nearly to the horizontal limb of the Sylvian fissure, being bounded in front and behind by two large and well-marked convolutions, and separating the frontal from the parietal lobe.

The *Parieto-occipital fissure* separates the parietal and occipital lobes more or less completely, being sometimes a mere notch at the

Fig. 262.



upper margin of the hemisphere. It is continuous with the parieto-occipital fissure seen on the inner surface of the hemisphere (Fig. 263), which commences near the posterior extremity of the corpus callosum, where it is continuous with the calcarine fissure, and passes upwards and backwards to the upper surface of the hemisphere.

The *Frontal Lobe* (Figs. 261, 262) contains one well-marked vertical convolution bounding the fissure of Rolando, and called the *ascending frontal convolution*, separated by the *præcentral sulcus* from the three horizontal convolutions in front of it, which are named

Fig. 262.—Lateral view of the convolutions of the brain (after Thane).

The references to the Convolutions and the Sulci are distinguished by differences in type.

respectively *superior*, *middle*, and *inferior frontal convolutions*, and are divided from one another by the *superior* and *inferior* frontal sulci.

The *Parietal Lobe* contains anteriorly a well-marked vertical convolution posterior to the fissure of Rolando, and called the *ascending parietal convolution*. The lower part of this convolution is bounded behind by the *interparietal sulcus;* this, after ascending for a certain distance, turns backwards, but is continued almost to the great longitudinal fissure by the *post-central sulcus*. The posterior part of the interparietal sulcus divides the remainder of the parietal lobe into two portions, the *superior parietal lobule* and the *inferior parietal lobule*. The former is well marked, and corresponds to the quadrate lobule on the inner surface of the hemisphere (Fig. 263), reaching forwards to the calloso-marginal sulcus, and backwards to the parieto-occipital fissure. The latter is again subdivided into two very indefinite convolutions; the *supra-marginal*, which curves round the end of the horizontal limb of the fissure of Sylvius, and the *angular*, which is separated from the last by the end of the parallel or superior temporo-sphenoidal sulcus, round which it arches, and posteriorly is connected with the occipital lobe by the *second annectant convolution*.

The *Temporo-sphenoidal Lobe* contains three well-marked horizontal convolutions. The superior lies between the fissure of Sylvius and the *superior temporal* or *parallel* fissure, and the middle and inferior are immediately below, separated from one another by the *superior* and *Middle temporal fissures*. The *Parallel Fissure* is a well-marked fissure parallel to and below the horizontal Sylvian fissure, separating the upper and middle convolutions of the temporal lobe, and turning upwards at its posterior extremity between the angular and supra-marginal gyri. An *inferior temporal fissure* is found on the under surface, separating the inner from the outer temporal convolutions. The middle and inferior temporo-sphenoidal convolutions are connected with the occipital lobe by the *third* and *fourth annectant convolutions*.

The *Occipital Lobe* is continuous with the temporo-sphenoidal lobe, and contains three badly-defined convolutions placed horizontally, and named *superior*, *middle*, and *inferior*. They are connected with other convolutions by means of the *Annectant Gyri*, which are four in number and very ill-defined. The first unites the first occipital convolution with the superior parietal lobule, the second the middle occipital with the angular gyrus, the third the middle occipital with the lower part of the angular gyrus, or the middle temporo-sphenoidal, and the fourth unites the lower occipital with the lower temporo-sphenoidal.

The *Island of Reil*, or central lobe, may be seen by gently separating the lips of the fissure of Sylvius. It consists of a triangular eminence occupied by five or six convolutions, called the *gyri operti*, which radiate outwards from a point just external to the anterior perforated spot. It corresponds to the corpus striatum in the interior of the brain.

The name *Operculum* is applied to those convolutions or parts of convolutions belonging to the frontal and parietal lobes, which conceal the Island of Reil, occupying the angle between the ascending and horizontal limbs of the fissure of Sylvius.

The Inner Surface of the Hemisphere.

The **Inner Surface of the Hemisphere** is not, like the outer, divided into lobes, but presents several well-marked convolutions and fissures; the manner in which these correspond with the lobes and sulci on the outer surface may be seen in Fig. 263. At its anterior part it presents two large convolutions, the upper, the *marginal convolution* (convolution of longitudinal fissure), and the lower, the *convolution of the corpus callosum* or *gyrus fornicatus*, separated by the *calloso-marginal fissure*, which commences below the anterior part of the corpus callosum, and reaches the margin of the hemisphere just behind the fissure of Rolando.

The *Marginal Convolution* begins in front of the anterior perforated spot and extends backwards as far as the place where the calloso-marginal sulcus terminates. From its posterior part a small piece called the *Paracentral* or *oval lobule* is cut off by a short perpendicular sulcus.

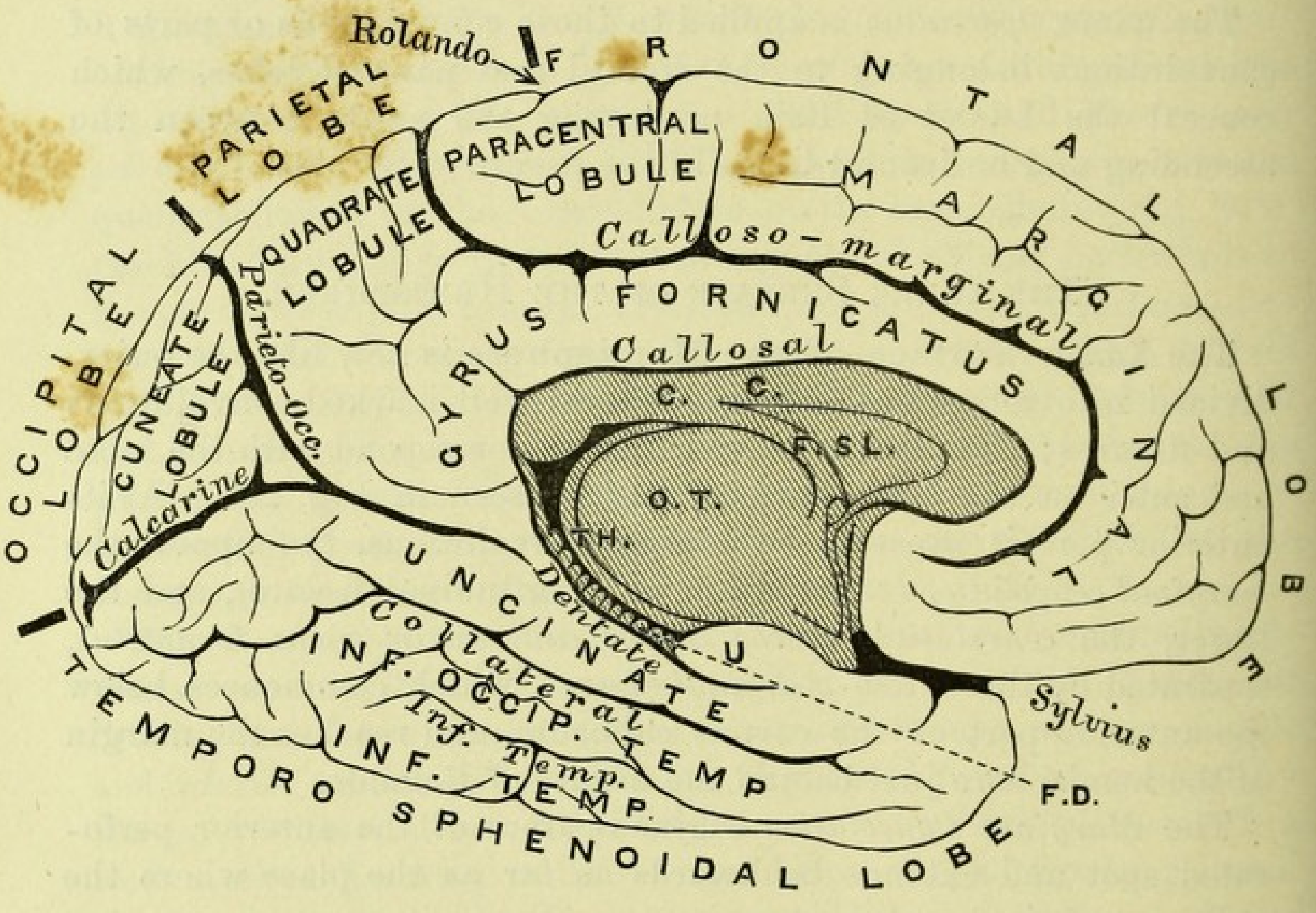
The *Gyrus Fornicatus* is a well-marked convolution, which begins at the anterior perforated space in the base of the brain, and winds round the corpus callosum to the posterior part, where it becomes continuous with the quadrate lobule and the upper internal temporo-sphenoidal convolution or *uncinate gyrus*. It is separated from the corpus callosum by the *callosal groove*.

Posterior to the marginal convolution, and continuous below with the *gyrus fornicatus*, is the *quadrate lobule*, which is separated from the *occipital lobule* by the internal *parieto-occipital fissure*, a continuation of the fissure of the same name seen externally. It corresponds with the parietal lobule on the exterior of the brain.

The *Occipital* or *Cuneate Lobule* is triangular in shape, and is placed between the parieto-occipital and the calcarine fissures, the latter separating it from the internal convolutions of the temporo-sphenoidal lobe.

The *Calcarine Fissure* of Huxley runs below the occipital lobule to the extremity of the gyrus fornicatus, being joined midway by the parieto-occipital fissure. It is an important fissure, since it

Fig. 263.



corresponds to the projection called the *hippocampus minor* in the posterior cornu of the lateral ventricle.

The *Occipito-temporal Convolutions* form the lower part of the inner wall of the hemisphere, and are continuous with those of the temporo-sphenoidal lobe externally. The most important is the *superior Occipito-temporal* or *Uncinate Gyrus*, which is immediately below the calcarine fissure, and runs horizontally forward, becoming united with the gyrus fornicatus and passing below the fascia

Fig. 263.—The inner and under surface of a cerebral hemisphere showing the convolutions and sulci (modified after Thane).

C. C. Corpus callosum.
S. L. Septum lucidum.
F. Fornix.
O. T. Optic thalamus.
T. H. Tænia hippocampi.
F. D. Fascia dentata.

The Convolutions and Sulci are distinguished by differences in type.

dentata. It then makes a sudden bend backward for half an inch, forming a hook-like process, from which it derives its name. It is separated from the tænia hippocampi by the *dentate fissure*, which ends beneath the hook, and at the bottom of which the *fascia dentata* is situated; this is a grey body, to which the term *dentate convolution* is sometimes applied, and which will be better seen afterwards. The dentate fissure corresponds to the hippocampus major in the descending cornu of the lateral ventricle.

Below or external to the uncinate gyrus is the inferior or external occipito-temporal convolution, from which it is separated by the *Collateral Fissure,* which is very irregular. The collateral fissure causes the prominence in the descending cornu of the lateral ventricle known as the *eminentia collateralis.* The inferior occipito-temporal convolution is separated from the lowest temporo-sphenoidal convolution by the *inferior temporal fissure*, mentioned on page 542.

The Interior of the Brain.

[A slice of brain substance about an inch thick is to be taken from the top of the right hemisphere, the knife being carried through the calloso-marginal sulcus; the centrum ovale minus will thus be exposed.]

The *Centrum Ovale Minus* is the oval mass of white cerebral matter, surrounded by convolutions, which forms the hemisphere. The convolutions will be seen to have a cortical layer of grey substance superficial to their white substance, which is continuous with that of the centre of the hemisphere. Numerous minute dark points will be seen on the surface of the white matter, which are the *puncta vasculosa,* or orifices of minute blood-vessels, from which blood exudes in the recent condition.

[By slicing off one hemisphere to the level of the corpus callosum, a side view of the upper part of the opposite hemisphere will be obtained, but the convolutions of the inner surface can be thus only very imperfectly observed. By removing the upper parts of both hemispheres to the level of the corpus callosum the centrum ovale majus will be displayed.]

The *Centrum Ovale Majus* is the great white mass formed by the continuation of the fibres of the corpus callosum into the hemispheres, the grey convolutions surrounding its circumference.

The **Corpus Callosum** (Fig. 265, 5) forms the great commissure of the brain, and consists of fibres passing transversely from one hemisphere to the other, and forming the roof of the central and anterior parts of the lateral ventricles. It is nearer the anterior than the posterior extremity of the brain, and in the median line forms the floor of the longitudinal fissure, being slightly arched from before backwards. On a vertical section it will be seen to bend abruptly anteriorly to pass to the base of the brain, thus forming the *genu* (6). Beneath it is the *septum lucidum*, and further back the *fornix* (8), with which it is continuous by means of its thickened posterior portion, which has been called the *splenium*. The genu is prolonged at the base of the brain by the *rostrum* and *peduncles*, which have been previously seen.

On the surface of the corpus callosum in the middle line is a longitudinal depression, the *raphé*, which is bounded on each side by the slight projections called the *nerves of Lancisi* or the *mesial longitudinal striæ*, which may be traced round the genu into the peduncles. Externally to these are some transverse markings called the *lineæ transversæ*, which are crossed beneath the gyrus fornicatus by the longitudinal fibres forming the *covered band of Reil* or the *lateral longitudinal striæ*.

The Lateral Ventricles.

[To open the cavity in each hemisphere called the lateral ventricle, the corpus callosum is to be carefully cut through about half an inch from the middle line, until the delicate membrane (*ependyma ventriculorum*) lining the ventricle is seen; the handle of the scalpel should then be used to reflect the brain substance and expose the cavity, which bends away from the median line in front, and towards it behind.]

The **Lateral Ventricle** (Fig. 264) consists of a *central cavity* and three *cornua*, anterior, posterior, and descending, of which the descending will be exposed by a subsequent dissection. The *anterior* cornu turns outward in the anterior lobe of the cerebrum, and the *posterior* cornu turns inward in the posterior lobe of the cerebrum, thus forming, with the central portion, a cavity shaped (on the right side) like the italic letter *f*. The body of the ventricle is bounded superiorly by the corpus callosum, which forms its *roof*, the *floor* being formed by the following parts, from before backwards—1. Corpus striatum; 2. Tænia semicircularis; 3. Thalamus (opticus); 4. Choroid plexus; 5. Corpus fimbriatum; 6. Fornix.

The **Corpus Striatum** (Fig. 264, 3) or *superior ganglion of the hemisphere* forms a pyriform prominence of grey substance in the floor of the ventricle, the greater end being forwards and the narrow part being directed backwards and outwards. If it be divided transversely it will be seen to consist of two grey portions, the *intraventricular* or *caudate nucleus* already described, and a larger *extraventricular* or *lenticular nucleus* which corresponds in position with the Island of Reil. These are separated by a band of white fibres, called the *internal capsule*, prolonged from the crus cerebri, amongst which pass strands of grey matter causing a striated appearance, from which the name of corpus striatum is derived. A thin layer of grey substance called the *claustrum* is found outside the lenticular nucleus, from which it is separated by a band of white fibres, called the *external capsule*. The two corpora striata are separated behind by the two optic thalami.

The **Tænia Semicircularis** (Fig. 264, 6) is a narrow band of white matter, which becomes slightly widened posteriorly, and connects the corpus striatum with the optic thalamus; in front it joins the anterior pillar of the fornix.

The **Thalamus** (opticus) (Fig. 264, 7) is a white body, in the part at present exposed, which will be better seen in a subsequent dissection.

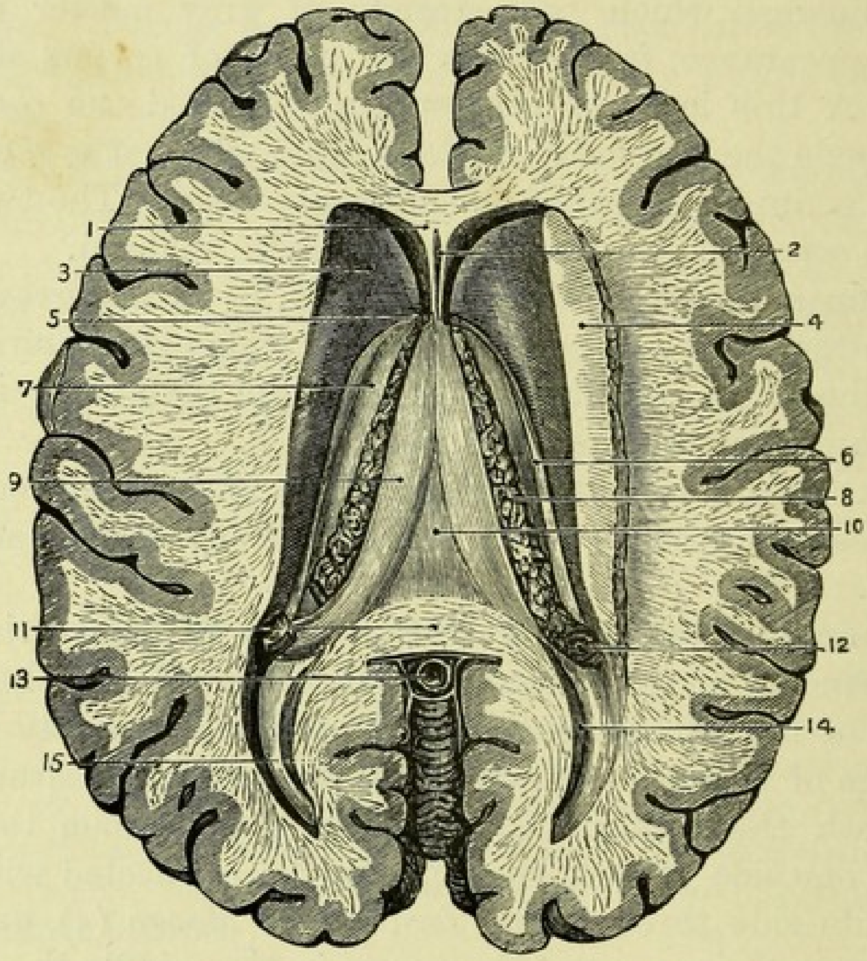
The **Choroid Plexus** (Fig. 264, 8) is a vascular fringe lying upon the surface of the thalamus, and continued into the descending cornu of the lateral ventricle. It will subsequently be seen to be the edge of a process of pia mater (velum interpositum), which lies beneath the fornix. By drawing gently upon the choroid plexus of one side it may be shown to be connected with that of the opposite side through the *foramen of Monro* (5), an opening beneath the anterior part of the fornix in the middle line.

[To see the fornix thoroughly, the remnant of the corpus callosum in the middle line should be cut through transversely about its centre, when the posterior part is to be carefully dissected away from the subjacent fornix.]

The **Fornix** (Fig. 264, 10) is a thin white body, of triangular shape, placed beneath the corpus callosum in the middle line. Anteriorly it is prolonged into two anterior crura or pillars, which pass to the base of the brain to form the corpora albicantia, and will be afterwards seen. Posteriorly it is incorporated with the splenium of the corpus callosum, and gives off laterally the two posterior cornua, each of which is continuous with the corpus fimbriatum and hippocampus major of its own side. The fornix is separated from the corpus callosum in front by the septum lucidum.

The lateral ventricles are separated from one another by the **Septum Lucidum**, a very thin double layer of white cerebral matter, grey externally, containing the fifth ventricle, and extending between the anterior part of the corpus callosum and the fornix. It is deeper in front than behind (Fig. 271, 6).

Fig. 264.



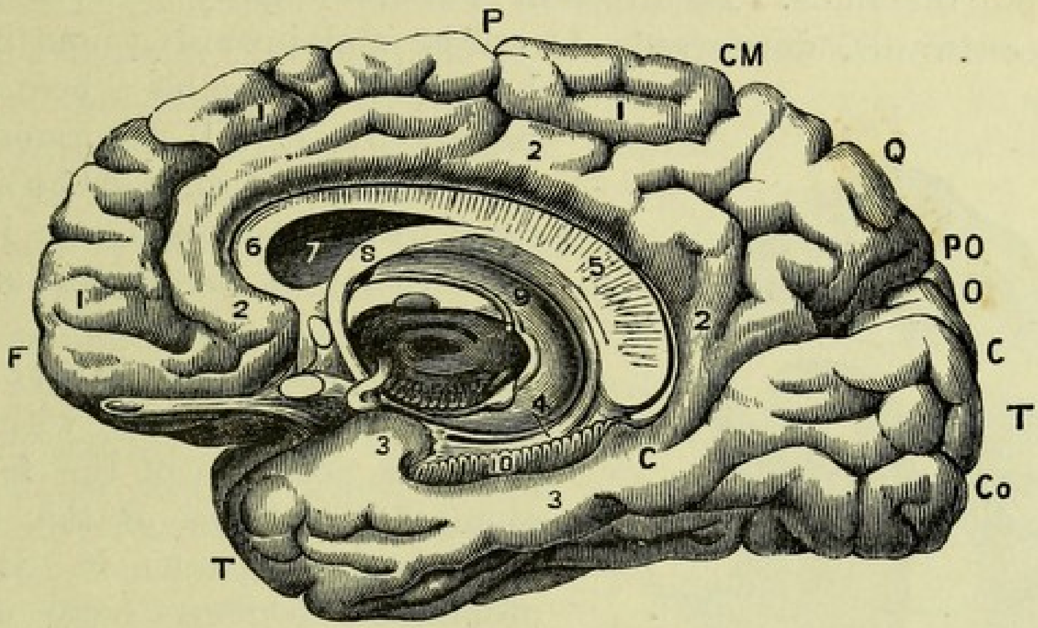
The **Fifth Ventricle** (Fig. 264, 2) can be shown by cutting through the septum lucidum with a pair of scissors close to the remains of the corpus callosum, which must be turned forward. It lies between the two layers of the septum lucidum, and is deepest in front. It is not lined by epithelium like the lateral ventricles; in the adult it forms a shut sac, but in the fœtus it was part of the great longitudinal fissure.

Fig. 264.—Lateral ventricles of the brain (from Hirschfeld and Leveillé).

1. Septum lucidum.
2. Fifth ventricle.
3. Corpus striatum.
4. Corpus callosum, reflected.
5. Foramen of Monro.
6. Tænia semicircularis.
7. Thalamus (opticus).
8. Choroid plexus.
9. Corpus fimbriatum.
10. Fornix.
11. Posterior extremity of corpus callosum.
12. Commencement of descending cornu.
13. Vena Galeni.
14. Hippocampus minor.
15. Posterior cornu of lateral ventricle.

The **Foramen of Monro** (Fig. 264, 5) is the communication between the two lateral and the third ventricles. It is thus Y-shaped, and is placed beneath the anterior part of the fornix,

Fig. 265.



immediately behind its anterior pillars, and the choroid plexus has already been traced to it (Fig. 267, 6).

The **Hippocampus Minor** (Fig. 266, 7), or *calcar avis*, is a projection of variable size from the inner wall of the posterior cornu of the lateral ventricle, corresponding to the *calcarine fissure*. It is white on the surface but grey in the interior.

[To see the descending cornu, the side of the brain should be freely cut through opposite the point at which the choroid plexus disappears, by making vertical incisions passing obliquely forwards and outwards, and then shaving off the substance of the hemisphere with the knife directed horizontally; the choroid plexus being

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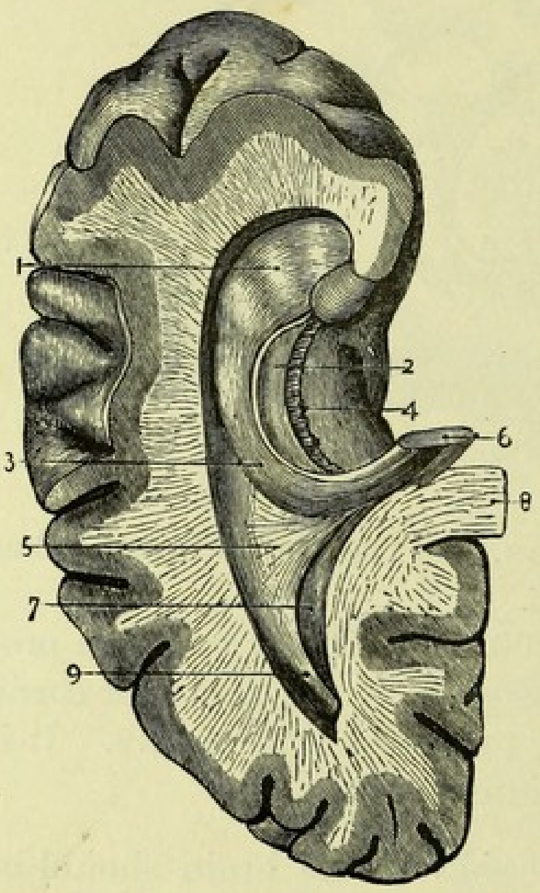
Fig. 265.—The inner and under-surfaces of the brain to show the convolutions (from Hirschfeld and Leveillé).

F. Frontal lobe.
P. Parietal lobe.
Q. Quadrate lobule.
O. Occipital lobule.
T. T. Temporo-sphenoidal lobe.
C. M. Calloso-marginal fissure.
P. O. Internal parieto-occipital fissure.
C C. Calcarine fissure.
Co. Collateral fissure.
1, 1. Marginal convolution.
2, 2. Gyrus fornicatus.
3, 3. Uncinate gyrus.
4. Dentate convolution.
5. United corpus callosum and fornix.
6. Genu of corpus callosum.
7. Cavity of lateral ventricle.
8. Fornix.
9. Thalamus with corpora geniculata.
10. Fascia dentata in dentate fissure.

taken as the guide, the descending cornu can be opened along its side, and the cavity exposed by drawing the parts asunder.]

The **Descending** or **Middle Cornu** (Fig. 266) takes a curved course downward in the middle lobe of the cerebrum and beneath the optic thalamus. Its direction is at first slightly backwards and then outwards, downwards, forwards, and inwards,* and it has been said to resemble a bent forefinger. In it will be found the continuations of some of the structures which have been seen in the main cavity of the ventricle, but under different names.

Fig. 266.



The **Hippocampus Major** (Fig. 266, 3) is continuous with the posterior peduncle of the fornix, some of the fibres of the latter being prolonged upon it. It is a prominent convex body corresponding to the *dentate fissure*, and winds forward to the extremity of the cornu. Its anterior extremity is enlarged, and is continuous here with the hook of the uncinate gyrus; this part is marked with more or less distinct transverse grooves, and to it the name *Pes Hippocampi* (1) has been given from its fancied resemblance to the foot of an animal. The hippocampus major has a thin layer of white fibres on the surface, the deeper part consisting of grey matter continuous with that on the surface of the hemisphere.

At the anterior border of the hippocampus major is a thin band of white cerebral matter continuous with the fornix, known as the *Corpus Fimbriatum* or **Tænia Hippocampi** (Fig. 266, 2). By

* Artificial Memory, BODFI.

Fig. 266.—Descending cornu of the lateral ventricle of brain (from Hirschfeld and Leveillé).

1. Pes hippocampi.
2. Tænia hippocampi.
3. Hippocampus major.
4. Fascia dentata.
5. Pes accessorius (Eminentia collateralis).
6. Fornix (cut).
7. Hippocampus minor.
8. Corpus callosum (cut).
9. Posterior cornu.

lifting this up with the handle of the scalpel and turning it aside, a serrated free border of grey nervous matter will be seen, which has been sometimes called the dentate convolution. This is the *Fascia Dentata* (4), the convolution which blends with the hook of the uncinate convolution and forms the pes hippocampi, as may be seen by making a transverse section of it.

The **Choroid Plexus** of the descending cornu is continuous with the choroid plexus of the lateral ventricle, and can now be seen to be connected with the pia mater through a slit immediately in front of the tænia hippocampi (transverse fissure of Bichât).

The **Pes Accessorius** or **Eminentia Collateralis** (Fig. 266, 5) is a projection of variable size at the commencement of the descending cornu, and between the hippocampus major and hippocampus minor, corresponding to the *collateral fissure*.

[By cutting through the fornix opposite the foramen of Monro, it can be carefully lifted up with the handle of the scalpel and turned backward, when some transverse markings on its under surface will be seen (from which it has been called the *Lyra*), and the velum interpositum beneath will be brought into view. By carefully scraping away the brain substance with the handle of the knife, the continuity of the velum interpositum with the pia mater through the great transverse fissure may be demonstrated.]

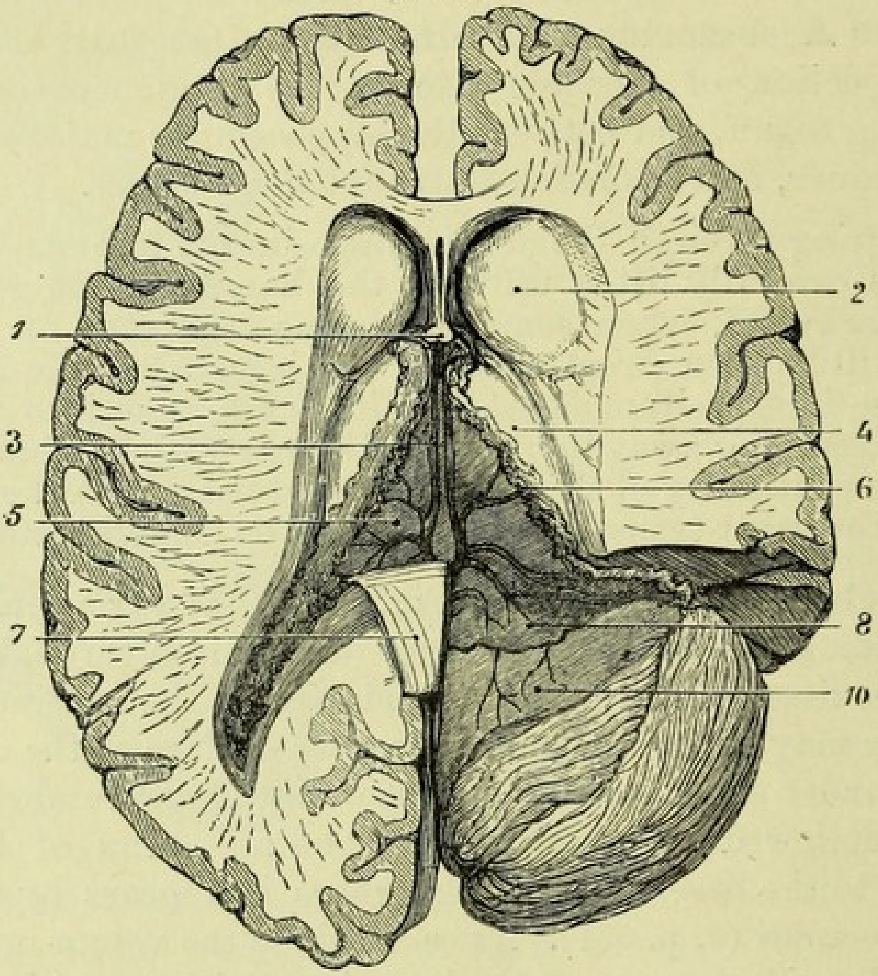
The **Velum Interpositum** (Fig. 267, 5) is a triangular process of pia mater carried into the interior of the brain through the great transverse fissure, which is now laid open. The continuity of the pia mater may be traced upon the upper surface of the cerebellum and the under surface of the posterior lobe of the cerebrum, and it may be followed through the descending cornu of the lateral ventricle to the base of the brain, where it appears by the side of the crus cerebri (*v.* p. 531). At each side of the velum interpositum are the choroid plexuses of the lateral ventricles, and in the centre are two veins (*Venæ Galeni*), which open into the straight sinus of the dura mater (Fig. 267, 3).

The **Great Transverse Fissure** or **Fissure of Bichât** (Fig. 271, 11) which is now opened, is the slit by which the pia mater enters the brain. It is opposite the interval between the cerebrum and the cerebellum, and reaches forward in the brain beneath the fornix and corpus callosum, as far as the foramen of Monro, and above the corpora quadrigemina and the optic thalami. The fissure is continued downward on each side in the descending cornu of the lateral ventricle, and reaches the base of the brain at the outer side of each crus cerebri.

[The velum interpositum is to be reflected, when the two small *choroid plexuses of the third ventricle* will be seen on its under surface near the middle line. The third ventricle will now be seen, and behind it the corpora quadrigemina and the pineal gland, which latter is very liable to be removed with the velum interpositum, unless it is carefully dissected.]

The **Third Ventricle** (Fig. 268) is the space in the middle line between the two optic thalami, which, with the peduncles of the

Fig. 267.



pineal gland, form its *lateral* boundaries. Its *roof* is formed by the fornix and velum interpositum, and its *floor* by the structures contained within the circle of Willis at the base of the brain, viz., the

Fig. 267.—The velum interpositum, showing its continuity with the pia mater (from University College Museum).

1. Fornix divided.
2. Corpus striatum.
3. Venæ Galeni.
4. Thalamus opticus.
5. Velum interpositum.
6. Choroid plexus.
7. Left fornix reflected, showing lyra.
8. Pia mater on under surface of cerebrum, continuous with
10. Pia mater on upper surface of cerebellum.

lamina cinerea, optic chiasma, tuber cinereum, corpora albicantia, and locus perforatus posticus (from before backwards).

The *anterior* boundary of the ventricle is formed by the *anterior commissure* (5), a round white band passing between the two corpora striata; it lies in front of and may be seen between the two anterior pillars of the fornix; the *posterior* boundary is the *posterior commissure* (Fig. 271, 14), a slender white band passing between the two optic thalami, which may be seen immediately in front of, and a little beneath, the pineal gland. Stretching across the ventricle between the two optic thalami is the *middle* or *soft commissure* (Fig. 268, 7) (of grey colour and frequently torn), which divides the ventricle into two portions, to which the names *foramen commune anterius* and *foramen commune posterius* are sometimes given.

The third ventricle communicates with the two lateral ventricles by the foramen of Monro, and with the fourth ventricle by the *iter a tertio ad quartum ventriculum* or *aqueduct of Sylvius*, which passes beneath the posterior commissure, the pineal gland, and the corpora quadrigemina (Fig. 271, 16). In the fœtus the third ventricle communicated in addition with the fifth ventricle, and with the infundibulum (*iter ad infundibulum*).

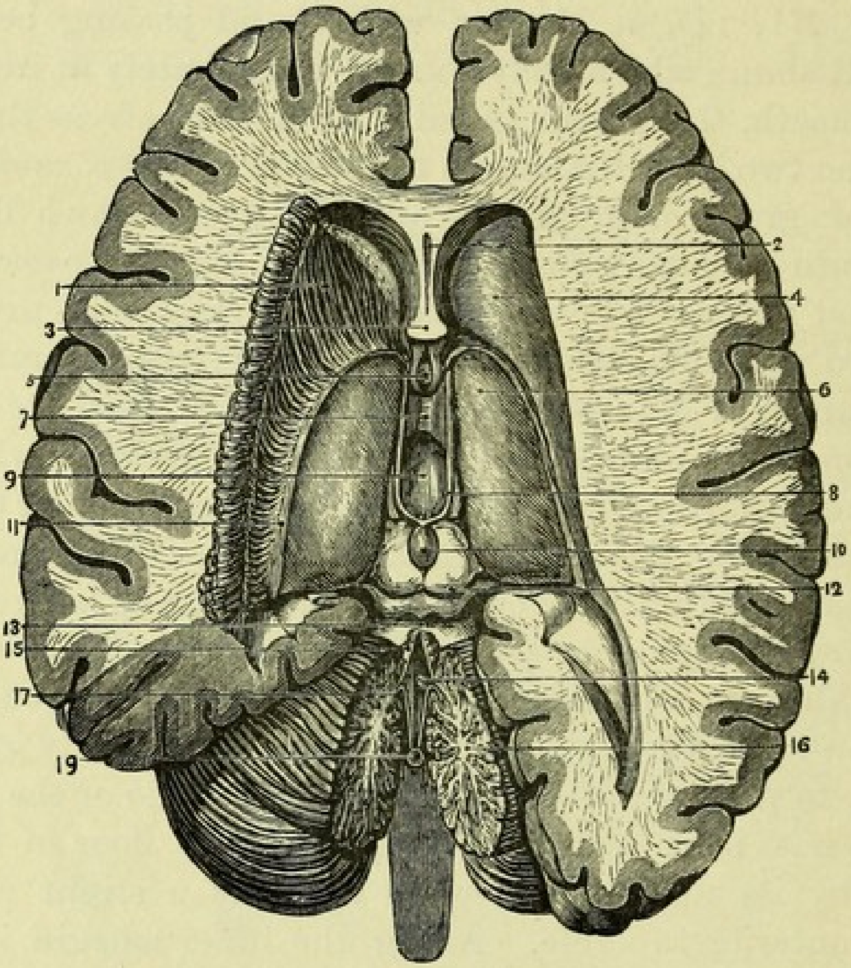
The **Thalamus Opticus** (Fig. 268, 6) is now fully exposed, and will be seen to be a large body partly white and partly grey, placed posteriorly to the corpus striatum and at the side of the third ventricle. It has been seen to form part of the floor of the lateral ventricle by its upper surface, on which is a slight prominence called the anterior tubercle. Along the inner margin is a narrow white band, one of the peduncles of the pineal body; and by its inner surface, which bounds the third ventricle, it gives attachment to the middle and posterior commissures of the third ventricle, the posterior piercing its substance.

The thalamus opticus forms the roof of the descending cornu of the lateral ventricle, and by drawing it upward on the side upon which the cornu has been opened, two projections on its under surface may be seen. These are the *Corpora Geniculata* (externum and internum), of which the outer one is the larger. By turning the brain on its side the optic tract may be readily traced to the under surface of the optic thalamus, to which it is attached; and will be found to divide into two parts, which are connected with the corpora geniculata, and pass on to the corpora quadrigemina.

The outer surface of the optic thalamus is enclosed in the substance of the hemisphere; the lower surface rests for the most part upon the crus cerebri.

The **Pineal Body** or **Gland** (Fig. 268, 10) (*conarium*) is a pink body of a conical shape, lying between the anterior pair of the corpora quadrigemina, and above the posterior commissure of the third ventricle. Its anterior part or base is connected with the

Fig. 268.



margins of the optic thalami by two slender *anterior peduncles* or *habenæ*, and is also connected with the subjacent bodies by slender *inferior peduncles*. The velum interpositum gives a special investment of pia mater to the gland. The pineal body contains a cavity, in which are some particles of calcareous matter (acervulus).

Fig. 268.—Third ventricle of brain (from Hirschfeld and Leveillé).

1. Corpus striatum dissected.
2. Fifth ventricle.
3. Anterior crura of fornix (cut).
4. Corpus striatum.
5. Anterior commissure of third ventricle.
6. Optic thalamus.
7. Middle or soft commissure.
8. Habenæ or peduncles of pineal gland.
9. Third ventricle.
10. Pineal gland.
11. Tænia semicircularis.
12. Corpora quadrigemina.
13. Valve of Vieussens.
14. Fourth ventricle.
15. Anterior extremity of superior vermiform process.
16. Arbor vitæ cerebelli.
17. Anterior extremity of inferior vermiform process (nodulus).
19. Communication of 4th ventricle with subarachnoid space.

The **Corpora Quadrigemina** (Fig. 268, 12) are four white prominences placed immediately behind the third ventricle, and named *Nates* and *Testes*, from their fancied resemblance to those parts; but it is to be noted that their position is the reverse of that in man, since the two anterior bodies are the nates and the posterior the testes. Both sets of bodies are connected to the optic thalami by white bands, and the nates are also connected to the pineal gland, which lies upon their upper surface.

The two broad white bands, passing from the cerebellum to the testes, are the superior peduncles of the cerebellum (*processus a cerebello ad testes*) (Fig. 269, 3), and between them is a thin layer of white matter, the *Valve of Vieussens* (Fig. 268, 13, Fig. 271, 15), to which the fourth pair of nerves may be traced round the superior peduncles of the cerebellum.

The small band of white matter passing transversely beneath the corpora quadrigemina on each side, and seen immediately in front of the superior peduncles of the cerebellum, is the *Fillet of the Olivary body* (Fig. 269, 2).

[Opportunity may now be taken to trace out the anterior commissure of the third ventricle and the anterior pillar of the fornix, by carefully scraping away the corpus striatum of one side.]

The *Anterior Commissure* is a cylindrical white band, which may be traced through the corpus striatum to the roof of the descending cornu of the lateral ventricle.

The *Anterior pillar of the Fornix* descends in front of the third ventricle, and reaches the base of the brain, where it makes a twist to form the superficial white substance of the corpus albicans of one side, and then ascends to be lost in the grey matter of the optic thalamus (Fig. 265, 8).

The Cerebellum.

The **Cerebellum** (Fig. 260, 28), or small brain, lies beneath the posterior lobes of the cerebrum, and in the skull is separated from them by the tentorium cerebelli. It is of a darker colour than the cerebrum, and its surface is divided into laminæ instead of convolutions, and these are separated by shallow sulci. The cerebellum is divisible into two lateral halves united by a commissure, and the *horizontal fissure*, which passes round the margin, divides the organ into an upper and a lower part.

The upper surface is flat except in the median line, where there is a slight ridge forming the commissure, and called the *superior vermiform process*. There is a deep notch in the middle line behind. The upper part of each hemisphere is divided into an anterior and a posterior lobe by an indistinct fissure.

The *anterior lobe* is the larger, and of a square shape, reaching as far back as the posterior extremity of the vermiform process.

The *posterior lobe* is the small portion behind the level of the vermiform process, and reaches to the horizontal fissure.

The *central lobe* consists of a few folia close to the anterior border, and is partly concealed by the anterior lobe. It is continuous by means of a few transverse laminæ called the *lingula*, with the *anterior medullary velum* or *valve of Vieussens*.

The cerebellum is connected to the cerebrum and spinal cord by three peduncles or crura, of which the superior one can now be seen.

The **Superior Peduncle** (Fig. 269, 3) (*processus a cerebello ad testes*) is a broad, flattened white band, which is connected below with the inferior vermiform process, and passes forwards to the corpora quadrigemina, the two peduncles of opposite sides converging at the posterior border of the testes. The two processes are prolonged beneath the corpora quadrigemina to the optic thalami, their fibres decussating in their passage.

The **Valve of Vieussens** (Fig. 268, 13) (*Velum medullare anterius*) is the thin layer of white nervous matter stretched between the two superior peduncles of the cerebellum, and connected with the anterior extremity of the inferior vermiform process. It is narrow in front, but broader behind, where it has a little grey matter connected with it, and is often torn through, in which case the cavity of the fourth ventricle is exposed. The fourth pair of nerves arises from the middle line of the valve close behind the corpora quadrigemina (Fig. 271, 15).

[The preparation is to be turned over for the examination of the remaining peduncles and of the under surface of the cerebellum.]

The **Middle Peduncle** (Fig. 269, 4) (*processus a cerebello ad pontem*) has been already seen at the base of the brain. It is the largest of the three peduncles, and the fibres pass across the pons from one hemisphere of the cerebellum to the other, constituting the superficial transverse fibres of the pons, which have been already dissected.

The **Inferior Peduncle** (Fig. 269, 5) (*processus a cerebello ad* *medullam*) forms part of the restiform body of the medulla, and will be better seen when the fourth ventricle is opened.

The **Inferior Surface** (Fig. 270) of the cerebellum is divided into two hemispheres by a deep fissure, the *vallecula*, at the bottom of which is the *inferior vermiform process*, which is to be seen by drawing the medulla oblongata well forward.

Each hemisphere is divided somewhat arbitrarily into lobes, since the divisions between them are very uncertain. Beginning behind is the *Posterior Lobe* (11); next the *Slender Lobe* (10); and in front of that the *Biventral* or *Digastric Lobe* (5).

The *Amygdala* or *Tonsil* (Fig. 260, 29) is a prominent lobe close to the vallecula, which it partially conceals.

The *Flocculus* (Fig. 270, 4) is a small lobe immediately in front of the biventral lobe, which lies beneath the crus cerebelli, and is hence called the subpeduncular lobe.

The **Inferior Vermiform Process** (Fig. 270) is divided into the following portions. Most anteriorly is the *Nodule* (6) which projects into the fourth ventricle;

Fig. 269.

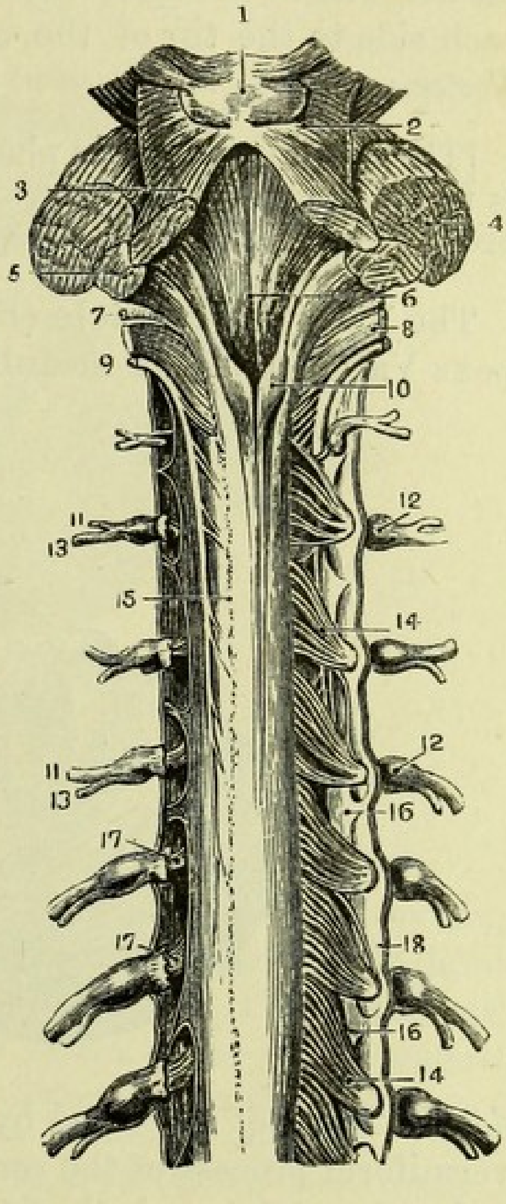


Fig. 269.—Fourth ventricle and upper part of spinal cord and membranes. The posterior roots of the nerves are removed on the left side (from Hirschfeld and Leveillé).

1. Corpora quadrigemina.
2. Fillet of the olivary body.
3. Processus a cerebello ad testes.
4. Processus a cerebello ad pontem.
5. Processus a cerebello ad medullam.
6. Floor of fourth ventricle.
7. Glosso-pharyngeal nerve.
8. Pneumo-gastric nerve.
9. Spinal-accessory nerve.
10. Posterior columns of spinal cord.

11, 11. Anterior divisions of spinal nerves.
12, 12. Ganglia of nerves.
13, 13. Posterior divisions of spinal nerves.
14, 14. Posterior roots of spinal nerves.
15. Line of origin of posterior roots of left side.
16, 16. Ligamentum denticulatum.
17, 17. Anterior roots of spinal nerves.
18. Dura mater.

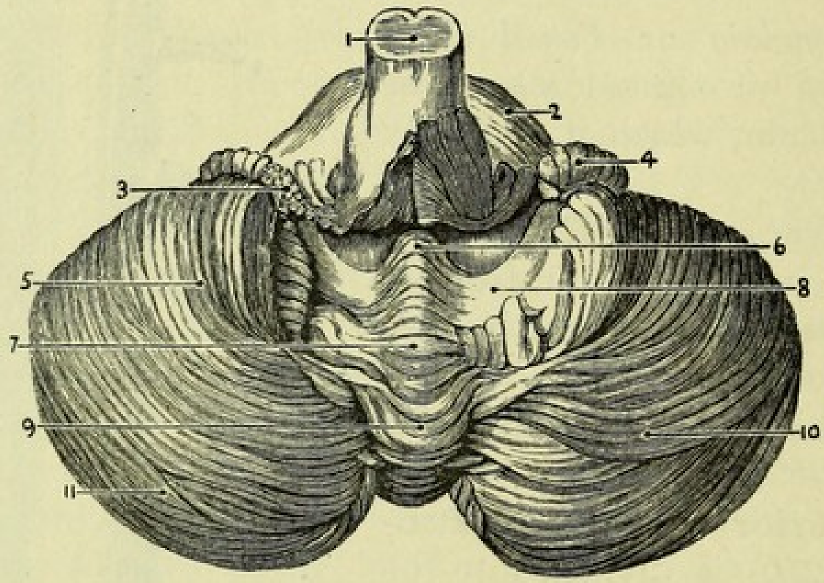
posterior to this is the thin ridge called the *Uvula* (7), from the fact of its lying between the two tonsils; behind this is the *Pyramid* (9), and posterior to this again are a few transverse commissural fibres.

By turning aside or cutting away the amygdalæ, a layer of white matter will be brought into view, extending from the flocculus on each side to the tip of the nodule. This is the *Velum Medullare Posterius* (8).

[The brain being again placed with the base downward, an incision is to be made through the valve of Vieussens and the cerebellum, in order to expose fully the cavity of the fourth ventricle.]

The **Fourth Ventricle** (Fig. 269, 6) is situated at the back of the pons Varolii and the medulla oblongata, those bodies forming its

Fig. 270.



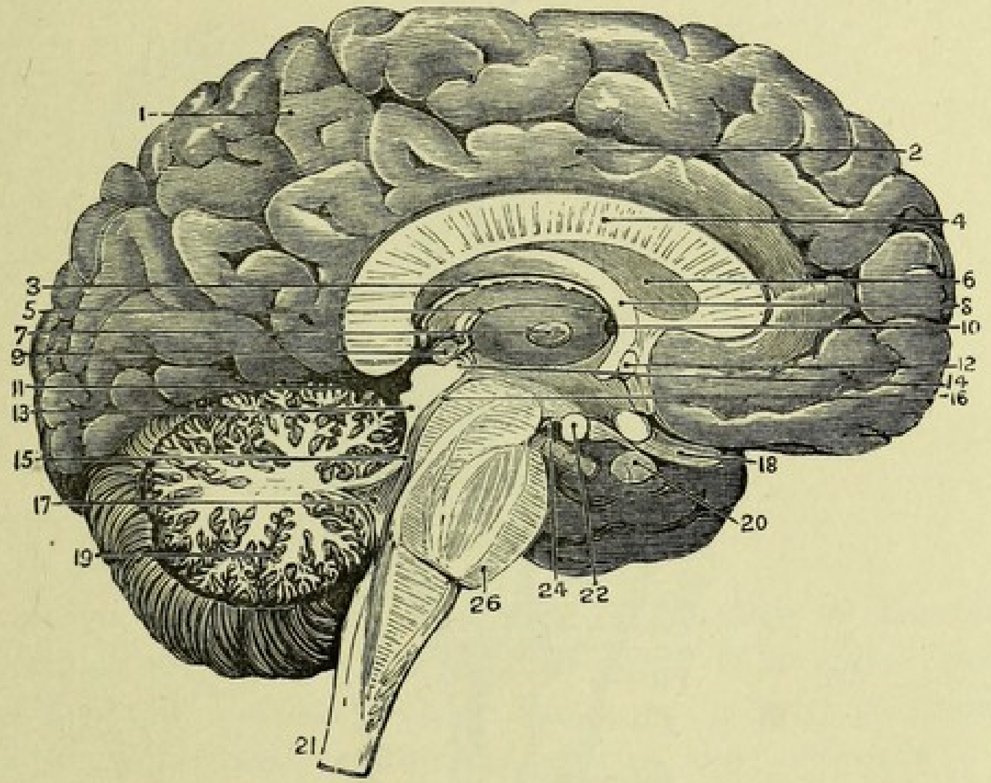
floor. The *roof* is formed by the valve of Vieussens and the inferior vermiform process of the cerebellum; the *sides* by the two superior peduncles of the cerebellum (processus ad testes) above, and below by the restiform body (Fig. 272, *r.b.*), the *funiculus cuneatus* (*f.c.*) and the *funiculus gracilis* (*f.g.*), the prolongations respectively of the

Fig. 270.—Under surface of cerebellum, the amygdalæ having been removed (from Hirschfeld and Leveillé).

1. Medulla oblongata.
2. Pons Varolii.
3. Choroid plexus of the 4th ventricle.
4. Flocculus.
5. Biventral lobe of cerebellum.
6. Nodulus of inferior vermiform process.
7. Uvula.
8. Posterior medullary velum.
9. Pyramid.
10. Slender lobe.
11. Posterior inferior lobe.

posterior lateral and posterior median columns of the cord. The cavity of the ventricle is lozenge-shaped, and it communicates above with the third ventricle by the Aqueduct of Sylvius (*iter a tertio ad quartum ventriculum*), which passes beneath the corpora quadrigemina Fig. 271, 16). Below, the fourth ventricle is closed

Fig. 271.



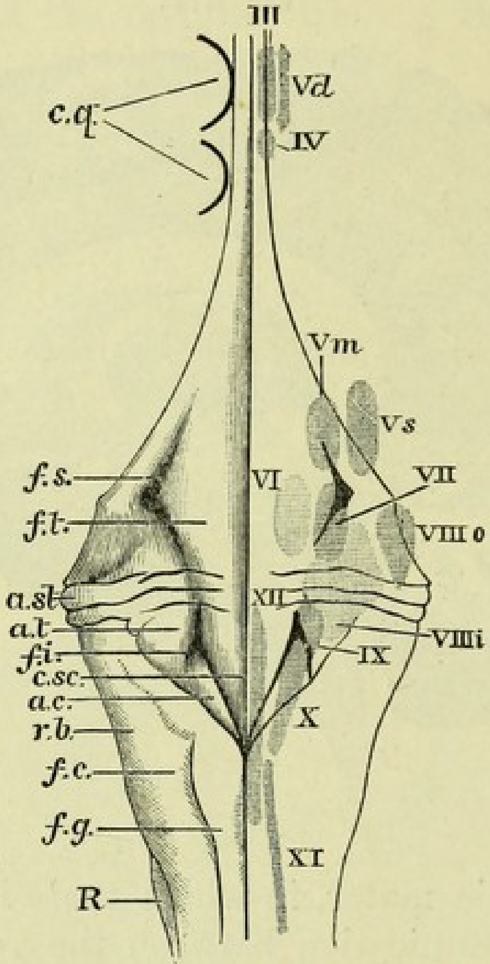
by a reflection of pia mater, in which there is usually an opening establishing a communication between the ventricles of the brain and the subarachnoid space of the spinal cord. Connected with this process of pia mater is the *Choroid plexus of the fourth ventricle* (Fig. 270, 3), which extends for some distance into the cavity.

Fig. 271.—Vertical longitudinal section of the brain (from Hirschfeld and Leveillé).

1. Convolution of longitudinal fissure.
2. Gyrus fornicatus.
3. Velum interpositum.
4. Corpus callosum.
5. Peduncle of Pineal gland on the margin of optic thalamus.
6. Septum lucidum.
7. Middle commissure of third ventricle.
8. Fornix.
9. Pineal gland.
10. Foramen of Monro.
11. Fissure of Bichât.
12. Anterior commissure.
13. Corpora quadrigemina.
14. Posterior commissure.
15. Valve of Vieussens.
16. Iter a tertio ad quartum ventriculum.
17. Fourth ventricle.
18. Optic nerve.
19. Arbor vitæ cerebelli.
20. Pituitary body and infundibulum.
21. Section of medulla oblongata.
22. Corpus albicans.
24. Locus perforatus posticus.
26. Section of pons Varolii.

In the floor of the ventricle (Fig. 272) is a median groove, which when traced downward will be found to end in a small hole, the commencement of the central canal of the spinal cord. On each side of this groove is a convex body, the *fasciculus teres* (*f.t.*), which

Fig. 272.



is white at the upper part of the ventricle, but covered below by grey matter, and is the continuation of fibres derived from the lateral tract and restiform body of the medulla. In the groove outside this eminence are two depressions, the *fovea superior* (*f.s.*) and the *fovea inferior* (*f.i.*), and below the latter is a spot of darker colour

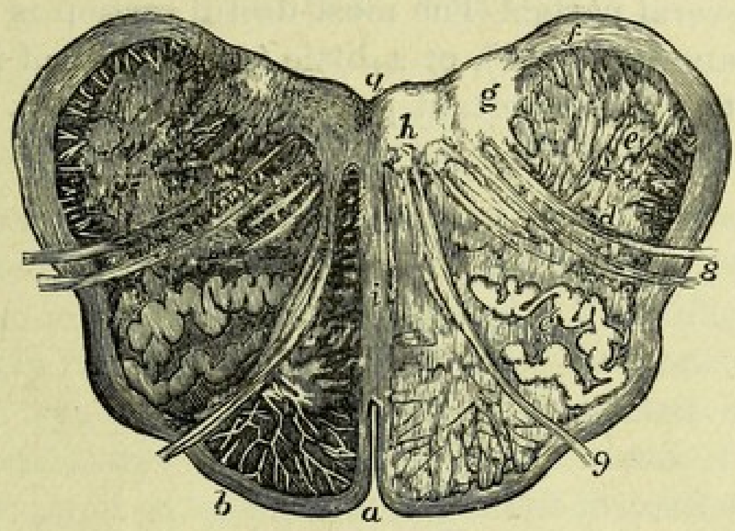
Fig. 272.—Diagram showing the position of the nerve nuclei near the floor of the fourth ventricle (after Thane).

c.q. Position of the corpora quadrigemina.
f.s. Fovea superior.
f.t. Fasciculus teres.
a.st. Auditory striæ.
a.t. Auditory tubercle.
f.i. Fovea inferior.
c.sc. Calamus scriptorius.
a.c. Area cerulea.
r.b. Restiform body.
f.c. Funiculus cuneatus.
f.g. Funiculus gracilis.
R. Tubercle of Rolando.

The Roman numbers indicate the nuclei of the corresponding nerves: V*d.* Nucleus of the descending root of 5th. V*m.* Motor nucleus of 5th. V*s.* Sensory nucleus of 5th. VIII*o.* Outer auditory nucleus. VIII*i.* Inner auditory nucleus.

than the rest called the *ala cinerea* (*a.c.*) which corresponds to the nucleus of the pneumo-gastric nerve, while on the outer side is an elevation, the *auditory tubercle* (*a.t.*) which corresponds to the inner auditory nucleus, and is crossed by some well marked white lines, *auditory striæ*, or *lineæ transversæ* (*a.s.*), which pass out into the

Fig. 273.



auditory nerve, and separate that part of the floor of the fourth ventricle which belongs to the medulla from that which corresponds to the pons Varolii. Above the superior fovea is a narrow depressed area of bluish colour called the *locus ceruleus*. The positions of the nuclei of the various nerves arising from this region are marked by Roman numbers in Fig. 272. The lower extremity of the ventricle, which is bounded on each side by the *funiculi cuneati* (*f.c.*) and *funiculi graciles* (*f.g.*), has been called the *calamus scriptorius* (*c.sc.*) from its fancied resemblance to a pen, of which the lineæ transversæ form the feathers.

By slicing vertically either hemisphere of the cerebellum, the appearance known as the *arbor vitæ* (Fig. 271, 19) will be brought into view. This is due to the peculiar arrangement of white cerebral matter within the grey matter of the external laminæ; and by careful slicing, an irregular grey body (*corpus dentatum*) will be

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Fig. 273.—Transverse section of Medulla oblongata magnified (after Stilling).

a. Anterior fissure.
q. Posterior fissure.
b. Anterior pyramid.
c. Corpus dentatum of olivary body.
d. Grey tubercle of Rolando in lateral column.
e. Restiform body, and its nucleus.
f. Nucleus of glosso-pharyngeal.
g. Nucleus of pneumo-gastric.
h. Nucleus of hypoglossal nerve.
i. Septum or raphé.
8. Pneumo-gastric nerve.
9. Hypoglossal nerve.

seen in the centre of the white matter of each hemisphere. By making a transverse section of the medulla oblongata a small *corpus dentatum* will also be seen in the olivary body of each side (Fig. 273, *c*).

When possible, the student, as soon as he has finished the above dissection, should procure another brain in order that he may make various sections of it, and so more thoroughly understand the relations of the several parts. The most useful section is one made in the median plane (Fig. 271), or a little to one side of it (Fig. 265), by which most of the important parts will be exposed.

PART VIII.

DISSECTION OF THE EYE.

In order to study the general anatomy of the globe of the eye it will be best to procure half-a-dozen bullocks' eyes, since the parts are larger than in the human eye, which also it is difficult to procure in a sufficiently recent condition. It must be borne in mind however that the eye of the bullock differs from that of man in the following particulars: the cornea is oval instead of being nearly circular; the pupil is elongated into a slit instead of being a circular aperture; the choroid coat presents the peculiar coloured appearance known as the *tapetum lucidum*, which is absent in man; and the yellow spot which is present in the human retina is wanting in the eyes of quadrupeds. The following description will be of the human eye, which the student will find no difficulty in following.

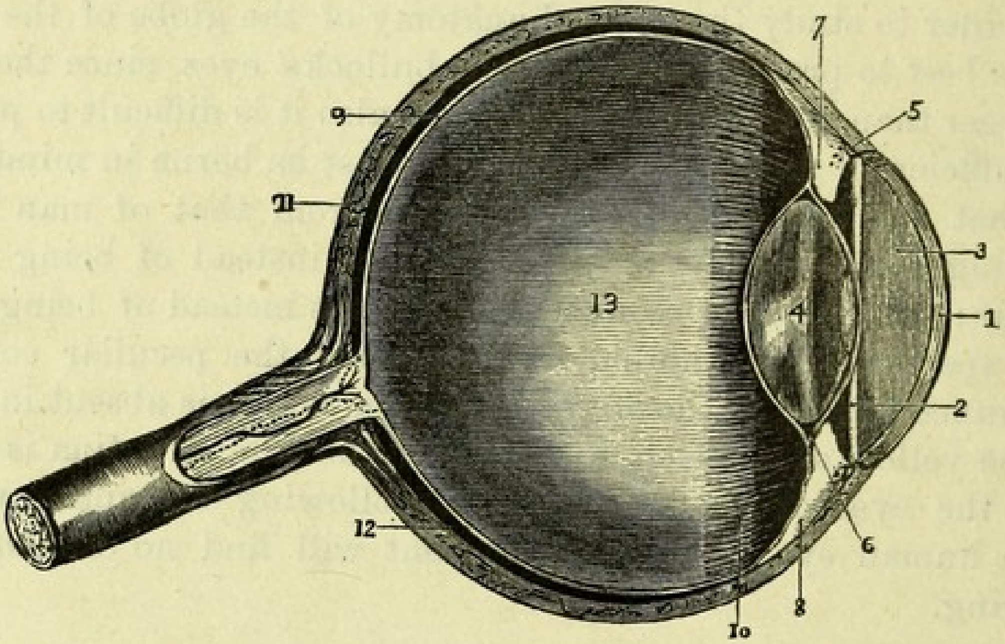
[All the fat and the remnants of the muscles of the eye are to be removed with scissors, the optic nerve being carefully preserved.]

The **Human Eyeball** (Fig. 274) is nearly globular in shape, but has a portion of a smaller sphere (the cornea) projecting anteriorly, thus making its antero-posterior greater than the transverse diameter.

The **Sclerotic** (Fig. 274, 11) or external tunic is composed of dense white fibrous tissue, and serves to maintain the shape of the eyeball and to protect the internal parts. It is thicker behind than in front, and is pierced posteriorly by the optic nerve, which enters at a distance of about its own breadth to the inner side of the axis of the eyeball. The opening in the sclerotic for the optic nerve is funnel-shaped, and the fibrils of the nerve pass through a fine fibrous tissue, which has been named *lamina cribrosa* from its numerous apertures, one of which in the centre for the *arteria centralis retinæ* has been called the *porus opticus*. The sclerotic is pierced at various points by the ciliary vessels and nerves. In front, the sclerotic gives insertion to the recti muscles, from which it receives an expansion, and in front of this point the conjunctiva is reflected upon its surface, but can be readily stripped up as far as the margin of the cornea. Around the middle of the eyeball is a loose capsule of fascia perforated by the tendons of the muscles, and called the *Capsule of Tenon.*

The sclerotic overlaps the margin of the cornea as the case of a watch does the watch-glass, and encroaches upon it slightly above

Fig. 274.



and below. The sclerotic and the cornea are inseparably united, the tissue of the two structures being continuous.

By squeezing the eyeball between the finger and thumb the cornea will be rendered white and opaque, but will resume its former appearance when the pressure is relaxed.

The **Cornea** (Fig. 274, 1) is one of the transparent media of the eye; and in man is perfectly circular when seen from within, but

---

Fig. 274.—Longitudinal section of the eye (drawn by H. Power).

1. Cornea.
2. Iris.
3. Anterior chamber communicating with the posterior chamber through the pupil.
4. Lens enclosed in its capsule.
5. Canal of Fontana.
6. Canal of Petit.
7. Ciliary body and process.
8. Ciliary muscle.
9. Retina.
10. Ciliary zone.
11. Sclerotic.
12. Choroid.
13. Vitreous humour.

appears wider transversely from without, on account of the greater overlapping of the sclerotic above and below.

The curvature of the cornea varies in different individuals, but the anterior and posterior surfaces are always parallel. The cornea is divisible into five layers: 1, anterior epithelium (conjunctiva); 2, anterior elastic lamina; 3, cornea proper; 4, posterior elastic lamina; 5, posterior epithelium (of aqueous humour). The cornea in health is a non-vascular structure, no blood-vessels existing in it, and its nourishment being derived from the surrounding structures. Minute branches of the ciliary nerves have however been traced into and through it.

[Holding the eye lightly with the left hand, the scalpel is to be thrust through the margin of the cornea into the anterior chamber, when the aqueous humour will necessarily escape. With scissors the cornea may then be removed entirely.]

The **Anterior Chamber** (Fig. 274, 3) is the space between the cornea and the iris. It communicates with the posterior chamber through the pupil, and is filled with the aqueous humour.

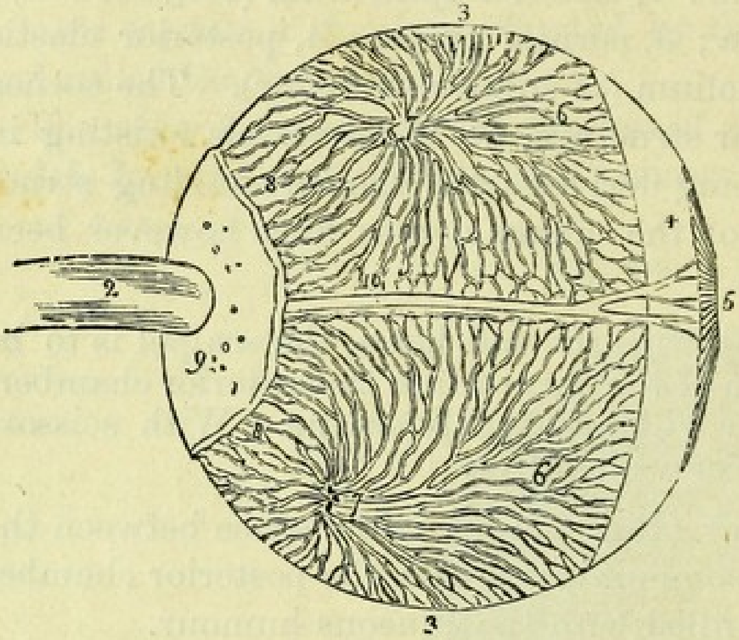
The **Iris** (Fig. 274, 2) is the highly vascular curtain which separates the anterior from the posterior chamber. It is composed of involuntary muscular fibres, blood-vessels, and pigment, and may be considered to be a prolongation of the choroid coat. In man, the pigment of the iris is of various colours, but it is absent altogether in albinos, and occasionally the iris itself is wanting. The *Pupil* is a circular opening (in man) in the centre of the iris, which varies in size according to the contraction of the circular fibres of the iris under the influence of light.

The **Posterior Chamber** is smaller than the anterior, and can be hardly said to exist when the aqueous humour has been let out. It is between the iris and the anterior layer of the capsule of the lens.

[In order to see the choroid coat entire, a fresh eye should be taken, and a puncture having been made through the sclerotic, about its middle, a blowpipe is to be introduced, through which air may be forced between the sclerotic and choroid coats, and they will thus be separated from one another. The sclerotic may then be cautiously divided circularly, and the posterior cup-like portion of the sclerotic being left as a support to the eye, the anterior part (with the cornea) is to be carefully detached from the choroid. In order to do this it will be necessary to scrape the interior of the sclerotic with the handle of the scalpel near its junction with the cornea, so as to tear through the ciliary muscle which attaches the choroid and iris to the sclerotic coat.]

The **Choroid Coat** (Fig. 275, 3) is a vascular structure containing pigment, expanded over the whole of the posterior portion of the globe of the eye, and continuous in front with the iris. It is pierced by the optic nerve, at which point it is closely connected to the sclerotic; but is attached to the inner surface of that coat only by a delicate fibrous tissue, called the *membrana fusca.* On the outer surface of the choroid may be seen (in an injected specimen) the loops of blood - vessels; the name *vasa vorticosa* has been given to the veins; the arteries are derived from the ciliary branches of the ophthalmic. Within this is the *tunica Ruyschiana*, a plexus of capillaries. The dark pigment of the choroid is interspersed among the vessels, and is washed out when the eye is immersed in water.

Fig. 275.



Surrounding the iris is a ring which is the **Ciliary Muscle** (Fig. 274, 8), composed of unstriped fibre and having a grey appearance. The anterior part of the ciliary muscle is connected with the sclerotic coat, and the posterior part is attached to that portion of the choroid which is called the ciliary body, and from which the ciliary processes pass inwards to be connected with the capsule of the lens. Thus the ciliary muscle, by drawing forward the anterior part of the choroid, relaxes the suspensory ligament of the lens and allows its own elasticity to come into play, in consequence of which the

---

Fig. 275.—The choroid coat and the distribution of the vasa vorticosa (from Wilson, after Arnold).

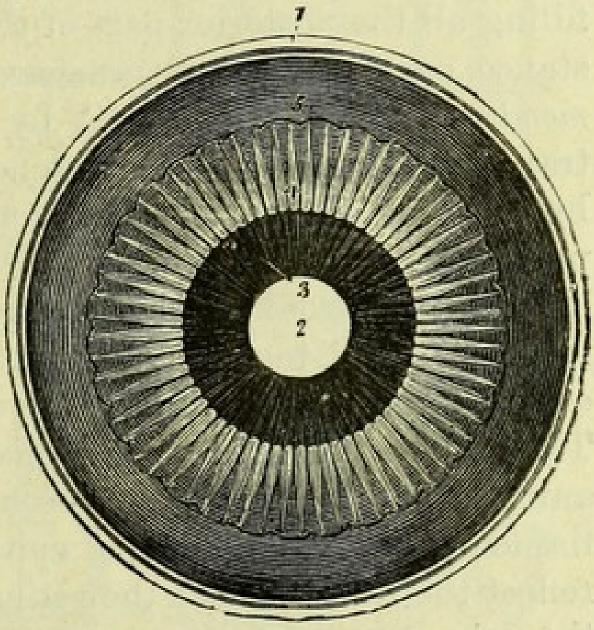
1. Part of the sclerotic coat.
2. Optic nerve.
3, 3. Choroid coat.
4. Ciliary muscle.
5. Iris.
6, 6. Vasa vorticosa.
7, 7. Trunks of the vasa vorticosa at the point where they have pierced the sclerotica.
8, 8. Posterior ciliary veins which leave the eyeball in company with the posterior ciliary arteries, by piercing the sclerotic at 9.
10. One of the long ciliary nerves, accompanied by a long ciliary artery.

lens increases in thickness in order to accommodate the focus of the eye to near objects.

[In order to see the ciliary body and processes, a third eye should be divided circularly through the sclerotic and choroid coats, without damaging the vitreous humour; the vitreous humour and lens are then to be carefully separated from the anterior part of the choroid, the ciliary processes being detached from the hyaloid membrane, upon which they will leave a circle marked with more or less pigment (circle of Zinn). The ciliary processes and iris are now seen from behind. If the lens and vitreous humour be drawn out of the fundus of an eye and left attached to the ciliary processes, a magnified view of these will be obtained.]

The **Ciliary Body** (Fig. 274, 7) is the thickened portion of the choroid from which the **Ciliary Processes** (Fig. 276, 4) project towards the centre of the eye. These are vascular fringes, which resemble a series of plaits in appearance, and which form a circular curtain parallel but posterior to the iris, from which they are separated by the *posterior chamber*. They fit into a corresponding series of grooves in the hyaloid membrane of the vitreous humour and together constitute the *ciliary zone*.

Fig. 276.



Between the anterior margin of the sclerotic and the ciliary body is a minute canal, which runs round the entire circumference of the eye and is called the *Canal of Fontana* (Fig. 274, 5).

[The lens will be seen on the posterior half of this section, or may be shown on the first eye by carefully removing the iris.]

The **Lens** (Fig. 274, 4) is situated in front of the vitreous humour, and is contained in a delicate and perfectly transparent *capsule*, which is united behind with the hyaloid membrane of the

Fig. 276.—Anterior half of the eye, seen from within (from Wilson).

1. Divided edge of the three coats; sclerotic, choroid (the dark layer), and retina.
2. Pupil.
3. Posterior surface of the iris.
4. Ciliary processes.
5. The anterior border of the retina (ora serrata)

vitreous humour. The capsule is kept in its place by the *suspensory ligament of the lens*, a transparent membrane which passes from the ciliary processes to the capsule in front of the hyaloid membrane. By tearing through the capsule (as in the operation for extraction of cataract), its existence will be demonstrated and the lens itself allowed to escape.

The lens is bi-convex, but the posterior surface has a greater curve than the anterior. It is perfectly transparent in health, but has a complicated structure, consisting of fibres arranged around three axes running in different directions, of which indications are usually visible in the bullock's eye. The exterior of the lens readily breaks down, but the interior or nucleus is very dense.

The **Canal of Petit** (Fig. 274, 6) is a minute space surrounding the lens immediately around the capsule, and is bounded in front by the suspensory ligament and behind by the hyaloid membrane.

The **Vitreous Humour** (Fig. 274, 13) is the transparent body filling all the posterior part of the eyeball. It is a gelatinous substance contained in a transparent membrane called the *hyaloid membrane*, and is traversed by numerous delicate and perfectly transparent septa. The existence of these may be demonstrated by crushing the vitreous humour with the fingers, when the fluid portion will drain away.

In the eye from which the vitreous humour has been removed the retina will fall together, leaving the inner surface of the choroid exposed, and in the bullock's eye the *tapetum lucidum* will be seen. This is the coloured appearance which is peculiar to the lower animals, and is due to the presence of a thick layer of wavy fibrous tissue outside the choroidal epithelium. The object of this is to reflect the rays through the retina a second time, and thus to enable the animal to see with a very small amount of light.

[The retina is best seen by looking through the vitreous humour of an eye from which the iris and lens have been removed.]

The **Retina** (Fig. 274, 9) is the nervous coat of the eye and its essential part. It lines the choroid coat, being connected posteriorly with the optic nerve, and extends in front nearly as far forward as the ciliary body, where it terminates about one-eighth of an inch behind the margin of the cornea in a finely jagged border, the *ora serrata*, being thicker behind than in front. During life the retina is transparent, so that the vascular choroid can be seen through it with the ophthalmoscope; but after death it has a greyish colour, and is thrown into folds, owing to the diminution of the tension of the globe.

The entrance of the optic nerve may be seen about one-tenth of an inch to the inner side of the axis of the eye, and radiating from this may be seen the branches of the *arteria centralis retinæ* and its accompanying veins, which pierce the sclerotic at this point. In the axis of the eyeball in the human eye is the *yellow spot of Soemmering*, the most sensitive point, which consists of a small elevation, in the centre of which is a minute depression, the *fovea centralis*.

The retina (Fig. 278) consists of eight layers with two delicate limiting membranes, which are arranged as follows, beginning from the inner surface:—A. The *membrana limitans interna*. 1. The *fibrous* layer continuous with the optic nerve (the fibrillæ of which here lose their white substance of Schwann), and having numerous ganglionic cells and nuclei developed in it. 2. The

Fig. 277.

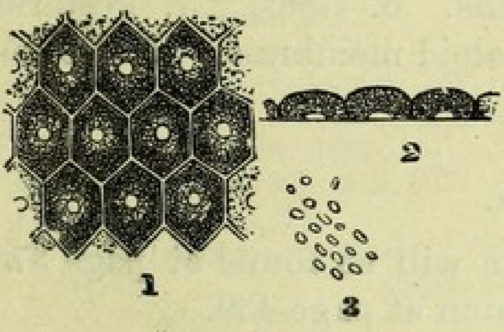


Fig. 278.

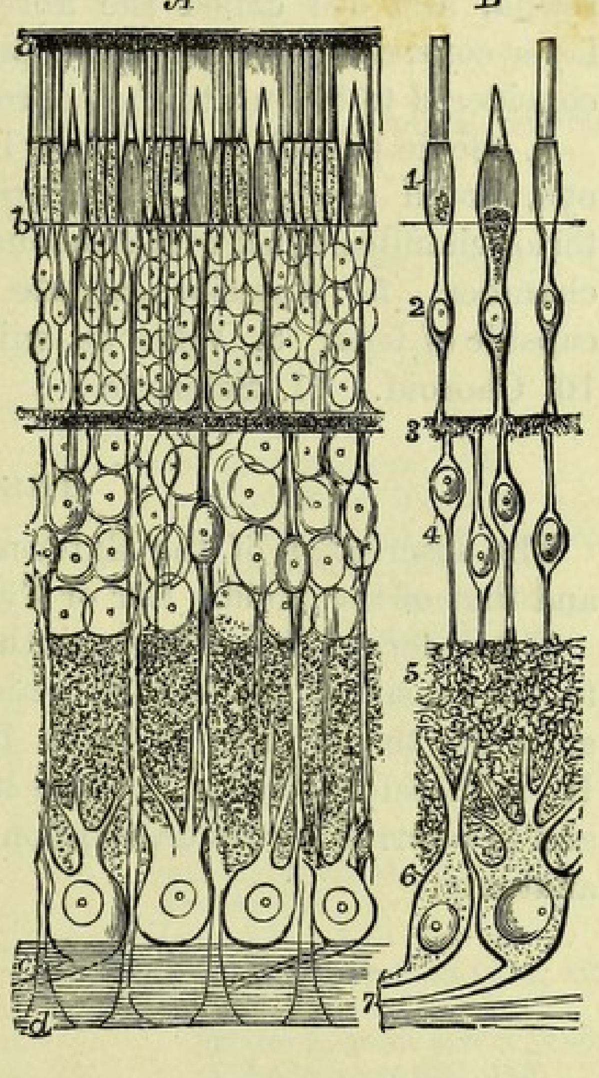


Fig. 277.—Pigmentary layer of the retina.
1. The surface. 2. Cells seen edgeways. 3. Pigment.

Fig. 278.—The Retina (from Schultze).

A. The structures viewed *in situ*.
B. The supposed connection of the several layers.
1. Baccillary layer (rods and cones).
2. Outer nuclear layer.
3. Outer molecular layer.
4. Inner nuclear layer.
5. Inner molecular layer.
6. Ganglionic layer.
7. Fibrous layer.
a. Pigmentary layer.
b. External limiting membrane.
c. Rods of Müller.
d. Internal limiting membrane.

ganglionic layer consisting of nerve cells of spheroidal or pyriform shape. 3. The *inner molecular* layer. 4. The *inner nuclear* layer consisting of transparent nucleus-like bodies. 5. The *outer molecular* layer much thinner than the inner one. 6. The outer *nuclear* layer. b. The *membrana limitans externa*. 7. The outer layer or *Jacob's membrane* consists of a peculiar arrangement of particles to which the name *rods* and *cones* has been given. These rods are continuous with some fibres which pierce the whole depth of the retina, and are called the fibres of Müller. 8. The *pigmentary* layer consisting of hexagonal pigment cells, which were formerly considered to belong to the choroid coat (Fig. 277).

A needle passed from before backwards through the axis of the eye, would pierce the following structures:—1. Cornea. 2. Anterior chamber filled with aqueous humour. 3. Pupil. 4. Posterior chamber. 5. Anterior capsule of lens. 6. Lens. 7. Posterior capsule of lens. 8. Vitreous, with hyaloid membrane. 9. Retina. 10. Choroid. 11. Sclerotic.

The Ear.

The description of the External Ear will be found at page 376, and that of the Middle Ear or Tympanum at page 439.

The Internal Ear or Labyrinth is so difficult of dissection, owing to the density of the bone in which it is embedded, that it is impossible for the student to make its dissection with any advantage. He is therefore advised to study its anatomy on prepared specimens, and is referred for its description to works on general and minute anatomy.

INDEX.

THE END.

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15. Abdominal viscera immediately under the surface.
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17. Inferior mesenteric artery and the cœliac axis.
18. Abdominal muscles, arteries, veins, and nerves.

19, 20. Parts concerned in the anatomy of inguinal and femoral hernia.

21. Perineum, with the anatomy of the perineal space.

[*See also next page.*

22. Parts exposed by removal of the triangular ligament. Section of the male pelvis.
23. Side view of the pelvis, with its muscles, arteries, and nerves.
24. Pelvic fascia, bladder, prostate, urethra, and rectum.
25. Sacral plexus and abdominal viscera, from behind.
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27. Contents of the left side of the thorax after removal of the lung.
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29. View obtained after removal of the back of the thoracic parietes.
30. Anterior mediastinum, pleural sacs, anterior borders of the lungs, and the pericardium.
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34. Inner and upper part of the thigh and its relation to the pelvis.
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36. Back of the knee-joint. The popliteal space.
37. Back of the leg.
38. Tibialis posticus. Inner and outer sides of the ankle and foot.
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41. The axilla and surrounding regions.
42. The pectoral regions.
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44. Structures at the back of the arm.
45. The front and inner side of the arm.
46. The front of the forearm and of the palm of the hand.
47. The front of the forearm and outer side of forearm and hand.
48. The back of the forearm and hand.

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