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A TEXT-BOOK

OF

NAKED-EYE ANATOMY:

BEING

An Accompanying Text to Masse's Plates.

BY

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THIRD EDITION.

ILLUSTRATED WITH 113 PLATES ENGRAVED ON STEEL,

AFTER DESIGNS BY, AND UNDER THE DIRECTION OF,

PROFESSOR MASSE.

LONDON:

BAILLIÈRE, TINDALL, AND COX,

20, KING WILLIAM STREET, STRAND.

1886.

PREFACE TO THE THIRD EDITION.

THE idea of extending the text of Masse's work from a description of the plates simply, to a descriptive text of naked-eye anatomy generally, is the most marked advance in this edition. The first and second editions, written by Mr. Bellamy, have been supplemented, at his suggestion, by the additions in this, the third edition.

Microscopic anatomy and development have been avoided as much as possible, and the bare facts of naked-eye anatomy adhered to. Uninteresting and unscientific as these omissions may stamp the work, they have been committed after due consideration, and after serious deliberation with those competent to judge of such matters.

The Author was induced to undertake this work in the belief that the coloured steel-plates of Masse's were unique of their kind, were admirably executed, and were excellent means of affording an exact knowledge of anatomy, so far as that is possible from plates.

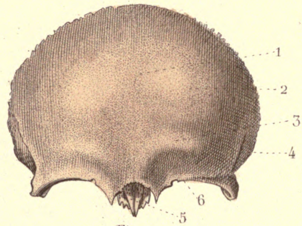
The Author has to thank W. H. Elam, F.R.C.S., late Senior Assistant Demonstrator, and Mr. Pisani and Mr. Braine, Assistant Demonstrators of Anatomy, Charing Cross Hospital, for help with the text and for much valuable aid.

J. C.

14, SUFFOLK STREET, PALL MALL,
January 1st, 1886.

Pl. I.

Fig. 1.



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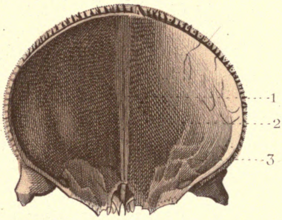

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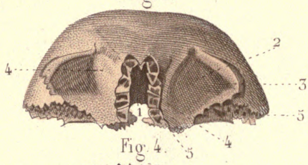

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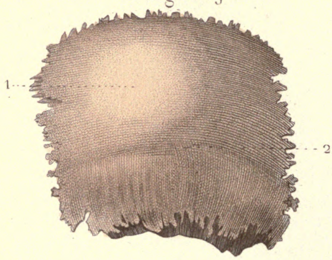


Corbié del. et sc.

MASSE'S PLATES,

WITH SHORT DESCRIPTIVE TEXT.

PLATE I.

Fig. 1. FRONTAL BONE (*anterior surface*).

1. Mesial line, in which are seen the remains of the frontal suture.—2. Frontal eminence.—3. Superciliary ridge.—4. Portion of the temporal ridge and of the temporal fossa.—5. Nasal spine and notch.—6. Orbital ridge, which has on its internal third the supra-orbital notch, and at its extremities the internal and external angular processes.

Fig. 2. FRONTAL BONE (*posterior surface*).

1. Portion of the groove for the superior longitudinal sinus, terminated by the crista galli.—2. Frontal fossa.—3. Orbital eminence.

Fig. 3. FRONTAL BONE (*inferior surface*).

1. Ethmoidal notch.—2. Orbital plate.—3. Fossa for lachrymal gland.—4. Depression for the pulley of the superior oblique.—5. Surfaces articulating with the sphenoid bone.

Fig. 4. RIGHT PARIETAL BONE (*external surface*).

1. Parietal eminence.—2. Temporal ridge.

The FRONTAL BONE consists of two parts, a Vertical and Horizontal.

The *Vertical* portion shows in the median line a groove, a ridge, or remains of a suture, marking the spot where the two original pieces of the bone came together and united. It presents two aspects, an anterior and posterior.

The anterior aspect shows on either side the two frontal eminences; above these the bone is nearly horizontal, and below these are seen the superciliary ridges running upwards and outwards from the root of the nose and the two supra-orbital arches. Each arch terminates at the internal and external angular processes, and presents on the internal third the supra-orbital notch or foramen.

The posterior aspect shows in the centre the groove for the superior longitudinal sinus, and on either side the ridges to which the falx cerebri is attached. The general surface shows the shallows and eminences corresponding to the convolutions and sulci of the brain.

The *Horizontal* portion consists of two triangular plates, separated by the ethmoidal notch. Each plate has an upper and lower surface. The upper or cerebral surface is convex, and has markings for the brain. The under or orbital surface is smooth and concave; it presents a depression internally for the pulley of the superior oblique muscle, and a fossa externally for the lachrymal gland.

The ethmoid notch shows on either side unclosed air-cells.

Running up from the external angular process is a ridge of bone, continuous with the temporal ridge. Below its level, the frontal bone forms part of the temporal fossa.

Development.—By two centres which appear at the fourth week, and unite along the middle line about the third year.

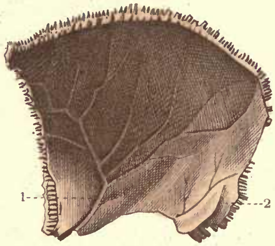
Articulations (with twelve bones):

Cranial.—Ethmoid, Sphenoid, and two parietal.

Facial.—Two superior maxillary, two malar, two nasal, two lachrymal.

Pl. 2.

Fig. 1.



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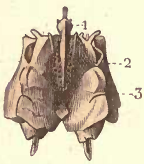

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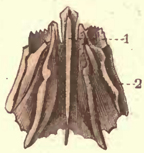

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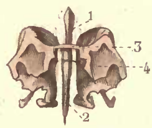

Fig. 5.

Fig. 6.

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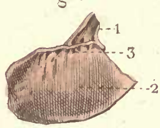

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PLATE II.

Fig. 1. Right Parietal Bone (*internal surface*).

1. Groove for middle meningeal artery.—2. Groove for the lateral sinus.

Fig. 2. Ethmoid Bone (*superior surface*).

1. Crista galli.—2. Cribriform plate of the ethmoid.—3. Anterior ethmoidal foramen.

Fig. 3. Ethmoid (*inferior surface*).

1. Perpendicular plate.—2. Lateral mass of ethmoid.

Fig. 4. Ethmoid, seen from behind.

1. Crista galli.—2. Perpendicular plate.—3. Cribriform plate.—4. Posterior ethmoidal cells.

Fig. 5. Ethmoid, seen from the front. 1. Crista galli.—2. Perpendicular plate.—3. Anterior ethmoidal cells.

Fig. 6. Ethmoid (*external surface*). 1. Os planum.

Fig. 7. Ethmoid (*internal surface*). 1. Superior turbinated bone. 2. Superior meatus.—3. Middle turbinated bone.

Fig. 8. 1. The crista galli.—2. The perpendicular plate.—3. The cribriform plate.

The Parietal Bone presents for examination:

1. Two aspects: (*a*) The External, presents the parietal eminence and the temporal ridge. The part above the ridge belongs to the scalp, the part below to the temporal fossa. (*b*) The Internal aspect exhibits the depressions and elevations for the convolutions of the brain; the depressions for the Pacchionian bodies; the grooves for the middle meningeal artery—especially at the anterior inferior angle; the groove for the lateral sinus along the upper border; and the groove for the lateral sinus at the posterior inferior angle.

2. The angles are: anterior superior, anterior inferior, posterior superior, and posterior inferior.

3. The borders are: superior, inferior, anterior, and posterior.

It *articulates* with five bones: The parietal, the occipital, the temporal, the sphenoid, and the frontal.

It is *developed* in membrane from one centre, which appears at the fifth week of fœtal life.

The Ethmoid Bone consists of:

(*a*) A horizontal plate—forming part of the base of the cranium.

(*b*) A perpendicular plate—the septum nasi.

(*c*) Two lateral masses—which contain air-cells.

(*a*) The *horizontal plate*, called cribriform, presents in the centre a smooth triangular process of bone—the *crista galli.* Its posterior border is rather long and curved, and gives attachment to the falx cerebri. Its anterior border articulates with the frontal bone and completes the foramen cæcum behind. At the front part of the cribriform plate, on each side of the crista galli, is a small slit, for the passage of the nasal twig of the ophthalmic nerve.

This plate supports the olfactory lobes and gives passage by three rows of foramina on either side to the olfactory nerves.

(*b*) The *perpendicular plate*, thin and flat, descends from under the surface of the cribriform plate. It is thinner at the centre than at the circumference, is generally bent a little on one side, and partly forms the septum of the nose.

Its anterior border articulates with the frontal spine and crest of the nasal bones. Its posterior border is connected by its upper half with the septum of the sphenoid and by its lower half with the vomer. Its inferior border has attached to it the triangular cartilage of the nose. On either side grooves are seen, leading from the foramina above mentioned. They lodge filaments of the olfactory nerve.

(*c*) The *lateral masses* consist of thin-walled, cellular cavities (ethmoid cells), placed between two plates of bone, the outer plate forming part of the inner wall of the orbit, the inner, part of the nasal fossa.

When the bone is disarticulated, many of the cells seem to be broken, but when the bone is articulated they are entirely closed in by the neighbouring bones.

Two grooves are seen crossing the upper border on each side; they are closed in by articulation with the frontal bone, and are the *anterior and posterior ethmoidal foramina*, which open on the inner and upper wall of the orbit; they serve for the passage of vessels and nerves.

The *outer* surface is formed by a square plate of bone called the *os planum.* It forms part of the inner wall of the orbit, and articulates above with the orbital plate of the frontal; below, with the superior maxillary and orbital process of the palate; in front with the lachrymal, and behind with the sphenoid bone.

From the lower part of the lateral mass, immediately beneath the os planum, projects downwards and backwards a hook-like process, called the *unciform* process; it serves to close in the upper part of the antrum of Highmore, and articulates with the ethmoidal process of the inferior turbinated bone. From the *inner* surface are seen to project two curved bones, the superior and middle turbinated bones. Between the two is a space called the superior meatus of the nose, and above the upper a recess called the fourth meatus.

Development.—By three centres—one for the perpendicular plate, and one for each lateral mass. The former appearing in the first year, the latter at the fourth month.

Articulations.—With thirteen bones—two for the cranium, and eleven for the face, *viz.:* (*a*) cranial, sphenoid and frontal: (*b*) facial, eleven: two nasal, two superior maxillary, two lachrymal, two palate, two superior turbinated, and vomer. The sphenoidal turbinated, reckoned as separate bones, would raise the number to fifteen.

PLATE III.

Fig. 1. OCCIPITAL BONE (*external surface*).

1. External occipital protuberance.—2. External occipital crest.—3. Foramen magnum.—4. The basilar process.—5. Superior curved line.—6. Inferior curved line.—7. The condyle.

Fig. 2. OCCIPITAL BONE (*internal surface*).

1. Groove for superior longitudinal sinus.—2. The groove for the lateral sinuses.—3. Internal occipital crest.—4. Superior occipital fossa.—5. Inferior occipital fossa.

Fig. 3. SPHENOID BONE (*superior surface*).

1. Sella turcica.—2. Optic foramen.—3. Quadrilateral plate.—4. Lesser wing.—5. Greater wing.—6. Sphenoidal fissure.—7. Foramen rotundum.—8. Foramen ovale.—9. Foramen spinosum.

Fig. 4. SPHENOID BONE, SEEN FROM THE FRONT.

1. Septum.—2. Sphenoidal cells.—3. Orbital surface of greater wing.—4. Temporal aspect of greater wing.

Fig. 5. TEMPORAL BONE (*external surface*).

1. Temporal fossa.—2. Zygomatic process.—3. Temporal ridge.—4. Glenoid cavity.—5. External auditory meatus.—6. Mastoid process.—7. Mastoid foramen.

Fig. 6. TEMPORAL BONE (*internal surface*).

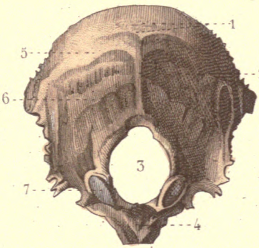
1. Petrous portion.—2. Internal auditory foramen.—3. Styloid process.—4. Groove for lateral sinus.

The OCCIPITAL BONE presents A, two aspects; B, four angles and four borders.

A. The *external* aspect presents a prominence—the external occipital *protuberance*, for muscular and ligamentous attachment. Above this, the bone is covered by the posterior belly of the occipito-frontalis muscle. From the protuberance the *crest* runs down to the foramen magnum; on either side the superior curved line runs outward to the lateral angles; from half way down the crest the inferior curved lines run outward to the margin of the bone. On either side of the foramen magnum are seen the *condyles;* they lie in front of a line drawn transversely across the middle of the foramen magnum. Behind both condyles are seen the posterior condyloid fossæ (in some cases foramina); in front of both are seen the anterior condyloid foramina, and on either side of both the jugular process.

Pl. 3.

Fig. 1.



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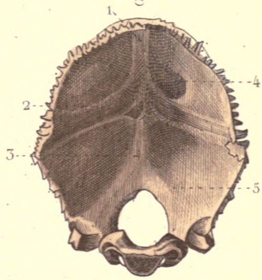

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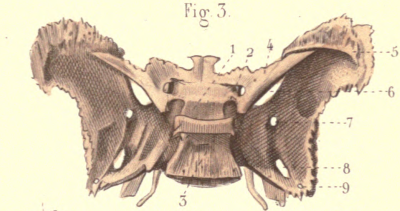

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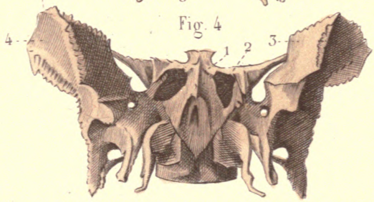

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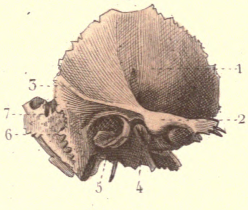

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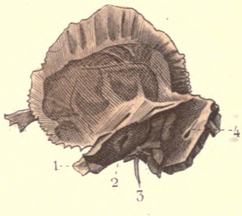

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The part in front of the foramen magnum is called the basilar process, and about its centre is seen the pharyngeal spine.

The *internal* aspect presents behind the foramen magnum the Torcular Herophillii—a depression at one or other side of the internal occipital protuberance; running upwards from this is the groove for the superior longitudinal sinus, downwards the internal occipital crest, and laterally the grooves for the lateral sinuses. The fossæ formed by this crucial arrangement are two above for the cerebrum, two below for the cerebellum. B. The *angles* are superior, inferior, and two lateral. The *borders* are two superior—and two inferior—lateral. The superior lateral borders articulate with the parietals, the inferior lateral with the mastoid and petrous portion of the temporals.

In front of the foramen magnum is the concave surface of the basilar process, and on either side is seen the cranial aspect of the jugular process, having a groove for the lateral sinus. The *jugular* process is a short blunt piece of bone with two surfaces and four borders; its *surfaces* are the upper or cranial, marked by the jugular sinus; the under surface for muscular attachment—the rectus capitis lateralis muscle; the anterior *border* is grooved for the jugular vein; the external articulates with the jugular surface of the petrous portion of the temporal; the posterior, and internal, are continuous with the bone.

Articulations.—Two parietal, two temporal, sphenoid, and the atlas.

Development.—By four pieces: one for the basilar, which appears about the seventh week; two for the condyloid processes, which appear about the eighth week, and a group of four for the posterior or tubular portion. The basilar portion unites with the condyloid processes at the fourth year, the posterior or tubular portion with the condyloid processes at the sixth year.

The TEMPORAL BONES are placed at the side and base of the skull, and may be described in three parts: the Squamous, Mastoid, and Petrous.

A. The *Squamous* portion extends forwards and upwards from its connection with the other portions. It is scale-like in shape. It presents for examination two surfaces—inner and outer.

1. The *inner* surface is concave, and presents numerous eminences and depressions for the convolutions of the brain, and some well marked grooves for the branches of the middle meningeal arteries. At its upper part the outer table is prolonged considerably higher than the inner, presents a fluted appearance, and articulates with the lower border of the parietal bone. In front the border is thicker, where it articulates with the great wing of the sphenoid.

2. The *outer* surface is convex, smooth, and forms part of the temporal fossa; it gives attachment to the temporal muscle. Pro-

jecting from its lower part is a long process of bone—the *zygomatic process.* This process is at first directed outwards, its two surfaces being superior and inferior; it then becomes narrower, and is twisted on itself so as to present an outer and an inner surface. The superior margin is thinner, and prolonged further forwards than the inferior, which ends in a serrated border and articulates with the malar bone. At its base the zygomatic process presents three roots —anterior, middle, and posterior. The anterior root is short, and runs transversely inwards into a rounded eminence—the eminentia articularis—which bounds the glenoid fossa in front, and in the recent state is covered with cartilage. The middle root forms the outer boundary of the glenoid fossa; running inwards, it terminates at the commencement of the fissure of Glaser. The posterior root, well marked, runs upwards and backwards, forming the posterior part of the temporal ridge. At the junction of the anterior root with the zygoma is a projection—the tubercle—to which the external lateral ligament of the jaw is attached. Between the anterior and middle roots is a depression—the glenoid fossa—which, together with the eminentia articularis, forms the concavo-convex surface, for articulation with the lower jaw. Just behind the glenoid fossa is a transverse slit—the Glaserian fissure—which leads to the tympanum and lodges the processus gracilis of the malleus. The chorda tympani nerve passes through a separate canal (the canal of Huguier), parallel to the Glaserian fissure.

B. The *Mastoid* portion is placed at the posterior part of the bone. Its *outer* surface is rough and perforated by numerous foramina; one of larger size, placed at the posterior part of the bone, is called the mastoid foramen, and transmits a vein to join the lateral sinus. The mastoid portion is continued below into a conical projection—the mastoid process—which gives attachment by its outer surface to the sterno-mastoid, splenius capitis, and trachelo-mastoid muscles. On the inner side of this process is a deep groove—the digastric groove—for the attachment of the digastric muscle; running parallel with it internally is another groove—the occipital groove—which lodges the occipital artery. The mastoid process is hollowed out into a number of spaces, called the mastoid cells; they open into the back part of the tympanum.

The *internal* surface of the mastoid portion is marked by a deep groove which forms part of the groove for the lateral sinus.

Borders.—The superior border is broad, and serrated for articulation with the posterior inferior angle of the parietal bone. The posterior border, also serrated, articulates with the inferior border of the occipital bone, between its lateral angle and jugular process.

C. The *Petrous* portion, named from its extreme hardness, is pyramidal in shape, wedged in the base of the skull between the occipital and sphenoid bones. It is directed forwards, inwards, and downwards. It has an apex, base, three surfaces, and three borders, and contains in its interior the organ of hearing. The base lies against the inner surface of the mastoid and squamous portions, the upper half being concealed, but the lower half is exposed by the divergence of these two portions, which show an oval orifice—the external auditory meatus. The apex, placed between the great wing of the sphenoid and the basilar portion of the occipital, forms the posterior and external boundary of the middle lacerated foramen.

1. The anterior surface is continuous with the squamous portion and presents six points for examination: 1. Near the apex, the inner opening of the carotid canal; 2. Above this a shallow depression for the reception of the Casserian ganglion; 3. A shallow groove —the hiatus fallopii—for the passage of the great petrosal nerve; 4. A small opening external to this for the passage of the small petrosal nerve; 5. Near the centre, an eminence which indicates the situation of the superior vertical semicircular canal; 6. On the outer side of this a depression corresponding to the roof of the tympanum.

2. The posterior surface is continuous with the inner surface of the mastoid portion, and presents three points: 1. About the centre a large orifice—the internal auditory meatus; it transmits the facial and auditory nerves and the auditory artery from the basilar; 2. Behind this a small slit—the aqueductus vestibuli—which transmits a small artery and vein; 3. Between and above these two openings an angular depression which lodges a process of dura mater.

3. The inferior surface, rough and irregular, forms part of the base of the skull. It presents eleven points for examination. Commencing at the apex: 1. A rough quadrilateral surface for the attachment of muscles; 2. The external opening of the carotid canal, which runs at first vertically, and then, bending, runs horizontally forwards and inwards: it transmits the carotid artery; 3. The aqueductus cochleæ transmits a small vein from the cochleæ to join the internal jugular; 4. A small foramen for the passage of Jacobson's nerve (tympanic branch of the glosso-pharyngeal) in the bony ridge separating the carotid canal from the jugular fossa; 5. A deep depression—the jugular fossa—it forms part of the jugular foramen or posterior lacerated foramen; 6. A small foramen on the inner wall of the jugular fossa for the passage of Arnold's nerve (auricular branch of the vagus); 7. Behind the jugular fossa a square piece of bone—the jugular surface—which articulates with the jugular process of the occipital; 8. The vaginal process, a thin plate of bone splitting behind to enclose 9. The styloid process, directed downwards, forwards, and slightly inwards: it gives attachment to the stylo-

pharyngeus, stylo-hyoid, and stylo-glossus muscles, and the stylo-hyoid and stylo-maxillary ligaments; 10. The stylo-mastoid foramen, placed between the styloid and mastoid processes: it transmits the facial nerve and stylo-mastoid artery; 11. The auricular fissure, between the vaginal and mastoid processes, gives exit to the auricular branch of the vagus.

Borders.—The *superior*, the longest, is grooved for the superior petrosal sinus, and has attached to it the tentorium cerebelli. The *posterior* border: its outer half presents a deep notch—the jugular fossa—which with a similar notch on the occipital forms the jugular foramen; its inner half is marked by a groove for the inferior petrosal sinus. The *anterior* border, also divided into two parts—the outer joined to the squamous portion, the inner articulating with the spinous process of the sphenoid.

Articulations.—(*a*) Cranial: the sphenoid, occipital and parietal. (*b*) Facial: the malar and lower jaw.

Development.—By three centres. The squamo-zygomatic appears at the seventh week; the petro-mastoid at the sixth month; and the tympanic ring round the meatus at the third month.

The SPHENOID BONE is situated at the anterior part of the base of the skull, where it articulates with all the other bones of the cranium. In shape it resembles a bat with extended wings, and may be described as having a body, two greater and two lesser wings, and two processes—the pterygoid processes—which project downwards. The sphenoid enters into the formation of the cavity of the cranium, the orbits, and the posterior nares.

A. The *body* is solid posteriorly, but anteriorly it is hollowed out into two large cavities—the sphenoidal sinuses—separated by a thin mesial lamina. It is cuboidal in form, and has *six* surfaces: superior, inferior, anterior, posterior, and two lateral.

The *superior* surface presents in front a narrow spine—the ethmoidal spine—for articulation with the ethmoid; behind this a smooth surface presenting a median ridge, with a slight depression on each side for lodging the olfactory nerves. A shallow transverse groove—the optic groove—bounds the depressions behind, and ends on each side in the optic foramen, which transmits the optic nerve and the ophthalmic artery. Behind this groove is a small olive-shaped eminence—the olivary body—and still more posteriorly a deep depression—the pituitary fossa or sella turcica—which lodges the pituitary body; this fossa is bounded in front by the olivary body and an eminence on either side—the middle clinoid process; and behind, by a square-shaped piece of bone with a tubercle—the posterior clinoid process—at each superior angle. These processes serve for the attachment of the tentorium cerebelli, and the sides of the piece of bone supporting the posterior clinoid processes is notched for the passage of the sixth nerves; on each side this surface presents a broad groove—the cavernous groove, shaped like the italic letter *f;* it lodges the internal carotid artery and the cavernous sinus. At the bottom of this groove, and in the angle between the body and greater wings, is a small process of bone called the ligula sphenoidalis.

The *inferior* surface presents in the middle line a prominent spine, the rostrum, which is continuous with the plate on the anterior surface, and is received between the two alæ of the vomer. On each side is a projecting lamina, called the vaginal process, which articulates with the edges of the vomer. Close to the root of the pterygoid process is a groove, converted into a canal when the sphenoidal process of the palate is articulated, and called the pterygo-palatine canal.

The anterior surface has in its centre the septum, which sérves to divide the body of the bone into air chambers; the holes on either side allow of communication with the nose.

The *posterior* surface, quadrilateral in shape, articulates with the basilar portion of the occipital bone; during early life they are separated by a piece of cartilage, but at about the twenty-fifth year it becomes ossified and the bones form one piece.

The *lateral* surfaces have projecting from them the great wings.

B. The *great wings* project upwards and outwards from the sides of the body; they are prolonged backwards into a sharp process—the spinous process of the sphenoid. Each wing presents three surfaces and a circumference. The *superior* or cerebral surface is concave, and forms part of the middle fossa of the skull. It is marked by eminences and depressions for the convolutions of the brain. At the anterior and inner part is a round aperture—the foramen rotundum—for the passage of the second division of the fifth nerve. Behind and externally to this is a large foramen—the foramen ovale—for the passage of the third division of the fifth nerve and the small meningeal artery. Still more posteriorly, and situated in the spine of the sphenoid, is the foramen spinosum, for the passage of the middle meningeal artery. Close to the foramen ovale and to its inner side is a small aperture—the foramen Vesalii—which transmits a vein to join the cavernous sinus. The *external* surface is smooth and convex; it is divided into two by a transverse ridge—the pterygoid ridge; the part above forms part of the temporal fossa, and gives attachment to the temporal muscle; the part below enters into the formation of the zygomatic fossa, and gives attachment to the outer head of the external pterygoid muscle. Behind, it presents a prominent spine—the spinous process—which gives attachment to the external lateral ligament of the jaw. The *anterior* or orbital surface, smooth and quadrilateral, forms part of the outer wall of the orbit; there is a small piece of bone below this, which forms part of the spheno-maxillary fossa, and is perforated by the foramen rotundum. The margin between the superior and external surfaces articulates with the temporal and parietal bones. Anteriorly the margin between the anterior and external surfaces articulates with the malar bone; the margin below this forms the upper part of the posterior boundary of the spheno-maxillary fissure; internally the cerebral and orbital surfaces meet at the sphenoidal fissure. The circumference of the great wing, from the back part of the body to the spine, by its inner half forms part of the middle lacerated foramen, while the outer half is serrated, and articulates with the petrous portion of the temporal bone. In front of the spine the circumference is sharp, and bevelled at the expense of the internal table below and the external table above; it articulates with the squamous portion of the temporal. At the tip of the great wing is a triangular portion, bevelled at the expense of the inner table, and articulates with the anterior inferior angle of the parietal bone; internal to this is a broad surface, serrated for articulation with the frontal bone. C. The *small wings*—wings of Ingrassias—extend horizontally outwards from the anterior part of the superior surface of the body; each wing is triangular with its apex outwards, nearly touching the great wing. The superior surface is smooth, and forms part of the anterior fossa of the skull. The inferior surface forms part of the roof of the orbit, and the upper boundary of the sphenoidal fissure. The anterior border is thin and serrated, and articulates with the orbital plate of the frontal bone. The posterior border, rounded and free, terminates internally in a round swelling—the anterior clinoid process. Below and to the inside of this is the optic foramen, for the passage of the optic nerve and ophthalmic artery. D. The *pterygoid processes* project downwards and forwards from between the body and great wings; they consist of an external and an internal plate, separated by the pterygoid notch and fossa, but partially joined in front. The external pterygoid plate, the broader of the two, is directed backwards and outwards, and gives attachment by its outer surface to the external pterygoid muscle, and by its inner surface to the internal pterygoid muscle. The internal pterygoid plate is prolonged downwards into a hook-like process—the hamular process—round which plays the tendon of the tensor palati muscle. At the base of this plate is a small oval depression—the scaphoid fossa—from which arises the tensor palati. Above this, and at the root of the pterygoid plates, is an aperture—the vidian foramen—which transmits the vidian nerve.

The *sphenoidal turbinated bones* are two thin plates of bone, situated at the anterior and inferior parts of the body of the sphenoid. They are irregularly shaped, being broad and thin in front, and tapering to a point behind. Each articulates in front with the ethmoid, externally with the palate; behind, its point is received between the rostrum of the sphenoid and the root of the pterygoid process.

Articulations.—(*a*) Cranial: the occiput, the parietals, the temporals, the frontal and ethmoid. (*b*) Facial: the malar and palate bones, and the vomer. The sphenoidal turbinates close in the body of the bone in front.

Development.—The bone is divided into parts, a post-sphenoid and a pre-sphenoid. The post-sphenoid nuclei appear as a pair at the eighth week at the back part of the body. The nuclei for the great wing and external pterygoid plate appear as a single nucleus on either side. The two sets unite in the first year. The internal pterygoid plate has a separate point of ossification, which appears at the fourth month, and unites with the external at the sixth month. The pre-sphenoid nuclei appear at the eighth week, and those for the lesser wings at the ninth week. The pre- and post-sphenoid unite at the eighth month.

PLATE IV.

Fig. 1. Skull, seen from the left side and in front.

1. Temporal fossa.—2. Temporo-parietal suture.—3. Spheno-parietal suture. — 4. Parieto-frontal suture. — 5. Spheno-temporal suture.—6. Zygomatic fossa.

Fig. 2. Skull, seen from below.

1. Palatine arch and point of union of four sutures, where five bones can be touched with the point of a scalpel, viz.: The two superior maxillary, the two palate bones and the vomer.—2. Posterior openings of the nasal fossæ.—3. Pterygoid fossa.—4. Spheno-maxillary fissure.—5. Zygomatic fossa limited by the zygomatic arch. —6. Foramen ovale.—7. Foramen spinosum.—8. Foramen lacerum medium.—9. Carotid canal.—10. Vaginal process.—11. Foramen lacerum posterius.—12. Occipital condyle.—13. Foramen magnum.

Fig. 3. Base of Skull, from above.

1. Crista galli, foramen cæcum, and cribriform plate.—2. Articulation of the frontal with the lesser wings of the sphenoid.—3. Lesser wing of sphenoid.—4. Sella turcica, or sphenoidal fossa, bounded by the four clinoid processes and grooves for the cavernous sinus.—5. Foramen rotundum.—6. Foramen ovale.—7. Foramen spinosum.—8. Foramen lacerum medium.—9. Basilar groove.—10. Internal auditory meatus.—11. Posterior lacerated foramen.—12. Anterior condyloid foramen.—13. Groove for lateral sinus.

Pl. 4

Fig. 3

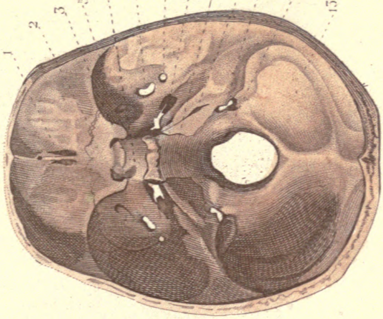
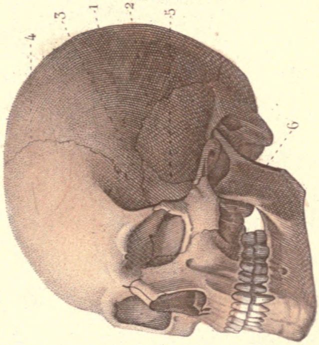


Fig. 1.



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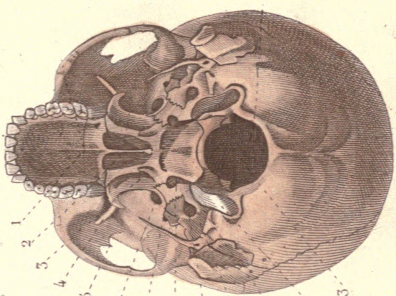

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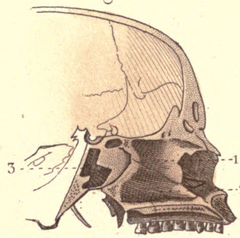
Pl. 5.

Fig. 1.



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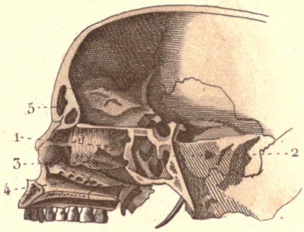

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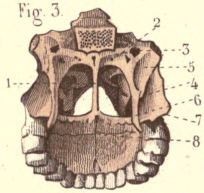

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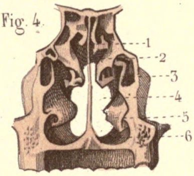

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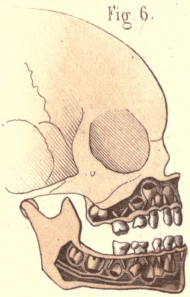

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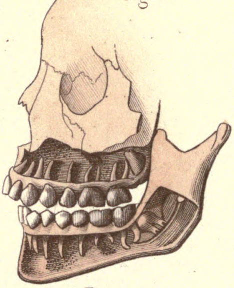

Fig. 8.

Fig. 7.

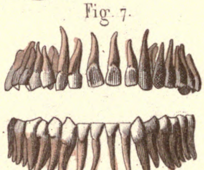

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PLATE V.

Fig. 1. VERTICAL SECTION OF THE SKULL, SHOWING NASAL SEPTUM.

1. Perpendicular plate of ethmoid.—2. Vomer.—3. Sphenoidal cells.

Fig. 2. VERTICAL SECTION, TO SHOW THE EXTERNAL WALL OF THE NASAL FOSSÆ.

1. Superior turbinated bone. — 2. The sphenoidal sinus. — 3. Middle turbinated bone.—4. Inferior turbinated bone.—5. Frontal sinus.

Fig. 3. POSTERIOR OPENINGS OF THE NASAL FOSSÆ.

1. The vomer.—2. Pterygo-palatine foramen.—3. Vidian foramen. —4. Pterygoid fossa.—5. Scaphoid fossa.—6. Internal pterygoid plate.—7. External pterygoid plate.—8. Sutures of the palate.

Fig. 4. VERTICAL SECTION OF THE NASAL FOSSÆ.

1. Superior turbinated bone.—2. The superior meatus.—3. The middle turbinated bone.—4. The middle meatus.—5. The inferior turbinated bone.—6. The inferior meatus.

Fig. 5. The external plates of the two maxillæ have been removed to show the teeth in their alveoli.

Fig. 6. The external plates of the two maxillæ have been removed to show the teeth of the first and second dentition.

Fig. 7. The teeth of the two maxillæ seen in front, showing the peculiarities of the four incisors and two canines in each.

Fig. 8. The teeth on the left side of each maxilla, showing the peculiarities of the canines and the lesser and larger molars.

PLATE VI.

Fig. 1. Left Superior Maxilla (*external aspect*).

1. Nasal process.—2. Nasal notch.—3. Orbital surface.—4 and 5. Infra-orbital groove and foramen.—6. Canine fossa.—7. Malar process.

Fig. 2. Palate Bone (*external surface*).

1. Groove forming part of the posterior palatine canal.—2. Orbital process.—3. Sphenoidal process.—4. Notch forming part of the spheno-palatine foramen.

Fig. 3. Palate Bone (*internal surface*).

1 and 2. Portion of the superior and inferior meatuses.—3. Orbital process.—4. Sphenoidal process.—5. Portion of spheno-palatine foramen.—6. Palatine tuberosity.

Fig. 4. Palate Bone, seen from behind.

1. Posterior border.—2. Orbital process.—3. Palatine tuberosity.—4. Horizontal plate.

Fig. 5. Nasal Bone (*external surface*).

Fig. 6. Lachrymal Bone (*external surface*).

Fig. 7. Right Malar Bone (*external surface*).

1. Malar foramen.—2. Portion of orbit.

Fig. 8. Vomer.

1. Superior border.

Fig. 9. Inferior Turbinated Bone.

Fig. 10. Lower Jaw (*external surface*).

1. External oblique line.—2. Mental foramen.—3. Condyle.—4. Coronoid process.—5. Sigmoid notch.

Fig. 11. Right Half of the Inferior Maxilla (*internal surface*).

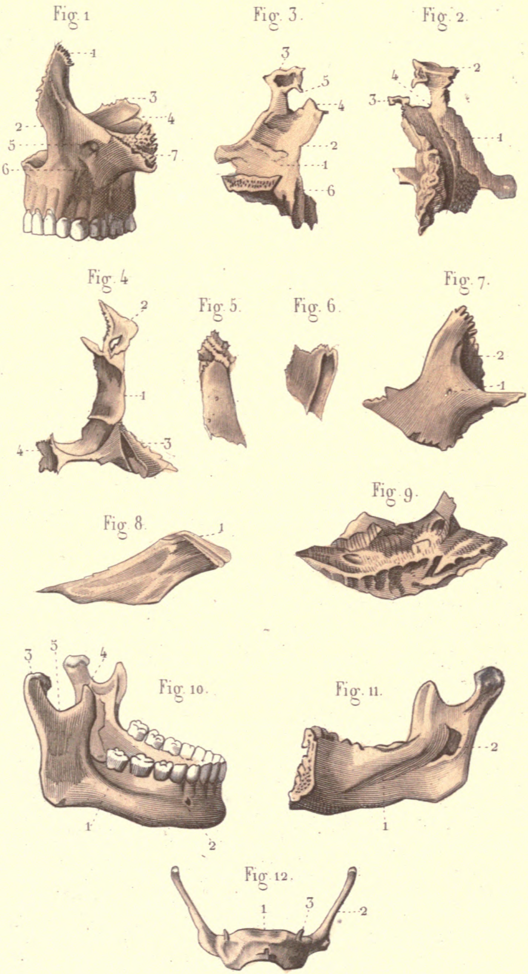
1. Mylo-hyoid ridge.—2. Inferior dental foramen.

Fig. 12. Hyoid Bone (*anterior surface*).

1. Body.—2. Greater cornu.—3. Lesser cornu.

The Superior Maxillary Bone occupies the central and lateral part of the face, and presents for examination A, two aspects

Pl. 6.



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—an external and an internal, and B, four processes—malar, nasal, palatine, and alveolar.

A. 1. The *external* aspect is that part of the bone which can be seen without separating it from its neighbours. It presents in the centre the malar process, which divides this aspect into three parts: in front is the facial surface, behind is the zygomatic surface, above the orbital surface.

The *facial* surface presents in the middle line the anterior nasal spine, external to which is the incisive fossa immediately above the incisor teeth. The canine ridge separates this fossa from the next, the canine fossa, which occupies the rest of the anterior aspect. The infra-orbital foramen appears as its name implies, and at the upper part of this fossa.

The *zygomatic* surface is directed backwards and outwards; it presents the rough impressions for the articulation with the palate bone and numerous holes—the posterior superior dental foramina—for the passage of vessels and nerves.

The *orbital* surface is smooth and triangular, and presents at the back part a groove deepening into a canal—the infra-orbital groove and canal—for a vessel and nerve. Following the canal forward by cutting the bone, it is found to drop down towards the front teeth—the anterior dental canal; the canal itself ends at the infra-orbital foramen.

2. The *internal* aspect is divided into two by the palate process; the part above belongs to the nose, the part below belongs to the mouth. The nasal part is marked by grooves, holes, and ridges. The groove in front is for the nasal duct; the passages above and below the ridges are the middle and inferior meati. The largest foramen, or gap rather, is the opening into the antrum of Highmore. In the separate bone the rent looks huge, but it is closed in the articulated bone by the palate behind, the ethmoid above, and the inferior turbinated below. The mucous membrane of the nose still further diminishes the size of the opening. The ridges give attachment to the inferior and middle turbinated bones.

The oral part of the internal aspect is marked by numerous pits for the mucous membrane of the mouth and the glands therein.

B. *Processes.*—The *malar* process is situated at the meeting of the three surfaces upon the external aspect. The *nasal* process presents two surfaces—a nasal and facial, and four borders; the upper *border* articulating with the frontal, the anterior with the nasal, and the posterior with the lachrymal, whilst the inferior is continuous with the body of the bone. The *alveolar* process presents sockets for the teeth. The *palate* process has two surfaces—an oral and nasal; and four borders—the anterior and external, being continuous with the body of the bone; a posterior, articulating with the palate, and an internal, articulating with its fellow.

Articulations.—(*a*) Cranial: with the frontal and ethmoid; (*b*) facial: with the nasal, lachrymal, malar, vomer, inferior turbinated, palate, and fellow of the opposite side.

Development.—By a number of ossific nuclei, which appear about the seventh week and speedily fuse. The inter-maxillary bone, distinct in some animals, is usually seen on the palatine aspect as a fine fissure running outwards from the anterior palatine foramen to the alveolar border in front of the socket for the canine tooth. It is at this fissure clefts occur, owing to arrest in development between the inter-maxillary and maxillary bones.

The Palate Bones are situated at the back part of the nasal fossæ. Each bone helps to form three cavities—the floor and outer wall of the nose, the roof of the mouth, and the floor of the orbit; it also enters into the formation of three fossæ—the zygomatic, spheno-maxillary, and pterygoid; and one fissure—the spheno-maxillary. The bone is shaped like the letter L, and is described as having A, a horizontal, and B, a vertical plate.

A. The *horizontal* plate, quadrilateral in shape, presents two surfaces and four borders. *Surfaces.*—The superior surface, concave from side to side, forms the back part of the floor of the nose. The inferior surface is rough, and forms the back part of the hard palate; at its posterior part is a transverse ridge for the attachment of the palatine muscles, and at the outer end of this ridge is a groove, converted into a canal by its articulation with the tuberosity of the superior maxilla, forming the posterior palatine canal. Close to this groove are usually seen the openings of two small canals—the accessory posterior palatine canals. *Borders.*—The anterior border, bevelled at the expense of its under surface, articulates with the palate process of the superior maxilla. The posterior border is concave, and free from the attachment of the soft palate; its inner extremity is sharp and pointed, and forms with the other bone the posterior nasal spine for the attachment of the azygos uvulæ. The external border is united with the vertical plate. The internal border, the thickest, is serrated, and articulates with its fellow of the opposite side; their upper edges form a crest, which articulates with the vomer.

B. The vertical plate is also more or less quadrilateral in form, and presents two surfaces—internal and external, and four borders.

Surfaces.—The *internal* surface presents below a shallow depression, which forms part of the inferior meatus of the nose. Above this is a well-marked ridge—the inferior turbinated ridge, for articulation with the inferior turbinated bone; above this is another depression, which forms part of the middle meatus. Still more superiorly is another ridge—the superior turbinated ridge, for articulation with the middle turbinated bone; above this ridge is a narrow groove, which forms part of the superior meatus.

The *external* surface is rough and irregular, for articulation with the superior maxilla, being smooth only at its upper and back part, where it enters into the formation of the spheno-maxillary fossa; at its back part is a groove, converted into a canal—the posterior palatine—by its articulation with the superior maxilla.

Borders.—The *anterior* border is thin, and presents at the margin of the inferior turbinated crest a process—the maxillary process—which closes in the lower and back part of the antrum. The *posterior* border presents a groove, and is serrated for articulation with the pterygoid process of the sphenoid. At the lower part of this border is a conical projection of bone—the tuberosity of the palate—which is received in between the two pterygoid plates at their lower end. At the base of this process are seen the openings of the accessory descending palatine canals; its external surface is rough, for articulation with the inner surface of the superior maxillary bone.

The *superior* border of the vertical plate presents two processes—the anterior or orbital, and the posterior or sphenoidal—separated by a notch or foramen—the spheno-palatine foramen.

(*a*) The orbital process, placed on a higher level than the sphenoidal, is directed upwards and outwards. It presents five surfaces, enclosing a hollow cavity, and is joined to the vertical plate by a constricted neck. Of these five surfaces two are non-articular, and three are articular. The *non-articular* are: the superior or orbital, triangular in shape, smooth, concave, and forming the back part of the floor of the orbit; the external or zygomatic oblong in shape, smooth, and forming part of the zygomatic fossa. These two surfaces are separated by a smooth rounded border, which enters into the formation of the spheno-maxillary fissure. The three *articular* are: the posterior or sphenoidal, usually presenting an open cell, which communicates with the sphenoidal sinus; its edges are serrated for articulation with the sphenoidal turbinated; the internal or ethmoidal articulates with the lateral mass of the ethmoid; the anterior or maxillary is oblong and rough, for articulation with the superior maxilla.

The *sphenoidal process* is thin, compressed, and directed upwards and inwards. It presents (*A*) three surfaces and (*B*) two borders. *A.* The superior, the smallest, articulates with the sphenoidal turbinated; the internal is concave, and forms part of the outer wall of the nose; the external is divided into an articular part which articulates with the pterygoid process of the sphenoid, and a non-articular part which is smooth, and forms part of the zygomatic fossa.

B. The anterior border forms the posterior boundary of the spheno-palatine foramen. The posterior border articulates with the inner surface of the pterygoid process.

The spheno- or naso- palatine foramen, placed between the two processes, opens into the superior meatus, and transmits the spheno-palatine vessels and nerves.

Articulations.—(*a*) Cranial: the sphenoid and ethmoid. (*b*) Facial: the superior maxillary, the opposite palate bone, the vomer, sphenoidal turbinated, and the inferior turbinated.

Development.—By one centre, which appears at the seventh week.

The MALAR BONE forms the prominence of the cheek, and enters into the formation of the orbit, the temporal and zygomatic fossæ.

It has (*A*) three surfaces, (*B*) four borders, and (*C*) four angles.

A. The *external* surface is subcutaneous, and presents a foramen for the malar branch of the temporo-malar nerve.

The *posterior* surface enters into the formation of the temporal and zygomatic fossæ, and presents a foramen for the temporal branch of the temporo-malar nerve.

The *orbital* surface forms part of the lower and outer walls of the orbit, and in it are found the foramina for the temporo-malar nerve.

The borders and angles are best understood by arranging them according to an imaginary line drawn from the upper to the lower angle.

B. Borders.—The anterior superior, forming the margin of the orbit; the anterior inferior, articulating with the superior maxilla; the posterior superior, forming part of the temporal ridge; the posterior inferior, forming part of the zygomatic arch.

C. Angles.—The superior, articulating with the frontal; the posterior, articulating with the zygoma; the inferior and anterior, articulating with the superior maxilla.

Articulations.—Four: with frontal above, sphenoid behind, superior maxilla below, and by the posterior angle with the temporal.

Development.—From one centre, which appears about the eighth week.

NASAL BONES.

Each presents for examination two surfaces and four borders.

The outer surface is subcutaneous.

The inner surface, covered by the mucous membrane of the nose, has a longitudinal groove for a branch of the nasal twig of the fifth nerve.

Borders.—Superior, inferior, external, and internal.

Articulations.—Four: frontal, ethmoid, opposite nasal, and superior maxilla.

Development.—The centre appears about the fourth month.

The Vomer forms part of the septum of the nose. It presents two lateral surfaces, covered by the mucous membrane of the nose, and grooved by the naso- palatine nerve.

Borders and Articulations.—The superior border articulates with the sphenoid; the anterior, with the ethmoid; the inferior, with the two palate and two superior maxillary bones; the posterior border is free, and forms the medium septum of the nose posteriorly.

Development.—By two centres, appearing at the eighth month.

The Lachrymal Bones are placed on the inner wall of the orbit. Each has two surfaces and four borders. The outer or orbital surface is grooved in front for the nasal duct, but flat behind, where it forms part of the orbital wall. The inner surface is lined by the mucous membrane of the nose.

Borders and Articulations.—The superior border articulates with the frontal; the inferior with the inferior turbinated; the posterior with the ethmoid; the anterior with the superior maxilla.

Development.—The centre appears at the eighth week.

The Inferior Turbinated Bone is the only one of the turbinated which has a separate growth; the superior and middle being merely parts of the ethmoid. The bone is like a scroll of paper partly rolled up.

Surfaces.—It presents a convex surface towards the nose, and a concave surface towards the upper jaw.

Borders.—An upper, which articulates along the outer wall of the nose with the superior maxilla and palate bones, assisting at the same time to close in the antrum of Highmore. From the junction of the anterior and middle third springs a process of bone—the lachrymal process—which articulates with the lachrymal bone, and helps to form the nasal duct. The anterior and posterior ends taper off to fine points; it *articulates* with the superior maxilla, palate, ethmoid and lachrymal bones.

Development.—By one centre, which appears in the eighth month.

The Hyoid Bone consists of a body, lesser cornua and greater cornua. The bone at first consists of five pieces, which afterwards coalesce to form a horseshoe-shaped piece of bone. For descriptive purposes the bone will be regarded as a whole. It presents, then, (*A*) an anterior and posterior aspect, and (*B*) an upper and lower border. *A.* The *anterior* aspect is convex, directed upwards and forwards, and marked by a vertical ridge in the middle line, and a horizontal ridge running round the bone. The *posterior* surface is concave, and directed downwards and backwards. The extremities of the bone end off in two rounded knobs posteriorly. The small projections upwards and backwards are the lesser cornua; all in front of these belongs to the body, all behind to the greater cornua.

Development.—The nucleus for the body appears in the ninth month, in the greater cornua also in the ninth month; in the lesser cornua in the first year. The parts coalesce in the third year.

The Inferior Maxillary Bone presents for examination (*A*) a body, (*B*) the ramus on either side, and (*C*) processes upon each ramus.

A. The *body* is shaped like a horseshoe, and presents (*a*) two borders and (*b*) two surfaces.

(*a*) *Borders.*—The upper is the alveolar, presenting the sockets for the teeth. The lower is horizontal, rounded, and of considerable thickness; it is grooved and polished where it joins the ramus, for the passage of the artery to the face—the facial artery.

(*b*) *Surfaces.*—The *anterior or outer* presents in front the symphysis menti, marked by a ridge where the two halves meet; at the lower part it terminates at a triangular surface, called the mental eminence or process. Opposite the second bicuspid tooth is the mental foramen. From the mental eminence runs the external oblique line; it ends at the anterior part of the ramus. The *posterior or inner surface* presents in the middle line a furrow, which corresponds to the ridge on the anterior aspect of the symphysis. On either side of the middle line are seen the two upper and the two lower genial tubercles. From below the lower tubercles the internal oblique line runs upwards and backwards to the front part of the ramus. It is sometimes called the mylo-hyoid ridge, after the muscle which is attached to it. Above the line is a fossa for the sublingual gland, and below it a pit in front for the digastric muscle, and behind a shallow for the submaxillary gland.

B. The *ramus* presents four borders and two surfaces.

Borders.—The anterior has a groove on it, for the temporal muscle. The posterior is rounded and thick. The inferior is continuous with the lower border of the body of the bone. The superior border presents two processes, the coronoid and condyloid, with a notch between.

Surfaces.—The external surface is slightly concave; it gives attachment to the masseter muscle. The internal surface presents at its centre the inferior dental foramen overhung by a sharp spine. From the lower part of the foramen runs down a groove, the mylo-hyoidean, for the passage of a vessel and nerve. Above the foramen the bone is free from muscular attachment, but below it is wholly occupied by the internal pterygoid muscle.

C. The *condyloid* process, the more posterior, is a rounded articular eminence, with its long axis placed from without inwards, and slightly from before backwards; in front is a pit for muscular attachment. The *coronoid* process is sharp and prominent, projecting higher than the condyle; it is embraced by the temporal muscle. Between the two processes is the sigmoid notch, having the condyle behind and the coronoid process in front.

Articulations.—With the glenoid fossa of the temporal bone, between which an intervening piece of fibro-cartilage acts as a buffer.

Development.—By several pieces which coalesce very early. The cartilage of Meckel is the rod on which the bone is laid down. The ossific nucleus appears about the sixth week. The angle of the jaw changes in size from childhood to old age. At birth the ramus joins the jaw at an angle of 140°; at twenty-five the two meet at nearly a right angle; in old age, when the teeth and alveolar border are gone, the angle becomes again about 140°.

PLATE VII.

Fig. 1. ATLAS (*superior surface*).

1. Articular facet.—2. Anterior arch.—3. Posterior arch.—4. Transverse process and foramen for vertebral artery.

Fig. 2. ATLAS (*inferior surface*).

1. Articular facet.—2. Facet for odontoid process of the axis.

Fig. 3. AXIS (*anterior surface*).

1. Body.—2. Odontoid process.—3. Articular facet.—4. Transverse process.

Fig. 4. AXIS, SEEN FROM THE RIGHT SIDE.

1. Body.—2. Odontoid process.—3. Articular facet.—4. Transverse process.—5. Spinous process.

Fig. 5. A CERVICAL VERTEBRA (*superior surface*).

1. Body.—2. Projecting lip.—3. Transverse process.—4. Articular processes.—5. Lamina.—6. Spinous process, bifid.

Fig. 6. A DORSAL VERTEBRA, SEEN FROM THE RIGHT SIDE.

1 and 2. Body and demi-articular facet.—3. Pedicle.—4. Superior articular process.—5. Transverse process with its articular facet.—6. Spinous process.

Fig. 7. A LUMBAR VERTEBRA (*superior surface*).

1. Transverse process.—2. Superior articular process and transverse tubercle.—3. Spinous process.

Fig. 8. A LUMBAR VERTEBRA, SEEN FROM THE RIGHT SIDE.

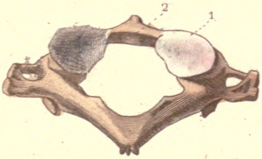
1. Inferior articular process.

THE VERTEBRÆ.—The named parts of a vertebra are: The *body*, which in all parts presents six surfaces—anterior, posterior, superior, inferior, and two lateral. The *neural arch* is formed on either side by the *pedicles*, short, stout processes, having a notch above and below, which, when articulated with its fellows, completes the intervertebral foramina. Behind, the arch is enclosed by the *laminæ*, flat plates which protect the spinal cord, and have an anterior and posterior surface, and an upper and lower border for ligaments.

The processes are articular and non-articular. The *articular* are two above and two below, to articulate with the vertebræ above and below. The non-articular are the spinous processes which project posteriorly to give attachment to muscles and ligaments.

Pl. 7.

Fig. 2.



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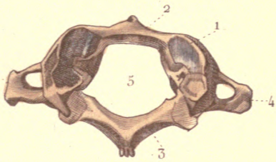

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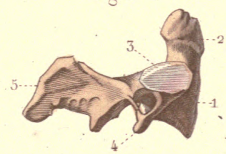

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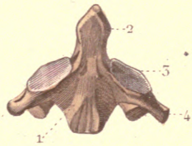

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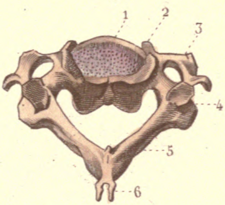

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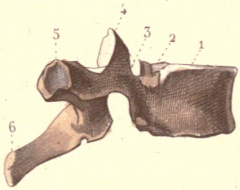

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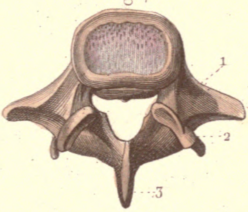

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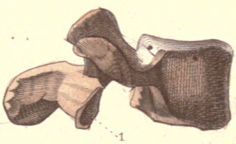

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The transverse processes are articular in the dorsal region, where they articulate with the ribs; but non-articular in the cervical and lumbar regions.

Development.—By three centres: the one for the body appears at the eighth week; those for the lateral parts at the seventh week. The laminæ unite in the first year. The lateral parts and body unite at the third year. There are five supplementary nuclei: one at the tip of the spinous process, one at the tip of either transverse, and one for a plate immediately above and below the body. These processes appear from the sixteenth to the twentieth year, and unite by the twenty-fifth.

A Typical Cervical Vertebra presents the following characteristics:

The *body* is greater in the transverse measurement than in the antero-posterior.

Superiorly.—It is slightly convex from before back, and concave from side to side, ending in small lateral prolongations upwards.

Inferiorly.—It is convex from side to side, and concave from before backwards. On each side there is a depression to receive the process of bone which projects upwards from the subjacent vertebra.

Anteriorly.—It is convex from side to side, and flat from above downwards.

Posteriorly.—It is flat, and marked by small foramina for the venæ basis vertebræ.

The *pedicles* project from near the centre of the body, and are directed outwards. The *laminæ* are long, thin, and flat. The *spinal canal*, enclosed by the arch, is large and triangular, to accommodate the cervical swelling of the cord.

The *articular* processes are ovoid in shape; the superior looking backwards and upwards, the inferior downwards and forwards. The non-articular are the transverse and spinous. The *transverse* processes are bifurcated, tuberculated, perforated for the vertebral artery; lipped for muscular attachment; and grooved for the passage of nerves. The *spinous* processes are bifurcated, short, and stout.

The First Cervical Vertebra, called also the Atlas, presents for examination an anterior and posterior arch and two lateral masses. The anterior arch forms one-fifth of the circumference, the posterior arch two-fifths, and the lateral masses one-fifth each. The *anterior* arch has two surfaces and two borders. On the anterior surface is a tubercle for muscular attachment; on the posterior surface is an ovoid facet for the odontoid process of the second. The *posterior* arch has also two surfaces and two borders. On the posterior surface is the posterior tubercle for muscular attachment; on the upper border is a groove for the vertebral artery, close under cover of the lateral mass. Each *lateral mass* is concave above to articulate with the occipital condyles, and flat below, where it articulates with the second. Internally are tubercles for ligaments; externally are the transverse processes, stout and far-projecting.

Development.—The nucleus for the anterior arch commences in the first year; the nuclei for either lateral part appear in the seventh week. The union behind takes place in the third year; the union with the nucleus of the anterior arch at the sixth year.

The SECOND CERVICAL VERTEBRA, called also the AXIS, affords a pivot on which the atlas moves, and where the side-to-side motion of the head takes place. Its peculiarities are:

1. The odontoid process—a short stout tooth-like process of bone which projects upwards from the centre of the body. It is pointed above and constricted below; it presents in front a facet for the posterior arch of the atlas; behind, a facet for the transverse ligament; and on either side above, a depression for the attachment of the check ligaments.

2. The superior articular facets are placed on the junction of the body, transverse processes and pedicles. They articulate with the under surface of the lateral mass of the atlas.

3. The foramen in the transverse process is directed horizontally outwards instead of being vertical, as in the others.

Development.—The arch and processes, as in other vertebræ, appear at the seventh week. In the body ossification begins in the fourth month. In the odontoid processes two nuclei appear at the fifth month. These unite with the body at the third year; another nucleus in the apex of the process appears at the second year.

The SEVENTH CERVICAL VERTEBRA is called also VERTEBRA PROMINENS, on account of its long prominent spinous process.

This spinous process is thick, projects horizontally backwards, and affords attachment to the ligamentum nuchæ.

The transverse processes are very large, not generally bifurcated, but they are pierced by a foramen, although no vessel normally passes through them.

In all other respects it simulates the typical cervical vertebræ.

The TYPICAL DORSAL VERTEBRÆ have the following peculiarities: The body is heart-shaped above, more ovoid below; each vertebra has a half-facet above and below at the sides for the ribs. The pedicles project backwards and outwards; they belong more to the upper than to the lower part of the body. The laminæ are broad, and overlapping; the spinous processes prismatic, and slanting so as to overlap each other. The transverse processes are bent backward; each presents an oval facet for the tubercle on the rib. The articular surfaces of the upper processes are directed backwards and outwards; those of the lower, forwards and inwards.

The peculiar *Dorsal Vertebræ* are five in number. The first has on the side of the body a whole facet above, and a half below, for the heads of ribs. The ninth has a half facet above, and none below. The tenth has a whole facet. The eleventh has a whole facet for the head of the rib, none on the transverse process. The twelfth has the same peculiarities as the eleventh, only that its articular processes more distinctly resemble a lumbar vertebra.

The *Lumbar Vertebræ* present the usual points for examination. The body is thicker in front than behind, so as to form the lumbar curve. The pedicles are broad and stout, and project backwards. The laminæ are rugged and broad; they do not overlap, as in the dorsal region. The articular processes: the superior are directed backwards and inwards; the inferior forwards and outwards. The spinous processes are stout, and project straight back. The transverse processes are long, tapering, straight, and end in a slight knob. On the superior articular processes are placed rudimentary nodules of bone, called the mammillary processes. They correspond to large projections for muscular attachment in various animals.

The *Development* is as already described, except that the mammillary processes have points of ossification of their own. The only peculiar lumbar vertebra is the fifth; it is peculiar only in having its inferior articular processes wider apart than its upper.

PLATE VIII.

Fig. 1. VERTEBRAL COLUMN, SEEN FROM THE LEFT SIDE.

1 and 2. Two demi-facets.—3 and 4. Two intervertebral foramina. —5. Cervical vertebræ and curve.—6. Dorsal vertebræ and curve.—7. Lumbar vertebræ and curve.—8. Sacrum.

Fig. 2. STERNUM.

1. Gladiolus.—2. Manubrium sterni.—3. Interclavicular notch.—4. Surface articulating with clavicle.—5. Xiphoid or ensiform cartilage.

Fig. 3. FIRST RIB (*superior surface*).

1 and 2. Tubercles for insertion of the scalene muscles.—3. Groove for subclavian artery.—4. Head.—5. Tuberosity.

Fig. 4. SECOND RIB (*inferior surface*).

Fig. 5. MIDDLE RIB (*inferior surface*).

1. Head.—2. Neck.—3. Tuberosity.—4. Angle.

Fig. 6. LAST RIB, WITHOUT ANGLE AND WITHOUT TUBEROSITY.

Fig. 7. GENERAL VIEW OF THE WALLS OF THE CHEST.

The constituent parts of it are—Behind: 1. Dorsal part of vertebral column. In front: 2 and 3. Sternum and costal cartilages. On either side: 4 and 5. The twelve ribs. 6. Union of a rib with a costal cartilage.

Fig. 8. RIGHT CLAVICLE, SEEN FROM ABOVE.

Fig. 9. RIGHT CLAVICLE, SEEN FROM BELOW.

The CLAVICLE forms the anterior portion of the shoulder. It is a long bone, and prevents a double curvature, the convexity being forwards at the sternal end, and backwards at the scapular end.

The *outer third* is flattened from above downwards.

The *inner two-thirds* are prismatic.

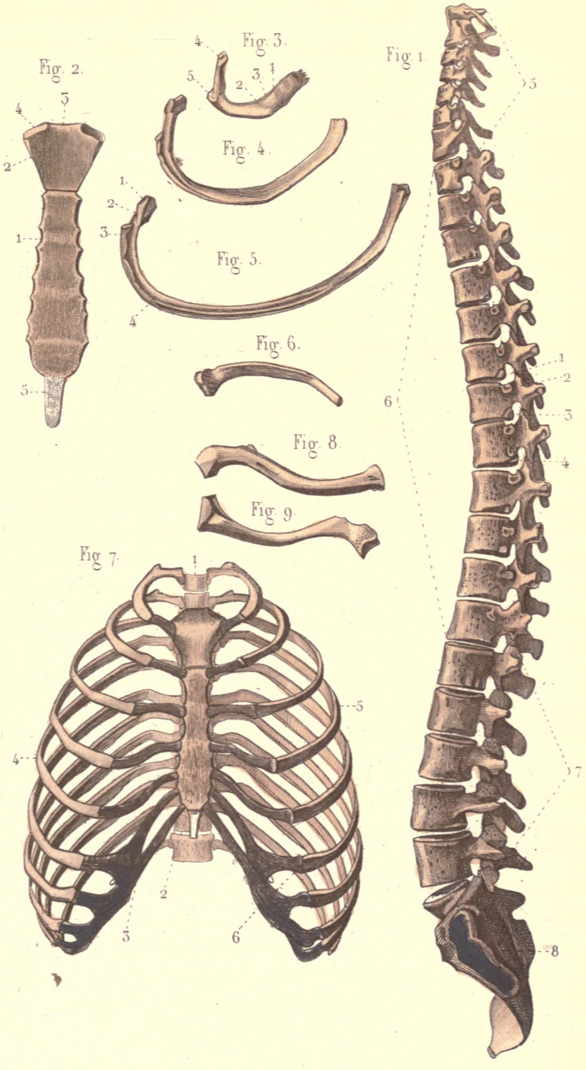
I. The *outer third* presents (*A*) two surfaces—Upper, lower. (*B*) Two borders—Anterior, posterior.

A. (*a*) Upper surface is flattened and rough, and is for the most part subcutaneous.

(*b*) Under surface is flattened. At its posterior part, where the flattened joins the prismatic portion, is the *conoid tubercle*, and running forwards and outwards from it to the anterior border is the *oblique line*.

B. (*a*) Anterior border is concave, thin, and rough, and gives attachment to the deltoid muscle.

Pl. 8.



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(*b*) Posterior border, convex, rough, broader than the anterior, and gives attachment to the trapezius.

II. The *inner two-thirds*, or prismatic portion, is curved, being convex in front and concave behind. Is marked by (*A*) three borders separating (*B*) three surfaces.

A. The borders are—superior, anterior, and posterior.

(*a*) The superior border is continuous externally with the posterior margin of flat portion, where it is smooth and rounded; it ends at the upper angle of the sternal extremity, where it is rough for the attachment of the *sterno-mastoid* muscle.

(*b*) The anterior border is continuous externally with the anterior margin of the flat portion; it is smooth at its commencement, but splits about its centre to enclose an elliptical space for the attachment of the *pectoralis major* muscle.

(*c*) The posterior or subclavian border extends from the *conoid tubercle* to the *rhomboid impression*, limits the origin of the subclavius muscle, and has attached to it the fascia enclosing that muscle.

B. The surfaces are:

(*a*) The inferior surface. It is narrower internally than externally. At the sternal end is a facet for the cartilage of the first rib. External to this the rhomboid impression, about one inch long, for attachment of the costo-clavicular ligament. The remaining part is occupied by a groove for the attachment of the subclavius muscle and the fascia enclosing it.

(*b*) The anterior surface: Externally it is smooth and nearly subcutaneous, being covered only by the platysma. The inner half is rough for attachment of the pectoralis major and sterno-mastoid.

(*c*) The posterior surface is smooth, and looks backwards towards the root of the neck. It is limited above, by the superior border; below, by the subclavian border. It is concave from within outwards, and presents near the middle the *nutrient foramen* directed outwards. Near the sternal extremity it gives attachment to part of the sterno-hyoid muscle.

III. The *inner* or *sternal* end is triangular in form, and is directed inwards and a little downwards and forwards. It presents an articular facet which is concave, from before backwards; convex, from above downwards; it articulates with the sternum by means of an inter-articular fibro-cartilage ; the circumference is rough for the attachment of ligaments.

IV. The *outer* or *acromial* end is directed outwards and forwards. It presents a small, flattened, oval facet, looking obliquely downwards to articulate with the acromial process of the scapula; the circumference of the facet is rough for the attachment of ligaments.

Articulations:

1. With the sternum.
2. With the scapula.
3. With the cartilage of the first rib.

Development.—By a nucleus for the shaft which appears at the sixth week, and by an epiphysis at the sternal end which appears at the eighteenth year, and unites at the twenty-fifth year.

The STERNUM is a flat narrow bone, placed in the median line of the chest ; it is triangular in its long axis, with the base above and the apex below. It consists of three portions : (*A*) the Manubrium, or first piece ; (*B*) the Gladiolus, or second piece ; (*C*) the Ensiform or Xiphoid Appendix, or third piece.

A. Manubrium.—Triangular in outline, broad above, narrower below.

The anterior surface is convex from side to side, concave from above downwards, smooth for attachment of muscles.

The posterior surface is also smooth and concave, and gives attachment to muscles.

The superior border presents the interclavicular notch, and on either side an oval surface for articulation with the sternal end of the clavicle.

The inferior border presents a rough oval surface for articulation with the gladiolus.

The lateral borders present above a depression for articulation with the first costal cartilage, and below half a facet, which with a similar facet on the gladiolus affords articulation for the second costal cartilage.

B. Gladiolus.—The middle and longest portion of the bone is slightly broader below than above.

The anterior surface is nearly flat, and is marked by three transverse ridges, situate opposite the third, fourth, and fifth articular depressions. They mark the line of union of the four pieces of which the bone originally consisted. There is sometimes seen a foramen—the sternal foramen—at the junction of the third and fourth pieces.

The posterior surface is concave, also marked by the transverse lines, but less distinct.

The superior border presents an oval rough surface for articulation with manubrium.

The inferior border is narrow, and articulates with the ensiform appendix.

The lateral borders present at each superior angle a small facet, corresponding to the facet on the manubrium, for the cartilage of the second rib; and the four succeeding angular depressions receive the cartilages of the third, fourth, fifth, and sixth ribs, and each inferior angle presents a small facet, which, with a similar one on the ensiform appendix, forms a depression for the cartilage of the seventh rib. The spaces between each of these notches correspond to the intercostal spaces, which diminish in breadth from above downwards.

C. The *Ensiform Appendix* is the smallest of the three pieces; it is very slim; it is formed of cartilage, which becomes ossified in old age.

The anterior surface gives attachment to the costo-xiphoid ligament.

The posterior surface affords attachment to the triangularis sterni muscle and to the diaphragm.

The lateral borders afford attachment to the abdominal muscles.

The superior border articulates with the gladiolus.

The apex gives attachment to the linea alba. At each superior angle is a small facet, which, with a similar one on the gladiolus, forms a notch for the cartilage of the seventh rib.

Articulations.—With the clavicle, and the cartilages of all the true ribs on each side.

Development.—By six centres which appear as follows:

1 for the manubrium, appearing at fifth or sixth month.

4 for the gladiolus	2, 3	sixth or seventh month.
	4	ninth month.
	5	first year.

1 for the ensiform appendix.

The Ribs.—A typical rib presents for examination two extremities and a shaft. The *posterior* extremity consists of a head, neck, and tuberosity. The head has two facets separated by a horizontal ridge; each facet articulates with the vertebra immediately above or below it. The neck presents two surfaces and two borders; the anterior surface is flat and smooth; the posterior rough for the attachment of the middle costo-transverse ligament; the superior border gives attachment also to a ligament; the inferior is smooth and rounded. The tuberosity has a smooth facet internally for articulation with the tip of the transverse process of the vertebra behind; the non-articular part is for the attachment of ligaments.

The *shaft* presents two surfaces and two borders. The external surface is convex and smooth; at its back part there is a rough oblique line for muscular attachment called *the angle;* at this spot the rib changes its direction, passing forwards.

The internal surface is concave, and presents a ridge commencing at the head; between this and the inferior border lies the intercostal groove. The groove ends half-way forwards; it protects the vessels and nerves.

The superior border is rounded, and has two lips for the attachment of the intercostal muscles; the inferior border is sharp and thin, and projects downwards, protecting the vessels and nerves in the groove. The sternal extremity has a porous oval depression for the costal cartilage.

Peculiar Ribs (five in number.)

The *First rib* differs from all other ribs in its surfaces being superior and inferior; the head has only one facet for the first dorsal vertebra; the neck is rounded; the tuberosity rests on the outer border of the rib; the shaft is not twisted on its axis; it has no angle.

The upper surface presents two grooves separated by a prominent elevation—the 'scalene tubercle' for the anterior scalene muscle; the groove in front being for the subclavian vein, that behind for the subclavian artery; between the latter groove and the tuberosity the middle scalene muscle is attached.

The under surface has no intercostal groove.

The outer border is thick and rounded.

The inner border is thin and concave.

The *Second rib* has a slight angle near the tuberosity.

The outer surface looks upwards and outwards, and the inner in the opposite direction. The shaft is not twisted on its axis, and presents externally a rough eminence for the second and third digitations of the serratus magnus.

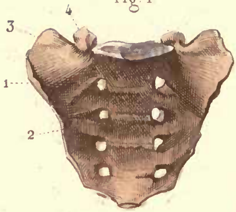
The *Tenth rib* has a single articular facet on its head.

The *Eleventh rib* has one facet on its head, no neck or tuberosity, and only a slight angle, and a shallow groove on its lower border.

The *Twelfth rib* differs from the eleventh in being shorter, and in having no angle or groove. Neither the eleventh nor twelfth has facets on its transverse processes.

Pl. 9.

Fig. 1



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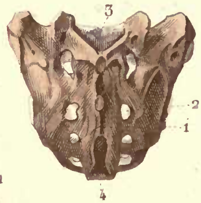

Fig. 3.

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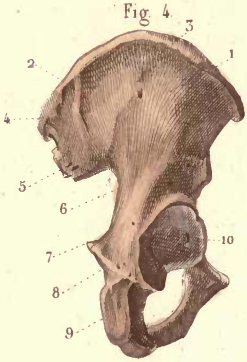

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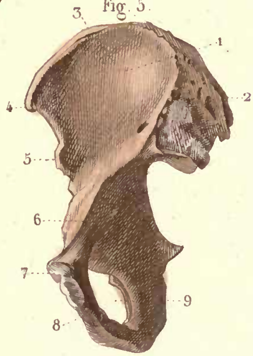

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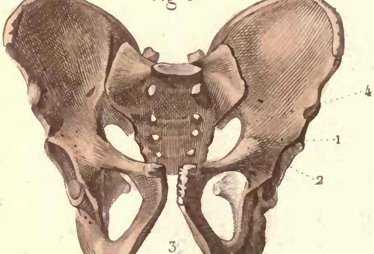

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PLATE IX.

Fig. 1. SACRUM (*anterior surface*).

1. The anterior sacral foramina.—2. Ridge between sacral foramina.—3. Lateral mass of sacrum.—4. Articular process of sacrum.

Fig. 2. SACRUM (*posterior surface*).

1. Crest.—2. A posterior sacral foramen.—3. Superior aperture of the sacral canal.—4. Inferior aperture.

Fig. 3. COCCYX (*anterior surface*).

1. Cornu of coccyx.

Fig. 4. OS INNOMINATUM (*external surface*).

1. Dorsum.—2. Superior curved line.—3. Middle curved line.—4. Posterior superior iliac spine.—5. Posterior inferior iliac spine.—6. Great sciatic notch.—7. Spine of the ischium.—8. Lesser sciatic notch.—9. Tuberosity of ischium.—10. Acetabulum.

Fig. 5. OS INNOMINATUM (*internal surface*).

1. Iliac fossa.—2. Auricular articulation for sacrum.—3. Crest of ilium.—4. Anterior superior iliac spine.—5. Anterior inferior iliac spine.—6. Ilio-pectineal eminence and line.—7. Pubes and symphysis pubis.—8. Junction of rami of pubes and ischium.—9. Obturator foramen.

Fig. 6. PELVIS.

1. Ilio-pectineal eminence.—2. Horizontal ramus of pubes.—3. Pubic arch.—4. Brim of pelvis.

The SACRUM consists of five (rarely six) vertebræ anchylosed together. It presents (*A*) four surfaces, (*B*) a base, and (*C*) an apex.

A. The *anterior* surface presents the anterior aspects of five bodies separated by four ridges, four anterior sacral foramina at the end of each ridge, and the anterior surface of the lateral masses, with grooves for the passage of nerves.

The *posterior* surface has rudimentary conditions of typical vertebræ. These are (from within outwards) rows of processes corresponding to spinous processes; laminæ; inner tubercles (corresponding to articular processes); four posterior sacral foramina; outer tubercles (corresponding to transverse processes). Between outer tubercles and spines is the continuation of the vertebral groove, here called the *sacral groove.*

The spinous processes and laminæ are wanting in the fifth and lower half of the fourth, giving place to a groove bounded by ridges, which project down to form the sacral cornua, with notch below.

The *lateral* surfaces present an auricular articular surface above and in front. The rest is rough for ligaments.

B. The base is an oval facet for articulation with the fifth lumbar, and presents the orifice of the *sacral canal;* the upper border of the laminæ and spine of the first sacral vertebra; the upper articular processes. Laterally two smooth triangular surfaces or alæ, bounded in front by a ridge, and behind by the upper prominent transverse process.

C. The apex has an oval facet for articulation with the coccyx.

The Os Innominatum is the name given to either large mass of bone which constitutes the lateral and anterior wall of the pelvis. The two pieces meet in front at the symphysis pubis, but behind are separated by the sacrum. Each bone is made up of three primary pieces, namely, the ilium, the ischium, and the pubes. The ilium forms the upper, the ischium the lower, and the pubes the anterior portions. All three meet at the acetabulum, where they are at first separated by a piece of cartilage, which subsequently ossifies and blends the separate pieces.

The os innominatum, considered as a whole, presents (*A*) four borders and (*B*) two surfaces.

A. *Borders.*—The *superior*, called the crest of the ilium, is curved like the italic *f*, and presents an outer and inner lip and an intervening space, all for the attachments of muscles. This border terminates behind and in front in angular processes, termed respectively the anterior and posterior superior spinous processes of the ilium.

The *anterior* is irregularly concave: its upper half, belonging to the ilium, is directed downwards and inwards; its lower half, belonging to the ramus of the pubes, is horizontal. It forms, by its junction with the crest, the anterior superior spinous process already described; below which there is a notch, and below this again is another prominence, the anterior inferior spinous process. Subjacent to this process is a groove, bounded internally by an eminence, the ilio-pectineal eminence, which indicates the junction of the pubes and ilium; farther inwards is the horizontal ramus of the pubes, limited behind by a sharp edge, forming the linea ilio-pectinea. At the inner end of the pubes is a short ridge called the crest of the pubes. This ridge ends internally at the angle of the pubes, and externally in a tubercle called the spine of the pubes.

The *inferior* border extends from the angle of the pubes to the tuberosity of the ischium; its upper-third is vertical, and presents a rough oval aspect, which is united to a similar surface on the opposite bone by the intervention of a fibro-cartilage, forming the articulation called the symphysis pubis.

The remainder of the inferior margin formed of the descending ramus of the pubes and the ascending ramus of the ischium constitutes —with the opposite bone—the pubic arch.

The *posterior* border extends from the posterior superior spinous process to the tuberosity of the ischium; it presents from above downwards the following:—posterior superior spinous process; the notch below; the posterior inferior spinous process; the great sciatic notch; the spine of the ischium separating it from the lesser sciatic notch; finally, the tuberosity of the ischium, the posterior part of which is for muscular attachment; the anterior part is used to sit on.

B. The surfaces are external and internal.

The *external* aspect presents above and behind the dorsum of the ilium traversed by three lines, the superior, middle, and inferior curved lines. The superior commences from the crest two inches in front of the posterior superior spinous process, and cuts off a triangular surface above it; the middle curved line commences two inches behind the anterior superior process, at the most external part of the iliac crest, and cutting off a falciform-shaped surface, ends at the great sciatic notch; the inferior curved line commences at the anterior inferior spinous process, and cutting off a quadrilateral surface, ends at the great sciatic notch. Below the dorsum of the ilium is the *acetabulum.* This is a deep cavity presenting a sharp brim or outline, which is notched internally, forming the cotyloid notch. The surface is not wholly articular, the femur resting only on a ribbon-shaped-looking surface, which passes round the cavity near its margin, leaving the bottom of the cavity non-articular. Internal to the acetabulum is the obturator foramen. This is a large window left in the bone, having the horizontal ramus of the pubes above, the descending ramus of the pubes and ascending ramus of the pubes inside, the tuberosity of the ischium below, and the acetabulum outside. The foramen is closed in by a membrane, which is flush with the inner wall; above is a groove in the bone, and a gap in the membrane for the passage of the obturator vessels and nerve.

Around this foramen are the bony surfaces already mentioned; they give attachment to the adductor muscles of the thigh.

The *internal* surface looks toward the pelvis, and is divided by the brim of the pelvis into an upper part or false pelvis, and a lower part or true pelvis. The *false pelvis* is bounded laterally by the iliac fossa, and gives attachment to the iliacus muscle. The nutrient foramen is found at the lower and back part. The *true pelvis* is only partly formed by the innominate bones. In front is seen the back of the symphysis; and on either side from before, backwards, are seen the back of the body of the pubes, the obturator foramen and the large mass of bone forming the inner wall of the acetabulum. Behind, the brim of the pelvis ends at a large auricular-shaped surface for articulation with the sacrum; and behind this is a large rough surface for the attachment of ligaments—the sacro-iliac.

Development of Pelvic Bones:

I. *The Ilium.*—By three primary centres: one for the ilium; a second for the pubes; and a third for the ischium. These three meet at the acetabulum, the ilium forming the upper, the pubes the inner, and the ischium the lower and back part of the same; the ischium forms in bulk a little more than two-fifths; the ilium a little less than two-fifths; and the pubes the remaining fifth of the acetabulum. The nuclei for the ilium, ischium, and pubes appear at the second, third and fifth months respectively. The rami of the pubes and ischium unite at the tenth year. The Y-cartilage becomes ossific at the thirteenth year, and the three bones unite at the seventeenth year. About the fifteenth year four other nuclei appear: one along the crest of the ilium; a second at the anterior inferior spine; a third at the ischial tuberosity; and a fourth to form the symphysis. By the twenty-fifth year all are united.

When the three component bones are described separately, they possess the following individual parts: The ILIUM presents an external and an internal surface; a superior (crista ilii), an anterior, and a posterior border. The PUBES presents a quadrilateral body with two surfaces, a prismatic horizontal ramus, and a flattened descending ramus, with two surfaces and two borders. The ISCHIUM possesses a body placed posteriorly, with three surfaces, internal, external, and posterior; a tuberosity supporting the body, and an ascending flattened ramus with two surfaces and two borders. All these points are described above, only the named parts assigned to each body are here mentioned.

II. *The Sacrum.*—Each of the five vertebræ has the primary central, and two lateral nuclei, making fifteen in all; in addition, thin circular plates above and below each piece appear as in other vertebræ; a couple of special nuclei appear on either side of the first three vertebræ about the seventh month; finally, two lateral epiphysal plates appear on either side, the upper covering the upper three vertebræ forms the auricular surface, the lower the edges of the last two. There are thus thirty-five nuclei in all. The vertebræ of the sacrum coalesce from below upwards between the eighteenth and thirtieth years. At the later period the lateral plates coalesce with the general mass.

III. The *Coccyx* consists of four or five pieces, the times of the ossification of which are very indefinite. The upper end presents an oval facet for articulation with the sacrum, a notch to complete a fifth sacral foramen on either side, and two cornu to meet those of the sacrum. The second piece of the coccyx is square, the third oblong, and the fourth a mere nodule. By the thirtieth year all are united; frequently the sacrum and coccyx unite.

Pl. 10.

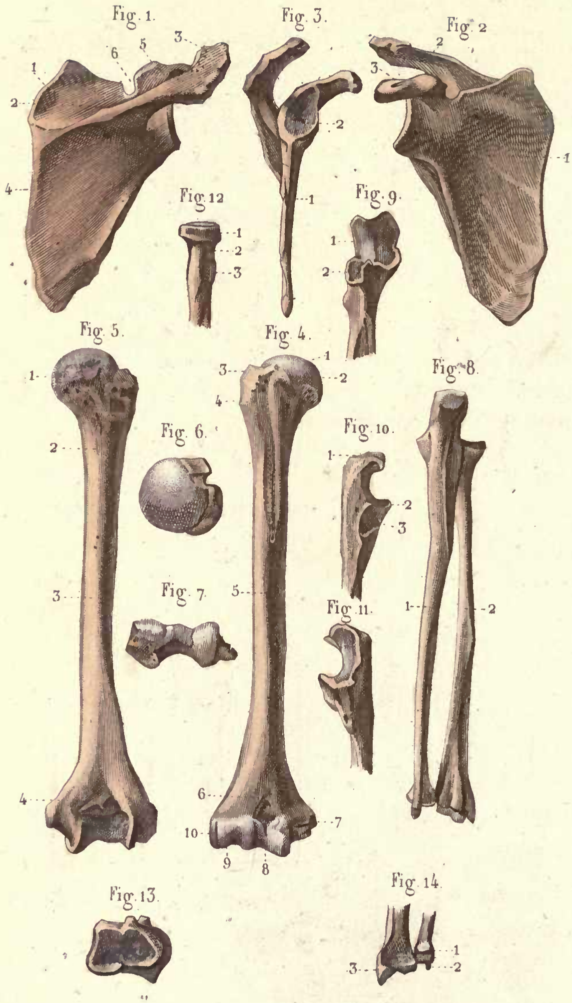

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PLATE X.

Fig. 1. SCAPULA (*posterior surface*).

1. Supra-spinous fossa.—2 and 3. Spine and acromion process.—4. Infra-spinous fossa.—5. Coracoid process.—6. Supra-scapular notch.

Fig. 2. SCAPULA (*anterior surface*).

1. Venter.—2. Spine, terminating in the acromion.—3. Coracoid process.

Fig. 3. SCAPULA, SEEN FROM ITS EXTERNAL OR AXILLARY BORDER.

1. Axillary border.—2. Glenoid cavity, overhung by the coracoid process.

Fig. 4. HUMERUS, SEEN FROM THE FRONT.

1. Head and neck of humerus.—2. Lesser tuberosity.—3. Greater tuberosity.—4. Bicipital groove.—5. Anterior border of humerus.—6. Coronoid fossa.—7. Internal condyle.—8. Trochlear surface.—9. Capitellum.—10. Internal condyle,

Fig. 5. HUMERUS (*posterior surface*).

1. Anatomical neck.—2. Surgical neck.—3. Posterior surface.—4. Olecranon fossa.

Fig. 6. SUPERIOR ARTICULAR EXTREMITY OF HUMERUS.

Fig. 7. INFERIOR ARTICULAR EXTREMITY.

Fig. 8. RADIUS AND ULNA, SEEN FROM BEHIND.

1. Ulna.—2. Radius.

Fig. 9. SUPERIOR EXTREMITY OF ULNA (*anterior view*).

1. Greater sigmoid notch.—2. Lesser sigmoid notch.

Fig. 10. EXTERNAL VIEW OF THE UPPER EXTREMITY OF ULNA.

1. Olecranon.—2. Coronoid process.—3. Lesser sigmoid notch.

Fig. 11. INTERNAL VIEW OF THE SUPERIOR EXTREMITY OF ULNA.

Fig. 12. SUPERIOR EXTREMITY OF RADIUS.

1. Head.—2. Neck.—3. Bicipital tuberosity.

Fig. 13. INTERIOR ARTICULAR EXTREMITY OF RADIUS.

Fig. 14. INFERIOR EXTREMITIES OF RADIUS AND ULNA.

1. Head of ulna.—2. Its styloid process.—3. Styloid process of radius.

The SCAPULA is a thin, flat bone, triangular in shape, lying on the posterior and lateral walls of the thorax, covering the ribs from the second to the eighth.

It presents for examination (*A*) two surfaces, (*B*) three borders, and (*C*) three angles.

A. The surfaces are anterior and posterior.

The *anterior* surface, or venter of scapula, is concave, forming the subscapular fossa. Its posterior two-thirds are marked by several rough ridges which run from behind, upward and forward. Its anterior or external third is quite smooth.

The *posterior* surface, or dorsum, is convex from above downward, and alternately convex and concave from side to side. It is divided into two unequal portions by the *spine* of the scapula, a process of bone projecting backwards and upwards, thus converting the otherwise flat surface into two hollows, the supra-spinous, and infra-spinous, fossæ.

The SPINE OF THE SCAPULA is a strong triangular plate of bone, projecting backwards and upwards from the dorsum.

Commencing at the vertebral border, near its upper fourth, by a smooth triangular surface, it extends outwards and a little upwards; its attached border stopping short about an inch from the head (leaving an interval through which the supra and infra-spinous fossæ communicate with each other), its free border being continued into the acromion process. It has two surfaces, upper and lower; and three borders, anterior, posterior, and external.

Surfaces.—The upper is concave, and assists in forming the supra-spinous fossa. The lower forms, in like manner, part of the infra-spinous fossa.

Borders.—The anterior is attached to the dorsum of the scapula, and forms the root of the spine. The posterior, or crest, is wide, and presents two lips and an intervening space. The external is short, thick, and rounded; it is continuous below with the neck, and above with the under surface of the acromion process.

The ACROMION PROCESS, projecting outwards and forwards from the extremity of the spine, overhangs the glenoid fossa, and forms the summit of the shoulder.

Surfaces.—Superior and inferior. The superior, convex and rough; the inferior, smooth.

Borders.—Internal and external. The internal concave, and presents near the top of the acromion a small oval facet for articulation with the clavicle; the external, convex, rough and irregular.

B. The borders of the scapula are three: superior, external, internal. The *superior*, the shortest, presents at its outer end the supra-scapular notch.

The *external* or axillary border is the thickest of the three. Above its middle it presents a slight groove for the passage of an artery (the dorsalis scapulæ).

The *internal* or vertebral border is the longest, and extends from the superior to the inferior angle.

C. The angles of the scapula are: superior, inferior, and external. The *superior*, formed by the junction of the upper and internal borders. The *inferior*, formed by the junction of the axillary and vertebral borders. The *external* is truncated, and occupied by the thickened portion, the head of the bone which bears the pear-shaped *glenoid* fossa, for articulation with the humerus.

The CORACOID PROCESS (resembles a crow's beak). It rises for a short distance almost vertically from the upper border of the neck, its surfaces then being anterior and posterior; and then bending almost at a right angle, it is directed forwards and outwards, the surfaces becoming upper and lower, the borders anterior and posterior.

Ossification.—By seven centres: one for the body appears at the eighth week; one for the coracoid at the first year; other five appear between the fifteenth and seventeenth years, viz., two for acromion; a second for the coracoid; one for inferior angle; one for vertebral border.

The epiphyses join the body between the twenty-second and twenty-fifth years.

Articulations.—With the humerus and clavicle.

The HUMERUS presents for examination (*A*) an upper extremity, (*B*) a shaft, and (*C*) a lower extremity.

A. The *upper extremity* presents for examination the head, neck, and tuberosities, great and small. The head is globular, less than half a sphere, and ends at the anatomical neck; to the neck the capsule of the joint is attached.

The greater tuberosity is situated at the upper and outer, and the lesser tuberosity at the anterior aspect of the upper end of the humerus, immediately below the anatomical neck. Between the two is the bicipital groove. The greater tuberosity presents three facets for muscles; the lesser tuberosity has a rough surface for muscular attachment.

B. The *shaft* of the humerus presents (*a*) three borders and (*b*) three surfaces.

(*a*) The anterior border runs from the front of the greater tuberosity to the coronoid depression below. Its upper half is prominent, and forms the outer lip of the bicipital groove.

The external border runs from the back of the greater tuberosity to the external condyle. Its centre is marked by the musculo-spiral groove; its lower part is marked by a prominent ridge, the external supra-condyloid ridge, for the attachment of muscles.

The internal border runs from the inner aspect of the head to the internal condyle, above which is the supra-condyloid ridge.

(*b*) The external surface presents nearly half-way down the deltoid impression placed obliquely to the axis of the bone; the surface looks outwards above the impression, but forwards and outwards below.

The internal surface presents in its centre the impression of the coraco-brachialis muscle; above this, the surface presents the bicipital groove with its two lips, below a smooth surface looking forwards and inwards.

The posterior surface presents in the centre of its course the musculo-spiral groove directed obliquely from above downwards, and from within outwards; the part above seems twisted, so that it looks inwards; the part below looks directly backwards, and ends at the olecranon fossa.

C. The *Lower Extremity* presents from without inwards a rounded eminence, the radial head of the humerus or the capitellum; internally is a shallow groove, and still farther in a ridge, then a shallow and a ridge again. The head is articular only in front and below. The shallow internal surface between the two ridges, the trochlear (pulley-like) surface, is for articulation with the ulna; it ends in front in a fossa—the coronoid—and behind in the olecranon fossa. The anterior fossa is very shallow, the posterior wide and deep. On either side of the lower extremity are seen the internal and external condyles. They are situated at the lower end of the lateral borders, which just above the condyles form sharp ridges—the supra-condyloid ridges. The external condyle is small and tubercular, the internal large and prominent. Each gives attachment to groups of muscles by stout tendons.

Articulations.—With three bones: the scapula, the radius, and the ulna.

Development.—By eight centres. One for the shaft appears at the eighth week; the nucleus for the head at the second year; for the great tuberosity at the third year; for the lesser tuberosity at the fifth year; for the capitellum at the third year; for the internal condyle at the fifth year; for the trochlear surface at the twelfth year; for the external condyle at the thirteenth year; the upper nuclei coalesce and join to the shaft at the twentieth year; the lower nuclei coalesce and join to the shaft at the seventeenth year, all except that for the internal condyle, which joins by itself at the eighteenth year.

The Radius is the smaller of the two forearm bones; being a long bone, it has a shaft and two extremities.

A. The *Upper Extremity* consists of three parts, viz.: (*a*) A Head; (*b*) a Neck; (*c*) a Tuberosity.

(*a*) The *Head* presents above a circular cup, which articulates during flexion with the capitellum of the humerus. It has a smooth border, which rotates in the 'lesser sigmoid cavity of the ulna.' In the recent state it is kept in position by the orbicular ligament.

(*b*) The *Neck* is placed immediately below the head; it is the narrowest part of the bone.

(*c*) The *Tuberosity* consists of two parts; a *posterior* rough, for muscular insertion, the biceps; and an *anterior* smooth, on which a bursa is placed.

B. The *Shaft* is prismoid in shape, and is narrower above than below. It has three borders, viz.—anterior, posterior, and internal; and three surfaces—anterior, posterior, and external.

The anterior border extends from the tuberosity to the anterior aspect of the styloid process. Its upper part is very prominent, and from its direction has been named the 'oblique line of the radius.'

The posterior border extends from the back part of the neck of the radius to the posterior part of the styloid process.

The internal border, also called the interosseous border, is very sharp and prominent. It commences above at the tuberosity, and below, dividing into two, runs to the anterior and posterior margins of the sigmoid cavity of the radius.

The anterior surface is concave above, but broad and flat below.

The posterior surface is convex and smooth in its upper third; its middle third is slightly concave; and its lower-third is broad and convex.

The external surface is round and convex, and about its centre is an impression for attachment of a muscle—pronator radii teres.

C. The *Lower Extremity* is cuboidal in shape, and has therefore six surfaces, of which the superior is continuous with shaft of the bone.

The inferior surface is triangular in shape, and is divided by a slight ridge into two parts; an internal quadrilateral for articulation with the semilunar, and an external triangular for articulation with the scaphoid.

The internal surface forms the sigmoid cavity of the radius, and articulates with the ulna.

The external surface is prolonged downwards into a conical projection, named the styloid process, on the outer surface of which are two grooves, separated by a slight ridge.

The anterior surface is a prominent ridge for ligamentous attachment.

The posterior surface is convex, and marked by three grooves which transmit the tendons of muscles. The central groove is very narrow and deep, and the outer groove is subdivided into two by a slight ridge.

Articulations.—The radius articulates with four bones: the humerus, the ulna, the scaphoid, and semilunar.

Development.—The radius is developed from three centres. The nucleus for the shaft appears at the eighth week; in the lower epiphysis at the second year; and in the upper at the fifth year. The upper epiphysis joins the shaft at the fifteenth year, the lower at the twentieth year.

The ULNA, so called from its forming the elbow, is a long bone, prismatic in form, placed at the inner side of the forearm, parallel with the radius. It is larger and longer than the radius. The upper extremity, of great thickness and strength, forms a large part of the articulation of the elbow-joint; it diminishes in size from above downwards, its lower extremity being very small, and excluded from the wrist joint by the interposition of an interarticular fibro-cartilage. It is divisible into a shaft, and two extremities.

A. The *Upper Extremity*, the strongest part of the bone, presents the olecranon and coronoid processes, and the greater and lesser sigmoid cavities.

The *Olecranon* process presents six surfaces: a superior surface, rough for muscles and ligaments; an inferior surface or base, continuous with the shaft; an anterior surface, concave from above downwards, and with a ridge which fits the trochlear surface of the humerus; the posterior surface, triangular in shape for a bursa. The lateral margins give attachments to ligaments.

The *Coronoid* process is a short, stout prominence of bone, presenting three surfaces: a superior, inferior, and posterior. The superior forms part of the greater sigmoid cavity, having a ridge thereon to fit into the trochlear surface of the humerus. The inferior surface is rough for the attachment of muscles. The posterior or base is the attached surface. On the external aspect is the lesser sigmoid cavity. The apex is received into the coronoid fossa of the humerus on complete flexion of the elbow-joint.

The greater sigmoid cavity is comprised between the olecranon above and the coronoid below; it is divided by a slightly elevated ridge into two parts, of which the internal is the broader.

The lesser sigmoid cavity, situated on the outer side of coronoid process, is narrow, concave from before backwards; its extremities give attachment to the orbicular ligament of the radius.

B. The *Shaft* is prismatic in its upper two-thirds, but rounded below. It presents three surfaces—anterior, posterior, and internal; and three borders—anterior, posterior, and external.

Surfaces.—The anterior surface is concave through most of its length. The posterior presents an oblique line, running from the back of the lesser sigmoid cavity to the posterior border, above which is a triangular surface ; from the centre of the oblique line runs a perpendicular line to near the lower end of the bone. The internal surface is nearly flat throughout its whole length.

Borders.—The anterior runs from the front of the coronoid to the styloid process ; the posterior from the olecranon to the styloid process ; the internal from the lesser sigmoid cavity of the ulna to the inner aspect of the head ulna. Each border divides into a triangular surface above. The anterior embraces the inferior surface of the coronoid process ; the posterior, the triangular surface at the back of the olecranon ; and the external, the triangular surface below the lesser sigmoid cavity.

C. The *Lower Extremity* is excluded from the wrist-joint by the triangular fibro-cartilage.

The head is articular below, where it is flattened and plays upon the triangular fibro-cartilage, and externally where it is semi-cylindrical, it is received into the sigmoid cavity of the radius.

The styloid process descends from the inner and back part of the head. Between the head and styloid process there exists below a depression for attachment of the triangular fibro-cartilage ; behind, a groove for a tendon.

Articulations.—With the humerus and radius; between it and the cuneiform bone is a triangular cartilage.

Development.—The shaft appears at the seventh week ; the lower epiphysis about the fourth year; the upper at the sixth. The upper unites about the eighteenth ; the lower at the twenty-second.

PLATE XI.

Fig. 1. Bones of Carpus, seen from behind.

In the first row: 1. The scaphoid.—2. Semilunar.—3. Cuneiform.—4. Pisiform. In the second: 5. Trapezium.—6. Trapezoid. —7. Os magnum.—8. Unciform.

Fig. 2. Bones of the Hand, seen in front.

1. Bones of carpus.—2. Metacarpal bones.—3. First phalanges.—4. Second phalanges.—5. The third phalanges.—The thumb has no middle phalanx.

Fig. 3. Bones of the Hand, seen from behind.

Fig. 4. Patella, seen from before.

Fig. 5. Patella, seen from behind.

1. Articular facets.

Fig. 6. Femur (*anterior surface*).

1. Head.—2. Neck.—3. Trochanter major.—4. Trochanter minor. —5. Trochlear surface.

Fig. 7. Femur, seen from behind.

1. Digital fossa.—2. Posterior intertrochanteric line.—3. Insertion of gluteus maximus.—4. Linea aspera, with nutrient foramen.—5. Internal tuberosity.—6. External tuberosity.—7. Internal condyle. —8. External condyle.

Fig. 8.—Superior extremity of Femur, seen from above.

Fig. 9.—Inferior extremity of Femur, seen from below.

Fig. 10.—Tibia, seen from before.

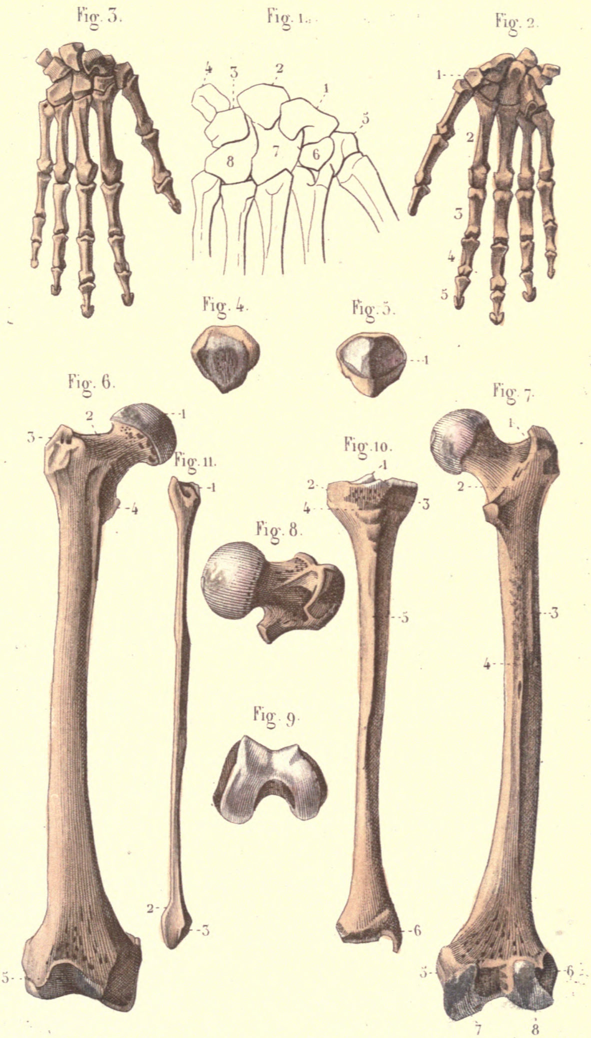
1. Spine.—2. External tuberosity.—3. Internal tuberosity.—4. Tubercle.—5. Shaft.—6. Internal malleolus.

Fig. 11. Right Fibula, seen from before.

1. Head.—2. Inferior extremity or external malleolus.—3. Articular facet for astragalus.

The Carpus consists of eight small bones arranged in two rows: the first or upper, and the second or lower row. Each bone (with the exception of the pisiform) presents six surfaces: an anterior or palmar, rough for the attachment of ligaments; a posterior or dorsal, also for ligaments. The posterior surface is in all the bones, except the semilunar, larger than the anterior. The lateral, superior,

Pl. 11.



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and inferior surfaces are, with the exception of the extreme inner and outer lateral surfaces, all articular.

I. The bones of the first row are from without inwards: the scaphoid, the semilunar, the cuneiform, and the pisiform.

The SCAPHOID presents an anterior and posterior surface, rough for ligaments; the anterior has a tubercle for attachment of muscles and the anterior annular ligament; the posterior has a groove for a ligament.

The superior is convex, smooth, and triangular for articulation with the lower end of radius.

The inferior is convex. A ridge divides it into two articular surfaces, of which the external articulates with the trapezium, and the internal with the trapezoid.

The internal presents two articular surfaces: the superior of which articulates with the semilunar, and the inferior concave with the os magnum.

The external is non-articular, and gives attachment to the external lateral ligament.

Articulations.—With five bones: the radius above; the trapezium and trapezoid below; the os magnum and the semilunar bones internally.

To determine the side, hold it with the tubercle towards the ceiling and away from you; the concavity for the os magnum is internal.

Ossification.—The nucleus appears at the sixth year.

The SEMILUNAR BONE is situated between the scaphoid and cuneiform bones.

Surfaces.—The anterior is broader than the posterior; both are rough for ligaments.

The superior convex and smooth articulates with the radius.

The inferior is divided into two by a ridge. The external part articulates with the head of os magnum; the internal (narrow) with the unciform bone.

The internal presents a smooth quadrilateral facet for articulation with the cuneiform bone.

The external presents a narrow semilunar facet for articulation with the scaphoid.

Articulations.—With five bones: radius above; os magnum and unciform below; scaphoid externally; cuneiform internally.

To determine to which side it belongs, place it with the broad non-articular surface towards the ceiling, the concavity away from you; the semilunar articular surface for the scaphoid is on the outer side.

Ossification.—At the fifth year.

The CUNEIFORM BONE may be distinguished by an oval isolated facet for articulation with the pisiform bone.

Surfaces.—The anterior presents at its inner side the oval facet for articulation with the pisiform.

The posterior is rough for attachment of ligaments.

The superior has two parts : an internal, rough and non-articular ; an external, convex and smooth, being in relation with the inter-articular fibro-cartilage of the wrist.

The inferior is concave, and articulates with the unciform bone.

The internal is rough and pyramidal for attachment of the internal lateral ligament of wrist.

The external is quadrilateral, and articulates with the semilunar.

Articulations.—With three bones : semilunar externally, pisiform in front, unciform below.

To determine to which side it belongs, place it with the oval facet for pisiform bone upwards, and the surface for the unciform away from you ; the quadrilateral facet is external.

Ossification.—At the third year.

The PISIFORM BONE is known by its small size, and by its possessing only one facet. It is more or less circular.

Surfaces.—The anterior is rounded and rough for attachment of anterior annular ligament.

The posterior possesses an oval facet at its upper part, and two muscles for articulation with the cuneiform bone.

The superior, inferior, internal and external surfaces are rounded and rough.

Articulation.—With one bone : the cuneiform.

Ossification.—At the twelfth year.

II. The second row of carpal bones are from without inwards : The trapezium, the trapezoid, the os magnum, and the pisiform.

The TRAPEZIUM, the outer bone of the second row of the carpus, presents the usual surfaces for examination.

Surfaces.—The superior is directed upwards and inwards for articulation with the outer division of the lower surface of the scaphoid.

The inferior is directed downwards and outwards, convex from before backward, concave from side to side ; it articulates with the first metacarpal bone, by this saddle-shaped surface.

The internal is divided into two parts by a horizontal ridge. The upper and larger portion is concave, and directed inward and backward for articulation with the trapezoid bone. The lower portion is a little flat facet, for articulation with a corresponding small surface on the second metacarpal bone.

The external and posterior surfaces are rough for the attachment of ligaments.

The anterior presents in the middle a prominent ridge running from above downward and a little inward; it gives attachment to the anterior annular ligament, and to muscles of the thumb. On its inner side is a groove for the tendon of the flexor carpi radialis.

Articulations.—With the scaphoid, os magnum, trapezoid and second metacarpal bones.

To tell the side it belongs to, hold it with the ridge towards the ceiling, the saddle-shaped surface outwards; the groove running parallel to the ridge runs lengthwise to the hand.

Ossification.—The nucleus appears in the fifth year.

The TRAPEZOID is smaller than the previous bone.

The anterior and posterior surfaces are rough for ligaments.

The superior surface articulates with the scaphoid.

The inferior surface presents a ridge in its centre; it articulates with the second metacarpal.

The external surface articulates with the trapezium; the internal with the os magnum.

Articulations.—With four bones: the scaphoid, trapezium, os magnum and second metacarpal.

To ascertain which side it is, hold the narrow anterior surface towards the ceiling; a prolongation from this surface runs downwards as a ledge between the first and second metacarpal bones. The long prominence on the posterior surface points to the little finger.

Ossification.—The ossific nucleus appears in the eighth year.

The OS MAGNUM is the largest bone of the carpus, and has a head, neck, and body.

The superior surface is round, smooth, and articulates with the semilunar.

The inferior surface articulates with the second, third, and fourth metacarpal bones by three facets.

The internal surface has posteriorly and superiorly an oblong facet for articulation with the unciform, and is rough in parts for attachment of a ligament.

The external surface articulates with the trapezoid below, and with the scaphoid above.

The palmar and dorsal surfaces are rough for the attachment of ligaments.

Articulations.—With seven bones: scaphoid, semilunar, second, third and fourth metacarpal bones, trapezoid and unciform.

Ossification.—The nucleus appears at the first year.

To tell the side: hold the rounded head towards you, the smaller tubercular surface towards the ceiling, the long process at the distal or lower end points towards the little finger.

UNCIFORM, wedge-shaped; presents for examination four surfaces, base, and an apex.

The palmar surface presents a hook-like process—'the unciform process'—the concavity of which is directed outwards.

The dorsal surface is rough for the attachment of ligaments.

The external surface articulates above and behind with the os magnum; the remaining part is rough for ligamentous attachment.

The internal surface is oblique, and articulates with the cuneiform.

The base is directed downwards, and has two facets for articulation with the fourth and fifth metacarpal bones.

The apex is directed upwards, and articulates by a narrow surface with the semilunar.

To tell the side, hold it with the hook towards the ceiling, and the apex of the wedge towards you; the concavity of the hook looks outwards.

Articulations.—With five bones: fourth and fifth metacarpal, os magnum, cuneiform, and semilunar.

Ossification.—At the second year.

GENERAL CHARACTERS OF THE METACARPAL BONES.—A metacarpal bone presents for examination a shaft, a head, a proximal or carpal extremity.

The *Shaft* presents three borders and three surfaces.

Borders.—The anterior border is single in the middle of its course, but bifurcates both above and below, enclosing two triangular spaces. The lateral borders run from the lateral aspects of the carpal extremity to the lateral tubercles on either side of the head of the bone.

Surfaces.—The surfaces are two lateral and a posterior. The posterior is flat and smooth; the lateral are slightly hollowed out for the attachment of muscles. The shaft is narrowest just below the carpal end. The nutrient foramen, when seen, is on the anterior border half-way along.

The *Carpal* or proximal end is more or less cuboidal, with a rough surface for ligaments, and smooth articular surfaces. The articular surfaces are, a superior, where it articulates with a carpal bone; and two lateral, which articulate with the neighbouring bones.

The *Head* or distal extremity presents a round head, ending below in two condyles with a notch between. On either side is a rough depression, bounded by a small tubercle.

The peculiarities of each metacarpal bone are: The first is compressed, presenting only two surfaces and two borders. The carpal end presents a saddle-shaped surface. To tell right from left, hold the bone with the concave palmar surface towards the ceiling; the straight border is the outer. The second has a bifurcated carpal end, the inner limb of which is the longer. The third has a long styloid projection on its outer side. The fourth is square cut at its carpal end, and has facets on either side—two on the outer, one on the inner; different from the fifth, which has a facet only on its inner side.

Articulations.—The numbers of the articulations from the thumb to the little finger are 2, 5, 4, 5, 3. The articulations of the metatarsal bones are the same in number.

Development.—The shaft appears in the ninth week. The epiphysis is at the distal end, and ossifies at the fourth year, joining the shaft at the twentieth year. The epiphysis for the metacarpal bone of the thumb is at its proximal end.

The Phalanges.

The phalanges are fourteen in number, three for each finger except the thumb, which has two. Each phalanx possesses a proximal and distal end and a shaft. The bones of the *first* row, named the first, proximal or metacarpal phalanges, are concave anteriorly in their general outline. The proximal ends have oval facets; the distal are compressed antero-posteriorly, presenting a shallow central groove with lateral condyles. The shafts are convex posteriorly, flattened in front, with two lateral ridges for the attachment of the ligaments of the sheaths of the fingers. The bones of the *second* row, named the second or middle phalanges, are similar to the previous but much smaller. The proximal facets are not oval, but expanded transversely with a ridge down the centre to fit the groove on the first. The *third* set of bones, the third, terminal, ungual or distal phalanges, are very short; the proximal end has a transversely placed surface for the second; the distal presents compressed and roughened surfaces to support the pulp of the fingers and the nail.

Bones of the Lower Extremity.

The Femur is divisible into a shaft, upper and lower extremities.

A. The *Upper Extremity* consists of a head, neck, greater and lesser trochanters. The *head* is a globular portion of bone a little more than half a sphere, smooth and covered with cartilage in the recent state. A little below its centre is a depression for the attachment of the ligamentum teres. At the junction of the head and neck is a well-marked ridge; this is contained within the capsule, but has nothing to do with its attachment.

The *neck* is a pyramidal piece of bone connecting the head to the shaft. It has two surfaces and two borders.

The anterior surface is pierced by numerous foramina, and ends below at the anterior intertrochanteric line.

The posterior surface is of larger extent, and ends externally at the posterior intertrochanteric line.

The superior border passes from the head to the great trochanter.

The inferior border passes from the head to the lesser trochanter, being twice as long as the superior border.

The GREAT TROCHANTER (τροχαω, to roll) is a quadrilateral mass of bone projecting upwards from the junction of the neck and shaft; it is situated below the level of the head, and has two surfaces, four borders, and four angles.

The internal surface is small in extent, and presents a fossa—the *digital fossa.*

The external surface is of much larger extent; it is quadrilateral in shape.

Running from the posterior superior angle to the anterior inferior angle on the external surface is the *diagonal* line.

The borders are: the superior, inferior, anterior, and posterior.

The angles are also four: posterior superior, posterior inferior, anterior superior, and anterior inferior.

The LESSER TROCHANTER is a conical process projecting downwards, inwards, and a little backwards.

Three lines converge towards it: from behind, the posterior intertrochanteric line; from above, the inferior border of the neck; and from below the middle division of the linea aspera.

Joining the greater and lesser trochanters behind is the posterior intertrochanteric line, which has, running from about its centre, a perpendicular line, the *linea quadrata.*

Leading from the great trochanter is the anterior intertrochanteric line, which winds round the shaft in front and below the lesser trochanter, under the name of the *spiral line* of the femur, to join the internal lip of the linea aspera.

At the junction of the anterior intertrochanteric line with the great trochanter is a tubercle—the *tubercle* of the femur.

B. The *Shaft* is described as having three borders and three surfaces. More correct would it be to describe the bone as a cylinder with a prominent ridge behind the linea aspera.

Surfaces.—The surfaces are called internal, external, and anterior; but they really form one continuous surface, and give attachment to muscles all the way round.

Borders.—The internal and external borders run from the upper to the lower part; but are only marked below where they run to their corresponding condyles. The posterior border presents in its middle third the rough line—the *linea aspera;* it consists of two lips and an intervening surface for the attachment of muscles. The linea aspera divides above into three: The inner division runs to the front part of the great trochanter, under the name of the spiral line of the femur or the anterior intertrochanteric line; it ends above at the tubercle. The outer division ends at the posterior intertrochanteric line. The middle division ends at the lesser trochanter.

Below the linea aspera divides into two, the lines running to the corresponding condyles, and enclosing between them the ham. The internal line ends at the *adductor tubercle.*

C. The *Lower Extremity* is in general outline cuboidal, but it presents two stout condyles, separated by a deep notch, the intercondyloid notch.

Surfaces.—The superior surface is continuous with the shaft. The inferior aspect presents the lower surfaces of the condyles for articulation with the tibia, and between the two the intercondyloid notch, with its rough lateral surfaces for attachment of the crucial ligaments. The anterior aspect presents a trochlear surface for articulation with the patella. The posterior aspect presents the notch and the back part of the condyles. The internal aspect is rough for the internal lateral ligament, and has at its back part the adductor tubercle. The external aspect is rough for the external lateral ligament, and below presents a pit and groove for the attachment and passage of a muscle (the popliteus). The differences between the condyles may be summed up thus: the internal projects more from the axis of the shaft than does the external; the internal is the broader; the internal also projects the lower. The external projects the farther forward, and has the articular surface for the patella extending higher up than on the internal.

The *articulations* are with the os innominatum, tibia and the patella.

Development.—The centre for the shaft appears in the eighth week; the lower epiphysis at the ninth month; the upper at the end of the first year; the great trochanter at the fourth year; the lesser at the fourteenth year. These parts unite at about the twentieth year.

The PATELLA is a triangular bone, compressed from before backwards, situated in front of the kneejoint, with its apex below and its base above; it presents two surfaces, two borders, a base and an apex.

The *surfaces* are: Anterior and Posterior.

The *borders* are: Superior, Internal and External.

The anterior surface is convex, perforated by numerous nutrient foramina, and marked longitudinally by striæ. It is also covered by an expansion of the quadriceps extensor. To the inferior portion is attached the ligamentum patellæ.

The posterior surface is divided into two portions by a vertical ridge, which corresponds to the groove on the trochlear surface of the femur. The portions are not equal, for the external is much the larger of the two, and articulates with the external condyle, whereas the internal is the smaller, and articulates with the internal condyle. In addition there is a transverse or horizontal ridge which crosses the posterior surface, and with the vertical apportions it into four areas. Further, a small semilunar articular surface along the inner edge can be seen in some specimens; it touches a similar surface on the internal condyle during extreme flexion. Below these facets, which are situated at the upper portion of the bone, is a rough non-articular depression, to the lower portion of which the ligamentum patellæ is attached.

The superior and lateral borders give attachments to the tendon of the quadriceps extensor.

The apex of the patella presents a pointed process of bone below, to which the ligamentum patellæ is attached.

The apex reaches to a level with the upper border of the head of the tibia when the knee is extended.

Articulations.—With the Femur; the two upper facets touch the condyles during extension, the two lower during flexion. To ascertain the side to which it belongs, lay the bone on the table with the apex placed distally; the bone falls towards the side to which it belongs.

Development.—It is developed by a single ossific centre, sometimes by two, which appear about the third year.

Pl. 12.

Fig. 3.

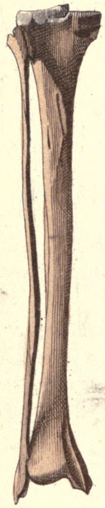
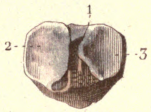


Fig. 1



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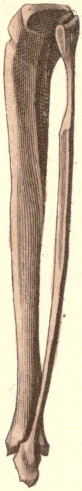

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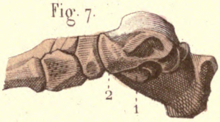

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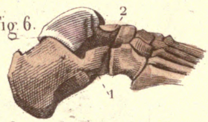

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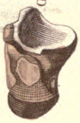

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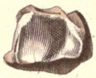

Fig. 9.

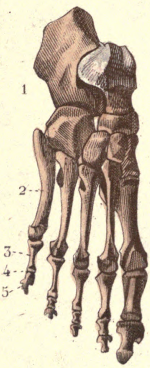

Fig. 5

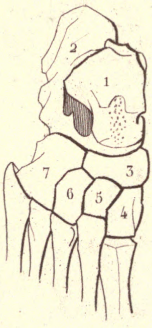

Fig. 10.

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PLATE XII.

Fig. 1. Superior Articular Surface of Tibia.

1. Spine.—2. Internal articular facet.—3. External articular facet.

Fig. 2. Inferior Articular Surface of Tibia.

Fig. 3. The Bones of the Leg, seen from behind.

Fig. 4. Side View of the Bones of the Left Leg (*fibular aspect*).

Fig. 5. Bones of the Tarsus, seen from above.

1. The astragalus.—2. The os calcis.—3. The scaphoid.—4. The internal cuneiform.—5. The middle cuneiform.—6. The external cuneiform.—7. The cuboid.

Fig. 6. Right Tarsus, seen from the outer side.

1. Greater process of os calcis.—2. Canal for calcaneo-astragaloid (interosseous) ligament.

Fig. 7. Right Tarsus, seen from the inner side.

1. Sustentaculum tali.—2. Head of astragalus.

Fig. 8. Os calcis (*superior surface*).

Fig. 9. Bones of the Right Foot, seen from above.

This drawing shows successively: 1. The tarsal bones.—2. The five metatarsal.—3. The first phalanges.—4. The second phalanges. 5.—The last phalanges, or ungual. The great toe has no middle phalanx.

Fig. 10. Bones of the Foot, seen from below.

1. Internal tuberosity of os calcis.—2. External tuberosity.

The Tibia, a prismoid-shaped bone, presents for examination an upper end, a shaft, and a lower end.

A. The *Upper End*, or head, is cuboidal in shape, and possesses two lateral masses or tuberosities.

The superior surface presents in the middle the spine, which is bifurcated, with its projections placed laterally; in front and behind are non-articular parts for ligaments, and at the posterior part a notch called the popliteal notch. On either side of the middle line are two concave articular surfaces for the femur: the inner longer from before backwards, and the outer well-nigh circular.

The inferior surface is continuous with the shaft.

The inner and outer aspects are for ligamentous attachments.

The anterior aspect is triangular, with its apex below at the tubercle; it is perforated by numerous vascular foramina.

The posterior aspect presents a groove behind the inner tuberosity for a muscle, and a facet behind the outer for the head of the fibula.

B. The *Shaft* has three borders and three surfaces.

Borders.—The anterior border runs from the tubercle to the anterior border of the inner malleolus; it is sharp and sinuous.

The internal border runs from the inner aspect of the head to the back of the inner malleolus.

The external border runs from the facet for the head of the fibula to the rough surface below, where it bifurcates to enclose the surface for the inferior tibio-fibular articulation.

Surfaces.—The internal surface is smooth and subcutaneous.

The external surface is concave above for muscular attachment, convex below where it passes on to the front part of the lower extremity.

The posterior surface presents an *oblique line* running from the facet for the fibula, downwards and inwards, to join the internal border at the junction of the upper and middle third. Above the oblique line is a triangular surface for attachment of a muscle (the popliteus). From the centre of the oblique line runs down a *perpendicular line* which divides the surface for the attachment of two muscles.

The *Lower End* of the tibia is cuboidal.

The upper surface is continuous with the shaft.

The lower surface is articular, and presents a ridge running from before backwards, which occupies the groove in the trochlear surface of the astragalus.

The anterior surface is smooth and rounded.

The posterior is flat, showing a groove internally for the passage of two tendons, and a groove half-way along for another tendon.

The internal surface projects downwards on the inner malleolus.

The external surface presents a rough triangular aspect, for the articulation of the fibula.

The internal malleolus is a short, stout tongue of bone, which forms the internal part of the ankle-joint. It has a depression under cover of its apex for the internal lateral ligament of the ankle, and a pear-shaped facet for articulation with the astragalus.

Articulations.—With the femur, fibula, and astragalus.

Development.—The nucleus for the shaft appears at the seventh week; that for the upper end during the first year; that for the lower end during the second. The lower epiphysis unites at the twentieth year; the upper at the twenty-fifth.

The FIBULA (*fibula*, a brooch) is the small or splint bone of the leg. It presents a shaft, upper and lower extremities.

A. The *Upper Extremity*, or head, is a truncated piece of bone continuous with the shaft. It presents a facet for articulation with the tibia, which looks upwards, forwards, and inwards; also at the outer and back part a process of bone—the *styloid process*—for the attachment of a ligament and a muscle. Numerous muscles are attached around the head.

B. The *Shaft* is best described as having three borders and three surfaces, as in the case of the tibia.—*Struthers*.

The borders are anterior, internal, and external; the surfaces, internal, external, and posterior.

The anterior border runs from the front of the head to the lower end, where it bifurcates in the malleolus to form its anterior and external border.

The external border runs from the outer aspect of the head to the posterior border of the external malleolus.

The internal or interosseous border runs from the inner aspect of the head to just above the malleolus, where it divides to enclose a rough surface from the attachment of ligaments which tie it to the tibia.

The external surface is hollow, for the attachment of the outer group of muscles.

The posterior, a flat surface, gives attachment to muscles of the posterior group.

The internal surface is divided into two by a perpendicular line for the interosseous membrane, denominated the *interosseous line*. Part of the internal surface is behind this line, and gives attachment to a muscle of the posterior group; part is in front, and presents a narrow surface for two muscles, separated by a ridge.

The interval between the anterior border and this ridge is by some called the anterior surface; but it is here called an anterior part of the internal surface, thus making the surfaces and borders of the fibula the same as those of the tibia.

C. The *Lower Extremity* forms the pyramidal-shaped projection called the external malleolus. It presents three borders and three surfaces. The borders are anterior, posterior and external.

The anterior and external are continued from the bifurcation of the anterior border of the fibula; whilst the posterior is continuous with its external border.

The surfaces are: the anterior, a subcutaneous surface; the posterior, grooved from the passage of tendons; an internal, marked above by a rough surface for the ligaments between the tibia and fibula, and below by a triangular-shaped articular surface for articulation with the astragalus.

The base of the malleolus is continuous with the shaft of the bone; the apex projects below the level of the internal malleolus, and gives attachment to ligaments.

Articulations.—With two bones, the tibia and astragalus.

Development.—The nucleus of the shaft appears at the eighth week; that for the lower epiphysis at the second year, and that for the upper at the fourth year. The lower epiphysis unites at the twentieth year, the upper at the twenty-fourth year.

The OS CALCIS, or calcaneum, is the largest bone of the foot; it largely supports the weight of the body by forming the heel.

It presents six surfaces for examination.

Superior: posteriorly it is covered by fat; in its centre is an obliquely convex surface for articulation with the astragalus; in front of this is a deep rough groove for a ligament; the surface ends in front on the greater process of the os calcis.

Inferior: presents behind two tuberosities, the inner or greater and the outer or lesser; in front of these is a long rough convex surface for ligaments; at the anterior part is a round knoll, the tubercle for the attachment of ligaments.

Posterior: rough below for the attachment of the *tendo Achilles;* frequently there is a smooth facet at its upper part for a bursa.

Anterior: presents an articular surface for the cuboid; it is uneven, and possesses a projecting point to overlap the cuboid.

Internal: presents a deeply concave surface overhung by the lesser process of the os calcis—the *sustentaculum tali.* This process presents an articular surface above for the head of the astragalus; it is rough for ligaments at all other points except below, where it is grooved by a tendon.

The *external* aspect presents a rough surface with two tubercles. The more anterior is the *peroneal tubercle,* with a groove above for the peroneus brevis, and one below for the peroneus longus. The more posterior tubercle is for the middle slip of the external ligament of ankle.

Articulations.—With two bones, the astragalus and the os calcis.

Development.—By a nucleus appearing at the sixth month. An additional nucleus for the heel appears at the tenth year.

The ASTRAGALUS possesses a head, a neck, and a body; but it is most conveniently described as having six surfaces, like other tarsal bones.

Surfaces:—The *Superior* presents a trochlear surface for the tibia, slightly wider in front than behind; in front of this, the upper part of the neck and head.

Inferior: presents posteriorly an obliquely concave surface for the os calcis; in front the under aspect of the neck and the head, the latter presenting two facets, one, the posterior, for the sustentaculum tali, the other, the anterior, for the calcaneo-scaphoid ligament.

Anterior: rounded for articulation with the scaphoid.

Posterior: a narrow ridge marked by a groove for the tendon of the flexor longus pollicis.

Internal: presents a pear-shaped surface, wide end forwards, for articulation with the internal malleolus; below this a rough surface for ligaments.

External: presents a triangular facet for the external malleolus and a rough part for ligaments.

Articulations.—Four bones: tibia, fibula, scaphoid, and os calcis.

Development.—Ossification begins at the seventh month.

The SCAPHOID presents six surfaces:

Superior and *Inferior*, *i.e.* dorsal and plantar: rough for ligamentous attachment.

Internal: presents a rounded eminence—the tubercle—projecting towards the sole of the foot.

External: rough for ligaments, with, in some bones, a facet for the cuboid.

Posterior: concave for the head of the astragalus.

Anterior: possesses three facets for the three cuneiform bones; the inner more or less triangular, with the base below; the middle, also triangular, with the base upwards; the external, quadrilateral.

Articulations.—Four, sometimes five; the astragalus, the three cuneiform, and sometimes the cuboid.

Development.—Ossification begins at the fourth year.

The INTERNAL CUNEIFORM is irregularly triangular, with its apex upwards and inclined outwards. It has six surfaces—of which the *superior*, *inferior*, and *internal* are respectively pointed, rounded, and flat, for ligamentous attachment.

External: presents along its posterior part a facet for the middle cuneiform, and at its anterior part a point for articulation with the second metatarsal; the rest of the surface is rough for ligaments.

Posterior: a glenoid surface for the scaphoid, wide end down.

Anterior: kidney-shaped surface for the first metatarsal.

Articulations.—Four; scaphoid, middle cuneiform, first and second metatarsal bones.

Development.—Ossification begins at the third year.

The MIDDLE CUNEIFORM is regularly wedge-shaped, the point of the wedge below. It has six surfaces.

Superior: broad for ligaments.

Inferior : a rough ridge.

Internal : presents an L-shaped facet along its posterior and superior borders for articulation with the internal cuneiform.

External : a facet for the external cuneiform.

Posterior : a triangular facet for the scaphoid.

Anterior : a triangular facet for the second metatarsal.

Articulations.—Four ; the internal and external cuneiform, the scaphoid, and the second metatarsal.

Development.—Fourth year.

The External Cuneiform is wedge-shaped, and bent so that it is slightly concave inwards and convex outwards ; it has the point of the wedge downwards; it has, like other tarsal bones, six surfaces.

Superior and *Inferior :* these, respectively broad and narrow, are for ligamentous attachment.

Internal : presents a facet for the middle cuneiform posteriorly.

External : posteriorly presents a facet for the cuboid.

Posterior : a quadrangular facet for the scaphoid.

Anterior : a large central and two small lateral facets for the third, second, and fourth metatarsal bones respectively.

Articulations.—Six : the scaphoid, middle cuneiform, cuboid, the second, third, and fourth metatarsal.

Development.—First year.

The Cuboid Bone, although cuboidal, is narrowed externally so that the broadest part of the bone is internal.

It has six surfaces ; these are :

Superior : rough for attachment of ligaments.

Inferior : presents a ridge behind for muscles and ligaments, and a groove in front for the passage of the tendon of the peroneus longus.

Internal : is in shape quadrilateral, and has in front an oval facet for articulation with the external cuneiform, and behind sometimes another for the scaphoid. The rest of the surface is rough for the attachment of the interosseous ligaments.

External : shows the commencement of the ridge and groove seen in the under surface ; the ridge has a facet for the tendon of the peroneus longus muscle and the sesamoid bone developed therein.

Posterior : presents an uneven surface for the os calcis.

Anterior : divided by a ridge separating two quadrilateral facets for the fourth and fifth metatarsal.

Articulations.—Four, sometimes five : os calcis, external cuneiform, fourth and fifth metatarsals ; sometimes also with the scaphoid.

Development.—At birth an ossific nucleus is found.

Common Characters of the Metatarsal Bones.

Each bone possesses a base, shaft, and head placed distally.

The *Bases* of all are wedge-shaped, except the first and last.

The *Shafts* possess typically three borders and three surfaces as in the metacarpal, but owing to lateral compression only two borders and two surfaces are seen in the metatarsal. The borders are dorsal and plantar, the surfaces internal and external.

The *Heads* are rounded and prolonged below into condyles, as in the metacarpals. Laterally also are tubercles for ligamentous attachment.

Special Characters.

The first is stout and short, its proximal end kidney-shaped, its distal end marked by a ridge running from before backwards. The shaft is straight along its inner, but concave along its outer aspect.

The second bone has at its base one facet internally and four externally, two in front and two behind. The third has two facets internally and one externally. The fourth has a single facet on either side. The fifth has a facet inside and a tubercle externally.

Articulations.—Number as in the hand, but from within outwards, 2 : 5 : 4 : 5 : 3.

Development.—The shaft appears in the ninth week; the epiphysis placed distally between the third and eighth year. These unite at the twentieth year.

The epiphysis of the metacarpal bone of the thumb, as in the big toe, is placed at the proximal end.

The phalanges of the toes closely resemble those of the fingers (*q. v.*). The first toe presents broad and stout bones, but the others narrow and small bones, compressed laterally and narrowed in the middle. The shaft in the second row is almost wanting. The third row of bones presents a set of nodules only.

Development.—The shaft appears at the tenth week; the epiphysis is at the proximal end, and appears at the tenth year. These unite at the twenty-first year.

Classification of Bones.

Bones are arranged in four groups:—

1. Long Bones.—These consist of a shaft and two extremities, and have a more or less marked medullary cavity: they are—the femur, the tibia, the fibula, the humerus, the radius, the ulna, the metatarsal and metacarpal bones, and the phalanges of the feet and hands. The clavicle is by some also relegated to this category.

2. SHORT BONES are found in the tarsus and carpus, being intended for strength and closely-fitting articulations.

3. FLAT BONES are met with as two flattened tables of compact tissue with cancellous tissue between. They are :—the occipital, the parietals, the frontal, the nasals, the lachrymals, the vomer, the scapulæ, the sternum, the ribs, and the innominate bones. The patella is also placed in this class.

4. IRREGULAR or MIXED BONES are all those which cannot be placed in any of the preceding groups. They are :—the vertebræ, the temporals, the sphenoid, hyoid, etc., etc.

WORMIAN BONES, ossa triquetra or ossa suturarum, are irregularly serrated patches of bones met with in the sutures which the parietal bone forms with its neighbours. They seldom exceed an inch in diameter.

SESAMOID BONES are ossific nodules developed in tendons, the most constant of which are those met with in both heads of the short plexors of the thumb and big toe, and in the tendon of the peroneus longus, where it touches the cuboid.

Pl. 13.

Fig. 1.

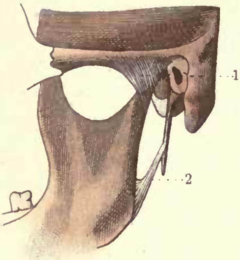
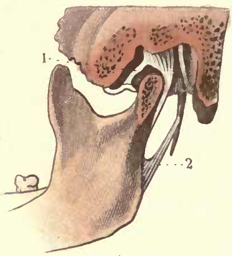


Fig. 2.

Fig. 3.



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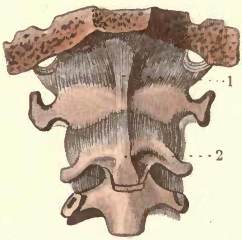

Fig. 6.

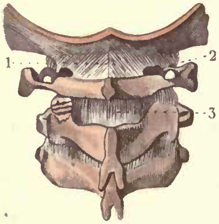

Fig. 5.

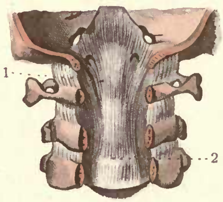

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PLATE XIII.

Figs. 1, 2, and 3. TEMPORO-MAXILLARY ARTICULATION.

Fig. 1.—1. External lateral ligament.—2. Stylo-maxillary ligament.

Fig. 2.—1. Internal lateral ligament.—2. Stylo-maxillary ligament.

Fig. 3.—TEMPORO-MAXILLARY ARTICULATION, SEEN FROM THE OUTER SIDE, AND OPENED LATERALLY.

1. Inter-articular fibro-cartilage.—2. Stylo-maxillary ligament.

Fig. 4.—1. Anterior occipito-atloid ligament.—2. Commencement of the anterior common vertebral ligament.

Fig. 5.—1. Occipito-axoid ligament.—2. Commencement of the posterior common ligament of the vertebræ.

Fig. 6.—1. Posterior occipito-atloid ligament.—2. Opening in the ligament for the vertebral artery. 3. Ligament uniting the laminæ of the two first vertebræ, taking the place of the ligamentum subflavum.

LIGAMENTS BETWEEN THE ATLAS AND THE AXIS.

Two anterior atlo-axoid. (*a*) Superficial : a rounded cord extending from the tubercle on the anterior arch of the atlas to the base of the odontoid process and the body of the axis. (*b*) Deep: broad and thin, stretching from the lower border of the anterior arch of the atlas to the base of the odontoid process and body of the axis.

Posterior atlo-axoid: broad and thin, attached above to the lower border of the neural arch of the atlas, and below to the upper edge of the lamina of the axis.

Transverse ligament: thick and strong, attached laterally to the tubercle on the inner aspect of the lateral mass of the atlas; as it crosses the odontoid process, a process passes upwards to the basilar process of the occipital, and another downwards to the root of the odontoid process, thus giving to the whole ligament a *cruciform* appearance. This ligament is separated from the neural canal by the occipito-axoid ligament.

Capsular ligaments: connecting the articular surfaces.

Ligaments connecting the Vertebral Column with the Cranium.

1. *Ligaments connecting the Atlas with the Occipital.*

Two anterior occipito-atloid. (*a*) Superficial: a rounded cord, extending from the tubercle on the anterior arch of the atlas to the basilar process of the occipital. (*b*) Deep: broad and thin, extending from the upper border of the anterior arch of the atlas to the anterior margin of the foramen magnum.

Posterior occipito-atloid: broad and thin, blended with the dura-mater, and stretching from the upper border of the posterior arch of the atlas to the posterior margin of the foramen magnum.

Lateral occipito-atloid: passing from the base of the transverse process of the atlas, upwards and inwards to the jugular process of the occipital.

Capsular ligaments, around the articular surfaces.

2. *Ligaments connecting the Axis with the Occipital.*

Occipito-axoid ligament, or apparatus ligamentosus colli: broad and strong, covering the cruciform ligament, is attached below, to the posterior surface of the body of the axis where it becomes continuous with the posterior common ligament, and above to the basilar process of the occipital.

Odontoid or check ligaments. (*a*) Two true check ligaments, arising one on each side of the apex of the odontoid process, and passing upwards and outwards to a rough depression on the inner side of the condyles of the occipital. (*b*) False check ligament, situated between the above two, and passing from the apex of the odontoid process to the anterior margin of the foramen magnum. It is covered by the upper fasciculus of the cruciform ligament.

Temporo-Maxillary Articulation.

Class of Joint.—Arthrodial.

Articular Surfaces.—1. The part of the glenoid fossa in front of the Glasserian fissure, together with the convex eminentia articularis situated anterior to it. 2. The condyle of the inferior maxilla, convex and oblong, elongated transversely, its outer extremity being more anterior and superior than the inner.

Ligaments.—*Capsular*, funnel-shaped, thin and loose, attached above to the front of the Glasserian fissure, to the front of the eminentia articularis, and to the circumference of the glenoid fossa; below, to the neck of the condyle. *External lateral*, short and narrow, attached above to the tubercle and to the outer surface of the zygoma; below to the outer surface and to the posterior border of the neck of the condyle. *Internal lateral* is a thin band passing from the spine of the sphenoid to the spine overhanging the inferior dental foramen. *Interarticular fibro-cartilage* is a thin plate adapted to the bony surfaces, connected to the surrounding ligaments, and to the external pterygoid muscle, and separating the joint into two cavities. *Stylo-maxillary* is a band of deep cervical fascia extending from the styloid process to the angle and posterior border of the ramus.

Synovial Membranes.—Two in number, one above and one below the interarticular fibro-cartilage.

PLATE XIV.

Fig. 1. 1. Vertical portion of the occipito-axoid ligament.—2. One of the odontoid or check ligaments.—3. Cruciform ligament.—4. Commencement of the posterior common ligament.

Fig. 2. Articulation of the bodies of the Vertebræ.

1. Middle portion of the anterior common ligament.—2 and 3. Lateral portions of the same.—4. Stellate ligament of costo-vertebral articulation.

Fig. 3. Vertebral canal opened to show—1. The posterior common ligament.

Fig. 4. A Vertebra, seen on its superior surface.

1. Fibres of the intervertebral ligament or disc.—2. Gelatiform substance of this disc.

Fig. 5. Vertebral Canal, opened to show some of the Ligamenta Subflava attached to the Laminæ.

1. Ligamentum subflavum.

Fig. 6. 1. Portion of the supraspinous ligament.—2. Interspinous ligament.

Articulations of the Vertebral Column.

Ligaments of the bodies of the Vertebræ.

Anterior common ligament: broad and strong, broader below than above, extends along the anterior aspect of the vertebral column, from the axis to the sacrum.

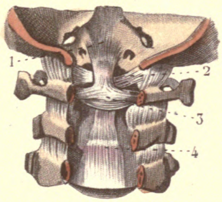
Posterior common ligament: broader above than below, situated in the spinal canal along the posterior aspect of the vertebral column, from the axis to the sacrum.

Each ligament presents constrictions opposite the bodies, and expansions opposite the intervertebral substances. The fibres run longitudinally, are firmly connected to the intervertebral substances and the margins of the bones, but behind the centre of the bodies is a wide interval for the passage of veins. The deep fibres run between adjacent bones, but the superficial connect bones three or four off.

An *Intervertebral substance* is a flat disc attached to the contiguous surfaces of the vertebræ, from the axis to the sacrum. The circum-

Pl. 14.

Fig. 1.



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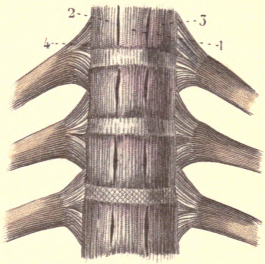

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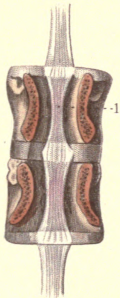

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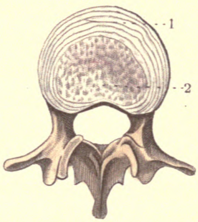

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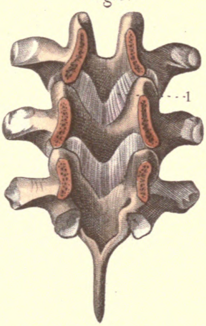

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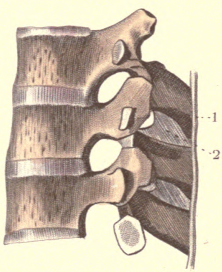

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ferential part consists of alternate concentric lamellæ of fibrous tissue and fibro-cartilage; the central part is soft and pulpy. The fibres in the outer part of the circumferential set are bent outwards; those in the inner are bent inwards towards the pulp. The direction of the fibres in the alternating layers are opposite, one being from right to left, the adjacent from left to right; the next from right to left, and so on. The discs in the cervical and lumbar regions are thicker in front than behind, causing the convexities met thereat; in the dorsal region the curve is chiefly owing to the shape of the bodies. A thin cartilaginous plate covers the surfaces of the vertebræ.

Ligaments of the Neural Arch and Processes.

Ligamenta subflava: these extend between the neural arches of the vertebræ; the first is situated between the axis and third cervical vertebra; the last, between the last lumbar and the sacrum, They consist of yellow elastic tissue, and extend from the lower margin and the anterior surface of the lamina above, to the upper margin and posterior surface of the lamina of the vertebra below.

Capsular ligaments, connecting the articular surfaces.

Interspinous ligaments: thin and membranous, interspersed between the spinous processes in the dorsal and lumbar regions.

Supraspinous ligament is a strong fibrous cord connecting the apices of the spinous processes from the seventh cervical to the sacrum.

Intertransverse ligaments: interposed between the transverse processes, generally wanting in the cervical region.

PLATE XV.

Fig. 1. Costo-vertebral Articulation.

1. An intervertebral disc.—2. Stellate ligament. 3. Interosseous ligament of the costo-vertebral articulation.

Fig. 2. Costo-Transverse Articulation.

1. Supraspinous ligament.—2. Posterior costo-transverse ligament. —3. Middle costo-transverse ligament.—4. Anterior costo-transverse ligament.

Fig. 3. A vertebra, and posterior portion of a rib cut horizontally, showing—1 and 2. The middle costo-transverse ligaments.

Fig. 4. Costo-sternal and Intercostal Articulations.

1. Costal cartilage.—2. Union of this cartilage with the rib.—3. Anterior costo-sternal ligament.—3′. Anterior membrane covering the sternum formed by the interlacing of the anterior ligaments.—4. Costo-xiphoid ligament.—5, 6, 7 and 8. Intercostal ligaments.

Fig. 5. Posterior View of Costo-sternal Ligaments.

1. Cartilage of rib.—2. Posterior ligament.—3. Posterior membrane covering the sternum.

Ligaments connecting the Ribs with the Vertebræ.

1. *Ligaments between the Heads of the Ribs and the Bodies of the Vertebræ.*

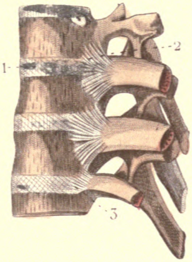
Anterior costo-vertebral or *stellate ligament:* passing from the anterior part of the head of the rib it divides internally into three fasciculi. The uppermost is connected with the body of the vertebra above, the middle with the intervertebral substance, and the lowest to the vertebra below. When the rib is connected with only one vertebra, one fasciculus passes to the vertebra above, and another to the adjacent vertebra.

Capsular ligaments connect the articular surfaces.

Interarticular ligament is a thin band of fibro-cartilage passing, from the sharp ridge separating the articular surfaces of the head of the rib, to the intervertebral substance; it divides the joint into two cavities, each lined by a separate synovial membrane. It is wanting in the ribs which only articulate with one vertebra.

Pl. 15.

Fig. 1.



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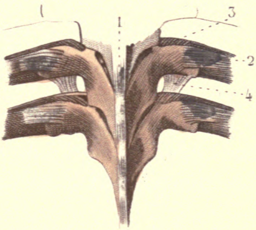
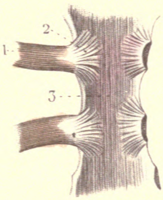
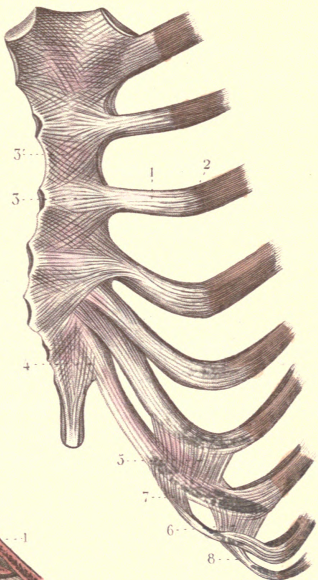


Fig. 4.

Fig. 5.





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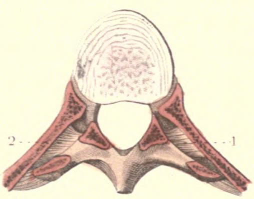


2. *Ligaments connecting the Neck and Tubercles of the Rib to the Transverse Processes.*

Anterior costo-transverse ligament: broad and strong, stretching from the upper border of the neck of the rib to the lower border of the transverse process of the vertebra above. There is no such ligament connected with the first and last ribs.

Middle costo-transverse or interosseous ligament, connects the posterior surface of the neck of the rib to the anterior surface of the adjacent transverse process; it is wanting in the eleventh and twelfth ribs.

Posterior costo-transverse ligament is a strong fasciculus extending from the tip of the transverse to the non-articular part of the tubercle of the adjacent rib; it is wanting in the eleventh and twelfth ribs.

Capsular: very thin, it connects the adjacent articular surfaces.

LIGAMENTS CONNECTING THE CARTILAGES OF THE RIBS WITH THE STERNUM, ETC.

Anterior costo-sternal radiates from the anterior aspect of the cartilage of each rib to the anterior surface of the sternum.

Posterior costo-sternal is similarly disposed along the posterior surface.

Capsular ligament connects the articular surfaces. The cartilage of the first rib is continuous with the sternum; the second has an interarticular fibro-cartilage separating two synovial surfaces.

Synovial Membranes.—None in the first; two connected with the second rib; the third has two in early life; but it, as well as the remaining true ribs, have only one in adult life.

The cartilage of the seventh rib is connected with the ensiform appendix by a ligamentous band, the costo-xiphoid ligament.

Between the adjacent borders of the cartilages of the sixth, seventh, eighth, and ninth, are found synovial membranes.

The ribs are connected with their cartilages by means of the periosteum.

PLATE XVI.

Figs. 1, 2, 3, and 4. Articulation of Pelvis.

Fig. 1.—1. Termination of anterior common ligament, extending as far as the third sacral vertebra.—2. Fibres forming the anterior membrane covering the sacrum.—3. Anterior sacro-coccygeal ligament.—4. Ilio-lumbar ligament.—5. Sacro-vertebral ligament.—6. Anterior sacro-iliac ligament.—7. Great sacro-sciatic ligament.—8. Lesser sacro-sciatic ligament.

Fig. 2.—1. Inferior part of supraspinous ligament.—2. Posterior sacro-coccygeal ligament.—3. Ilio-lumbar ligament.—4. Posterior sacro-iliac ligament.—5. Sacro-spinous ligament.—6. Great sacro-sciatic ligament.—7. Lesser sacro-sciatic ligament.

Fig. 3. Symphysis pubis, seen in front.

1. Interlacing fibres of anterior pubic ligament.—2. Superior pubic ligament.—3. Sub-pubic ligament.—4. Obturator membrane.—5. Foramen for the passage of the obturator artery and nerve.

Fig. 4. Posterior View of Symphysis Pubis.

Ligaments connecting the Pelvis with the Spine.

1. Those connecting the last lumbar vertebra with the sacrum, forming the sacro-vertebral articulation, are similar to those connecting the other segments of the spine.

2. *Lumbo-sacral ligament:* triangular, attached by its apex to the lower border of the transverse process of the fifth lumbar vertebra; by its base it blends with the anterior sacro-iliac ligament.

3. *Ilio-lumbar ligament:* thick and strong, passing from the apex of the transverse process of the fifth lumbar vertebra to the iliac crest an inch in front of the posterior superior spinous process.

Ligaments between the Sacrum and the Ilium.

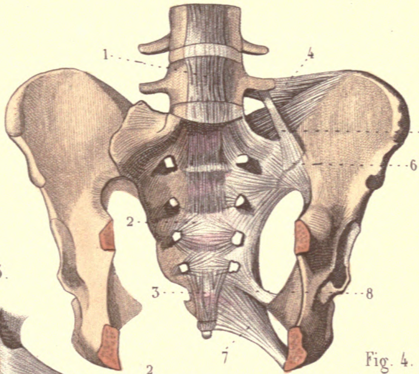
The articular surfaces in early life, and in the female during pregnancy, possess a delicate synovial membrane.

Anterior sacro-iliac ligament: connecting the two bones in front.

Posterior sacro-iliac ligament consists of strong fasciculi, three of which are of large size; the two superior are *horizontal,* and pass from the first and second transverse tubercles on the posterior surface of the sacrum to the rough surface at the back part of the ilium. The third fasciculus is *oblique* and *posterior;* it passes from the third transverse tubercle to the posterior superior spinous process.

Pl. 16.

Fig. 1



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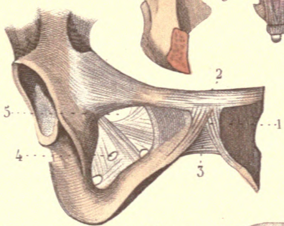

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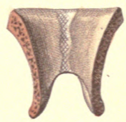

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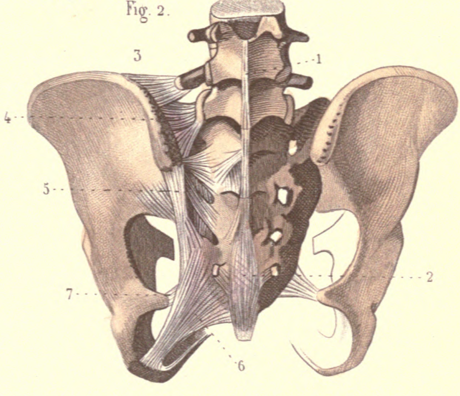

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Ligaments passing between the Sacrum and Ischium.

Great sacro-sciatic: triangular; attached by its base to the posterior inferior spinous process of the ilium, to the fourth and fifth transverse tubercles on the sacrum, and to the side of the sacrum and coccyx; by its apex to the inner margin of the tuberosity of the ischium, being prolonged forwards so as to form the *falciform* ligament.

Lesser sacro-sciatic: triangular; attached by its apex to the spine of the ischium; by its base to the margins of the sacrum and coccyx.

Ligaments between the Sacrum and Coccyx.

Anterior sacro-coccygeal, connecting the anterior surfaces of the two bones.

Posterior sacro-coccygeal, passing from the margin of the sacral canal to the posterior surface of the coccyx.

A Fibro-cartilage connects the articular surfaces.

Ligaments of the Pubes.

Anterior pubic, lies in front of the symphysis: the superficial fibres decussate, the deep are transverse.

Posterior pubic, thin and scattered, connects the bones behind.

Superior pubic, unites the bones superiorly.

Sub-pubic: triangular; connects the upper part of the pubic arch.

The *Fibro-cartilages* are two oval plates, connected externally to the ridges on the bone; internally, to the opposite cartilage by fibrous tissue. An interspace, lined by epithelium, is left between the two plates at the upper and back part; the space enlarges in the female during pregnancy.

PLATE XVII.

Fig. 1. Sterno-clavicular Articulation, seen from behind.

1. Posterior ligament.—2. The interclavicular ligament.—3. Costo-clavicular ligament.

Fig. 2. Sterno-clavicular Articulation, seen from the front.

1. Anterior ligament.—2. Inter-clavicular ligament.—3. Costo-clavicular ligament.—4. Articulation opened, showing the inter-articular fibro-cartilage and two synovial membranes.—5. Anterior stellate ligament.

Fig. 3. Scapulo-clavicular and Scapulo-humeral Articulations.

1. Acromio-clavicular articulation.—2 and 3. Coraco-clavicular ligament, formed by conoidal and trapezoidal fasciculi.—4. Coraco-acromial ligament.—5. Transverse ligament.—6. Tendon of biceps enclosed in its capsule.—7. Capsular ligament of the scapulo-humeral articulation.

Fig. 4.—1. Glenoid cavity.—2. Glenoid ligament.—3. Tendon of biceps continuous with this ligament.

Fig. 5. Elbow Joint, seen from the front.

1. Anterior ligament, composed of fasciculi passing in various directions continuous with the lateral ligament.—2. Orbicular ligament of radius.

Fig. 6. Elbow Joint, seen from behind.

1. Posterior ligament, composed of several fasciculi.—2. External lateral ligament.

Fig. 7. Elbow Joint, seen from below.

1. External lateral ligament.—2. Part of posterior ligament.

Fig. 8. Elbow Joint, seen from above.

1. Internal lateral ligament.—2. Anterior ligament.

Ligaments connected with the Clavicle.

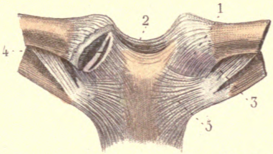
1. *Sterno-Clavicular.*

Class of Joint.—Arthrodial.

Articular Surfaces.—1. The sternal end of the clavicle directed downwards, forwards, and inwards, and presenting a convex articular surface continuous with one on the under surface for the cartilage of

Pl. 17.

Fig. 2.



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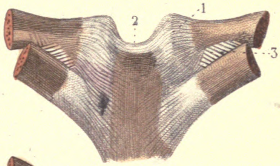

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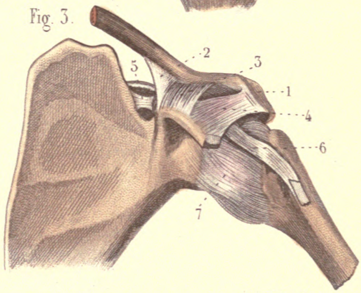

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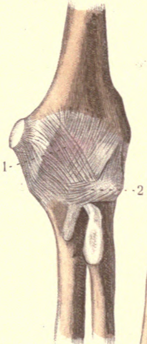

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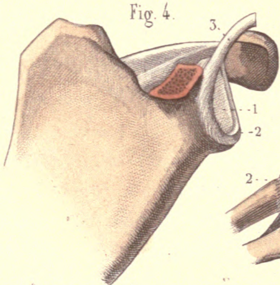

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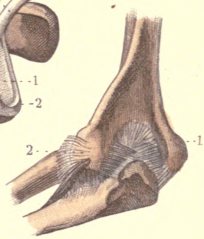

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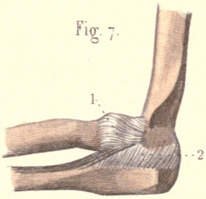

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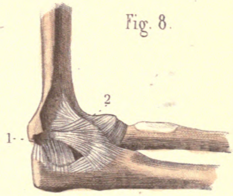

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the first rib. 2. An oval concave articular facet on the side of the manubrium sterni. 3. The cartilage of the first rib.

Ligaments.—Anterior, connects the clavicle and manubrium in front. *Posterior*, similarly disposed, on the posterior surface. *Interclavicular*, passing from the inner extremity of one clavicle to another, being closely connected to the suprasternal notch. *Interarticular* fibro-cartilage, is attached above, to the upper part of the inner extremity of the clavicle, below to the junction of the first rib with the sternum.

Synovial Membranes (two in number).—1. Between the sternal end of the clavicle and the fibro-cartilage, and extending to the cartilage of the first rib. 2. Between the articular surface of the sternum and the adjacent fibro-cartilage.

2. *Costo-Clavicular.*

The *Rhomboid* ligament passes obliquely outwards from the cartilage of the first rib to the rhomboid impression on the under surface of the clavicle.

3. *Acromio-Clavicular.*

Superior, connecting the bones superiorly.
Inferior, connecting the bones inferiorly.
Interarticular fibro-cartilage, usually perforated.

4. *Coraco-Clavicular.*

The *Trapezoid*, placed anterior and external to the conoid, is attached, below to the upper surface of the coracoid process, above to the oblique line on the inferior surface of the clavicle.

The *Conoid:* posterior and internal; attached, by its apex to a depression on the upper surface of the coracoid process, by its base to the conoid tubercle on the under surface of the clavicle, and to half an inch of the bone internal to it.

Ligaments of the Scapula.

The *Coraco-acromial:* triangular; attached by its apex to the acromion in front of the facet for the clavicle; by its base, to the posterior border of the coracoid process.

The *Transverse* converts the suprascapular notch into a foramen; it passes from the base of the coracoid process to the inner extremity of the superior border of the scapula.

Shoulder Joint.

Class of Joint.—Enarthrodial.

Articular Surfaces.—1. The nearly hemispherical head of the humerus, which is three or four times larger than the glenoid fossa; it is joined to the shaft at an acute angle. 2. The glenoid cavity of the scapula, concave, shallow, and pyriform, with the wider end downwards.

Ligaments.—(*A*) The *Capsular* surrounds the joint loosely, being attached above, to the margin of the articular surface beyond the glenoid ligament, and below to the anatomical neck of the humerus. (*B*) The *Coraco-humeral* is a strengthening band to the capsule, passing from near the root of the coracoid process to the front of the great tuberosity of the humerus. (*C*) The *Glenoid* is a fibrous band, triangular on section, and attached by its base to the margin of the glenoid cavity; it deepens the cavity by its being thin internally and thick around the margin. This ligament is joined by the bifurcation of the long tendon of the biceps at the upper part of the glenoid cavity.

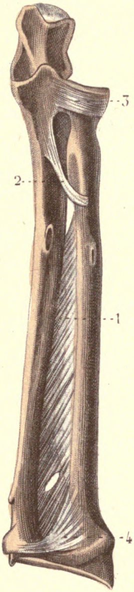
The Long *Tendon of the biceps* passes over the joint, but within the capsule, having a reflection of synovial membrane surrounding it. It is attached above to the top of the glenoid cavity, where it is continuous with the glenoid ligament; it acts as a superior ligament to the joint.

The *Synovial membrane* lines the inner aspect of the ligaments, and is prolonged on to the articular edges of the bones.

It possesses two prolongations:—(*a*) Below the coracoid process, for a communication between the synovial membrane and the bursa under the subscapularis; (*b*) Between the two tuberosities, for the passage of the long tendon of the biceps.

Pl. 18.

Fig. 1.



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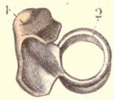

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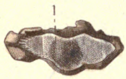

Fig. 4.

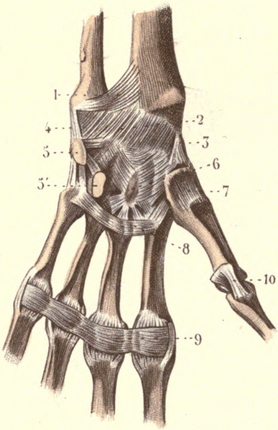

Fig. 6.

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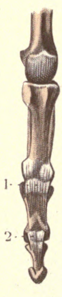

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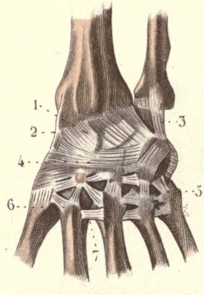

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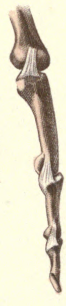

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PLATE XVIII.

Fig. 1. ARTICULATION OF THE BONES OF THE FORE-ARM.

1. Interosseous ligament.—2. Round ligament, or ligament of Weibrecht.—3. Orbicular ligament.—4. Anterior inferior radio-ulnar ligament.

Fig. 2.—1. Superior extremity of ulna.—2. Orbicular ligament.

Fig. 3.—1. Inferior extremity of the two bones, seen from below, to show the triangular ligament.

Fig. 4. ANTERIOR LIGAMENTS OF THE LOWER END OF THE RADIUS AND ULNA, OF THE CARPUS AND METACARPUS.

1. Anterior inferior radio-ulnar ligament.—2. Anterior radio-carpal ligament.—3. External lateral ligament.—4. Internal lateral ligament.—5. Pisiform bone, to which several ligaments are attached. —5′. Unciform process of the unciform bone.—6. Os magnum, to which most of the ligamentous fibres of the carpus and metacarpus are attached.—7. Capsular ligament of trapezium, and first metacarpal bone.—8. Palmar ligaments, uniting the superior extremities of the four internal metacarpal bones together.—9. Common transverse palmar ligament.—10. Lateral ligament of the metacarpo-phalangeal articulation of the thumb.

Fig. 5. POSTERIOR LIGAMENTS OF THE LOWER END OF THE RADIUS AND ULNA, CARPUS AND METACARPUS.

1. Posterior radio-carpal ligament.—2. External lateral ligament. —3. Internal lateral ligament.—4. Posterior ligament of carpus.—5. Posterior carpo-metacarpal ligament.—6. Ligaments between the trapezium and second metacarpal bones.—7. Dorsal ligaments uniting the four internal metacarpal bones.

Fig. 6. Lateral ligaments of the metacarpo-phalangeal articulation and phalangeal articulations

Fig. 7.—1 and 2. Anterior ligaments of the phalangeal articulation.

Fig. 8. Lateral ligaments of the metacarpo-phalangeal and phalangeal articulations.

ELBOW JOINT.

Class of Joint.—Ginglymus.

Articular Surfaces.—1. The lower extremity of the humerus, presents two continuous surfaces: (*a*) an external rounded eminence, the capitellum, for articulation with the upper end of the radius, and limited to the anterior and lower aspects; (*b*) an internal or trochlear, for articulation with the greater sigmoid cavity of the ulna, presenting a shallow groove between two borders, and reaching as far back as the olecranon fossa; it is directed obliquely from within outwards. 2. The greater sigmoid cavity of the ulna is semilunar, concave, and constricted laterally; it is divided by a ridge into two lateral portions, of which the external is the smaller, and nearly plane. 3. The head of the radius presents a cup-shaped depression on its upper surface.

Ligaments.—Anterior: broad and thin, is attached to the humerus above the coronoid fossa, below to the coronoid process and orbicular ligament. *Posterior:* thin and loose, is attached to the humerus above the olecranon fossa, below to the margin of the olecranon. *Internal lateral*, thick and triangular, consists of two portions: (*a*) an anterior, attached by its apex to the internal condyle of the humerus, and by its base to the inner margin of the coronoid process; (*b*) a posterior, passing from a similar point to the inner margin of the olecranon. *External lateral* is a rounded fasciculus passing from the external condyle to the orbicular ligament.

The *Synovial membrane* covers the margin of the articular surfaces of the bones, lines the coronoid and olecranon fossæ, and is reflected over the inner aspect of the ligaments; it sends down a pouch which lines the superior radio-ulnar articulation.

Ligaments connecting the Radius with the Ulna.

1. *Superior Radio-Ulnar Articulation.*

Class of Joint.—Lateral ginglymus.

Articular Surfaces.—1. The lesser sigmoid cavity of the ulna, oblong and concave. 2. The circumference of the head of the radius, convex and circular.

Ligaments.—Orbicular: a strong, flat band embracing the head of the radius. It is attached by its extremities to the front and back part of the lesser sigmoid cavity.

2. *Middle Radio-Ulnar Articulation.*

Ligaments.—Oblique · a rounded cord, extending from the coronoid process to the radius below its tuberosity. The *Interosseous* membrane: broad and thin, begins about an inch below the tubercle of the radius. Its fibres pass downwards and inwards from the interosseous ridge of the radius to that of the ulna. It presents at its lower part an opening for the anterior interosseous vessels.

3. *Inferior Radio-Ulnar Articulation.*

Class of Joint.—Lateral ginglymus.

Articular Surfaces.—1. A narrow and convex surface on the outer aspect of the head of the ulna, rotating in.—2. The sigmoid cavity of the radius, which is narrow, oblong, and concave.

Ligaments.—*Anterior* radio-ulnar: a band passing from the anterior margin of the sigmoid cavity to the front of the head of the ulna. *Posterior* radio-ulnar: unites the corresponding points posteriorly. *Triangular fibro-cartilage:* thickest at its margins; attached by its apex to a depression at the base of the styloid process of the ulna; by its base, to the edge of the radius which separates the sigmoid cavity from its carpal articular surface.

The *Synovial membrane*, called *membrana sacciformis*, owing to its lax state, lines the articular margins, the capsule and the upper part of the triangular cartilage.

Wrist Joint.

Class of Joint.—Arthrodial.

Articular Surfaces.—1. The lower extremity of the radius: triangular, concave, and subdivided into two parts by a ridge—the external triangular, for the scaphoid; the inner quadrilateral, for the semilunar. This bone, together with the under surface of the triangular cartilage, forms a transversely concave surface for the carpal bones. 2. The superior surface of the scaphoid, semilunar, and cuneiform together present a smooth and convex surface.

Ligaments.—*Anterior:* passes from the styloid process and margin of the radius to the palmar aspect of the scaphoid, semilunar, and cuneiform bones. *Posterior:* extends obliquely inwards from the margin of the radius to the same carpal bones. *External lateral:* passes from the styloid process of the radius to the scaphoid, and a few fibres to the trapezium and annular ligament. *Internal lateral:* a rounded cord, stretching from the styloid process of the ulna to the cuneiform and pisiform bones and the annular ligament.

The *Synovial membrane* lines the articular margins, the capsule and the under surface of the triangular cartilage.

Ligaments of the Carpus.

1. *Of the First Row.*

Between the Scaphoid, Semilunar, and Cuneiform.—Two dorsal; two palmar; two interosseous, attached laterally to the semilunar.

Between the Pisiform and Cuneiform.—Capsule, lined by synovial membrane. Two bands pass from the pisiform to the unciform and fifth metacarpal.

2. *Of the Second Row.*

Three dorsal; three palmar; two interosseous, connecting the os magnum with the trapezoid and unciform.

3. *Connecting the First with the Second Row.*

The *Anterior* and *Posterior*, consist of fibres connecting the individual bones of the two rows; *external lateral*, connects the scaphoid and trapezium; *internal lateral*, connects the cuneiform and unciform.

The *Synovial membrane of the carpus* lines the joints between the two rows, sending two prolongations upwards between the bones of the first, and three between the bones of the second row; the latter extend to the four inner carpo-metacarpal articulations. The pisiform bone has a separate synovial membrane.

Ligaments between the Carpus and Metacarpus.

1. *Connecting the Trapezium and first Metacarpal.*—Capsular.

2. *Connecting the four inner Carpo-metacarpal Joints.—Dorsal:* two for the second, one for the third, two for the fourth, and one for the fifth. *Palmar:* one for each joint except the third, which has three. *Interosseous:* connecting the inferior angles of the os magnum and unciform with the third and fourth metacarpals.

The *Synovial Membranes.*—1. A separate one for the first joint. 2. One, common to the four inner joints, which is a prolongation of the synovial membrane of the carpus.

Ligaments between the Four Inner Metacarpal Bones.

At their Bases—dorsal; palmar; interosseous, with synovial prolongations from between the carpal bones.

At their Heads is the transverse ligament uniting their lateral aspects.

Ligaments between the Metacarpus and Phalanges.

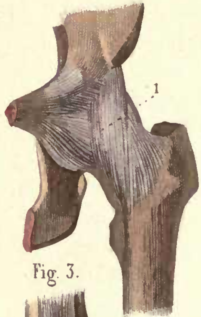
Anterior or glenoid; two lateral. The extensor tendon acts as a posterior ligament.

Ligaments between the Phalanges.

Anterior; two lateral. Posteriorly the extensor tendon.

Pl. 19.

Fig. 1.



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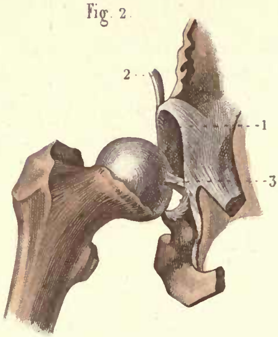

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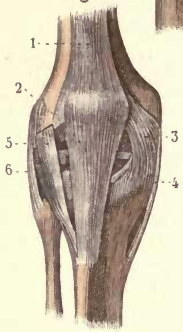

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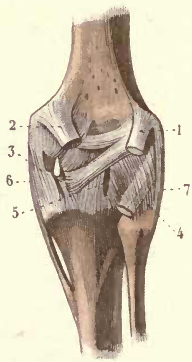

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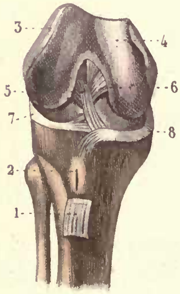

Fig. 6.

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PLATE XIX.

Fig. 1. Coxo-femoral Articulation.

1. Capsular ligament.

Fig. 2. Coxo-femoral Articulation with the Capsular Ligament removed.

1. Cotyloid ligament.—2. Reflected tendon of rectus femoris.—3. Ligamentum teres.

Fig. 3. Ligaments of Knee joint.

1. Tendon of quadriceps extensor femoris. — 2. Ligamentum patellæ.—3. Accessory band from vastus internus.—4. Internal lateral ligament.—5. Process of fascia lata serving as a ligament.—6. External lateral ligaments.

Fig. 4. Ligaments of Knee joint, seen from behind.

1 and 2. Cut tendons of origin of the gastrocnemei.—3. Cut tendon of semi-membranosus, giving off three fasciculi.—4. Tendon of popliteus.—5. Ligamentum posticum Winslowii.—6. Posterior border of internal lateral ligament.—7. External lateral ligament.

Fig. 5.—1. Ligamentum patellæ, cut and turned down.—2. Bursa.—3 and 4. External and internal condyles of femur. — 5 and 6. Anterior and posterior crucial ligaments.—7 and 8. Semilunar fibro-cartilages.

Fig. 6. Superior extremity of the Tibia, seen from above.

1 and 2. Anterior and posterior crucial ligaments.—3. Internal semilunar cartilage.—4. External semilunar cartilage.

Fig. 7. Tibio-fibular Articulation, seen from the front.

1. Interosseous ligament.—2. Opening, giving passage to anterior tibial vessels.—3. Anterior superior tibio-fibular ligament.—4. Anterior inferior tibio-fibular ligament.

Hip Joint.

Class of Joint.—Enarthrodial.

Articular Surfaces.—1. The head of the femur: globular, rather more than a hemisphere; directed upwards, inwards, and forwards; it has a depression below the centre for the round ligament. 2. The acetabular cavity of the os innominatum: cup-shaped, hemispherical, and presenting on its inner side a deep notch—the cotyloid notch—

which is continuous with a circular depression at the bottom of the cavity; the articular surface is like a band of ribbon.

Ligaments.—Capsular: attached above, externally to the edge of the acetabulum and to the transverse ligament; below, it surrounds the neck of the femur, being attached, in front to the anterior intertrochanteric line; above, to the base of the neck; behind, to a transverse band of fibres which arches, like a collar, over the neck of the femur a finger's breadth from the posterior intertrochanteric line. *Ilio-femoral* or λ-shaped: attached above, to the anterior inferior spinous process, below, to the anterior intertrochanteric line; it checks over-extension. *Pubo-femoral:* extends from the inner side of the acetabulum to the lower part of the neck; it checks over-abduction. *Ilio-trochanteric:* extends obliquely from the upper part of the acetabulum to the front of the great trochanter; it checks over-adduction. *Cotyloid:* surrounds the margin of the acetabulum, deepening the cavity and smoothing the edge. *Transverse:* is a band of fibres which converts the cotyloid notch into a foramen. *Round* or *ligamentum teres:* a flat band, folded on itself, attached, by one end to the head of the femur, by the other, which divides into two, into the margins of the cotyloid notch; it is tight during rotation outwards and abduction in the flexed position.

The *Synovial membrane* covers the part of the neck within the capsule, the inner surface of the capsular ligament, both surfaces of the cotyloid ligament, and the bottom of the acetabulum, from which it is prolonged around the ligamentum teres to the head of the femur.

Knee Joint.

Class of Joint.—Ginglymus.

Articular Surfaces.—1. The lower end of the femur, marked by a patellar and two tibial surfaces. (*a*) Patellar, placed in the middle line above the others, trochlear in the centre, with a slanting surface on each side, the external being the larger. (*b*) Tibial, occupying the end of the condyles and separated from the above by an oblique groove on each side. The under aspect of each is flattened, and rests on the tibia during extension; the posterior aspects, convex in shape, touch the tibia during flexion. The inner condyle presents externally a semilunar facet which touches the patella in extreme flexion. 2. The upper extremity of the tibia presents two articular hollows, the inner being deeper and larger; between the two surfaces is a spinous process surmounted on each side by a small tubercle. 3. The inner surface of the patella: divided by a vertical ridge into two surfaces, and these again by a transverse line into an upper and lower portion; the two lower touch the femur during extension, the two upper during flexion. Close to the inner edge is a fifth semilunar surface for the internal condyle during flexion.

Ligaments.—Anterior, or ligamentum patellæ: extending from the apex of the patella to the lower part of the tubercle of the tibia. *Posterior*, or ligamentum posticum Winslowii: broad and wide, passing obliquely from the back part of the inner tuberosity of the tibia to above the external condyle; it is formed by an expansion from the tendon of the semimembranosus. *Internal* lateral: broad and diamond-shaped: attached, above, to the inner tuberosity of the femur; below, to the inner tuberosity and shaft of the tibia. *Long external* lateral: rounded and strong: attached, above, to the outer tuberosity of the femur; below, to the outer part of the head of the fibula. *Short external* lateral: placed behind the long, and passes from a similar point to the styloid process of the fibula. *Capsular:* thin, fills the intervals between the preceding ligaments; it is attached to the bones external to their articular surfaces. *Crucial:* two in number, cross each other like the letter X, and are called anterior and posterior from the position of their attachment to the tibia. (*a*) Anterior: attached, above, to the inner and back part of the outer condyle of the femur; below, to a depression in front of the spine of the tibia. (*b*) Posterior: attached, above, to the outer and fore-part of the internal condyle of the femur; below, to a depression behind the spine of the tibia—the popliteal notch; it receives the posterior extremity of the external semilunar cartilage. As it crosses the anterior crucial, a fasciculus is given to it. *Semilunar* fibro-cartilages: crescentic, thickest at the circumference, they cover the outer two-thirds of the articular surfaces. (*a*) Internal: elongated from before backwards; its anterior extremity is attached to the rough surface in front of the spine of the tibia; its posterior, to a depression behind the spine between the external cartilage and the posterior crucial ligament; it is connected to the capsule by the coronary ligament. (*b*) External: nearly a circle, grooved posteriorly by the popliteus tendon; the extremities are attached to the depressions in front and behind the spine of the tibia; its posterior extremity gives off three slips—two pass to the outer side of the inner tuberosity of the tibia, namely, in front and behind the posterior crucial ligament; the third goes to the anterior crucial ligament. *Transverse:* a broad band connecting the semilunar cartilages in front. *Coronary:* are short bands connecting the semilunar cartilages to the capsule.

The *Synovial membrane* lines the capsule, and is continued to the articular ends of the bones. It invests both surfaces of the semilunar cartilages, and is reflected over the crucial ligaments. There are four pouches, two for the heads of the gastrocnemius, a large sac about three inches long extending upwards on the front of the femur under the extensor tendon, and another behind the external semilunar cartilage and the head of the tibia for the popliteus tendon. There are three named parts of the synovial membrane: (*a*) the *ligamentum mucosum*, extending from below the apex of the patella to the intercondyloid notch; (*b*) two *alar ligaments*, extending on either side of the ligamentum patella as fatty cushions.

Of the movements at the knee joint, extension and flexion are the most marked; lateral and rotatory movements are, however, possible during semiflexion. Owing to the crossing of the crucial ligaments internal rotation of the semi-flexed leg on the thigh is limited to a very slight movement, but external rotation, as it undoes the twist of the crucial ligaments, is much more extensive.

Ligaments connecting the Tibia and Fibula.

1. *Superior Tibio-fibular articulation.*—Consists of a facet upon the back part of the outer tuberosity, which looks downwards, backwards and outwards, to meet one looking in the opposite direction upon the head of the fibula. The joint consists of a synovial membrane, a capsule, and anterior superior and a posterior superior tibio-fibular ligament passing from the external tuberosity of the tibia to the head of the fibula.

2. *Middle Tibio-fibular.*—The interosseous membrane, passing from the external or interosseous border of the tibia downwards and outwards to the interosseus line upon the inner surface of the fibula.

3. *Inferior Tibio-fibular articulation.*—Consists of two rough surfaces upon the tibia and fibula, bound together by four ligaments. *Anterior-inferior-tibio-fibular* ligament connects the bones in front; *posterior-inferior-tibio-fibular* connects the bones behind; the *interosseous* binds the two rough surfaces together firmly, allowing of no synovial membrane between the bones. The *transverse* is a narrow band behind, continuous with the posterior ligament, and extending from the tibia to the external malleolus; this ligament acts as a posterior ligament to the ankle joint.

Pl. 20.

Fig. 1.

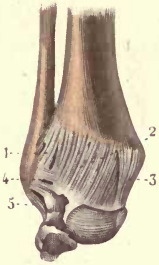


Fig. 5.

Fig. 6.

Fig. 2.

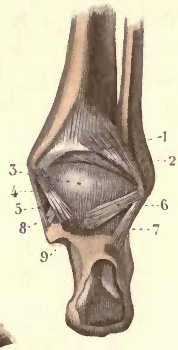
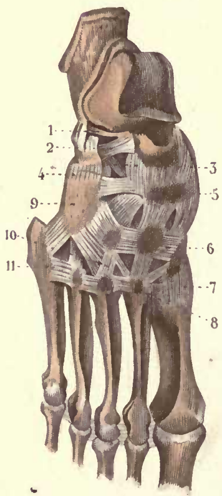


Fig. 7.

Fig. 3.



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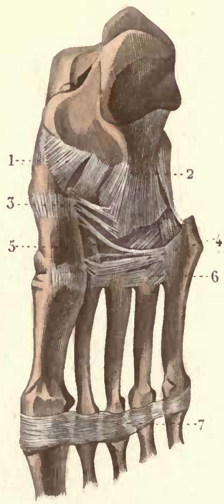

PLATE XX.—ARTICULATION.

Fig. 1. Tibio-tarsal Articulation, seen from the front.

1. Anterior inferior tibio-fibular articulation.—2. Anterior ligament of tibio-tarsal articulation.—3. Internal lateral ligament.—4. External lateral ligament (anterior fasciculus).—5. External lateral ligament (middle fasciculus).

Fig. 2. Tibio-tarsal Articulation, seen from behind.

1. Posterior inferior tibio-fibular ligament.—2. Accessory fibres extending between the two malleoli.—3. Capsule.—4 and 5. Fasciculi of internal lateral ligament.—6. External lateral ligament (posterior fasciculus).—7. External lateral ligament (middle fasciculus).—8. Internal calcaneo-astragaloid ligament.—9. Posterior calcaneo-astragaloid ligament.

Fig. 3. Dorsal Ligaments of Tarsus and Metatarsus.

1 and 2. Ligamentous fasciculi, situated in the fossa between the os calcis and astragalus.—3. Calcaneo-scaphoid and calcaneo-cuboid ligaments, together forming a Y.—4. Superior calcaneo-cuboid ligament.—5. Scaphoid bone, to which are attached ligaments for the three cuneiform and cuboid bones.—6. Dorsal ligaments of the cuneiform bones.—7. Ligament of internal cuneiform and first metatarsal bone.—8. Second metatarsal bone, to which are attached three ligaments from the cuneiform bones.—9. Cuboid bone, to which are attached ligaments for the third, fourth, and fifth metatarsal bones.—10. Ligament of the third cuneiform and third metatarsal bones.—11. Ligaments uniting the posterior extremities of the metatarsal bones.

Fig. 4. Plantar Ligaments of Tarsus and Metatarsus.

1. Calcaneo-scaphoid ligament.—2. Calcaneo-cuboid ligament.—3. Fasciculi of the tibialis posticus.—4. Transverse ligaments.—5. Internal cuneiform.—6. Transverse ligament, uniting the bases of the metatarsal bones.—7. Transverse ligament, uniting the head of the metatarsal bones.

Fig. 5.—1. Sesamoid bones of the metacarpo-phalangeal joint of the great toe.—2. Plantar ligament of the phalangeal joint.

Fig. 6.—1 and 2. Lateral ligaments of the phalangeal joint.

Fig. 7.—1. Lateral ligament of the phalangeal joint.

Ankle Joint.

Class of Joint.—Ginglymus.

Articular Surfaces.—1. The inferior surface of the lower extremity of the tibia and the outer surface of its malleolus. 2. The inner surface of the external malleolus of the fibula. These two form an arch for 3. The superior surface of the astragalus, which is trochlear, wider in front than behind; it is continuous with the lateral surfaces where the malleoli articulate, of which the external is triangular, the internal pyriform.

Ligaments.—*Anterior* or tibio-tarsal: broad; attached above to the margin of the tibia; below to the neck of the astragalus. *Internal* or deltoid: (*a*) The superficial layer: triangular; attached above to the apex and borders of the inner malleolus; below, the anterior fibres go to the scaphoid, the middle fibres to the sustentaculum tali, the posterior to the astragalus. (*b*) The deep layer passes from the apex of the malleolus to the inner surface of the astragalus below the articular facet. *External* lateral: consists of three fasciculi—(*a*) anterior: extends from the anterior margin of the external malleolus to the neck of the astragalus. (*b*) Middle: runs downwards and backwards to a tubercle on the outer surface of the os calcis. (*c*) Posterior: passes from a depression at the inner and back part of the external malleolus horizontally backwards to the posterior rough surface of the astragalus. The transverse ligament of the inferior tibio-fibular articulation takes the place of a *posterior* ligament.

The *Synovial membrane* invests the inner surface of the ligaments and the articular margins of the bones.

Ligaments of the Foot.

Ligaments of the Tarsus.

1. *Of the First Row.*

Calcaneo-astragaloid.—*External:* passes from the astragalus below its external facet to the outer edge of the os calcis. *Posterior:* connects the back part of the astragalus with the adjacent margin of the os calcis. *Interosseous:* very thick and strong, and about an inch in breadth; it is attached, below, to a depression on the upper surface of the greater process of the os calcis; above, to a similar depression on the under surface of the neck of the astragalus.

2. *Of the Second Row.*

Connecting the Scaphoid, Cuboid, and three Cuneiforms.—Between each bone and its neighbour is a dorsal, plantar, and interosseous set.

3. *Connecting the two Rows.*

(*A*) *Between the Os Calcis and the Cuboid.—Superior:* connecting the superior margins of the bones. *Internal:* or interosseous passes from the cavity (sinus pedis) between the astragalus and os calcis to the inner side of the cuboid. *Inferior* or *Plantar:* two in number. (*a*) Long: attached, behind, to the under surface of the os calcis from the front of the tuberosities to the anterior tubercle; in front, to the ridge on the cuboid and by some fibres which cross over the peroneal groove, to the bases of the second, third, and fourth metatarsals. (*b*) Short: lies nearer to the bone than the above, is very broad, and extends from the anterior tubercle of the os calcis and the bone in front, to the ridge on the under surface of the cuboid behind the peroneal groove.

(*B*) *Between the Os Calcis and the Scaphoid.—Superior* or *external:* arises, with the internal calcaneo-cuboid, from the sinus pedis between the os calcis and astragalus, forming the Y-shaped ligament, and passes forwards to the outer side of the scaphoid. *Inferior:* the calcaneo-scaphoid, extends from the sustentaculum tali to the tubercle of the scaphoid. This ligament supports the head of the astragalus, and is lined by a prolongation of the synovial membrane from the scapho-astragaloid articulation. A prolongation of this ligament to the inner side of the foot is called 'Hancock's ligament.'

(*C*) *Between the Astragalus and the Scaphoid.—Superior:* a broad band passing from the neck of the astragalus to the superior surface of the scaphoid. The calcaneo-scaphoid and Hancock's ligament enclose this articulation below and internally.

Synovial Membranes of the Tarsus.—Four in number. One for the posterior calcaneo-astragaloid articulation; one for the anterior calcaneo-astragaloid and astragalo-scaphoid; one for the calcaneo-cuboid articulation; one for the articulations of the scaphoid with the cuneiform bones: this sends expansions between the several cuneiform bones and also between the external cuneiform and the cuboid. The prolongation between the external and middle cuneiforms lines the second and third tarso-metatarsal articulations.

Ligaments between the Tarsus and Metatarsus.

Dorsal, one to each joint, except the second, which has three, one for each cuneiform bone. *Plantar. Interosseus*, three in number; one on each side of the second metatarsal, connecting it with the internal and external cuneiform bones, and a third connecting the latter bone with the fourth metatarsal.

Synovial Membranes.—Three in number. One common to the second and third joints—this is prolonged from the tarsal articulations; one between the first metatarsal and internal cuneiform; one common to the fourth and fifth metatarsal and the cuboid.

Ligaments between the Metatarsal Bones.

Dorsal; plantar; and interosseous unite the bones at their bases. A capsular ligament only, connects the internal cuneiform with the first metatarsal. Transverse ligaments connect the digital extremities of all the bones.

Ligaments between the Metatarsus and Phalanges.

Plantar, a fibrous or sesamoid plate; two lateral.

Ligaments between the Phalanges.

Plantar, a fibrous plate; two lateral.

Joints are classified as follows:

I. Diarthrosis.—Diarthrodial are true or movable joints with articular bony surfaces, covered with cartilage, and possessing synovial fluid enclosed in a capsule strengthened by ligaments. They are subdivided into—

1. Ginglymus.—Hinge joints such as the knee, ankle and elbow, where motion is mostly confined to flexion and extension.
2. Enarthrosis.—Enarthrodial joints are ball and socket joints, such as the hip and shoulder joints, where all typical motions are possible.
3. Arthrosis.—Gliding joints are met with in the articulations of the clavicle, carpus and tarsus, and at the articular processes of the vertebræ.
4. Diarthrosis rotatorius.—Joints such as those at the head of the radius and the odontoid process of the atlas, where a bone turns within an embracing ring of tissue.

II. Amphiarthrosis.—The joints in this group are called 'mixed articulations;' they are met with—

1. Between the bodies of the vertebræ.
2. Between the articular surfaces of the bones of the pelvis. The former have no synovial linings; the latter have them only partially developed.

III. Synarthrosis.—Immovable joints are subdivided into—

1. Gomphosis.—Socket articulations, as in the teeth.
2. Schindylesis.—A fissure receiving a thin plate: example, the vomer receiving the rostrum of the sphenoid.
3. (*a*) Sutura vera.—Joints with notched borders, as—*α*. Serrata (occipito-parietal); *β*. Dentata (interparietal).

   (*b*) Sutura notha.—Joints formed by the meeting of rough surfaces, as—*α*. Squamosa (squamo-parietal); *β*. Harmonia (intermaxillary).

Pl. 21.

Fig. 1.

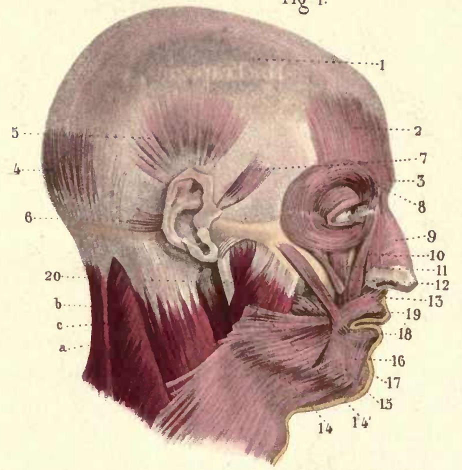

Fig. 3.

Fig. 2.

Léveillé del.

Lebrun sc.

PLATE XXI.—MYOLOGY.

Fig. 1. RIGHT SIDE OF THE HEAD, SHOWING THE SUPERFICIAL MUSCLES.

A. Sterno-cleido-mastoid, and—B. Trapezius, united above by an aponeurosis.—C. Splenius.

1. Epicranial aponeurosis.—2 and 3. Anterior belly of occipito-frontalis and pyramidalis nasi.—4. Posterior belly of occipito-frontalis.—5. Atollens aurem.—6. Retrahens aurem.—7. Attrahens aurem.—8. Orbicularis palpebrarum.—9. Triangularis nasi.—10. Levator labii superioris et alæ nasi.—11. Levator labii superioris proprius.—12. Zygomaticus minor.—13. Zygomaticus major.—14. Platysma myoides.—14′. Risorius of Santorini.—15. Depressor anguli oris.—16. Depressor labii inferioris.—17. Levator menti.—18. Orbicularis oris.—19. Part of buccinator.—20. Masseter.

Fig. 2. RIGHT SIDE OF THE HEAD, SHOWING THE UNDERLYING MUSCLES.

A. Masseter cut.—B. External lateral ligament of the temporo-maxillary articulation.

1. Temporal muscle. — 2. Corrugator supercilii. — 3. Superior oblique and its pulley.—4. Levator palpebræ superioris.—5. Compressor nares.—6. Depressor alæ nasi.—7. Levator anguli oris.—8. Buccinator, pierced by the duct of the parotid gland (Steno's), continuous with the orbicularis oris.—9. Depressor labii inferioris (quadratus menti).—10. Levator menti.

Fig. 3. ANTERIOR PORTION OF THE RIGHT ORBIT.

1. Anterior part of the globe of the eye.—2 and 2′. Eyelids cut and drawn forward.—3 and 3′. Two fasciculi of the lachrymal muscle of Horner (tensor tarsi).

MUSCLES OF MASTICATION (*supplied by Inferior Maxillary Nerve, i.e., the third division of the fifth*).

Temporal Muscle.—A large fan-shaped muscle, having its broad part upwards and its apex attached to the lower jaw. *Origin:* From the bones entering into the formation of the temporal fossa, and from the under surface of the temporal fascia. A quantity of fat separates the muscle from part of the malar. The anterior fibres are perpendicular, the posterior horizontal and the intermediate oblique. The fibres converge to a central tendon which passes beneath the zygomatic arch to the lower jaw. *Insertion:* The tendon embraces the coronoid process of the lower jaw, and occupies a groove on the anterior border of the ramus as far as the last molar tooth. *Nerve:* anterior and posterior temporal from the inferior maxillary. *Action:* it presses the teeth of the lower jaw forcibly against the upper teeth. The posterior fibres, being horizontal, draw the jaw backwards.

The *Masseter* is a quadrilateral muscle consisting of two parts—superficial and deep. *Origin:* the *superficial* portion is from the anterior two-thirds of the zygomatic arch, *i.e.*, from the ridge on the superior maxillary, and from the posterior inferior border of the malar. The fibres pass downwards and backwards. The *deep* portion, the shorter, is directed downwards and forwards. It arises from the lower border of the posterior third of the zygomatic arch, *i.e.*, the zygoma proper, and from the inner surface of the zygoma. *Insertion:* the superficial portion is inserted into the outer surface of the angle and contiguous part of the ramus and body of the lower jaw. The deep portion is inserted into the outer surface of the ramus above this, and into the same aspect of the coronoid process. *Nerve:* masseteric from inferior maxillary. *Action:* it raises the lower jaw, the superficial fibres drawing it slightly forwards and the deep slightly backwards.

External Pterygoid.—Origin: by two heads—1. From the outer surface of the great wing of the sphenoid below the pterygoid ridge. 2. From the outer surface of the external pterygoid plate (sometimes also from the tuberosity of the superior maxillary). The muscle is nearly horizontal; between its two heads the internal maxillary artery passes. *Insertion:* into a pit on the fore-part of the neck of the jaw, and into the inter-articular fibro-cartilage and capsule of the temporo-maxillary articulation by tendinous and muscular processes. *Nerves:* the deep temporal, the masseteric and the buccal branches of the inferior maxillary. *Action:* when both muscles act, the jaw is drawn forwards; one muscle acting alone (say the left) the jaw is drawn forwards and to the right across the upper jaw, and so assists in trituration of the food by the alternate action of the muscles.

Internal Pterygoid.—Origin: from the pterygoid fossa, mostly from the inner surface of the external pterygoid plate; also from the tuberosity of the palate between the pterygoid plates and the tuberosity of the superior maxillary bone. The muscle passes downwards and slightly backwards and outwards, being nearly parallel to the masseter. *Insertion:* the internal surface of the angle and the ramus of the lower jaw as high as the dental foramen. *Nerve:* from the inferior maxillary which enters its anterior border; this nerve has the otic ganglion developed upon it. *Action:* it elevates the jaw like the masseter. Buccinator, see p. 90.

MUSCLES OF EXPRESSION (*supplied by Facial Nerve*).

The *Occipito-frontalis* consists of two parts, anterior and posterior, with an intervening tendon or aponeurosis. *Origin of frontal part:* partly from bone, viz., internally, the internal angular process of the frontal; externally, the external angular process of the same. Between these points the muscular fibres blend with the orbicularis palpebrarum, corrugator supercilii and pyramidalis nasi. *Insertion:* the fibres are directed upwards, to the aponeurosis ending near the coronal suture. *Origin of occipital part:* from the outer two-thirds of the superior curved line of the occipital bone on either side. *Insertion:* into the aponeurosis near the lambdoidal suture. The two bellies of the occipital part are separated in the middle line by the aponeurosis. The aponeurosis intervening between the anterior and posterior portions of the muscle is attached behind to the external occipital protuberance and the inner third of both superior curved lines; laterally it is fixed to the side of the head and temporal fascia; it gives origin to the auricular muscles, is closely attached to the skin, but loosely to the pericranium. *Nerves:* occipital part, the posterior auricular (a branch of facial), and the occipital nerves; frontal part, the temporal branch of facial. *Action:* anterior part elevates the eyebrows, and draws forward the scalp; posterior part draws the scalp backwards.

The *Orbicularis Palpebrarum* comprises two parts, an outer or orbicular, an inner or palpebral. *Origin:* the *outer* part is attached: 1. With the tendo oculi in front of the lachrymal groove to the nasal process of the upper jaw; 2. Above this tendon to the same process and to the internal angular process of the frontal; 3. Below this to the superior maxilla at the margin of the orbit. The fibres form regular ellipses around the orbit; they spread over the malar bone externally. The *inner* part is attached internally to the tendo oculi, and externally to the external tarsal ligaments and the malar bone; a *third* portion under the name of the ciliary bundle lies along the free margin of each lid. *Nerves:* the temporal, malar and infra-orbital branches of the facial. *Action:* it closes the eyelids drawing them inwards, it also draws down the eyebrows and compresses the lachrymal sac in front. The *tendo oculi*, three lines long, is attached internally to the nasal process of the superior maxilla. It divides externally into two, one part going to the upper, the other to the lower eyelid, forming the superior and inferior internal tarsal ligaments; it crosses the front of the lachrymal sac.

The *Tensor Tarsi.*—Origin: from the lachrymal bone behind the lachrymal groove. Passing from behind the lachrymal sac it embraces it, and sends a slip to the punctum of either eyelid. Nerve: facial. Action: passing over the lachrymal sac it assists in compressing it, and being attached behind the puncta draws them backwards and thus opens them.

The *Corrugator Supercilii* lies beneath the orbicularis muscle. Origin: from the inner part of the superciliary ridge of the frontal bone. It passes obliquely upwards and outwards. Insertion: into the skin of the eyebrow about its centre. Nerve: facial. Action: draws the superciliary region inwards and downwards.

Muscles of the Ear (Auricular Muscles).

Attrahens Auriculam.—Origin: from the epicranial aponeurosis over the temple. Insertion: the fibres pass backwards to the helix at its fore-part and inner aspect. Nerve: facial. Action: draws the ear upwards and forwards.

Attolens Auriculam.—Origin: from the same aponeurosis, but above the previous muscle. Insertion: into the cranial aspect of the helix and concha. Nerve: a branch from the small occipital. Action: draws the ear upwards.

Retrahens Auriculam.—Origin: by three or more round fasciculi from the outer surface of the root of the mastoid process. Insertion: into the cranial aspect of the concha. Nerve: posterior auricular of the facial. Action: draws the ear backwards.

Muscles of the Pinna.—The six small muscles of the pinna are very thin and pale; four are on the external surface and two on the internal. I. The external set: The *musculus helicis minor* is connected to the part of the helix which springs from the bottom of the concha. The *musculus helicis major* is placed vertically along the anterior part of the helix. The *musculus tragicus* consists of vertical fibres covering the outer part of the tragus. The *musculus antitragicus* extends obliquely from the antitragus to the lower part of the antihelix. II. The internal set: The *musculus transversus* passes in a radiatory manner from the posterior surface of the concha to the eminence corresponding to the groove of the helix. The *musculus obliquus* extends from the back part of the concha to the back part of the inferior division of the antihelix.

Muscles of the Nose.

Pyramidalis Nasi.—Origin: a central nasal slip of the occipito-frontalis muscle. Insertion: into the aponeurosis over the tip of the nose. Nerve: facial. Action: tightens the skin over the nostril.

Compressor Naris.—Triangular in shape. Origin: by its apex from the canine fossa. Insertion: the muscle forms an aponeurosis with its fellow, and covers the nasal cartilages. Nerve: facial. Action: tightens the skin and compresses the nostril.

Levator Labii Superioris Alæque Nasi.—Origin: from the upper part of the nasal process of the superior maxilla, internal to the orbicularis palpebrarum. Descending along the side of the nose it divides into two parts, and its insertion is:—firstly, the smaller portion, into the wing of the nose; secondly, the larger portion into the upper lip, where it blends with the other muscles. Nerve: infra-orbital branch of the facial. Action: raises the upper lip; raises and dilates the nostril.

Depressor Alæ Nasi.—Origin: superior incisor fossa. Insertion: septum and posterior part of the alæ of the nose. Nerve: facial. Action: draws down the nostril.

The *Dilatator Naris* consists of two parts; the anterior part descends from over the cartilage at the tip of the nose to the skin at the margin of the nostril. The posterior part, arises from the small sesamoid cartilage contiguous to the superior maxilla; and descends to the skin of the nostril. These slips of muscular fibres dilate the nostril.

Muscles of the Mouth.

The *Orbicularis Oris* surrounds the mouth, and blends with the other muscles of the lips. It consists of two parts: the *inner* part is simply a thick rounded sphincter muscle of pale fibres surrounding the mouth at the red margin of the lips; it is unconnected with bone, passing from lip to lip. The *outer* part *arises* from bones, viz.: from the superior maxilla by two slips, one on each side (naso-labial) of the anterior nasal spine, the other (incisive muscle) from the margin of the alveolus, opposite the outer incisor teeth; also from the lower jaw by one slip on each side from the ridge formed by the canine tooth. *Insertion:* the fibres from the upper jaw pass downwards and outwards, and those from the lower jaw upwards and outwards to the angle of the mouth, where they blend with the other muscles, especially the buccinator. *Nerve:* facial (infra-orbital and supra-maxillary branch). *Action:* the whole muscle acting, the lips are pressed together and the mouth tightly closed. The inner fibres turn inwards the red margin, and close the mouth. The outer fibres draw the lips to the bone, depress the nose, raise the chin, and evert the free edges of the lips.

Levator Labii Superioris Proprius.—Origin: from the superior maxilla and malar bones at the margin of the orbit above the infra-orbital foramen. Insertion: upper lip, blending with the other muscles. Nerve: facial (infra-orbital branch). Action: raises the upper lip.

Levator Anguli Oris.—Origin: from the canine fossa beneath the infra-orbital foramen. Insertion: the angle of the mouth, and partly into the lower lip. Nerve: facial (infra-orbital branch). Action: elevates the corner of the mouth.

Depressor Anguli Oris (*Triangularis Menti*).—Origin: from the external oblique line of the lower jaw. Insertion: into the angle of the mouth. Nerve: facial (supra-maxillary branch). Action: draws down the angle of the mouth.

Depressor Labii Inferioris (*Quadratus Menti*).—Origin: from a depression on the lower jaw extending from near the symphysis to a point beyond the mental foramen. Insertion: into the lower lip, blending with the orbicularis. Nerve: facial (supra-maxillary branch). Action: depresses and everts the lower lip.

Levator Labii Inferioris (*Levator Menti*).—Origin: by a narrow process from the incisor fossa of the lower jaw. Insertion: into the integument of the chin. Nerve: facial. Action: dimples the chin and aids in elevating the lower lip.

Zygomaticus Major.—Origin: outer surface of malar bone near the zygomatic suture. Insertion: angle of the mouth, blending with the orbicularis. Nerve: facial. Action: draws the angle of the mouth upwards and backwards.

Zygomaticus Minor.—Origin: anterior inferior border of malar bone; internal to the preceding. Insertion: joins the outer border of the levator labii superioris proprius. Nerve: facial. Action: assists in drawing upwards the upper lip.

Risorius.—Origin: partly it is continuous with the platysma, and partly takes origin from the fascia over the masseter. Insertion: angle of mouth, joining with the orbicularis. Nerve: facial. Action: draws outwards and downwards the angle of the mouth.

Buccinator.—The muscle of the cheek is partly a muscle of expression and partly of mastication.—*Origin:* from the outer surface of the alveolar process—opposite the molar teeth (in each jaw), and behind from the pterygo-maxillary ligament, a band of fibrous tissue extending from the tip of the hamular process of the internal pterygoid plate to the back part of the mylo-hyoid ridge. *Insertion:* the central fibres converge and decussate, passing to opposite lips; the marginal fibres pass to the lips without decussating, the whole blending with the orbicularis at the angle of the mouth. The muscle forms a great portion of the cheek, and is perforated by Stenson's duct opposite the second upper molar tooth. *Nerve:* buccal branch of facial so far as it is a muscle of expression, and the buccal branch of the inferior maxillary so far as it is a muscle of mastication. *Action:* when one muscle acts, the corner of the mouth is drawn outwards; when both act, the mouth is widened transversely; in mastication it helps to bring the food between the teeth; assists in expelling air from the mouth, as in whistling or in blowing a wind instrument.

Pl. 22.

Fig. 1.

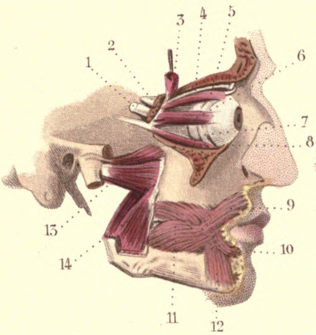

Fig. 2.

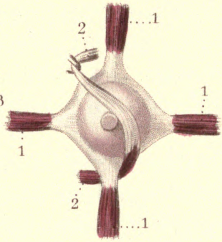

Fig. 3.

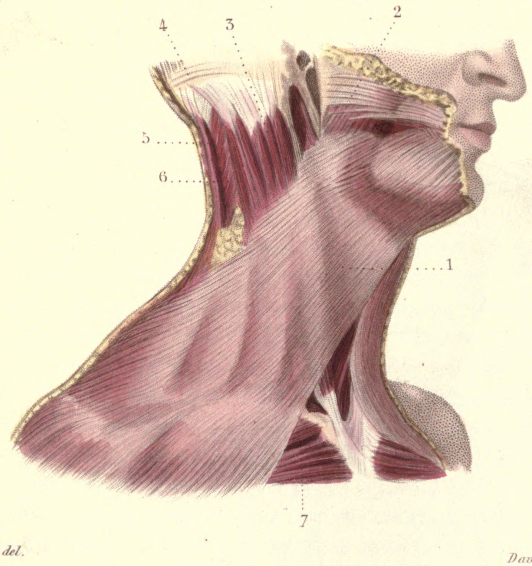

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PLATE XXII.

Fig. 1.—1. Optic nerve.—2. Aponeurotic origin of the muscles of the eyeball.—3. Levator palpebræ, cut and turned back.—4. Obliquus superior, passing through its pulley.—5. Rectus superior.—6. External rectus, showing its two heads of origin.—7. Obliquus inferior.—8. Inferior rectus and ligament of Zinn.—9. Superior portion of the orbicularis oris.—10. Inferior portion of the same.—11. Buccinator.—12. Quadratus menti.—13. External pterygoid. The superior fasciculus is inserted into the interarticular fibro-cartilage of the temporo-maxillary joint.—14. Internal pterygoid.

Fig. 2. EYEBALL, SEEN FROM BEHIND.

1, 1, 1, 1. Recti muscles, showing the expansion of their tendons.—2. Superior oblique, and 2′. Inferior oblique.

Fig. 3. SUPERFICIAL MUSCLES OF THE NECK, RIGHT SIDE.

1. Platysma myoides.—2. Risorius of Santorini.—3. Sterno-cleido-mastoid.—4. Aponeurosis of sterno-cleido-mastoid.—5. Trapezius.—6. Splenius capitis.—7. Pectoralis major.

Muscles of the Orbit.

Levator Palpebræ Superioris.—Origin: from the lesser wing of the sphenoid above the optic foramen. Insertion: by an aponeurotic expansion into the tarsal cartilage of the upper lid at its anterior and lower part. Nerve: upper division of the third. Action: draws the eyelid upwards and backwards over the eyeball, and so uncovers, *i.e.*, opens the eye.

Superior Rectus.—Origin: from the upper part of the fibrous ring (the ligament of Zinn), which surrounds the optic nerve at the optic foramen. Insertion: sclerotic coat of the eye about four lines, or rather more, behind the cornea. Nerve: the upper division of the third. Action: acting alone it draws the eye upwards and inwards.

Inferior Rectus.—Origin: from the ligament of Zinn below the optic foramen, and extending outwards as far as the inner border of the sphenoidal fissure. Insertion: sclerotic coat three lines behind the cornea. Nerve: branch from lower division of third. Action: acting alone it draws the eye downwards and outwards.

External Rectus.—Origin: by two heads, between which pass the following in order from above downwards—1. The upper division of third nerve; 2. Nasal twig of ophthalmic nerve; 3. Lower division of third nerve; 4. Sixth nerve; 5. Ophthalmic vein. Upper head: from the outer part of the ligament around the optic foramen. Lower head: from a spine on that border of the great wing of the sphenoid bone which forms the outer boundary of the sphenoidal fissure, and also from a tendinous band passing across the sphenoidal fissure to join the lower part of the common ligament. Insertion: sclerotic coat like the preceding. Nerve: the sixth. Action: rotates the eye outwards.

Internal Rectus.—Origin: from the inner part of the ligament around the optic foramen. Insertion: sclerotic coat about two lines nearer the cornea than the other recti, the superior rectus being farthest back. Nerve: lower division of the third. Action: rotates the eye inwards.

Superior Oblique.—Origin: by a pointed tendon from the lesser wing of the sphenoid above the levator palpebræ. Passing forwards as a fusiform-shaped muscle, it ends in a tendon which, passing through a pulley at the upper and inner angle of the orbit, is reflected outwards beneath the superior rectus. It is inserted into the sclerotic, between the superior and external recti muscles half-way along the eyeball. Nerve: the fourth. Action: it rotates the eye downwards and outwards.

Inferior Oblique.—Origin: from the superior maxillary bone, close to the margin of the orbit just external to the lachrymal groove.

Insertion: the muscle passes outwards and backwards between the floor of the orbit and the inferior rectus, to be inserted into the sclerotic coat beneath the external rectus, and near to, but farther back than, the superior oblique. Nerve: lower division of the third. A branch from the nerve to this muscle forms the motor root of the lenticular ganglion. Action: it rotates the eye upwards and out wards.

The Platysma Myoides is a skin muscle, placed between two layers of the cervical fascia, very thin and pale. Origin: from the fascia covering the clavicle, the acromion, the pectoralis major, the deltoid and the trapezius muscles. Insertion: the fibres pass upwards and inwards; (*a*) the most anterior, cross beneath the chin, the right being more superficial; (*b*) the next are inserted into the margin of the jaw from the symphysis to the angle; (*c*) the most posterior are prolonged over the jaw and the masseter muscle into the angle of the mouth. Nerves: facial (infra-maxillary), and the superficial cervical nerve. Action: when the jaw is tightly closed it raises the skin over the front of the chest, drawing at the same time the angle of the mouth outwards and downwards.

The *sterno-mastoid* or *sterno-cleido-mastoid* extends, as its name implies, from the sternum and clavicle to the side of the head. *Origin:* by two heads; the *outer*, the clavicular head, flat and fleshy, arises from the inner one-third of the superior border of the clavicle; the *inner*, the sternal head, is round, tendinous in front and fleshy behind it, arises from the anterior and upper aspect of the manubrium sterni. The two heads are separated by a narrow triangular interval; the two heads blend about the middle of the neck, and the muscle passing upwards and backwards divides the neck into the two triangles, anterior and posterior. *Insertion:* anterior border and external surface of the mastoid process and into the bone behind it, as well as by aponeurosis into the outer two-third of the superior curved line of the occipital bone. *Nerve:* the spinal accessory which pierces it, and the second and third cervical nerves. *Action:* when both muscles act the head is drawn forward and the neck bent towards the sternum; one muscle acting alone turns the head, as in listening.

PLATE XXIII.

Fig. 1. Muscles attached to the Hyoid Bone, right side.

1. Anterior, and—2. Posterior bellies of the digastric.—3. Mylo-hyoid.—4. Stylo-hyoid.—5. Stylo-glossus.—6. Stylo-pharyngeus.—7. Sterno-hyoid.—8. Omo-hyoid.—9. Thyro-hyoid.—10. Sterno-thyroid.—11. Scalenus anticus.—12. Scalenus posticus.—13. Levator anguli scapulæ.

Fig. 2. Muscles of the Tongue, right side.

1. Styloid process.—2. Stylo-hyoid.—3. Genio-hyoid.—4. Stylo-pharyngeus.—5. Stylo-glossus.—6. Hyo-glossus.—7. Lingualis.—8. Genio-hyo-glossus.

Fig. 3. Muscles of the right side of the Pharynx, seen from behind.

1. Sterno-thyroid.—2. Posterior median raphé.—3. Styloid process.—4. Stylo-pharyngeus.—5. Superior constrictor.—6. Middle constrictor.—7. Inferior constrictor.—8. The pterygo-maxillary ligament, common to the buccinator and superior constrictor.—9. Buccinator.—10. Duct of the parotid, or Steno's duct.—11 and 12. Stylo- and hyo-glossi muscles, cut.—13. Posterior fibres of the genio-hyo-glossus, continuous with the superior constrictor of the pharynx.—14. Genio-hyoid.

The Constrictors of the Pharynx.

Superior Constrictor of Pharynx.—Origin : 1. Lower third of the posterior border of the internal pterygoid plate ; 2. Hamular process ; 3. Posterior border of pterygo-maxillary ligament ; 4. Back part of the mylo-hyoid ridge on the inner surface of the lower jaw ; 5. Mucous membrane of mouth ; 6. The side of the tongue—the latter receiving a separate name, the *pharyngeo-glossus. Insertion :* the fibres pass backwards with varying degrees of obliquity ; the superior, ascending to their insertion at the pharyngeal spine curve round the levator palati muscle and Eustachian tube, having a lunated border. A space is thus left above, which has been named the *sinus of Morgagni ;* at this point the aponeurosis of the pharynx is visible. The rest of the fibres are inserted into the median raphé and into the aponeurosis of the pharynx. *Nerve :* pharyngeal plexus (Action, *see* below).

Middle Constrictor.—Origin : 1. Upper border of the great cornu of the hyoid bone ; 2. Lesser cornu of the same ; 3. Lower third of the stylo-hyoid ligament. *Insertion :* into the median pharyngeal

Pl. 23.

Fig. 1.

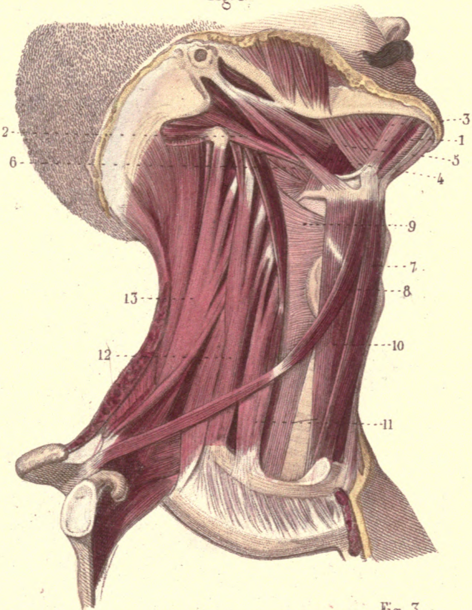


Fig. 2.

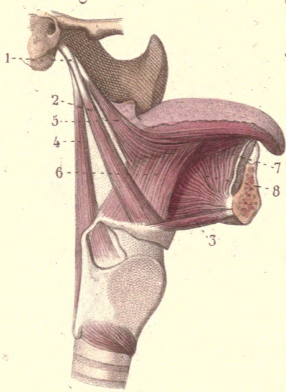
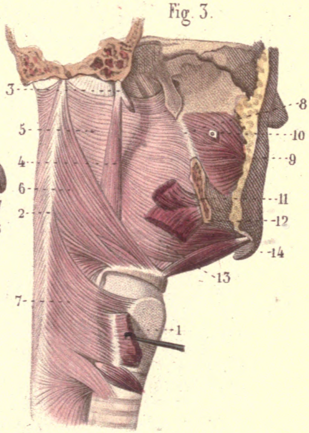


Fig. 3.



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raphé behind. The muscle overlaps the lower part of the superior constrictor, being separated laterally by the glosso-pharyngeal nerve and the stylo-pharyngeus muscle. *Nerve:* branches from the pharyngeal plexus. (Action, *see* bolow.)

Inferior Constrictor.—Origin: 1. From the side of the cricoid cartilage; 2. The oblique line on the thyroid cartilage; 3. The surface behind this line; 4. The lower cornu of the thyroid cartilage. *Insertion:* into the median raphé. It is separated from the middle constrictor by the superior laryngeal nerve and vessels; it overlaps the lower part of the middle constrictor. Like all the constrictors it is narrow at its origin in front and broad behind. Passing beneath its lower border are the inferior laryngeal nerve and vessels. *Nerve:* branches from the pharyngeal plexus. The pharyngeal plexus is formed by branches from the glosso-pharyngeal, vagus, and sympathetic nerves. *Actions:* all the muscles acting, the pharynx will be constricted and drawn forwards as well as upwards, but more contracted below than above. The food is first received from the mouth by the middle constrictor and the lower part of the superior; thence it is passed on to the inferior constrictor and the œsophagus. The upper constrictor, in conjunction with the palato- and salpingo-pharyngeal muscles, shuts off the pharyngo-nasal portion of the pharynx from the pharyngo-oral portion in deglutition.

Styloid Muscles.

Stylo-pharyngeus.—Origin: by fleshy fibres from the inner surface of the styloid process near its root. Insertion: the muscle passes downwards between the superior and middle constrictors, and is inserted partly into the pharynx, but chiefly into the upper cornu and posterior border of the thyroid cartilage. Nerve: the glosso-pharyngeal, probably by the facial by means of a communicating branch to the above nerve. Action: it draws upwards and outwards the upper portion of the pharynx in swallowing; it also elevates the larynx.

Stylo-hyoid.—Origin: by a slender round tendon from the outer surface of the styloid process about its middle. Insertion: it passes downwards and forwards, and, after having been pierced by the posterior belly of the digastric, is inserted into the body of the hyoid bone. Nerve: the facial. Action: it draws upwards and backwards the hyoid bone.

Stylo-glossus.—Origin: from the styloid process near its apex, but chiefly from the stylo-hyoid ligament. Insertion: into the side of the dorsum and tip of the tongue. Nerve: hypoglossal, entering it near its anterior part. Action : it raises the tongue and draws it backwards; one muscle will pull the tongue to its own side.

Salpingo-pharyngeus.—Origin : by a narrow tendon from the cartilage of the Eustachian tube. Insertion: into the pharynx in conjunction with the palato-pharyngeus. Nerve: a branch probably from the pharyngeal plexus. Action: it elevates the upper and lateral part of the pharynx.

Depressors of the Larynx and Hyoid Bone.

Sterno-hyoid.—Origin: from the posterior surfaces of the manubrium sterni, the sterno-clavicular articulation and the first costal cartilage; the muscles converge towards their insertion. Insertion: into the lower border of the body of the hyoid bone near the middle. Action: it draws down the hyoid bone; when the hyoid bone is fixed the muscle may raise the sternum. Nerve: see below.

Sterno-thyroid.—Origin: from the posterior surface of the manubrium below the sterno-hyoid, and also from the cartilages of the first and second ribs. These muscles diverge towards their insertion. Insertion: into the oblique line on the outer surface of the thyroid cartilage. Action: it draws down the thyroid cartilage and larynx; it also aids phonation by fixing the thyroid cartilage.

Omo-hyoid.—Origin: from the ligament crossing the supra-scapular notch, and from the contiguous part of the upper border of the scapula. The posterior belly passes forwards parallel to the clavicle; under cover of the sterno-mastoid muscle, there is a tendon developed, beyond which the muscle ascends as the anterior belly to be inserted into the lower border of the body of the hyoid bone. A process of cervical fascia binds the tendon down to the first costal cartilage. Action: it depresses the hyoid bone, and makes tense the cervical fascia.

The above muscles are supplied by branches from the ansa hypoglossi, which is a plexus formed by the descendens noni and the communicantes noni nerves.

Thyro-hyoid.—Origin: from the oblique line on the thyroid cartilage. Insertion: into the lower border of the outer part of the body of the hyoid bone, and into the great cornu of the same. Nerve: a special branch from the hypoglossal. Action: it will depress the hyoid bone or draw upwards the thyroid cartilage.

Depressors of the Lower Jaw and Elevators of the Hyoid Bone.

Genio-hyoid.—Origin: from the inferior genial tubercle on the posterior surface of the symphysis of the lower jaw. Insertion: the middle of the anterior aspect of the body of the hyoid bone. *Nerve:* hypoglossal. *Action:* it depresses the lower jaw, or raises the hyoid bone according as it is the hyoid bone or jaw that is fixed.

Genio-hyo-glossus.—A large fan-shaped muscle, having its apex at the jaw, and the base extending from the tip of the tongue to the hyoid bone. *Origin:* the superior genial tubercle behind the symphysis of the lower jaw. *Insertion:* 1. The tongue near the middle line from the apex to the root; 2. A few fibres into the side of the pharynx; 3. Into the middle of the upper border of the body of the hyoid bone. *Nerve:* hypoglossal. *Action:* the whole muscle will depress the tongue: the part attached to the hyoid bone will elevate it, or the hyoid bone being fixed, the muscle will depress the jaw; the part attached to the tongue will protrude this organ from the mouth, and turn the tip downwards over the teeth or lower lip.

Hyo-glossus.—A thin quadrilateral-shaped muscle. *Origin:* 1. Basio-glossus from the lateral surface of the body of the hyoid bone; 2. Kerato-glossus from the great cornu of the hyoid bone; 3. Chondro-glossus from the small cornu of the same. *Insertion:* the fibres pass upwards between the stylo-glossus and inferior lingualis, and blend with the muscular structure of the tongue on its lateral and dorsal surfaces. *Nerve:* hypoglossal. *Action:* the muscle will draw the tongue, if protruded, into the mouth; if the tongue is in the mouth, the muscle will depress it, and draw down the centre, making it concave. If the tongue be held against the roof of the mouth, the hyoid bone can be elevated.

The *Digastric.*—Consists of two parts, anterior and posterior, united by an intervening tendon. *Anterior belly: origin,* a rough impression on the inferior border of the lower jaw close to the symphysis. *Posterior belly:* origin, from the digastric groove under the mastoid process. The posterior belly passes downwards and forwards across the carotid vessels and pierces the stylo-hyoid muscle, to end in a tendon; the anterior, downwards and backwards to the intervening tendon, which is round and bound down by an aponeurotic loop to the hyoid bone at the junction of the body and great cornu; the loop is lined by a synovial sheath to facilitate the movement of the tendon. *Nerve:* the posterior belly is supplied by the facial; the anterior belly by the mylo-hyoidean branch of the inferior dental. *Action:* it depresses the lower jaw and opens the mouth; when the jaw is fixed the muscle will elevate the hyoid bone; the posterior belly acting alone will move the head backwards.

The *Mylo-hyoid* forms a sort of diaphragm at the floor of the mouth; it is triangular in shape, with the apex downwards. *Origin:* from the mylo-hyoid ridge on the inner surface of the lower jaw, extending from the symphysis to the ramus. *Insertion:* the posterior fibres pass almost horizontally inwards to the upper border of the body of the hyoid bone; the anterior pass backwards to unite in a median raphé between the symphysis of the jaw and the hyoid bone. *Nerve:* mylo-hyoid from the inferior dental. *Action:* when the hyoid bone is fixed the lower jaw will be depressed and the mouth opened; when the jaw is fixed the hyoid bone and the larynx will be raised.

On the mylo-hyoid muscle are the following structures, viz., the submaxillary gland, the facial vessels and their branches, and the mylo-hyoid nerve and vessels.

Resting on the hyo-glossus muscle from above downwards are the following, viz.: 1. Gustatory nerve; 2. Submaxillary ganglion; 3. Deep part of submaxillary gland; 4. Ranine vein; 5. Wharton's duct; 6. Hypoglossal nerve. Passing beneath the posterior border of the hyo-glossus, and upon the genio-hyo-glossus are: 1. Glosso-pharyngeal nerve; 2. Lingual artery with its venæ comites; 3. Stylo-hyoid ligament.

The muscles attached to the HYOID bone are thus arranged:

To the body.—To the upper border and anterior aspect: the mylo-hyoid, the hyo-glossus in part, the genio-hyoid, and the genio-hyo-glossus in order from front to back. To the lower border: the sterno-hyoid close to the middle line, the omo-hyoid immediately external to the sterno-hyoid, the stylo-hyoid at the junction of the greater cornu and the body; the thyro-hyoid is inserted, in part, beneath the sterno-hyoid and omo-hyoid.

To the lesser cornu: the middle constrictor at its posterior aspect.

To the greater cornu: the tendon of the digastric is bound down to, and the stylo-hyoid is attached to, the junction of the body and greater cornu; the thyro-hyoid is attached to the lower border, and the hyo-glossus, with the middle constrictor beneath it, to the upper border of the greater cornu.

The linguales muscles, superior and inferior, are connected by fibrous tissue—the hyo-glossal ligament—to the anterior and upper aspects of the body of the hyoid bone.

Pl. 24.

Fig. 1.

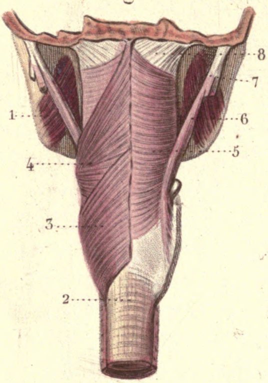

Fig. 2.

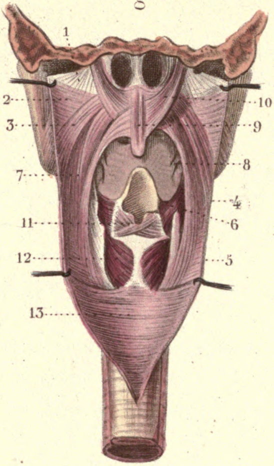

Fig. 4.

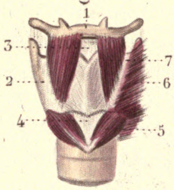

Fig. 5.

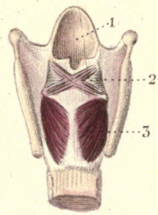

Fig. 3.

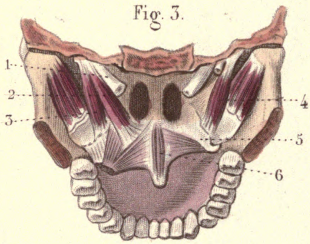

Fig. 6.

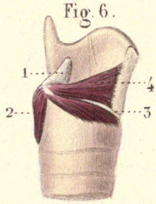

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PLATE XXIV.

Fig. 1. Muscles of the Pharynx, seen from behind, after Bichat's section.

1. Internal pterygoid muscle.—2. Transverse fibres of the œsophagus.—3. Inferior constrictor.—4. Middle constrictor.—5. Superior constrictor.—6. Stylo-pharyngeus.—7. Styloid process, showing the origin of the preceding muscle, the stylo-hyoid and stylo-glossus cut.—8. The sinus of Morgagni.

Fig. 2. Muscles of the Soft Palate.

1. Pharyngeal fascia (position of sinus of Morgagni).—2. Part of superior constrictor.—3. Portion of the same.—4 and 5. Fibres of the middle and inferior constrictors.—6. Fibres of stylo-pharyngeus, inserted between the superior and middle constrictors.—7. Palato-pharyngeus, divided into two fasciculi.—8. Palato-glossus.—9. Azygos uvulæ, consisting of two fasciculi.—10. Levator palati, in front of which are seen some fibres of the tensor palati.—11. Arytenoideus.—12. Crico-arytenoideus posticus.—13. The œsophagus opened, showing its attachment to the cricoid cartilage.

Fig. 3. Deeper view of the Muscles of the Soft Palate.

1. Eustachian tube.—2. Levator palati.—3. Vertical portion of tensor palati.—4. Tensor palati, showing its vertical and horizontal portions.—5. The hamular process of the sphenoid.—6. Azygos uvulæ.

Fig. 4. Muscles of the Larynx, seen from the front.

1. Hyoid bone.—2. Thyroid cartilage.—3. Thyro-hyoid membrane.—4. Crico-thyroid membrane.—5. Crico-thyroid muscle.—6. Inferior constrictor.—7. Thyro-hyoid muscle.

Fig. 5. Muscles of Larynx, posterior view.

1. Superior aperture of larynx.—2. Arytenoideus muscle.—3. Crico-arytenoideus posticus.

Fig. 6. Side view, Muscles of the Larynx.

The right ala of the thyroid cartilage is removed.

1. Arytenoid cartilage.—2. Crico-arytenoideus posticus.—3. Crico-arytenoideus lateralis.—4. Thyro-arytenoideus.

Muscles of the Soft Palate.

Levator Palati.—Origin: 1. From the rough quadrilateral surface on the inferior aspect of the apex of the petrous portion of the temporal; 2. From the cartilage of the Eustachian tube at its inner part. The thick round muscle passes downwards and inwards above the upper border of the superior constrictor. *Insertion:* the soft palate between the anterior and posterior parts of the palato-pharyngeus muscle. *Nerve:* the posterior palatine, a branch from Meckel's ganglion. *Action:* it draws upwards and backwards the soft palate, shutting off the pharynx from the posterior nares.

The *Tensor* or *Circumflexus Palati* is a thin muscle, but almost two inches in extent at its origin. *Origin:* 1. Scaphoid fossa at the root of the internal pterygoid plate; 2. Outer part of Eustachian tube; 3. Spine of sphenoid; 4. Vaginal process of temporal. The muscle converges to a narrow tendon, which winds round the hamular process (a synovial sheath being interposed), and becoming expanded, is finally *inserted*, partly into the aponeurosis of the palate, and partly into a ridge near the posterior border of the horizontal process of the palate bone on its inferior aspect. *Nerve:* a branch from the otic ganglion. *Action:* it fixes and makes tense the soft palate.

The *Palato-glossus* occupies the anterior pillar of the fauces. *Origin:* from the anterior surface of the aponeurosis of the soft palate, being connected with its fellow on the opposite side. *Insertion:* the tongue on its dorsal and lateral aspects. *Nerve:* the pharyngeal plexus. *Action:* it constricts the fauces; makes tense the soft palate, and can also raise and draw backwards the tongue.

The *Palato-pharyngeus* occupies the posterior pillar of the fauces. *Origin:* from the soft palate by two processes; the posterior, immediately beneath the mucous membrane behind, is connected with the muscle of the opposite side; the anterior is attached to the substance of the aponeurosis of the palate, and meets the corresponding muscle of the opposite side; the levator palati and azygos uvulæ muscles separate the two. *Insertion:* back part of the pharynx, some of the fibres decussating across the middle line; and also into the posterior border of the thyroid cartilage. *Nerve:* the pharyngeal plexus. *Action:* acting from below it makes tense the soft palate; when both muscles act the pharynx will be elevated, the posterior border of the soft palate is drawn towards the posterior wall of the pharynx, and the isthmus of the fauces narrowed as in swallowing.

The *Azygos Uvulæ* consists of two muscular slips placed in apposition in the substance of the soft palate. *Origin:* from the posterior nasal spine and from the aponeurosis of the palate. The muscles end in the tip of the uvula. *Nerve:* branches from Meckel's ganglion by the posterior palatine. *Action:* they elevate the uvula and lessen the depth of the soft palate.

Intrinsic Muscles of the Larynx.

The *Arytenoid* muscle occupies the posterior surface of the arytenoid cartilages, being attached to these surfaces, and passing transversely from one cartilage to the other. The following portion of the muscle is most superficial.

The *Aryteno-epiglottidean* muscles appear to be part of the arytenoid muscle attached to the outer angles of either cartilage; they pass upwards and to the opposite side, decussating; becoming partly attached to the upper and outer part of the opposite cartilage, and partly to the epiglottis and the aryteno-epiglottidean folds. Nerve: inferior laryngeal, and perhaps the superior, the latter piercing the arytenoid. Action: to approximate and depress the arytenoid cartilages; the whole of these two muscles acting, the aperture of the larynx will be constricted.

Crico-thyroid.—A short, thick, triangular muscle. Origin: the outer aspect of the cricoid cartilage from almost the median line in front backwards along the lateral surface. Insertion: inferior border of thyroid cartilage and anterior border of its lower cornu. Nerve: external laryngeal from the superior laryngeal. Action: makes tense the vocal cords in the following manner, thus—the thyroid cartilage being fixed by its intrinsic muscles, the crico-thyroid muscles then draw upwards and backwards the cricoid cartilage, rotating it on an axis passing through the thyro-cricoid articulation. The portion in front of the articulation is drawn upwards, whilst that behind is depressed, and the arytenoid cartilages being depressed along with the posterior part of the cricoid, the vocal cords are made tense.

Crico-arytenoideus Posticus.—Origin: from a depression on the posterior surface of the corresponding half of the cricoid cartilage. Insertion: the fibres, passing upwards and outwards, converge to a tendon, and are inserted into the outer angle of the base of the arytenoid cartilage. Nerve: inferior laryngeal. Action: to draw the arytenoid cartilages outwards and backwards, rotating the processus vocalis outwards, and with it the vocal cords, thus widening the rima glottidis. They act during inspiration.

Crico-arytenoideus Lateralis.—Origin: the upper border of the cricoid cartilage in front of the articular surface for the arytenoid cartilage. Insertion: outer angle of the base and contiguous outer surface of the arytenoid cartilage. Nerve: inferior laryngeal. Action: to pull the external angle forwards, thus rotating the arytenoid cartilage on its own axis, and so causing approximation of the vocal cords by the rotation inwards of the processus vocalis.

The *Thyro-arytenoid* consists of an inner and an outer portion, each having antero-posterior and oblique fibres. *Inner portion:* antero-posterior fibres arise from the lower half of the angle formed by the alæ of the thyroid cartilage and slightly from the adjacent part of the vocal cords; passing backwards they are inserted into the processus vocalis and adjacent part of outer surface of arytenoid cartilage. The oblique fibres arise in front from the anterior third of the crico-thyroid membrane below the vocal cord, and passing upwards and outwards over the ventricle of the larynx are attached to the ventricular bands (false vocal cords). *Outer portion:* antero-posterior fibres arise from the thyroid cartilage close to the origin of the internal portion, and passing backwards are inserted into the processus muscularis (outer angle) of the arytenoid cartilage and also into the outer border. The oblique fibres, arising mostly from the crico-thyroid membrane, pass upwards to the aryteno-epiglottidean fold and some to the ventricular bands. Nerve: inferior laryngeal. Action: the antero-posterior fibres draw forwards the arytenoid cartilage, relaxing the vocal cords and thus antagonizing the crico-thyroid muscles, whilst other parts of the fibres may give different parts of the cord varying degrees of tension or relaxation. The fibres going to the processus muscularis will rotate the arytenoid cartilages inwards, and those going to the aryteno-epiglottidean fold will tend to depress the epiglottis.

The *Thyro-epiglottidean* muscle (thyro-aryteno-epiglottidean—depressor of the epiglottis) is for the most part a portion of the preceding; arising in common with it from the thyroid cartilage, and also from the front of the arytenoid cartilage, and receiving some fibres from the arytenoid muscle it passes upwards, to be attached to the aryteno-epiglottidean fold and to the border of the epiglottis. Nerve: the inferior laryngeal. Action: it draws downwards the epiglottis, or forwards the arytenoid cartilage; a few of its fibres embrace the fundus of the saccule of the larynx, thus acting as a compressor—the *compressor sacculus laryngis* (Hilton).

NOTE.—By the extrinsic muscles are meant those muscles which, arising without, are inserted within some such organ, say, as the larynx or tongue. By intrinsic muscles are meant muscles arising within, and being inserted within, an organ, as met with in the tongue and larynx.

Pl. 25

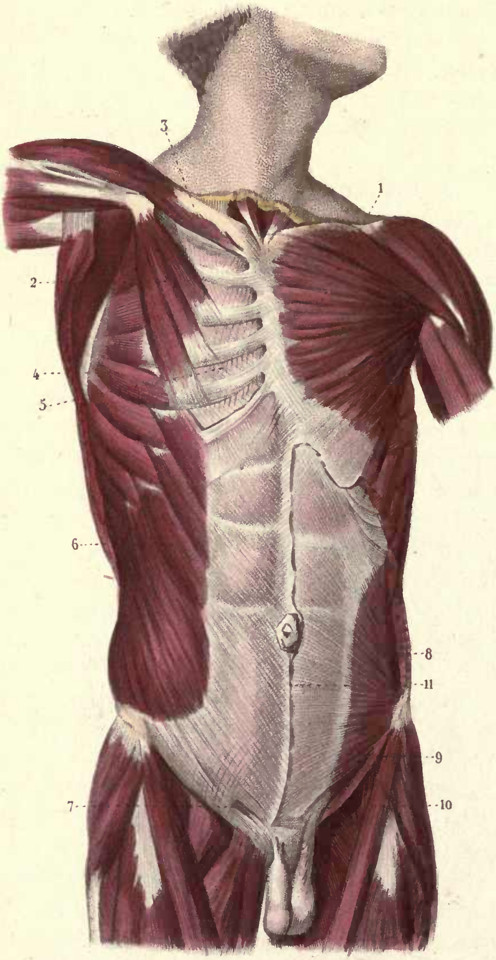

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PLATE XXV.

Anterior Superficial Muscles of the Trunk.

1. Pectoralis major.—2. Pectoralis minor.—3. Subclavius.—4. Serratus magnus.—5. Internal intercostals.—6. External oblique.—7. External abdominal ring.—8. Internal oblique.—9. Poupart's ligament.—10. Cremaster.—11. Linea alba.

Muscles of the Trunk (Abdominal).

External Oblique.—This, the most superficial muscle in the abdominal wall, is fleshy above and posteriorly, but aponeurotic below and in front. The direction of the fibres is downwards and forwards. *Origin:* by fleshy processes from the outer surfaces of the eight lower ribs, just external to the cartilages; these slips interdigitate with the digitations of other muscles, viz., the highest four with the serratus magnus, and the lowest three with the latissimus dorsi. *Insertion:* the posterior fibres descend almost vertically to be inserted into the anterior half of the outer lip of the iliac crest; the middle and anterior fibres, increasing in obliquity from above downwards. are continued into the aponeurosis. The *aponeurosis:* above it is connected externally with the pectoralis major muscle, whilst internally it covers the insertion of the rectus muscle, and is connected with the ensiform cartilage; lower down it passes in front of the rectus, forming part of its sheath, and is connected with the aponeurosis of the opposite side at the linea alba. The lowest portion is collected into a thick bundle, passing from the anterior superior spine of the ilium to the pubic spine, and named *Poupart's ligament;* reflected from this backwards and outwards, and attached to the ilio-pectineal line, is a small triangular process named *Gimbernat's ligament.* The lowest fibres above Poupart's ligament are inserted into the pubic crest of the same, and also into the pubic crest of the opposite, side, forming the *triangular ligament.* Just above the pubis is the triangular opening of the *external abdominal ring,* with its apex upwards and outwards, and its base at the crest of the pubis; the outer pillar is inserted into the spine, and the inner pillar into the angle, of the pubis; this opening is strengthened and partially closed above by some arched fibres going from pillar to pillar, the *inter-columnar fibres.* *Nerves:* branches from the intercostals, ilio-inguinal, and ilio-hypogastric. *Action:* it draws down the ribs or bends the body forwards when both muscles are acting, and laterally when only one acts; it also compresses the abdominal cavity anteriorly.

The *Internal Oblique* has some opposite characters to the external, viz., it is fleshy below and aponeurotic above; the direction also of its fibres is upwards and inwards.

Origin.—(1) By fleshy fibres from the outer two-thirds of Poupart's ligament; (2) anterior two-thirds of the middle lip of the crest of the ilium; (3) from the fascia lumborum between the iliac crest and the last rib.

Insertion.—The most posterior portion of the muscle is inserted by fleshy processes into the tips of the cartilages of the lower three or four ribs in a line with the internal intercostals. The rest of the portion from the iliac crest is continued into the aponeurosis, whilst that from Poupart's ligament, after arching over the inguinal canal, is inserted, in common with the transversalis aponeurosis, into the pubic crest and the ilio-pectineal line as the *conjoined tendon.* The lowest fibres of all form the cremaster muscle.

The *aponeurosis* on its way to the linea alba splits at the outer border of the rectus muscle, one part passing in front, the other behind, to enclose the muscle in a sheath. The part in front blends with the aponeurosis of the external oblique, and is continued upwards over the pectoralis major muscle; the part behind blends with the aponeurosis of the transversalis muscle, and is attached above to the cartilages of the eighth and seventh ribs, and to the ensiform cartilage. Midway between the pubes and the umbilicus, the aponeurosis does not split, but passes entirely in front of the rectus.

Nerves.—Branches from the intercostal, ilio-inguinal, and ilio-hypogastric.

Action.—The muscle draws down the ribs, assisting in expiration. At the same time it compresses the abdominal viscera; further it will draw upwards the pelvis, as in climbing.

The Cremaster Muscle. Origin.—By fleshy fibres from near the middle of Poupart's ligament, and the lower border of the internal oblique, of which it appears to be a portion.

Insertion.—The muscular fibres pass down in loops, with the convexity downwards, on the front and outer surface of the spermatic cord, to the testicle, and then upwards on the inner side to the spine, and front, of the pubes. Connected with the fibres is a fascia called the cremasteric fascia, one of the coverings of the cord.

Nerve.—The genital branch of the genito-crural.

Action.—Supports and elevates the testicle.

The *Transversalis Muscle* is attached all round; its fibres are transverse in direction.

Origin.—(1) Inner surfaces of the cartilages of the six lower ribs interdigitating with the diaphragm; (2) the fascia lumborum; (3) the anterior two-thirds of the inner lip of the iliac crest; (4) the outer third of Poupart's ligament.

The muscle has an anterior and posterior aponeurosis. The *posterior*, the fascia lumborum, occupies the space between the iliac crest and the last rib; it comprises *three lamellæ.* The most posterior, behind the erector spinæ, is attached to the spines of the lumbar vertebræ. The middle, in front of the erector spinæ, and behind the quadratus lumborum, is attached to the apices of the transverse processes (it also fills up the interval between them). The anterior lamella lies in front of the quadratus lumborum, and is attached to the anterior aspects of the transverse processes, to the ilio-lumbar ligament below, and to the last rib above, forming the *ligamentum arcuatum externum*, and giving attachment to the diaphragm; the posterior aponeurosis is pierced by the last dorsal and the ilio-hypogastric nerves and some small vessels.

Insertion.—The *anterior aponeurosis* represents the insertion of the muscle, and is continued to the linea alba. Passing beneath the rectus, it blends with the deep layer from the internal oblique as far as a point midway between the umbilicus and the pubes. Below that point it passes in front of the rectus to be inserted, in common with the internal oblique, by the conjointed tendon, into the pubic crest and the ilio-pectineal line. The lowest muscular fibres arch over the internal abdominal ring.

Nerves.—Branches from the lower intercostal, the ilio-hypogastric and ilio-inguinal.

Action.—Compresses the abdominal contents, and fixes the lower ribs.

The *Rectus Abdominis* is a long, flat muscle, extending between the thorax and the pelvis.

Origin.—By two heads; the outer, the larger and more fleshy, arises from the pubic crest behind the pyramidalis; the inner, rounded and tendinous, is connected with the fibrous tissues over the front of the symphysis pubis.

Insertion.—The ensiform cartilage, the cartilages of the seventh, sixth, and fifth ribs, as well as into the bony part of the fifth rib. The muscle has three *tendinous intersections* (the remnants of metameric segmentation)—one opposite the ensiform cartilage, one at the umbilicus, and one between these two; sometimes a fourth is found midway between the umbilicus and pubis.

The *Sheath of the Rectus* is formed: In *front*, from above, down to a point midway between the umbilicus and the pubes, by the aponeuroses of the external, and anterior layer of the internal, oblique; below this point by the aponeuroses of the external and internal oblique and transversalis muscles. *Behind* it is deficient both above and below —viz., above the ensiform cartilage, and below from midway between the pubis and the umbilicus down to the pubis ; between these two points the sheath is formed by the deep layer of the aponeurosis of the internal oblique and the aponeurosis of the transversalis. The superior epigastric artery passes over the margin of the sheath above, and the deep epigastric over the margin below, *i.e.*, *the fold of Douglas*, where the aponeurotic sheath of the rectus ends behind.

Nerves.—Lower intercostals.

Action.—Draws down the thorax and ribs, or raises the pelvis, or compresses the abdominal cavity.

The *Pyramidalis*, a small triangular muscle, placed in front of the rectus.

Origin.—From the crest of the pubes in front of the former.

Insertion.—Into the linea alba for three or four inches.

Nerve.—Ilio-hypogastric.

Action.—Makes tense the linea alba.

Muscles of the Thorax—Respiratory Muscles.

The *External Intercostals* are thin, flat muscles, occupying the intercostal spaces from the tubercles of the ribs behind to the cartilages in front. A thin aponeurosis is continued from their termination to the sternum.

Origin.—From the outer lip of the groove, on the inferior border of the ribs.

Insertion.—Into the upper border of the rib below. The fibres are directed from above downwards and forwards, like the external oblique. In the lower spaces, they extend between the cartilages, and in quite the lowest spaces, nearly to the anterior extremities.

Nerve supply.—Intercostals.

Action.—They elevate and evert the ribs in inspiration.

The *Internal Intercostals* commence near the angles, and end at the anterior extremity of the cartilages in front. The muscles in the upper and lower spaces approach nearer the vertebral extremity than in the middle; from the point of ending behind they are continued to the spine by a thin fascia.

Origin.—From the inner lip of the lower border of the rib.

Insertion.—The fibres run downwards and backwards to the upper border of the rib below. The intercostal vessels and nerves lie between the muscles.

Nerves.—Intercostals.

Action.—The portion between the cartilages are certainly elevators of the ribs, and inspiratory; the portion between the ribs (osseous) are probably elevators and inspiratory, although they are generally described as depressors, and therefore expiratory.

The *Infracostals*, or subcostal muscles, are fleshy slips lying beneath the pleura; they are better developed below than above; they are found internal to the point where the internal intercostals cease; they appear to be a part of these muscles, and have the same direction. They pass from one rib to the next, or second or third below, on the internal surfaces. They approximate the ribs, and are expiratory in action.

The *Levatores Costarum* are twelve fan-shaped muscles on each side of the vertebral column covered by the muscles of the back.

Origin.—From the tip of the transverse processes of the seventh cervical and the eleven upper dorsal vertebræ.

Insertion.—Outer surface of the rib below, between the tubercle and angle. The lower muscles are partly inserted into the rib below, and partly into the second or third rib below. These are named the *long levators.*

Nerves.—Intercostals.

Action.—They aid the external intercostal in raising the ribs, and are therefore inspiratory.

The *Triangularis Sterni* is a thin muscle placed behind the sternum and the costal cartilages, one on each side.

Origin.—(1) From the side of the ensiform cartilage (posterior aspect); (2) from the posterior aspect of the side of the sternum, as high as a level with the third costal cartilage; (3) also the posterior surfaces of the internal extremities of the seventh, sixth, and fifth costal cartilages.

Insertion.—The lower fibres pass horizontally outwards; the upper, upwards and outwards, to be inserted by the fleshy processes into the fifth, fourth, third, and second ribs at the junction of the bone and cartilage.

Nerves.—Intercostals.

Action.—Depresses the ribs, into which it is inserted, aiding expiration. It is really a continuation of the transversalis muscle upwards.

The *Diaphragm* is a great musculo-tendinous septum between the thoracic and abdominal cavities; it is the most important inspiratory muscle. It consists of a *central* portion and *two Crura.*

The *central* (septal) portion is tendinous centrally and fleshy circumferentially, convex on its superior aspect, concave below. It is attached (origin) at its margin, by fleshy slips, to the posterior surface of the ensiform cartilage; to the internal surfaces of the cartilages of the six lower ribs, where they interdigitate with the transversalis; to the ligamenta arcuata—interna and externa; and by the crura. Internally these fibres are attached (insertion) to the central tendon.

The *Crura*, right and left; take origin by tendon from the front of the bodies of the lumbar vertebræ, the intervertebral substance between them, and also the anterior common ligament. The *right*, the longer, is connected with the first, second, third and the upper margin of the body of the fourth, lumbar vertebræ; the *left*, the shorter, is connected with the bodies of the first and second, and the upper margin of the third, lumbar vertebræ.

Muscular fibres succeed the tendons and pass upwards from the crura—the outermost to the same side, but the innermost decussate (the right in front) having a figure-of-eight arrangement in front of the aortic opening, and behind and at the sides of the œsophageal opening; they are finally inserted into the central tendon.

The *central tendon* is the highest and most fixed part of the diaphragm. In shape it is three-lobed, the right leaflet being the largest, the left the smallest; around the central leaflet the pericardium is attached above, and on it lies the heart.

The *openings* in the diaphragm are three: aortic, œsophageal, and caval, there are also several small openings called fissures.

The *aortic opening* is slightly to the left of the middle line, formed at the sides and in front by the innermost fibres of the crura, behind by the body of the last dorsal vertebra. The opening is oblique in shape and osseo-tendinous in character. Passing through it are: the aorta, the thoracic duct, and the vena azygos major.

The *œsophageal opening* is in front and to the left of the aortic opening; elliptical in shape and muscular in character, it is formed behind and at the sides by the decussatory fibres of the crura; whilst the central tendon forms the anterior limit. Through it pass: the œsophagus; and the two pneumogastric nerves, the left in front, the right behind.

The opening for the *vena cava* is in the central tendon at the junction of the right and middle leaflets; it is quadrilateral in shape and aponeurotic in character. The inferior vena cava passes through it, being attached to its margin by fibrous cords.

The small openings or *fissures* are: (1) in front, between the muscular slips from the ensiform cartilage and the seventh rib; through these pass the superior epigastric vessels and a number of lymphatic vessels; (2) three or four in each crus transmit the splanchnic and sympathetic nerves; (3) in the left crus, an opening for the vena azygos minor; (4) on the right side behind, lymphatic vessels pass through from the upper surface of the liver.

Nerves.—Phrenics, with communicating branches from the nerve to the subclavius muscle and the descendens noni nerve.

The nerves ramify on the under surface of the muscle, and communicate with the sympathetic, forming a ganglion on the right side.

Action.—When the septal and crural muscular fibres contract, the diaphragm is drawn downwards and flattened chiefly at the sides (for the central tendon is very little movable), so that it slopes from the centre to the sides, and from before backwards. As the diaphragm descends, it increases the area of the thoracic cavity, and air is thus drawn into the lungs. The viscera in contact with the under surface of the diaphragm, viz., the liver, stomach, and spleen, are displaced downwards and compressed by each contraction. In expiration the muscular fibres relax, the under surface of the diaphragm becomes irregularly dome-shaped, bulging somewhat upwards on each side of the central tendon, the highest point on the upper surface reaching to the upper border of the fifth rib on the right side, but only to the upper border of the sixth on the left.

PLATE XXVI.

MYOLOGY, PLATE VI.

Fig. 1. Muscles of the Abdomen.

1. Internal oblique, the tendon of which is divided into—2. An anterior lamina, cut and turned back, and—3. A posterior lamina, which only goes as far as the lower fourth of the rectus muscle, forming a sheath for the other three-fourths.—4. Transversalis, the tendon of which is divided into—5. A superior lamina, which passes behind the rectus, and—6. An inferior, which passes in front.—7. Pyramidalis.—8. Rectus abdominis.—9. Linea alba.

Fig. 2. Muscles of the Male Perineum.

1. Erector penis.—2. Accelerator urinæ, united by a median raphé.—3. Transversus perinei, divided into two fasciculi, a super ficial and deep.—4. External sphincter.—5. Levator ani.

Pl. 26.

Fig. 1.

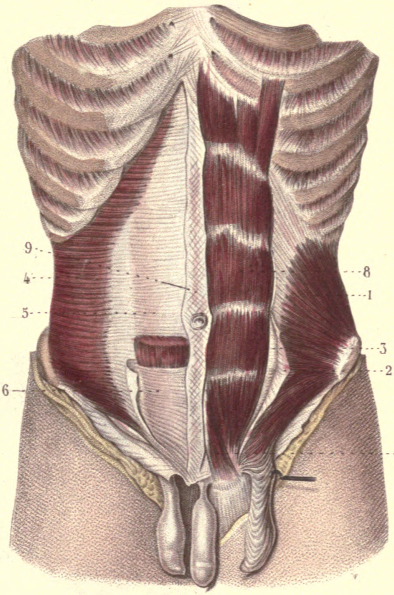
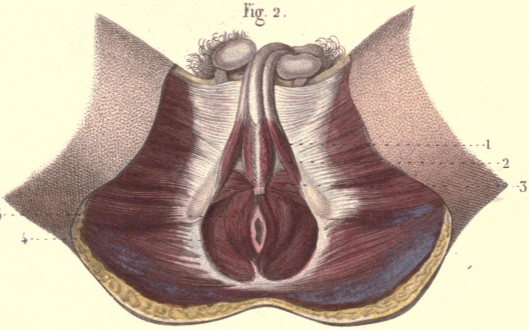


Fig. 2.



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Pl. 27.

Fig. 1.

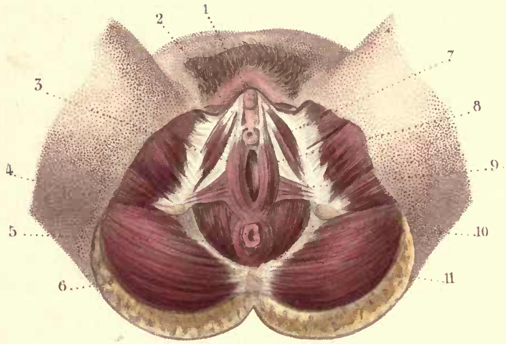

Fig. 4.

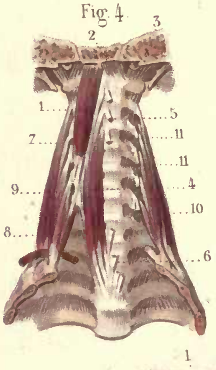

Fig. 3.

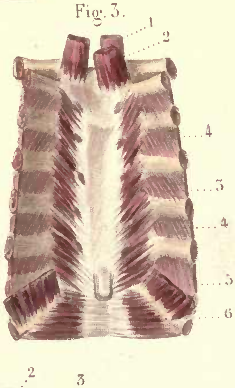

Fig. 2.

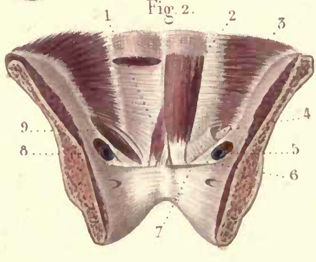

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PLATE XXVII.

Fig. 1. MUSCLES OF THE FEMALE PERINEUM.

1. Clitoris. — 2. Meatus urinarius.—3. Vulva. — 4. Anus. — 5. Margin of the great sacro-sciatic ligament.—6. Gluteus maximus. —7. Erector clitoridis.—8. Constrictor or sphincter vaginæ.— 9. Transversus perinei.—10. Levator ani.—11. External sphincter.

Fig. 2.—1. Pyramidalis.—2. Rectus abdominis leaving its sheath. —3. Transversalis. — 4. Position of internal abdominal ring.— 5. Superior orifice of the crural canal, in which are seen the femoral vessels. — 6. Gimbernat's ligament. — 7. Fascia transversalis. — 8. Crural arch.—9. Interior of the inguinal canal, the anterior wall raised.

Fig. 3. MUSCLES ATTACHED TO THE POSTERIOR PART OF THE STERNUM, ETC.

1. Origin of sterno-hyoid.—2. Origin of sterno-thyroid.—3. Triangularis sterni.—4, 4. Internal intercostals.—5. Attachment of diaphragm.—6. Superior part of transversalis.

Fig. 4. DEEP MUSCLES OF NECK, ETC.

1. Rectus capitis anticus major.—2. Rectus anticus minor.— 3. Rectus lateralis.—4. Longus colli.—5 and 6. Cut tendons of its vertical portion.—7. Its superior oblique portion.—8. Its inferior oblique portion.—9. Scalenus anticus, behind which is the subclavian artery.—10. Scalenus posticus.—11, 11′. Intertransversales.

PLATE XXVIII.

DIAPHRAGM.—LUMBAR MUSCLES, ETC.

Fig. 1.—1. Xiphoid cartilage, raised by a hook.—2. Central tendon. —3. Opening for the inferior vena cava.—4, 4. Lateral leaflets.—5. Œsophageal opening, containing the œsophagus and pneumogastric nerves.—6. Right crus of diaphragm.—6′. Left crus of diaphragm. —7. Aortic opening, completed above by the interlacing of some of the fibres of the crura.—8, 8. Opening for greater splanchnic nerves. 9. Ligamentum arcuatum internum (fibrous arch over the psoas muscle).—10. Psoas parvus.—11. Psoas magnus.—12. Ligamentum arcuatum externum.—13. Quadratus lumborum.

Fig. 2.—1. Xiphoid cartilage.—2. Fibres of origin of the diaphragm, the space between which is filled in with the cellular tissue of the anterior mediastinum.—3, 3. Origin of the diaphragm from the costal cartilages.

Fig. 3.—1. Psoas parvus.—1′. Aponeurotic expansion of the tendon of the psoas parvus, cut.—2. Psoas magnus.—2′. Inferior extremity of the psoas magnus, cut.—3. Quadratus lumborum, partly hidden by the psoas muscle.—3′. Quadratus lumborum.—4, 4. Apertures for lumbar arteries.—5, 5. Inter-transversales.—6. Iliacus internus. 7. Obturator externus.

Pl. 28.

Fig. 1.

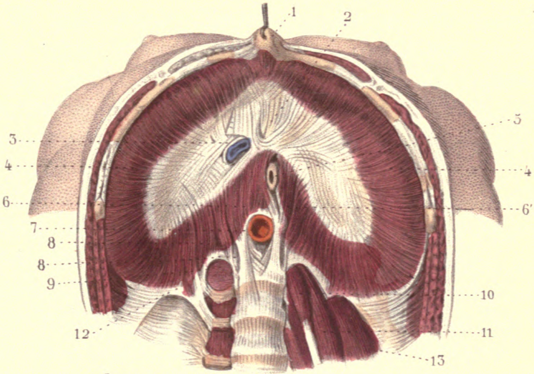


Fig. 2.

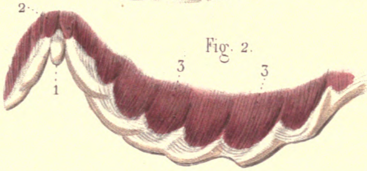
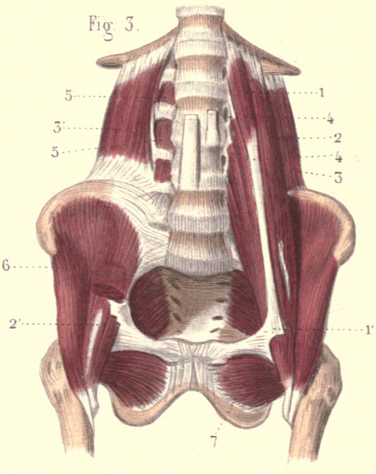


Fig. 3.



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In the adjacent plates are seen the muscles of the back, the Prevertebral muscles, the Scaleni, etc., etc.

The PREVERTEBRAL MUSCLES are those connected with the anterior tubercles of the transverse processes of the cervical vertebræ.

The *Longus Colli* lies on either side of the cervical vertebræ.

Origin.—By three slips. The *vertical* portion arises from the front of the lower three cervical and upper three dorsal vertebræ; the *inferior oblique*, external to, but conjoined with, the vertical portion, comes from the upper three dorsal; the *superior oblique* part comes from the anterior tubercles of the transverse processes of the second, third, and fourth cervical vertebræ.

Insertion.—The *inferior oblique* portion is inserted into the transverse processes of the fifth and sixth cervical; the *superior oblique* into the tubercle on the anterior arch of the atlas; the *vertical* portion is inserted into the bodies of the second, third, and fourth.

The RECTI MUSCLES number five pairs. The *Rectus Capitis Anticus Major: arises* from the anterior tubercles of the transverse processes from the third to the sixth cervical. It is *inserted* into the basilar portion of the occiput.

The *Rectus Capitis Anticus Minor: arises* anteriorly from the lateral mass of the atlas and from the root of its transverse process. It is *inserted* into the occiput immediately behind the major.

The *Rectus Capitis Lateralis: arises* from the upper and anterior border of the transverse process of the atlas. It is *inserted* into the under surface of the jugular process of the occiput.

The *Rectus Capitis Posticus Major: arises* from the bifid spine of the axis. It is *inserted* into the occiput behind, between the inferior curved line and the foramen magnum.

The *Rectus Capitis Posticus Minor: arises* from the tubercle on the posterior arch of the atlas. It is *inserted* into the occiput, beneath and internal to the preceding.

The SCALENE MUSCLES. *Anterior Scalene; arises* from the anterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ. It is *inserted* into the scalene tubercle on the inner border of the upper aspect of the first rib. *Relations.*—In front, the phrenic nerve, the transversales colli and humeri arteries; behind, the cords of the brachial plexus; in front and behind its insertion the subclavian vein and artery respectively lie.

The *Middle Scalene: arises* from the posterior tubercles of the six lower cervical vertebræ. It is *inserted* into the upper surface of the first rib behind the groove for the subclavian artery.

The *Posterior Scalene: arises* from the posterior tubercles of the fifth, sixth, and seventh cervical vertebræ, and is *inserted* into the second rib behind the serratus magnus.

THE MUSCLES OF THE BACK.

Five layers are usually enumerated.

The FIRST layer of muscles consists of the trapezius and latissimus dorsi. These are described at pages 118 and 119 respectively.

The SECOND layer of muscles is composed of the levator anguli scapulæ, the rhomboideus major and minor. See page 118.

The THIRD layer presents the following for examination:

The *Serratus Posticus Inferior: arises* from the spinous processes, and the supra-spinous ligaments of the last two dorsal and first two lumbar vertebræ. It ascends obliquely to be *inserted* into the four lower ribs just external to their angles.

The *Serratus Posticus Superior: arises* by an aponeurosis from the lower end of the ligamentum nuchæ, the spinous processes of the seventh cervical, and the first and second dorsal vertebræ. It descends obliquely to be *inserted* into the four ribs below the first.

The *Splenius* (*Capitis and Colli*) muscle *arises* from the lower half of the ligamentum nuchæ, the spinous processes of the seventh cervical and upper six dorsal vertebræ, and their supra-spinous ligaments. The *colli* portion is *inserted* into the posterior tubercles of the transverse processes of the upper four cervical vertebræ. The *capitis* portion is *inserted* into the mastoid portion of the temporal, and the occipital bone beneath the outer third of the superior curved line.

The FOURTH layer of muscles consists of the erector spinæ and its continuations, with the spinales dorsi and colli, and the complexus.

The *Erector Spinæ: arises* from the parts around the sacro-iliac groove, *i.e.*, the posterior aspect of the sacrum, the posterior fifth of the iliac crest and the ilium behind the auricular facet, from the lumbar and sacral spines, and from the lumbar aponeurosis covering it. The large fleshy mass is enclosed between the posterior and middle lamellæ of the posterior aponeurosis of the transversalis muscle, and opposite the last rib divides into: 1. The *Sacro-Lumbalis* (or Ilio-costalis), is inserted into the angles of the six lower ribs, and is continued upwards as the (*a*) accessorius ad sacro-lumbalem, (*b*) and the cervicalis ascendens. The *accessorius* arises from the angles of the six lower and is inserted into the angles of the six upper ribs. The *cervicalis ascendens* arises from the angles of the upper four ribs, to be inserted into the posterior tubercles of the fourth, fifth, and sixth cervical vertebræ. 2. The *Longissimus Dorsi*, the inner continuation of the erector spinæ, is inserted in the dorsal region by two sets of tendons; the outermost to the ribs between the tubercles and the angles; the innermost to the tips of the transverse processes of the dorsal vertebræ. Above it is continued upwards by: (1) The *Transversalis Colli: arises* from the transverse processes of the upper dorsal vertebræ, and ascends to be inserted into the posterior tubercles of the transverse processes of the lower five cervical. (2) The *Trachelo-Mastoid arises* from the transverse processes of the upper six dorsal and the articular processes of the four lower cervical vertebræ. It is *inserted* into the mastoid process of the temporal bone.

The *Spinalis Dorsi and Spinalis Colli* muscles arise from the lower spinous processes of the dorsal and cervical regions to which they respectively belong, and are inserted into the upper spinous processes of these regions.

The *Complexus* lies in the neck beneath the splenius. It *arises* from the articular processes of the fourth, fifth, and sixth cervical vertebræ, and from the transverse processes of the seventh cervical and three upper dorsal vertebræ. It is *inserted* into the occiput between the curved lines, close to the middle line.

The *Biventer Cervicis* is the innermost portion of the complexus.

The FIFTH layer of muscles is composed of the following:

The *Semispinales Dorsi and Colli* muscles arise from the lower transverse and articular processes of their respective regions, and are inserted into the upper spinous processes of these regions.

The *Multifidus Spinæ* occupies the hollow on either side of the spinous processes from the sacrum to the neck. In the sacral region the fibres arise from the back of the sacrum, and from the ilium and sacro-iliac ligament; in the lumbar region from the articular processes; in the dorsal from the transverse processes, and in the cervical from the articular again. The fibres from these points pass to be inserted into the laminæ and spinous processes.

The *Rotatores Spinæ* consist of eleven pairs. Each muscle arises from the transverse process of a dorsal vertebra, and passes to be inserted into the lamina of the vertebra above.

The *Supraspinales* and *Interspinales* lie, as their names imply, above and between the spinous processes of the vertebræ; the former are found only in the cervical region; the latter in the cervical, dorsal, and lumbar regions.

The *Intertransversales* muscles extend between the transverse processes in the cervical, dorsal and lumbar regions.

The *Obliquus Capitis Inferior* extends from the spine of the axis to the transverse process of the atlas.

The *Obliquus Capitis Superior* extends from the transverse process of the atlas to the outer end of the inferior curved line of the occiput.

The posterior recti muscles are described at page 112*.

Beneath the occiput behind, is the *sub-occipital* triangle. It is bounded: above and externally by the superior oblique; below and externally by the inferior oblique; internally by the rectus capitis posticus major. The roof is formed by the complexus, the floor by the posterior arch of the atlas and the occipito-atloid ligament. The contents are a quantity of fat, a plexus of veins, and the distribution of the sub-occipital nerve.

The *nervous* supply of the muscles enumerated is from the nerves in the neighbourhood. The recti and obliqui are supplied by the first cervical, and a few branches from the second. The muscles of the back are supplied, down to the fifth layer (with the exception of the complexus), by the *external* branches of the posterior primary divisions of the spinal nerves in their respective regions. The complexus and the fifth layer are supplied by the *internal* branches of these nerves. Action : the recti and obliqui have to do with the rotation, balance, and nodding motions of the head. The muscles of the back have to do with the movements of the spine and head, the balance of the body generally and the head in particular.

The upper serratus is a muscle of inspiration. The lower is concerned with expiration.

The *Extensor Coccygis* is found between the last piece of the sacrum and the coccyx, on the posterior surfaces of the bones.

The *Coccygeus* is met with on the pelvic aspect of the lesser sciatic ligament. It *arises* by its apex from the spine of the ischium, and is *inserted* into the side of the coccyx and the lowest piece of the sacrum. *Nerve:* from the fifth sacral. *Action:* to support the coccyx.

The *Quadratus Lumborum* occupies the interval between the crest of the ilium and the last rib. It presents two parts, an anterior, and posterior or main part. The *posterior arises* from the ilio-lumbar ligament and the adjacent anterior lip of the iliac crest for two inches ; it is *inserted* into the lower border of the last rib, and the transverse processes of the upper four lumbar vertebræ. The *anterior* portion *arises* from the transverse processes of the same vertebræ, and is *inserted* into the last rib. The muscle is enclosed between the anterior and middle lamellæ of the posterior aponeurosis of the transversalis muscle (q. v.). *Nerve:* branches of lumbar plexus. *Action:* supports the abdominal wall behind, and fixes the lower rib.

The *Obturator Externus* is seen in Plate XXVIII. The muscle *arises* from the femoral aspect of the obturator membrane, and the bones immediately internal to it; the fibres converge to a tendon, which passes below the head of the femur, and is *inserted* into the digital fossa on the inner aspect of the great trochanter. The muscle presents at its upper part a fibrous arch for the passage of the superficial branch of the obturator nerve; the deep branch pierces it.

Nerve: obturator. *Action:* external rotator of the lower limb.

Pl. 29.

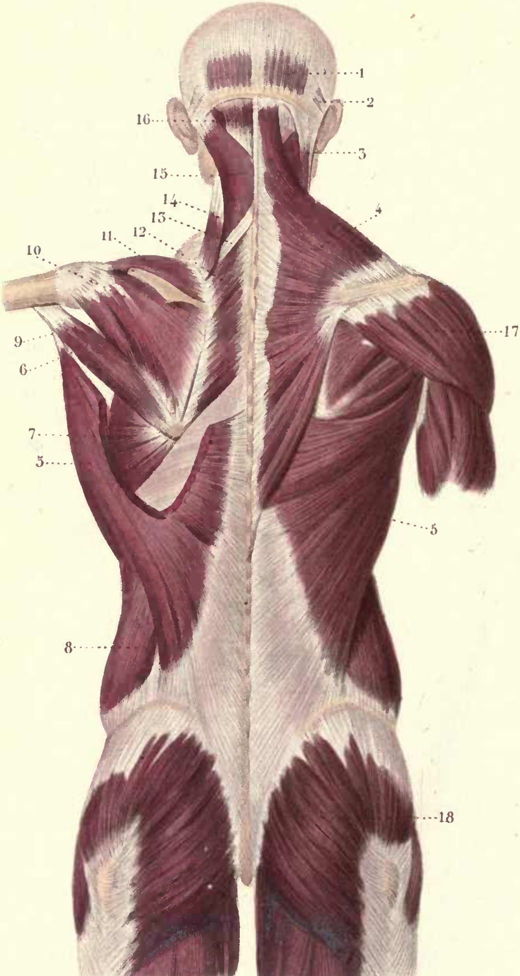

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PLATE XXIX.

Posterior Superficial Muscles of the Trunk.

1. Posterior belly of occipito-frontalis.—2. Retrahens aurem.—3. Sterno-cleido-mastoid.—4. Trapezius.—5, 5. Latissimus dorsi, the left muscle cut so as to show its relations.—6. Teres major.—7. Serratus magnus. — 8. External oblique. — 9. Teres minor. — 10. Infra-spinatus.—11. Supra-spinatus.—12. Rhomboideus major. — 13. Rhomboideus minor. — 14. Levator anguli scapulæ. — 15. Splenius.—16. Complexus.—17. Deltoid.—18. Gluteus maximus.

PLATE XXX.

Deep Muscles of the Posterior Part of the Trunk.

1. Serratus posticus superior.—1′. External intercostals.—2. Serratus posticus inferior.—3. Aponeurosis of the internal oblique, continuous with that of the preceding muscle.—4. Dorsal aponeurosis, to the outer side of which are seen the tendons of the sacro-lumbalis.—5. Splenius.—6. Sacro-lumbalis, drawn on one side.—6′. Accessorius ad sacro-lumbalis and Cervicalis ascendens.—7. Inferior portion of longissimus dorsi.—8. Internal tendons of longissimus dorsi, attached to the transverse processes.—9. Longissimus dorsi, cut and drawn aside.—9′. Internal tendons of this muscle, attached to the transverse processes.—10, 10. External tendons, attached to the space contained between the costal tubercle and angle.—11. Transversalis colli.—12. Trachelo-mastoid.—13. Complexus and Biventer cervicis.—14. Transverso-spinales.—15. Semi-spinalis of Winslow.—16. Inter-spinales cervicis.

Pl. 30

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Pl. 31.

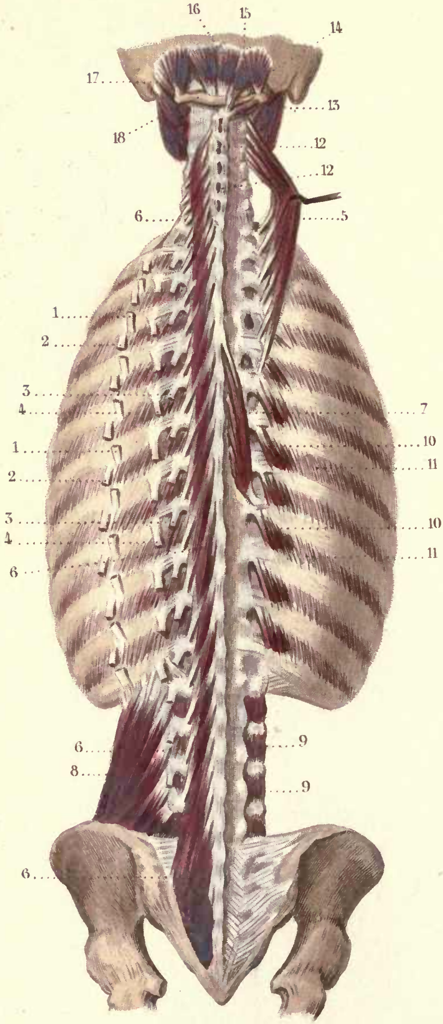

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PLATE XXXI.

DEEP MUSCLES OF THE POSTERIOR PART OF THE NECK AND TRUNK.

1, 1. Tendons of origin of the accessorius ad sacro-lumbalis, and transversalis colli and—2, 2. Tendons of insertion of the accessorius.—3, 3. Internal tendons of the longissimus dorsi.—4, 4. External tendons of this muscle.—5. Transversalis colli, drawn on one side by a hook.—6, 6, 6, 6. Multifidus spinæ.—7. Superficial, middle, and deep fasciculi of this muscle.—8. Quadratus lumborum.—9, 9. Inter-transversales lumborum.—10, 10. Levatores costarum.—11, 11. External intercostals.—12, 12. Inter-spinales cervicis.—13. Obliquus inferior.—14. Obliquus superior.—15. Rectus capitis posticus major.—16. Rectus capitis posticus minor.—17. Rectus capitis lateralis, posterior belly of digastric.—18. Atlas.

PLATE XXXII.

Fig. 1.—1. Deltoid, its tendon sends a slip to the brachial aponeurosis.

Fig. 2. MUSCLES OF THE POSTERIOR SCAPULAR REGION.

1. Supra-spinatus.—2. Infra-spinatus.—3. Teres minor.—4. Teres major.—5. Latissimus dorsi.

Fig. 3. ANTERIOR MUSCLES OF THE SCAPULA AND ARM.

1. Sub-scapularis.—2. Biceps.—3. Coraco-brachialis.—4. Brachialis anticus.—5. Tendon of pectoralis major, showing its two portions (attollens and attrahens).—6. Teres major.—7. Internal head of triceps.—8. Bicipital fascia.

Fig. 4.—1. Tendon of insertion of deltoid, enclosed by the upper part of the brachialis anticus.—2. Brachialis anticus.

Fig. 5.—1. Part of deltoid.—2. Triceps.—3. Long or middle head of triceps. 4. External head.—5. Internal head.—6. Anconeus.

MUSCLES OF THE UPPER EXTREMITY.

All muscles passing from the trunk to the arm, those connected with the shoulder girdle, as well as the intrinsic muscles, are included in the muscles of the upper extremity.

The *Pectoralis Major* is a triangular muscle, with its apex at the arm, and its base on the thorax.

Origin.—(1) Anterior border of the clavicle (inner half of); (2) antero-lateral aspect of the sternum; (3) cartilages of the true ribs, except the first and last; (4) bony part of the sixth rib at its anterior end; (5) aponeurosis of the external oblique of abdomen.

Insertion.—The part of the muscle arising from the sternum and

Pl. 32.

Fig. 1.

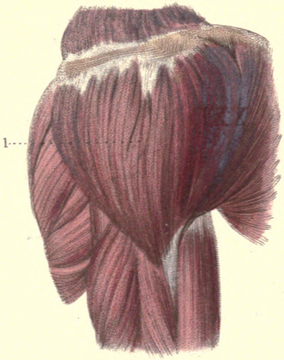


Fig. 2.

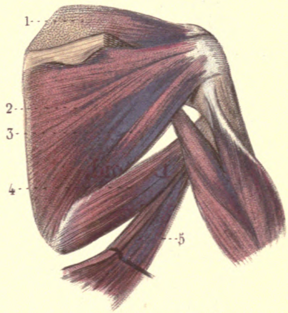


Fig. 3.

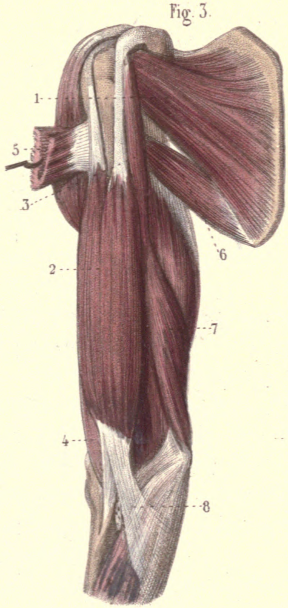
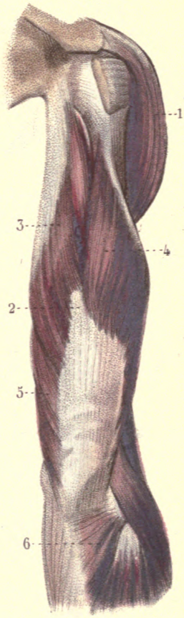


Fig. 4.

Fig. 5.



Léveillé del. *Annedouche sc.*

cartilages, passes upwards and outwards beneath the portion from the clavicle, which passes downwards and outwards; the former is inserted higher, the latter lower, into the outer lip of the bicipital groove of the humerus for its lower two inches.

Three processes are sent off by the tendon, viz., one to the capsule of the shoulder-joint, one to the deltoid insertion, and one to the fascia of the arm.

Nerve.—Anterior thoracic (internal and external branches).

Action.—When the limb is hanging the muscle will draw forwards and rotate inwards the arm. When the limb is raised the muscle depresses, and draws it forwards across the chest. The upper portion of the muscle draws the arm directly across the chest; the lower portion draws it downwards. When the arms are fixed it can raise the trunk, as in climbing; also the arms being fixed, it is a muscle of inspiration, raising the ribs.

Pectoralis Minor. Origin.—Outer surfaces of the third, fourth, and fifth ribs immediately external to the cartilages, and also from the fascia over the external intercostal muscles between these ribs.

Insertion.—By tendon into the anterior border, and part of the upper surface, of the coracoid process.

Nerve.—Internal anterior thoracic.

Action.—Draws the scapula and shoulder forwards. The shoulder being fixed, it raises the upper ribs.

Subclavius. Origin.—By a round tendon from the upper surface of the first rib, at the junction of the bone and the cartilage.

Insertion.—Into a groove on the inferior surface of the clavicle in front of the conoid tubercle.

Nerve.—A branch from the fifth and sixth cervical nerves, which crosses the third part of the subclavian artery.

Action.—Depresses the clavicle, and draws it slightly forwards; it may possibly elevate the first rib.

Serratus Magnus. Origin.—By nine pointed digitations from the eight upper ribs, the second rib having two; some fibres also take origin from the fascia covering the intercostal muscles between the ribs. The lower four digitations interdigitate with similar processes of the external oblique.

Insertion.—Into the posterior border and angles of the scapula in the following manner, viz.: the upper two digitations are inserted into the ventral aspect of the superior angle; the next three (from the second, third, and fourth ribs) are inserted into the anterior lip of the posterior border of the scapula; whilst the remaining (from the fifth, sixth, seventh, and eighth ribs) are inserted into the ventral aspect of the inferior angle of the scapula.

Nerve.—The posterior thoracic (Bell) from the fifth and sixth cervical.

Action.—The whole muscle will lift up and draw forwards the scapula; the upper and lower portions combine with the trapezius in rotating the scapula. When the scapula is fixed the muscle will raise the ribs, and so expand the chest.

The *Trapezius* muscle has its apex at the shoulder, and its base at the spine.

Origin.—(1) Inner third of superior curve of occipital bone; (2) external occipital protuberance; (3) the ligamentum nuchæ; (4) the spine of the seventh cervical vertebra; (5) the spines and supra-spinous ligaments of all the dorsal vertebræ.

Insertion.—(1) Into the posterior border of the outer third of the clavicle; (2) inner border of the acromion; (3) upper lip of the posterior border of the spine of the scapula; (4) the lower fibres are collected into a tendon, which glides over the smooth surface at the apex of the spine of the scapula, and is inserted across the posterior aspect of the spine external to this smooth surface.

Nerves.—Spinal accessory; branches from the cervical plexus of nerves; and branches from the posterior divisions of the cervical and dorsal nerves.

Action.—The whole muscle will draw the scapula towards the spine; the upper portion will draw upwards the scapula and shoulder, the lower draws them downwards. Assisted by the serratus magnus, it rotates the scapula on an axis passing through its centre.

Levator Anguli Scapulæ. *Origin.*—From the posterior tubercles of the transverse processes of the four upper cervical vertebræ.

Insertion.—Posterior lip of the superior angle and the vertebral border of the scapula as low as the apex of the spine.

Nerve.—Branches from the cervical plexus, and from the nerve to the rhomboid muscles.

Action.—Lifts the superior angle of the scapula upwards and inwards, and depresses the acromion; it has largely to do with elevating and shrugging the shoulders. The scapula being fixed, the muscle will incline the neck to the same side.

Rhomboideus Major. *Origin.*—From the spines and supra-spinous ligaments of the six upper dorsal vertebræ, except the first.

Insertion.—Base of scapula from below the apex of the spine to the inferior angle, most of the fibres being inserted into a fibrous arch.

Nerve.—From fifth cervical.

Action.—Draws the scapula upwards and backwards towards the spine depressing the acromion.

Rhomboideus Minor. *Origin.*—(1) Lower inch of ligamentum nuchæ; (2) spines and supra-spinous ligaments of the last cervical, and the first dorsal, vertebra.

Insertion.—The base of the scapula, opposite the apex of the spine.

Nerve.—From fifth cervical.

Action.—Elevates the scapula, and draws it towards the spine.

Latissimus Dorsi. *Origin.*—From the spines and supra-spinous ligaments of the lower six dorsal, all the lumbar, and the upper two sacral, vertebræ; by aponeurosis from the outer lip of the posterior half of the iliac crest; from the lumbar fascia; and by fleshy processes from the outer surface of the three or four lower ribs, interdigitating with the external oblique.

Insertion.—The fibres converge to, and pass over, the inferior angle of the scapula, where sometimes fibres take origin, and curving round to the front of the teres major are inserted by a thin aponeurosis into the bottom of the bicipital groove.

Nerve.—Long subscapular, and branches from the posterior divisions of the spinal nerves.

Action.—The muscle will draw the arm backwards if hanging, and if raised, backwards and downwards, rotating it inwards at the same time. If the arm is fixed, it can elevate the lower ribs and also the trunk, as in climbing.

The *Deltoid* is a triangular-shaped muscle, with its apex downwards, and its base at the shoulder.

Origin.—(1) The inferior lip of the crest of the scapular spine, except the apex; (2) outer and anterior border of acromion; (3) anterior border of outer third of clavicle; (4) the fascia over the infra-spinatus muscle; (5) the acromio-clavicular ligament.

Insertion.—The muscular fibres are attached in a penniform manner to tendinous processes, notably on the anterior and posterior borders, whilst others are in the substance of the muscle; the whole being finally inserted into the deltoid impression on the outer surface of the humerus immediately above the middle of the shaft.

The muscle forms the roundness of the shoulder, and covers the joint, a multilocular bursa being interposed.

Nerve.—Circumflex from the posterior cord.

Action.—Raises the limb at right angles to the trunk; the anterior part draws it forwards, the posterior backwards; and when the arm is fixed, the muscle will draw upwards the trunk as in climbing.

Supra-spinatus. *Origin.*—From the supra-spinous fossa, except at the outer fourth, and from the fascia covering it.

Insertion.—The highest facet on the great tuberosity of the humerus.

Nerve.—Supra-scapular from fifth and sixth cervical.

Action.—Raises the arm to a right angle; it also strengthens the capsule of the shoulder-joint above.

Infra-spinatus. *Origin.*—Infra-spinatus fossa, except the outer fourth; from the lower surface of the spine of the scapula; it also takes origin from the fascia covering the muscle.

Insertion.—The middle facet on the great tuberosity of the humerus; some fibres in both these post-scapular muscles are also inserted into the capsule of the shoulder-joint.

Nerve.—Supra-scapular.

Action.—Raises the limb, rotating it outwards, and drawing it backwards.

Teres Minor. *Origin.*—From the middle third of the axillary border of scapula; from a groove on the dorsal aspect of the same; the fascia covering it; and the intermuscular septa on each side of it.

Insertion.—The lowest facet on the great tuberosity of humerus, and into the outer surface of the humerus below the facet for about an inch, as far in fact as the external head of the triceps.

Nerve.—A branch from the circumflex; it has a ganglionic enlargement upon it.

Action.—Rotates outwards and draws backwards the limb, and depresses the humerus when raised.

Teres Major. *Origin.*—From a rough quadrilateral surface on the dorsal aspect of the inferior angle of the scapula, and from the lower third of the axillary border of the same; also from the fascia covering it and the inter-muscular septa.

Insertion.—Inner lip of the bicipital groove of the humerus for the lower two inches, and partly behind it.

Nerve.—Subscapular (middle branch).

Action.—Rotates the hanging limb inwards and carries it backwards; the raised limb is depressed and adducted. The limb being fixed, it will draw the inferior angle of the scapula forwards.

Subscapularis. *Origin.*—From the venter of the scapula (except at its neck, angles and vertebral border) by tendinous processes from ridges, and fleshy processes between these ridges.

Insertion.—The muscular fibres converge to a tendon which passes in front of and over the shoulder-joint, being separated from it by a bursa communicating with the joint, and is inserted into the lesser tuberosity of the humerus, and into the bone below for about an inch.

Nerve.—Highest and middle subscapular branches from the posterior cord of the brachial plexus.

Action.—Rotates the arm inwards and raises it slightly, and when raised depresses it.

Coraco-brachialis. *Origin.*—From the tip of the coracoid process, in common with the tendon of the short head of the biceps, and also from this tendon for two or three inches.

Insertion.—Inner border and inner surface of the humerus, for one inch and a half, exactly half-way down.

Nerve.—Musculo-cutaneous, which pierces it.

Action.—Raises and flexes the arm; when the humerus is fixed, it draws down the scapula.

Biceps. Origin.—By two heads, long and short; the *long* head arises from the upper border of the glenoid fossa and from the glenoid ligament. Within the capsule of the joint, the round tendon passes over the head of the humerus ensheathed by synovial membrane, and leaves the capsule of the joint by the bicipital groove. The *short* head arises in common with the coraco-brachialis from the tip of the coracoid process. The two heads blend about the middle of the arm, and form a thick fleshy fusiform belly.

Insertion.—By a thick flat tendon into the back part of the base of the radial tubercle, a bursa intervening between the apex of the tubercle and the tendon.

A process of fascia—the bicipital or semilunar fascia—is given off from the tendon to the fascia on the inner side of the forearm; it covers the brachial vessels, and supports the median basilic vein.

Nerve.—Musculo-cutaneous.

Action.—Flexes the elbow, supinates the forearm, and flexes the shoulder-joint. If the arm be fixed, the muscle will draw the scapula away from the thorax. Acting separately the short head flexes, the long head abducts, the arm.

Brachialis Anticus. Origin.—From the internal and external surfaces and anterior border of the lower half of the humerus, extending upwards on each side of the insertion of the deltoid, and downwards to the elbow-joint; for a short distance from the upper part of the external and the whole of the internal intermuscular septa on their anterior aspects.

Insertion.—Inferior surface of the coronoid process of the ulna.

Nerve.—Musculo-cutaneous, and frequently a branch from the musculo-spiral.

Action.—Flexes the elbow-joint.

Triceps. Origin.—By three heads: (1) The middle, or long, head arises from a depression on the upper third of the axillary border of the scapula, *i.e.*, from the facet immediately beneath the glenoid fossa; (2) the external head, from the outer border and posterior surface of the humerus, extending as high as the insertion of the teres minor, as low as the musculo-spiral groove, and also from a fibrous arch stretching across the musculo-spiral groove; (3) the inner head arises from the posterior surface of the humerus, extending upwards as high as the musculo-spiral groove and the insertion of the teres major; also from the whole of the internal and the lower part of the external intermuscular septa on the posterior aspect. The fibres converge to a tendon which is placed centrally and posteriorly.

Insertion.—Into the posterior part of the superior surface of the olecranon process. A bursa intervenes between it and the piece of the olecranon in front. A tendinous slip passes to the fascia of the forearm.

Nerve.—Musculo-spiral, a special branch going to every head.

Action.—Extends the elbow-joint. The long head will adduct the humerus or draw the scapula away from the thorax.

The *Subanconeus* arises from the upper margin of the olecranon fossa, and is inserted into the synovial membrane, or capsule of the elbow-joint.

It is a small uncertain muscle, which pulls the synovial membrane out of the way during extension.

Nerve.—Musculo-spiral.

Pl. 33.

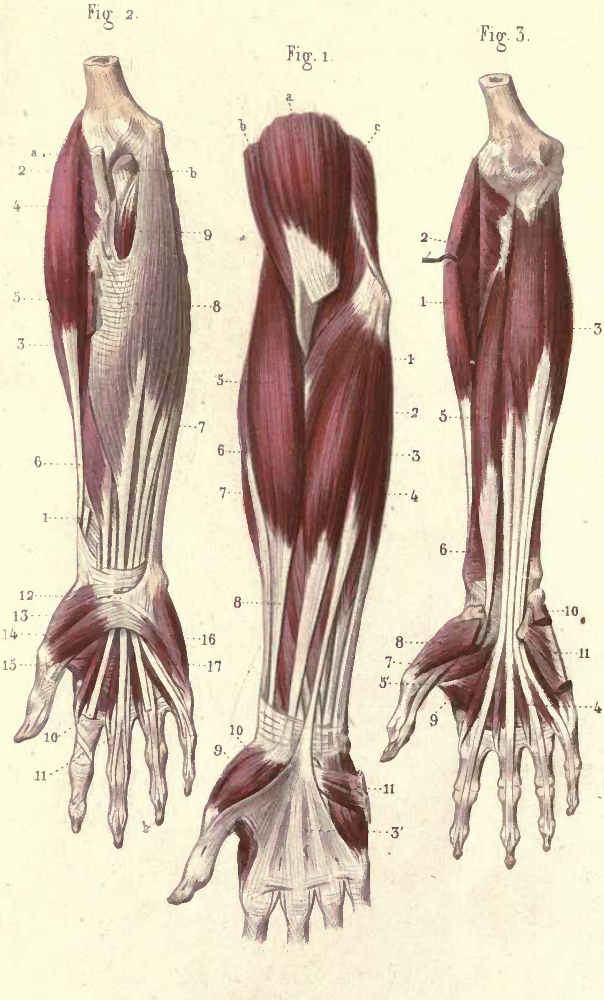


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PLATE XXXIII.

Anterior Muscles of the Forearm and Hand.

Fig. 1.—(*a*) Inferior extremity of the biceps, with the bicipital fascia, cut.—(*b*) Brachialis anticus.—(*c*) Triceps.

1. Pronator teres.—2. Flexor carpi radialis.—3. Palmaris longus, the tendon of which muscle is continuous with—3′. The palmar fascia.—4. Flexor carpi ulnaris.—5. Supinator longus.—6. Extensor carpi radialis longior.—7. Extensor carpi radialis brevior.—8. Flexor sublimis digitorum.—9. Abductor pollicis.—10. Opponens.—11. Palmaris brevis.

Fig. 2.—(*a*) Tendon of biceps.—(*b*) Insertion of brachialis anticus.

1. Tendon of supinator longus, cut.—2. Extensor carpi radialis longior.—3. Extensor carpi radialis brevior.—4. Supinator brevis.—5. Insertion of pronator radii teres.—6. Flexor longus pollicis.—7. Flexor carpi ulnaris.—8. Flexor sublimis digitorum.—9. Division of the heads of origin of this muscle, between which is seen the flexor profundus.—10. Flexor sublimis tendon passing into the digital sheath.—11. Flexor sublimis tendon perforated by the flexor profundus.—12. Anterior annular ligament of carpus.—13. Opponens pollicis.—14. Outer half of flexor brevis pollicis.—15. Adductor pollicis.—16. Abductor minimi digiti.—17. Flexor brevis minimi digiti.

Fig. 3.—1. Extensor carpi radialis brevior.—2. Supinator brevis.—3. Flexor profundus digitorum.—4. Lumbricales.—5. Flexor longus pollicis.—5′. Tendon of this muscle.—6. Pronator quadratus.—7. Inner head of flexor brevis pollicis.—8. Opponens pollicis.—9. Adductor pollicis.—10. Origin of abductor minimi digiti.—11. Opponens minimi digiti.

PLATE XXXIV.

Deep Muscles of Palm of Hand.

Fig. 1.—1. Tendon of flexor longus pollicis, cut.—2. Pronator quadratus.—3. The two heads of the flexor brevis pollicis.—4. Adductor pollicis.—5, 5, 5, 5. The seven interossei muscles. It must be borne in mind that the dorsal interossei are seen cropping up into the palm.

Posterior Muscles of the Forearm and Hand.

Fig. 2.—1. Tendon of extensor carpi ulnaris.—2. Tendon of extensor carpi radialis longior.—3. Tendon of extensor carpi radialis brevior.—4. Extensor secundi internodii pollicis.—5, 5, 5, 5. The four dorsal interossei.—6, 6, 6. The three palmar interossei, the upper part of these muscles being hidden by the dorsal interossei.

Fig. 3.—(*a*) Tendon of triceps.—(*b*) Brachialis anticus.

1. Supinator longus.—2. Extensor carpi radialis longior.—2′. Tendon of this muscle.—3. Extensor carpi radialis brevior.—3′. Its tendon.—4. Extensor ossis metacarpi pollicis.—5. Extensor primi internodii pollicis.—6. Extensor secundi internodii pollicis.—7. Extensor communis digitorum.—8. Extensor minimi digiti.—9. Extensor carpi ulnaris.—10. Anconeus.—11. Tendinous connection between the common extensor tendons.—12. Middle portion of the common extensor tendons.—13, 13. Lateral re-united portions of the same.—14. Expansions of the tendons of the interossei muscles, uniting with the common extensor tendon.

Fig. 4.—1. Anconeus.—2. Origin of extensor carpi radialis longior.—2′. Cut tendon of this muscle.—3. Extensor carpi radialis brevior.—4. Supinator brevis.—5. Extensor ossis metacarpi pollicis.—6. Extensor primi internodii.—7. Extensor secundi internodii pollicis.—8. Extensor indicis.—9. Tendon of common extensor with which it is united.—10. First dorsal interosseus.

Pl. 34.

Fig. 3.

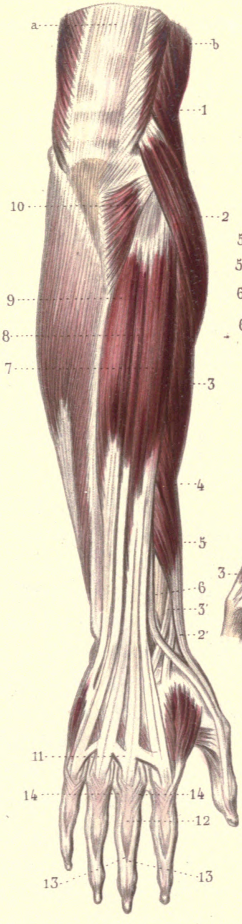


Fig. 2.

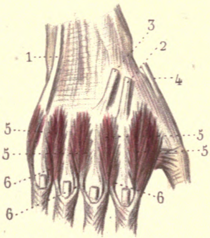


Fig. 1.

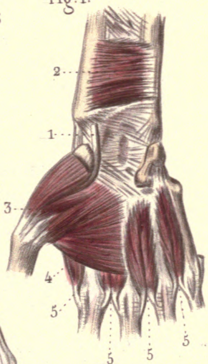
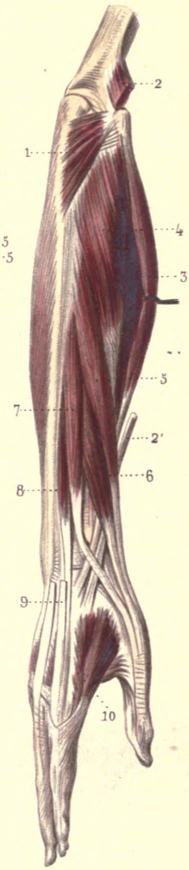


Fig. 4.



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Muscles of Forearm.

Pronator Radii Teres. Origin.—Superficial head (1) Lower end of internal supra-condyloid ridge, and contiguous part of the internal condyle, of the humerus; (2) by the common tendon of the flexor muscles attached to the tip of internal condyle; (3) fascia of the fore-arm and intermuscular septa; *deep head* (4) inner border of the coronoid process of the ulna.

Insertion.—An impression half-way down the outer surface of the radius.

Nerve.—Median. The nerve separates the superficial from the deep head passing between the two.

Action.—Pronates the forearm (and the hand), and flexes the elbow-joint.

Flexor Carpi Radialis. Origin.—Inner condyle of humerus by the common tendon, and from the fascia of the arm and intermuscular septa.

Insertion.—The muscular fibres end in a tendon about the middle of the forearm, which pierces the anterior annular ligament, and passes through a groove in the trapezium, to be inserted into the base of the second metacarpal bone, sending also a slip to the third metacarpal bone.

Nerve.—Median.

Action.—Flexes the wrist, inclining it to the radial side, and also bends the elbow.

Palmaris Longus. Origin.—From the common tendon at the internal condyle, the intermuscular septa, and fascia of the forearm.

Insertion.—The muscle ends in a long tendon, which passes over the annular ligament, and is inserted into the palmar fascia, sending a slip to the muscles of the thumb.

Nerve.—Median.

Action.—Makes tense the palmar fascia, and also assists in flexing wrist and elbow.

Flexor Carpi Ulnaris. Origin.—(1) Inner condyle of humerus; (2) inner border of olecranon (ulnar nerve and inferior profunda artery pass between these two slips of origin); (3) upper three-fourths of the posterior border of the ulna by a common aponeurosis.

Insertion.—Pisiform bone. It also sends slips to the fifth metacarpal bone, the annular ligament, and the muscles of the little finger.

Nerve.—Ulnar.

Action.—Flexes the wrist, and draws the hand to the ulnar side.

Flexor Sublimus Digitorum. Origin.—(1) By the common tendon from the internal condyle of the humerus; (2) intermuscular septa; (3) internal lateral ligament of elbow-joint; (4) inner part of the internal aspect of the coronoid process; (5) oblique line of radius, and anterior border of the radius below this for about two inches.

Insertion.—The muscle ends in four tendons, which pass beneath the anterior annular ligament in pairs, the two for the ring and middle fingers being anterior, and the two for the index and little fingers being posterior. In the palm of the hand the tendons diverge, each one entering the sheath of its corresponding finger, and opposite the first phalanx splits to permit the passage of the deep flexor tendons. From the inner border of each division a process is given off, and these, uniting beneath the deep flexor tendon, form a sort of pulley, over which the tendon glides. Finally, these united divisions again separate, and are inserted into the lateral borders of the second phalanx near the base.

Nerve.—Median.

Action.—Bends the middle phalanx, and acting further, will flex the metacarpo-phalangeal and wrist joints. It also flexes the elbow-joint.

Flexor Profundus Digitorum. Origin. — (1) Inner aspect of olecranon; (2) upper three-fourths of the anterior and inner surfaces of the shaft of the ulna; (3) for a corresponding distance from the interosseous membrane; (4) by an aponeurosis (common to it and the extensor and flexor carpi ulnares) from the posterior border of the ulna.

Insertion.—The muscle ends in four tendons, the one for the index-finger being first separated; they pass under the annular ligament, diverging in the palm of the hand; each tendon enters the sheath of its own finger, and, after passing through the opening in the superficial flexor, is inserted into the base of the terminal phalanx on its palmar aspect. The flexor tendons (superficial and deep) are bound down to the phalanges by the *ligamenta vaginalia*, and are attached to the floor of the sheath by a process of synovial membrane, the *vincula accessoria* or *vasculosa:* each tendon is also bound down to the head of the phalanx behind the one into which it is inserted by the *ligamenta brevia.*

Nerve.—From two sources—outer half of the muscle from the anterior interosseous from the median, the inner half from the ulnar.

Action.—Flexes the distal phalanges after the second have been bent by the superficial flexor; acting further, it will flex the second and first phalanges, and also the wrist.

The *Lumbricales* are four fleshy slips connected with the deep flexor tendons in the palm of the hand.

Origin.—The first two arise from the radial sides of the tendons of the index and middle fingers; the third takes origin from the contiguous sides of the tendons of the middle and ring fingers; and the fourth from the contiguous sides of the tendons of the ring and little fingers.

Insertion.—Each muscle ends in a small tendon, which is directed to the radial side of the corresponding digit, and takes part in forming the aponeurotic expansion of the extensor tendons (q.v.)

Nerves.—The first and second lumbricales are supplied by the median; the third and fourth by the deep part of the ulnar nerve.

Action.—Flexors of the metacarpo-phalangeal articulations.

Flexor Longus Pollicis. Origin.—(1) From the anterior surface of the radius, extending upwards as high as the oblique line, and downwards as low as the pronator quadratus; (2) from a corresponding extent of the outer half of the interosseous membrane; (3) by an occasional head from the outer border of the coronoid process of the ulna.

Insertion.—The muscle ends in a tendon which passes beneath the anterior annular ligament, and then between the two heads of the flexor brevis pollicis to be inserted into the palmar aspect of the base of the distal phalanx of the thumb.

Nerve.—Anterior interosseous—a branch of the median.

Action.—Flexor of the thumb; it can also flex the wrist.

Pronator Quadratus. Origin.—Lower two inches of the anterior border, and the anterior surface of ulna. The muscle is nearly square; its lower border, however, has an inclination downwards.

Insertion.—Lower two inches of the anterior surface of the radius.

Nerve.—Anterior interosseous (a branch of the median).

Action.—Pronator of the forearm and hand.

All the preceding muscles, except the inner half of the flexor profundus digitorum and the flexor carpi ulnaris and the two inner lumbricales, are supplied by branches of nerve from the median and anterior interosseous—a branch of the median.

Muscles of the Hand.

Palmaris Brevis.—A subcutaneous muscle two inches wide.

Origin.—From inner part of palmar fascia.

Inserted into skin at the inner border of the hand.

Nerve.—Ulnar.

Action.—Draws outwards the skin, and deepens the palm.

Abductor Minimi Digiti.—The most superficial of the group.

Muscles of the Hypothenar Eminence.

Origin.—Pisiform bone, and tendon of flexor carpi ulnaris.

Insertion.—Ulnar side of base of proximal phalanx of little finger.

Nerve.—Ulnar.

Action.—Abducts and flexes little finger at the metacarpo-phalangeal-joint.

Flexor Brevis Minimi Digiti. *Origin.*—From the tip of the unciform hook and the annular ligament.

The muscle is frequently absent; it is separated from the abductor by the deep branch of the ulnar artery and nerve.

Insertion.—With the abductor into the base of the first or proximal phalanx.

Nerve.—Ulnar.

Action.—Flexes the metacarpo-phalangeal joint of this finger, and draws the little finger towards the palm of the hand.

Opponens (or *Adductor*) *Minimi Digiti.* *Origin.*—Inferior border of the unciform hook and annular ligament.

Insertion.—Ulnar side of the shaft of the fifth metacarpal bone.

Nerve.—Ulnar.

Action.—Adducts and draws the little finger towards the palm.

The INTEROSSEI MUSCLES are seven in number—four dorsal and three palmar. Placed between the metacarpal bones, they fill up the spaces between these bones, and are numbered from without inwards.

Palmar.—*First:* arises from the ulnar side of the shaft of the second metacarpal bone, and is inserted into the ulnar side of the base of first phalanx of the index-finger and the dorsal expansion of extensor tendon.

Second: arises from the radial side of fourth metacarpal bone, and is inserted into the radial side of the base of the proximal phalanx of the ring-finger and dorsal expansion.

Third: arises from the radial side of the fifth metacarpal bone, and is inserted into the first phalanx (base and radial side) of the little finger and dorsal expansion.

Action.—Adduct the fingers, viz. second, fourth, and fifth, to the middle line of the hand; they also assist in flexion of the first phalanges at the metacarpo-phalangeal joint, at the same time extending the last two phalanges.

Dorsal.—Each muscle arises from the contiguous sides of the metacarpal bones on the dorsal aspect, and is inserted by tendon into the bases of the proximal phalanges and dorsal expansion in the following manner, viz.:

First: takes origin from the contiguous sides of the first and second metacarpal bones, and is *inserted* into the index-finger; it is named the *abductor indicis.*

Second: arises from the contiguous sides of the second and third metacarpal bones, and is *inserted* into the radial side of middle finger.

Third: arises from the third and fourth metacarpal bones, and is *inserted* into the ulnar side of the middle finger.

Fourth: arising from the fourth and fifth metacarpal bones, is *inserted* into the ulnar side of the ring-finger.

Between the heads of each dorsal interosseous muscle pass the perforating arteries, except the first, where the radial artery passes to the palm of the hand.

Nerves.—All the interossei (dorsal and palmar) are supplied by the ulnar nerve (deep branch).

Action (Dorsal).—Abduct the second and fourth finger from the middle line of the hand; and, through their connection with the extensor dorsal expansion, flex the first phalanges, and extend the two last.

Muscles of the Thenar Eminence.

The *Abductor Pollicis* is the most superficial of the group.

Origin.—The ridge of the os trapezium and the anterior annular ligament.

Insertion.—Radial side of the base of the proximal phalanx of the thumb.

Nerve.—Median.

Action.—Abducts the thumb, and slightly flexes the first phalanx.

The *Opponens Pollicis* is mostly concealed by the preceding muscle.

Origin.—The ridge of the os trapezium and annular ligament.

Insertion.—Into the whole length of the anterior surface and outer border of the shaft of the first metacarpal bone.

Nerve.—Median.

Action.—Flexes the thumb at the carpo-metacarpal joint, drawing it across the palm of the hand.

The *Flexor Brevis Pollicis* consists of two parts: a superficial or external, and deep or internal; the tendon of the long flexor passes between the two heads.

Origin.—The *outer* head arises from the ridge of the trapezium, and from the annular ligament. The *inner* head arises from the (1) os magnum; (2) trapezoid bone; (3) bases of the second and third metacarpal bones; (4) and from the insertion of the flexor carpi radialis.

Insertion.—By two tendons (in each of which a sesamoid bone is developed): the outer, into the outer side of the base of the first phalanx with the abductor; the inner, into the inner side of the same with the adductor.

Nerve.—Outer head median; inner head ulnar.

Action.—Flexes the thumb at the metacarpo-phalangeal joint, drawing it also forwards and inwards.

The *Adductor Pollicis* is a triangular-shaped muscle, and the deepest of the thumb-muscles.

Origin.—From the middle two-fourths of the anterior surface of the shaft of the third metacarpal bone.

Insertion.—The inner side of the base of the first phalanx of the thumb.

Nerve.—Ulnar.

Action.—Draws the thumb inwards, approximating it to the fingers.

Muscles supplied by Musculo-Spiral Nerve.

Supinator Longus. *Origin.*—From the upper two-thirds of the external supra-condyloid ridge of the humerus, extending up as high as the insertion of the deltoid; also from a corresponding extent of the external intermuscular septum. The muscle is superficial, and ends in a long tendon one-third of the distance down the forearm.

Insertion.—Into a ridge at the outer aspect of the radius at the base of the styloid process.

Nerve.—Musculo-spiral.

Action.—Chiefly flexes the elbow-joint; but will also bring the hand into a position midway between pronation and supination. Further, it will bring up the humerus in climbing.

Extensor Carpi Radialis Longior. *Origin.*—From the lower third of the external supra-condyloid ridge of the humerus, and from the external intermuscular septum on its anterior aspect. The muscle is concealed by the supinator longus, and its tendon passes through the same compartment in the annular ligament as the brevior.

Insertion.—Base of second metacarpal bone, a bursa intervening.

Nerve.—Branch from musculo-spiral.

Action.—Extends the wrist, slightly supinates, and also flexes the elbow.

The *Anconeus* is a small triangular muscle in a line with the lower border of the triceps.

Origin.—From the posterior aspect of the external condyle of humerus, internal to, and separate from, the common tendon.

Insertion.—Outer side of olecranon and the upper third of the posterior surface of the ulna, as far down as the oblique line.

Nerve.—A long slender branch from the musculo-spiral, which passes through the substance of the triceps.

Action.—Extends the elbow-joint.

Muscles on the Back of the Forearm supplied by Posterior Interosseous Nerve.

Extensor Carpi Radialis Brevior. *Origin.*—From the external condyle of the humerus by the common extensor tendon, and also from the capsular ligament of the elbow-joint. The muscle is concealed by, and passes through the second compartment in the annular ligament in common with, the long extensor of the carpus.

Insertion.—Base of metacarpal bone of middle finger, a bursa intervening.

Nerve.—Posterior interosseous.

Action.—Extends the carpus, and assists slightly in producing supination.

Extensor Communis Digitorum. Origin.—From the posterior aspect of the external condyle of the humerus by the common tendon, also from the fascia of the forearm, and from the intermuscular septa.

Insertion.—The muscle ends in three tendons, which pass beneath the posterior annular ligament; the innermost tendon then divides into two, one going to the ring-finger, the other going to the tendon of the extensor minimi digiti. The outermost tendon is joined by the tendon of the extensor indicis. Finally each tendon forms an expansion on the dorsum of the first phalanx, which is joined by the tendons of the lumbricales and the interossei. This expansion then divides into three portions, the central one being inserted into the base of the second phalanx, and the two lateral portions uniting to form one is inserted into the base of the distal phalanx. Opposite each of the phalangeal joints a process is given off to join the capsular ligament of these joints. Lateral vincula join the tendons on the dorsum of the metacarpus; those connecting the ring and little finger and the ring and middle finger being so strong that it is impossible to extend the ring-finger when the little and middle fingers are flexed.

Nerve.—Posterior interosseous.

Action.—The muscle extends the fingers, separating them at the same time from each other. Acting further, it can extend the wrist and elbow-joints.

Extensor Minimi Digiti. Origin.—In common with the preceding from the external condyle, also from the fascia of the forearm and intermuscular septa.

Insertion.—The muscle ends in a tendon, which passes through a separate compartment of the annular ligament, and is inserted into the dorsal expansion of the little finger.

Nerve.—Posterior interosseous.

Action.—Extends the little finger, the wrist, and elbow; it can act when the other fingers are flexed.

Extensor Carpi Ulnaris. Origin.—From the external condyle by the common tendon, the fascia of the forearm, and the intermuscular septa; it also takes origin by the common aponeurosis from the upper three-fourths of the posterior border of the ulna.

Insertion.—The muscle ends in a tendon, which passes through the most internal canal beneath the annular ligament, and is inserted into the base of the metacarpal bone of the little finger on its dorsal surface.

Nerve.—A branch from the posterior interosseous.

Action.—Extends the wrist-joint, inclining the hand towards the ulnar side. It also aids in extending the elbow-joint.

The *Extensor Ossis Metacarpi Pollicis* is placed beneath the superficial muscles, and below the supinator brevis; the posterior interosseous artery separating the ossis from the brevis.

Origin.—(1) From the outer division of the posterior surface of the ulna below the oblique line on this surface, for three inches or more; (2) the posterior surface of the radius below the supinator brevis, for the same distance; (3) between these two bones, from the interosseous membrane.

The muscle ends in a tendon, which passes through the outermost compartment of the posterior annular ligament.

Insertion.—Into the outer surface of the base of the metacarpal bone of the thumb, sending a slip also to the os trapezium.

Nerve.—The posterior interosseous.

Action.—Extends and abducts the thumb, and also the hand at the wrist-joint.

The *Extensor Primi Internodii Pollicis* is closely connected with the preceding muscle, below which it is placed, and having the same relations to the parts around.

Origin.—From the posterior surface of the radius near its middle, and for a corresponding extent from the interosseous membrane. The tendon of the muscle passes through the same compartment in the annular ligament as the ossis.

Insertion.—Into the base of the first phalanx of the thumb.

Nerve.—Posterior interosseous.

Action.—Extends the proximal phalanx and then the wrist.

Extensor Secundi Internodii Pollicis. *Origin*—From the outer division of the posterior surface of the ulna in its middle third, for three or four inches, and about one inch of the interosseous membrane, below the extensor ossis. The tendon passes by itself through the third compartment in the posterior annular ligament.

Insertion.—The base of the terminal phalanx of the thumb.

Nerve.—Posterior interosseous.

Action.—Extends the distal phalanx of the thumb and the wrist.

Extensor Indicis. *Origin.*—From the outer division of the posterior surface of the ulna below the extensor secundi internodii pollicis, and also from the adjacent piece of the interosseous membrane.

Insertion.—The muscle ends in a tendon, which passes through the compartment in the annular ligament, which transmits the extensor communis digitorum, and, blending with the outermost tendon of this muscle, is inserted in the manner already described.

Nerve.—Posterior interosseous.

Action.—Extends the fore-finger and also the wrist. It can point this finger when the others are flexed, and also draw it towards the other fingers.

The *Supinator (Radii) Brevis* surrounds for the most part the upper third of the radius.

Origin.—(1) From the external lateral ligament of the elbow; (2) the orbicular ligament of the radius; (3) a rough depression below the lesser sigmoid cavity of the ulna; and (4) from the ridge of the external or interosseous border of the ulna, below the sigmoid cavity for the distance of two inches.

Insertion.—The upper fibres embrace the neck of the radius except at its inner side; the fibres next below are inserted into the borders of the radial tubercle; whilst the remainder are inserted into the outer and upper aspects of this bone as far down as the insertion of the pronator teres, as far forward as the anterior oblique line, and as far back as the posterior oblique line.

Nerve.—Posterior interosseous, which pierces it.

Action.—Supinates the radius after it has been pronated.

The muscles on the back of the forearm are divided into superficial and deep. The *superficial* are from without inwards: Supinator longus, two radial extensors of the wrist, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, and a small muscle, the anconeus. The *deep* muscles are: Supinator brevis, three extensors of the thumb, and extensor indicis.

Muscles of the Male Perineum, Urethra and Anus.

External Sphincter Ani.—An elliptical muscle surrounding the anus immediately beneath the skin.

Origin.—By tendon from the back of the tip of the coccyx, and from the tissues on either side for the distance of ½ inch. The fibres pass around the anus, some decussating in front of it.

Insertion.—Central tendinous point of the perineum and the fascia on either side.

Nerve.—A branch from the fourth sacral, and another from the anterior superficial perineal branch of the pudic.

Action.—Closes the anus.

The *Corrugator Cutis Ani* is the name given by Ellis to a few involuntary fibres radiating from the anus, and attached inside the external sphincter to the skin.

The *Internal Sphincter Ani* is a layer of involuntary muscular fibres, about half an inch in depth, surrounding the lower part of rectum.

The *Levator Ani* is a thin, broad muscle, forming a sort of diaphragm, supporting the viscera at the lower part of the abdomen, and completing the closure of the outlet of the pelvis.

Origin.—(1) From an oblique line on the posterior surface of the pubis; (2) slightly from the posterior surface of the deep layer of the triangular ligament; (3) internal surface of the spine of the ischium; (4) between these two bony points, from the place of division of the pelvic fascia—the white line.

Insertion.—The fibres pass downwards and inwards, and are inserted as follows, viz.: (1) the posterior to the tip of the coccyx; (2) between the tip of the coccyx and the rectum the fibres meet in a median raphé; (3) the middle fibres blend with the side of the rectum; (4) in front of the rectum into the median raphé; (5) whilst the most anterior fibres, meeting beneath the prostate gland, form the *levator prostatæ* muscles.

Nerve.—From three sources: (1) a small branch from the lower part of sacral plexus; (2) a branch from the fourth sacral; (3) a few twigs from the superficial perineal nerve.

Action.—Elevates and inverts the lower part of rectum after the expulsion of fæces.

Urethral Muscles.

The *Erector Penis* surrounds the crus penis.

Origin.—From the inner surface of the ischial ramus below the attachment of the crus penis.

Insertion.—By an aponeurotic expansion into the outer and under surfaces of the crus penis.

Nerve.—The perineal from the pudic.

Action.—Constricts the crus penis.

Transversus Perinæi. *Origin.*—Inner side of ischial ramus internal to the erector penis.

Insertion.—Passes forwards to the central tendinous point.

Nerve.—A branch from the perineal nerve.

Action.—Makes tense the central tendinous point of the perineum.

Accelerator Urinæ. *Origin.*—Median raphé, and central tendinous point of perineum. The muscle is thin, and conceals the bulbous portion of the urethra for a distance of two inches.

Insertion.—The fibres are directed outwards and forwards, the posterior being inserted into the triangular ligament; the middle surround the bulb of the urethra for about two inches, and meet with those of the opposite side on the superior surface of this portion of the penis; whilst the anterior surround the whole penis, and are partly inserted into the outer aspect of the crura, and partly into an expansion over the dorsum of the penis, which compresses the dorsal vessels.

Nerve.—The perineal from the pudic.

Action.—Compresses the urethra, ejects its contents, and supports the penis in erection.

Constrictor, or Compressor Urethræ. Origin.—By aponeurotic fibres from the ischial ramus, between the two layers of the triangular ligament, and also from the ligament itself.

Insertion.—The fibres pass inwards and surround the membranous portion of the urethra.

Nerve.—The perineal.

Action.—Compresses the membranous portion of the urethra, and expels the contents therefrom.

The *Deep Transversus Perinæi* is a thin band of muscular fibres found between the layers of the triangular ligament concealing Cowper's gland.

It arises from the ramus of the ischium, and is inserted with its fellow into the central point of the perineum.

Probably it is only a well-developed portion of the compressor muscle.

Perineal Muscles in the Female.

The perineal muscles in the female differ from those of the male in the absence of the *Accelerator Urinæ* and the *Compressor Urethræ;* a rudimentary compressor is frequently found.

The *Levator Ani* embraces a part of the vagina.

The *Erector Clitoridis* is very small as compared with the erector penis.

The *Sphincter Ani* and *Transverse Perinæi* (superficial and deep) are the same as in the male.

The *Sphincter Vaginæ* is a special muscle, morphologically related to the accelerator urinæ.

Origin.—Behind from the central point of the perineum, some fibres being continuous with the sphincter ani; it surrounds the vaginal orifice and vestibule and covers the bulbi vestibuli and erectile tissue.

Insertion.—The muscles are inserted upon the clitoris, and slightly into the triangular ligament.

Nerve.—The perineal.

Action.—To constrict the vaginal orifice.

PLATE XXXV.

Muscles of the Gluteal Region, Pelvis, and back of Thigh.

Fig. 1. Sartorius.—2. Gracilis.—3. Semi-tendinosus. The semi-membranosus is seen between the two latter muscles.

Fig. 2.—1. Gluteus maximus.—2. Aponeurosis covering the gluteus medius (derived from fascia lata).—3. Origins of ham-strings.—4. Vastus externus.

Fig. 3.—1. Origin of gluteus maximus.—1′. Its insertion.—2. Great sacro-sciatic ligament.—3. Gluteus medius.—4. Pyriformis.—5. Obturator internus, its tendon passing between the two gemelli.—6. Quadratus femoris.—7. Upper part of semi-tendinosus, cut.—7′. Its inferior part.—8. Biceps.—10. Part of adductor magnus.—11. Part of gracilis.—12, 12, Gastrocnemius.

Fig. 4.—1. Gluteus minimus.—2. Gemellus superior—3. Obturator internus.—4. Gemellus inferior.—5. Insertion of gluteus maximus.—6. Origin of short head of biceps, cut.—7. Vastus externus.—8. Adductor magnus.—9. Gracilis.—10, 10, 10. Foramina for perforating arteries.

The *Gluteus Maximus* is a quadrilateral-shaped muscle of enormous size and thickness, belonging to the post-pelvic region.

Origin.—From (1) the triangular surface at the upper and back of the outer surface of the ilium, above the superior curved line; (2) from the sacro-iliac ligament; (3) from the lateral aspect of the last two pieces of the sacrum; (4) from the side of the coccyx; and (5) from the great sacro-sciatic ligament. The muscular fibres pass outwards, and slightly downwards across the buttock.

Insertion.—The upper two-thirds of the muscle are inserted into the fascia lata (ileo-tibial band); the lower third into the line leading from the linea aspera to the great trochanter. Of the lower third the lowest fibres are also inserted into fascia.

Nerve.—Inferior gluteal from the small sciatic.

Action.—Extensor of the hip joint; also an external rotator. Its most important action is to extend the trunk on the thigh when the lower limbs are fixed. It is the chief means by which the body is brought into and maintained in the erect position.

The *Gluteus Medius*, a triangular-shaped muscle, is situated for

Pl. 35.

Fig. 3.

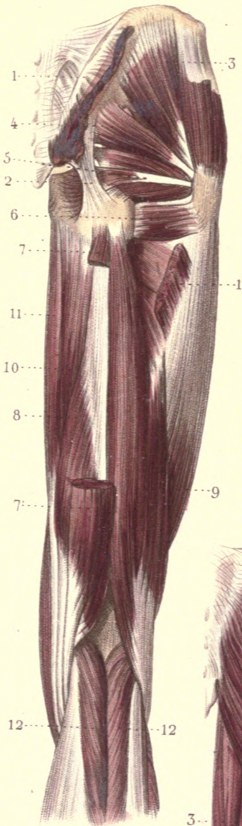


Fig. 1.

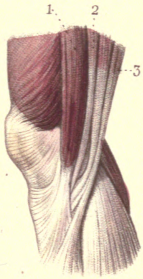


Fig. 4.

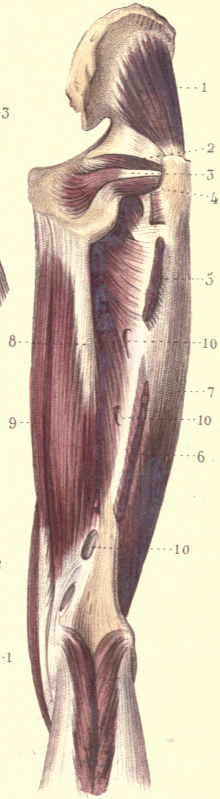
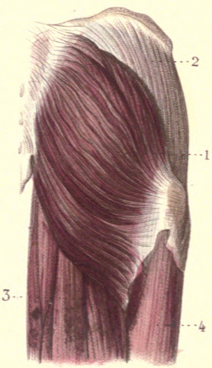


Fig. 2.



Léveillé del.

Lebrun sc.

the most part beneath the maximus, but comes slightly further forwards.

Origin.—From the falciform-shaped surface on the dorsum of the ilium, between the superior curved line and the outer lip of the crest of the ilium above, and the middle curved line below. It comes as far forward as two inches behind the anterior superior spine of the ilium.

Insertion.—Into the diagonal line on the great trochanter, which runs from the posterior superior to the anterior inferior angle.

Nerve.—The superior gluteal from the lumbo-sacral cord.

Action.—The central fibres abduct; the anterior fibres rotate the limb inwards; the posterior fibres rotate the limb outwards.

Gluteus Minimus.—Situated deeply to, but slightly further forwards than, the medius.

Origin.—From the dorsum of the ilium from a quadrilateral-shaped surface, bounded by the middle curved line and a part of the iliac crest above, and the inferior curved line below.

Insertion.—Into the anterior aspect of the great trochanter.

Nerve.—As for the medius.

Action.—As the medius; only from the fact of its coming further forwards, it has a stronger action in producing internal rotation.

Pyriformis.—A pear-shaped muscle, arising in the pelvis and passing out through the great sacro-sciatic foramen.

Origin.—(1) From the lateral part of the anterior aspects of the second, third and fourth sacral vertebræ; (2) from the ridges between the various anterior sacral foramina; (3) from the lateral mass of the sacrum; and (4) from the great sacro-sciatic ligament. Emerging from the pelvis the fibres converge to a tendon.

Insertion.—Into the upper border of the great trochanter immediately in front of the tip, *i.e.*, the posterior superior angle.

Nerve.—Branches of sacral plexus.

Action.—An external rotator.

Obturator Internus.—Arising within the pelvis this muscle emerges through the lesser sacro-sciatic foramen, where it is joined by the two gemelli.

Origin.—(1) From the inner aspect of the obturator membrane; (2) from the bone external to the foramen, reaching as high as the pelvic brim, as low as the ischial tuberosity, and as far back as the sacro-iliac synchondrosis; (3) from the fasciæ covering it—the pelvic and obturator; and (4) from the fascia protecting the obturator vessels and nerves. The muscle converges to a set of tendons (multipenniform) which pass through the lesser sacro-sciatic foramen, and there meet the gemelli. The *Gemellus Superior* arises from the outer surface of the ischial spine. The *Gemellus Inferior* arises from above the outer lip of the ischial tuberosity. Both muscles join the tendon of the obturator internus.

Insertion.—Into the inner aspect of the great trochanter between the tip and the pit, *i.e.*, the posterior superior angle and the digital fossa or pit.

Nerve.—Special branch from the sacral plexus. The gemelli are supplied by separate branches from the sacral plexus; the gemellus superior by a special branch from the sacral plexus; the gemellus inferior by a nerve from the sacral plexus, common to it, and the quadratus femoris; both the nerves find their way out of the great sacro-sciatic foramen, the latter nerve passing beneath the tendon of the obturator internus.

Action.—External rotation of the lower limb.

Quadratus Femoris.—This muscle seems to be a piece of the adductor magnus, separated by the trochanter minor.

Origin.—From the external aspect of the tuberosity of the ischium, from whence it passes horizontally outwards.

Insertion.—The linea quadrata on the back of the great trochanter.

Nerve.—Special branch from the sacral plexus to this muscle and the gemellus inferior (q.v.).

Action.—External rotation.

Tensor Vaginæ Femoris. Origin.—From the outer lip of the crest of the ilium for a distance of two inches behind the anterior superior spinous process. The muscle passes straight downwards for a distance of three or four inches between the layers of the fascia lata, ending in front of great trochanter.

Insertion.—Into the fascia lata, and especially into that part called the ilio-tibial band.

Nerve.—Superior gluteal.

Action.—By rendering tense the piece of fascia into which the gluteus maximus is inserted, it acts as a dependant of that muscle, supplying a fixed point for its action; it also gives lower down a fixed point of origin to the vastus externus.

Pl. 36.

Fig. 2.

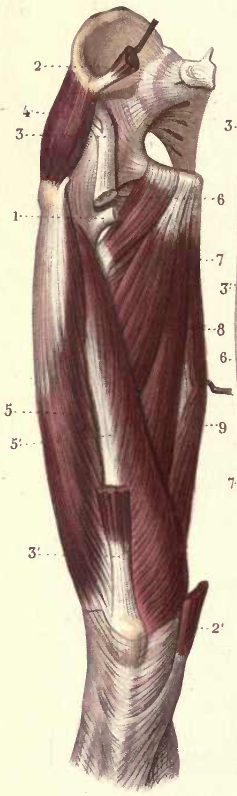


Fig. 1.

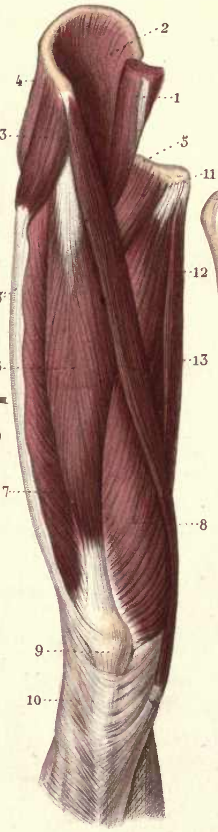


Fig. 3.

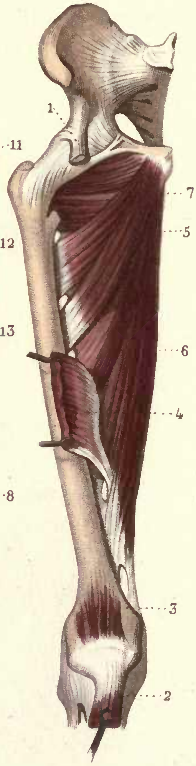


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PLATE XXXVI.

Anterior and Internal Muscles of the Thigh.

Fig. 1.—1. Psoas magnus.—2. Iliacus internus.—3. Tensor fasciæ, or tensor vaginæ, femoris.—3′. Fascia lata, into which this muscle is inserted.—4. Gluteus medius.—5. Sartorius.—6. Rectus femoris.—7. Vastus externus.—8. Vastus internus.—9. Patella.—10. Aponeurosis of knee.—11. Pectineus.—12. Adductor longus.—13. Gracilis.

Fig. 2.—1. Tendon common to the iliacus and psoas.—2. Origin of sartorius, cut and turned up.—2′. Insertion of this muscle.—3. Double origin of rectus femoris.—3′. Insertion of this muscle.——4. Anterior part of gluteus medius.—5.—Vastus externus (the external part of the quadriceps extensor).—5′. Vastus internus (the internal part of the quadriceps extensor).—6. Pectineus.—7. Adductor longus.—8. Adductor magnus.—9. Gracilis.

Fig. 3.—1. Origin of rectus femoris.—2. Insertion, cut and turned down.—3. Sub-crureus.—4. Insertion of adductor longus.—5. Adductor brevis.—6. Adductor magnus.—7. Obturator externus.

Muscles of the Front of the Thigh, supplied by the Anterior Crural Nerve.

Sartorius.—A long thin muscle extending the entire length of the thigh from the pelvis to the tibia.

Origin.—From the anterior superior spinous process of the ilium, and from an inch of the notch below. The muscle passes across the thigh to the inner side, from whence it descends along the posterior part of the inner side of the knee to the tibia.

Insertion.—Into the inner surface of the tibia on a level with, but one inch behind, the tubercle of the tibia.

Nerve.—Branches of the middle cutaneous and internal saphenous. Both nerves pierce it, one above and one below.

Action.—Flexion of both the hip and knee joints, producing at the same time abduction of the knee when bent.

Psoas. Origin.—(1) From the upper and lower borders of the vertebræ from the last dorsal to the fifth lumbar; (2) from the intervertebral substances; (3) from the fibrous arches protecting the lumbar vessels as they pass along the sides of the bodies of the vertebræ; and (4) from the anterior aspects of the transverse processes of the lumbar vertebræ. The muscle passes downwards and outwards along the pelvic brim to beneath Poupart's ligament.

Insertion.—Into the lesser trochanter, just beyond the tip, in common with the iliacus.

Nerve.—Branches from the lumbar nerves and the anterior crural.

Action.—Flexes the hip and rotates the lower limb outwards.

The *Psoas Parvus* (when present) *arises* from the last dorsal and first lumbar vertebræ and the intervertebral substance between them. From hence it passes downwards in front of the psoas, and gradually gaining its inner side is *inserted* into the brim of the true pelvis. Only the upper three inches are muscular; the lower part is a flattened tendon.

Iliacus, or iliacus internus as it was so called to distinguish it from the glutei, the old name of which was the Iliaci externi.

Origin.—(1) From the posterior two-thirds of the iliac fossa and the fascia covering it; (2) from the ilio-lumbar ligament; (3) from the lateral mass of the sacrum; and (4) from the capsule of the hip joint. The muscle passes down beneath Poupart's ligament external to the psoas.

Insertion.—Into the lesser trochanter, just beyond the tip, in common with the iliacus.

Nerve.—Branches from the anterior crural, one inside and one outside the pelvis.

Action.—Flexion of the hip-joint and rotation outwards of the lower extremity.

The *Quadriceps Extensor* consists of the following muscles: the rectus, the vastus externus, the vastus internus, the crureus and the subcrureus.

Rectus Femoris.—A long fusiform-shaped muscle with its fibres arranged in a bipenniform fashion.

Origin.—By two heads; the straight, or inner, from the outer aspect of the lesser trochanter; the reflected, or outer, from just above the highest point of the acetabulum. The two consist of stout tendinous substance, and soon unite, only admitting the blade of a forceps between the heads. The muscle descends straight down the front of the thigh.

Insertion.—Into the upper border or base of the patella; at the lower end the vasti blend with its tendon.

Nerve.—Anterior crural.

Action.—An extensor of the leg and a flexor of the thigh.

Vastus Externus.—This muscle covers over the outer half of the femur, all the way from the upper to the lower end.

Origin.—From the anterior and lower borders of the great trochanter, and from the outer lip of the line leading from the linea aspera to the great trochanter, and from the outer lip of the linea aspera itself for half its extent. The aponeurosis derived from the fascia lata, and the ilio-tibial band spread over its surface and give origin to its fibres. The fibres pass downwards and inwards.

Insertion.—Into the outer side of the rectus tendon, the patella, and the fascia around the knee.

Nerve.—Anterior crural.

Action.—An extensor of the leg.

Vastus Internus and Crureus surround the femur entirely; only a small part, viz., that corresponding to the internal border of the femur, does not give origin to these muscles. On the bare internal border descends the nerve to the subcrureus.

Vastus Internus.—Origin from the inner aspect of the line leading from the linea aspera to the front of the great trochanter—the spiral line; from the inner lip of the linea aspera; from the line leading from the linea aspera to the inner condyle; and from the internal surface of the femur. The internal intermuscular septum also affords a large point of attachment.

Insertion.—The fibres terminate on the inner side of the rectus tendon, the patella, and the fascia lata, over the front and inner side of the knee.

Nerve.—Anterior crural. The branch descends in Hunter's canal.

Action.—Extensor of the leg.

Crureus. Origin.—From the anterior and outer aspects of the femur for the entire length of the shaft; and from the linea aspera below where the vastus externus ceases to arise.

Insertion.—By fleshy fibres into the upper border and sides of the patella, blending inseparably with the vasti.

Nerve and *action* as for the vasti.

Subcrureus.—Arises by two small bundles of fibres from the front of the femur three inches above its lower articular surface. It goes downwards to be inserted into the synovial membrane of the knee joint, the fibres spreading out over its upper end.

Nerve.—A special branch from the anterior crural found between vastus internus and crureus.

Action.—It pulls the synovial membrane up out of the way, so that it shall not get nipped during sudden extension.

THE ADDUCTOR MUSCLES, SUPPLIED BY THE OBTURATOR NERVE.

Gracilis lies on the inner aspect of the thigh, covering over the inner border of the adductor muscles.

Origin.—From the margin of the perineal aspect of the innominate bone, from half-way down the symphysis to half-way down the ramus of the pubes and ischium.

Insertion.—Into the inner surface of the tibia at its upper part, behind the tubercle of the tibia, and under cover of the sartorius.

Nerve.—Superficial branch of the obturator.

Action.—Adductor of the limb; and an internal rotator of the leg when the knee is flexed.

Pectineus.—A quadrangular muscle, placed on the inner side of the hip-joint.

Origin.—From the triangular surface on the upper aspect of the horizontal ramus of the pubes, bounded internally by the pubic spine, posteriorly by the ilio-pectineal line, and externally by the pectineal eminence.

Insertion.—Into the line leading from the linea aspera to the lesser trochanter, and slightly behind that prominence.

Nerve.—Accessory obturator or superficial obturator when the former is absent; also by a branch from the anterior crural, which reaches the muscle behind the common femoral vessels.

Action.—Flexor and adductor of the thigh.

Adductor Longus.—The most anterior of the three adductors.

Origin.—From a triangular surface above a line drawn from the pubic spine to half-way down the symphysis. The muscle is pointed above, but spreads out into a flat muscle with two surfaces.

Insertion.—Into the linea aspera in the middle-third of the femur. It is attached immediately internal to the adductor magnus.

Nerve.—The superficial obturator.

Action.—An adductor and a slight flexor of the thigh; also a slight external rotator of the limb.

Adductor Brevis.—Placed between the adductor longus and magnus.

Origin.—From the anterior or pelvic aspect of the body of the pubes; bounded above by the adductor longus, internally by the gracilis, below by the adductor magnus, and externally by the obturator externus.

Insertion.—Into the line leading from the linea aspera to the lesser trochanter, behind and below the insertion of the pectineus.

Nerve.—The obturator nerve splits on the upper border of this muscle into its superficial and deep branches, both of which supply it.

Action.—As the longus.

Adductor Magnus.—A large sheet of muscle extending the whole length of the thigh upon the inner side.

Origin.—From the anterior aspect of the ramus of the ischium, and from the outer aspect of the tuberosity of the ischium.

Insertion.—Into the shaft of the femur, from the level of the lesser trochanter to the adductor tubercle. The upper fibres are inserted between the outer and middle of the lines leading from the linea aspera to the greater and lesser trochanters; the central fibres into the linea aspera itself; and the lowest fibres end in an aponeurosis and tendon, which is attached to the inner division of the linea aspera, and to the adductor tubercle. The muscular fibres are inserted in a line with those of the quadratus femoris.

Nerve.—The deep branch of the obturator; occasionally a branch from the great sciatic is distributed to this muscle behind.

Action.—As the longus.

PLATE XXXVII.

MUSCLES OF THE LEG AND FOOT.

Fig. 1. ANTERIOR MUSCLES OF THE LEG.

1. Tendon of biceps.—2. Tibialis anticus.—3. Extensor proprius pollicis.—4. Extensor communis digitorum.—5. Peroneus tertius.—6. Part of the gastrocnemius and soleus.—7, 7. Peroneus longus.—8, 8. Peroneus brevis.—9. Anterior annular ligament.—10. Extensor brevis digitorum.—11, 11.—Abductor minimi digiti.

Fig. 2. POSTERIOR AND SUPERFICIAL MUSCLES OF THE LEG.

1. Tendon of semi-membranosus.—2, 2. Gastrocnemius.—3. Plantaris.—3′. Its tendon.—4, 4. Soleus.—5. Union of gastrocnemius and soleus.—6. Tendo-Achillis.—7. Peroneus longus.—8. Flexor longus pollicis.—9. Flexor communis digitorum.—10. Tibialis posticus.

Fig. 3.—1. Tendon of semi-membranosus, splitting into three fasciculi.—2, 2. Origin of gastrocnemius, cut.—2′, 2′. Inferior portion of this muscle.—3. Plantaris.—4. Soleus.—5. Peronei.—6. Flexor communis digitorum.—7. Flexor longus pollicis.—8. Tibialis posticus.

Fig. 4. SUPERFICIAL MUSCLES OF THE SOLE.

1. Plantar fascia, cut.—2. Flexor brevis digitorum.—3. Abductor pollicis.—4. Internal portion of flexor brevis pollicis.—5. Tendon of flexor longus pollicis.—6. Abductor minimi digiti.—7. Flexor brevis minimi digiti.

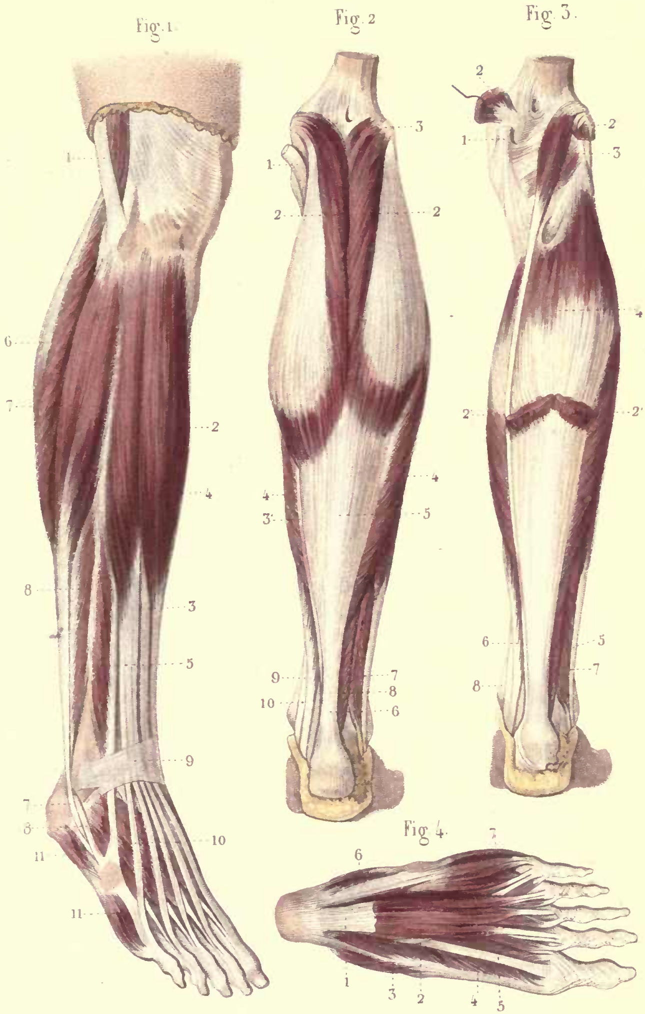
THE HAM-STRING MUSCLES, SUPPLIED BY THE GREAT SCIATIC NERVE.

The Semi-tendinosus. Origin.—In common with the biceps, the muscle arises from the back part of the tuberosity of the ischium, below and internal to the semi-membranosus. The muscle ends in a tendon two-thirds of the way down the thigh.

Insertion.—Into the upper part of the inner surface of the tibia, behind the tubercle, under cover of the sartorius, and below the level of the gracilis. (*See* Sartorius.)

Nerve.—Great sciatic.

Pl. 37.



Léveillé del. *Lebrun sc.*

Action.—A flexor of the leg; an extensor of the thigh; and an internal rotator of the leg when the knee is flexed.

The Biceps. Origin.—The *long* head arises, in common with the semi-tendinosus, from the ischial tuberosity, lying to its outer side. The *short* head arises from the outer lip of the linea aspera, and the line leading therefrom to the external condyle. On the linea aspera it reaches as high as the insertion of the gluteus maximus.

Insertion.—The heads unite to form a tendon, which is attached around the posterior and outer aspect of the head of the fibula. The tendon is split by the short external lateral ligament; hence the muscle is biped as well as biceps.

Nerve and Action—As the previous muscle, only that it causes external instead of internal rotation of the leg when the knee is bent.

Semi-membranosus. Origin.—From the upper and back part of the ischial tuberosity, above and external to the two previously mentioned muscles. The muscle commences as an aponeurosis running from the outer to the inner side of the biceps and semi-tendinosus and lying on a plane anterior to these muscles. It is muscular as far as the knee-joint.

Insertion.—Into a groove at the back part of the internal tuberosity of the tibia. From the insertion of this muscle processes pass thus: (1) To the internal lateral ligament; (2) to form a fascial covering to the popliteus muscle—the popliteus fascia; (3) the ligamentum posticum Winslowii, a ligament at the back of the knee-joint passing from the insertion of the muscle obliquely upwards and outwards to above the external condyle. It thus strengthens the capsule of the knee-joint behind.

Nerve and Action.—As for the semi-tendinosus.

The Muscles of the Calf of the Leg. Muscles supplied by the Internal Popliteal Nerve.

Gastrocnemius.—A large two-bellied muscle forming the swelling of the calf.

Origin.—By two heads; the inner from the upper and back part of the inner condyle above the articular surface; the outer from the corresponding condyle, only it is thrown a little to the outer side by the plantaris. The two heads converge about two inches below the origin, and united in a median raphe, the muscular fibres ending half-way down the leg, the inner belly extending the lower.

Insertion.—Into an aponeurosis on its under surface, the fibres of which, after converging below, come to form the tendo-Achillis. The *tendo-Achillis* is a thick piece of tendon attached to the lower part of the posterior surface of the os calcis; it extends upwards for about three inches, when it divides into two aponeuroses, one going to the under surface of the gastrocnemius, the other to the superficial surface of the soleus.

Nerve.—The internal popliteal by two branches.

Action.—An extensor of the foot, and a flexor of the leg.

Soleus.—A large flat muscle arising from the leg bones, and joining the tendo-Achillis.

Origin.—(1) From the oblique line of the tibia; (2) from the internal border of the tibia, below where the oblique line joins it, for a distance of two inches; (3) from the fibrous arch across the posterior tibial vessels and nerve; (4) from the back part of the head of the fibula and from the external border of the fibula, as low down on the fibula as it is on the tibia.

Insertion.—Into an aponeurosis covering it. The muscular fibres come as low down as within three inches of the ankle joint, and, where they end, the combined aponeuroses of the gastrocnemius and soleus are called the tendo-Achillis.

Nerve.—The internal popliteal.

Action.—An extensor of the foot.

Plantaris.—A short-bellied muscle three inches long, ending in a long tendon.

Origin.—From just above the upper and back part of the external condyle. The muscle descends to the inner side of the outer head of the gastrocnemius, and finally disappearing between the gastrocnemius and soleus, ends in a tendon. The tendon reaches from just below the knee to the inner side of the os calcis, where it is inserted. The tendon is thin, and can be spread out by lateral traction until it is like an aponeurosis.

Nerve and Action.—As the gastrocnemius in miniature.

The *Popliteus* is included in the muscles supplied by the popliteal nerve. This muscle lies obliquely across the back of the knee joint.

Origin.—By a rounded tendon, from a depression in front of a groove, on the outer surface of the external condyle, just above the articular edge. The tendon is within the capsule of the knee-joint; from this it gradually escapes, passes down behind the external semilunar fibro-cartilage; it then lies on a smooth surface, protected by a pouch of synovia from the knee-joint, at the back of the external tuberosity of the tibia; it rests on the posterior superior tibio-fibular ligament, on its way to the tibia.

Insertion.—Into the triangular surface at the upper and back part of the tibia above the oblique line.

The muscle is covered over posteriorly by the popliteus fascia—an expansion from the semi-membranosus.

Nerve.—The internal popliteal; the branch hooks round the lower border, and is supplied to the anterior surface of the muscle.

Action.—A flexor of the leg, and an internal rotator of the leg during flexion.

Muscles of the Back of the Leg, supplied by the Posterior Tibial Nerve.

Flexor Longus Digitorum is the most internal muscle at the back of the leg, but it crosses the tibialis posticus just above the ankle, and the flexor longus pollicis in the sole of the foot.

Origin.—From the posterior surface of the tibia internal to the perpendicular line; from the fascia covering it, and from the septum between it and the neighbouring muscles; reaching as high up as the soleus will allow it, and down to within three inches of the ankle-joint. The muscle passes behind the inner ankle, lying on the deltoid ligament. In the sole of the foot it is joined by the accessorius and lumbricales.

Insertion.—The tendon splits the flexor brevis digitorum opposite the first phalanx, and goes to be inserted into the base of the distal phalanges of the four outer toes.

Nerve.—The posterior tibial.

Action.—A flexor of the toes, and an extensor of the foot.

Tibialis Posticus.—The centre muscle at the back of the leg.

Origin.—From the surfaces of the tibia and fibula adjacent to the posterior surface of the interosseous membrane; reaching as far on the tibia as the perpendicular line on the posterior surface, and occupying the inner surface of the fibula behind the interosseous line. It reaches as high as the soleus will allow it, and to within two inches of the ankle. The muscle ends in a broad flat tendon, which grooves the back of the internal malleolus, lies on the deltoid ligament, and expands in the sole of the foot to its insertions.

Insertion.—Chiefly into the scaphoid tuberosity, but it gives tendinous slips to all the bones of the tarsus except the astragalus, and into the bases of all the metatarsal bones except the first and last.

Nerve.—The posterior tibial.

Action.—It acts upon the mid-tarsal joint, causing inversion of the foot; it also acts as an extensor of the foot. By its position below the deltoid ligament and the head of the astragalus, it supports the arch of the foot and the weight of the body. It aids in maintaining the antero-posterior and lateral arches of the foot.

Flexor Longus Pollicis. *Origin.*—From the posterior surface of the fibula; from the fascia covering it; from the septa on either side, reaching as high up as the soleus will allow it, and down to within one inch of the ankle-joint.

The muscle ends in a tendon which grooves the back of the tibia, crosses the centre of the back of the ankle, grooves the posterior surface of the astragalus, grooves the under surface of the sustentaculum tali, and gives a slip to join the digitorum in the sole of the foot.

Insertion.—Into the base of the distal phalanx of the great toe.

Nerve.—The posterior tibial.

Action.—Flexor of the great toe, and extensor of the foot.

Muscles of the Outer Side of the Leg, supplied by the Musculo-Cutaneous Nerve.

Peroneus Longus. *Origin.*—From the upper two-thirds of the outer surface of the shaft of the fibula; from the outer surface of the head of the fibula; from the fibrous arch protecting the external popliteal nerve; from the fascia covering it; and from the septa between it and the neighbouring muscles. The muscle passes downwards behind the outer ankle, behind and below the peroneus brevis; below the peroneal tubercle of the os calcis, enters the peroneal groove in the cuboid, and crosses the sole of the foot to its insertion.

Insertion.—Into the outer side of the base of the first metatarsal bone, and the adjacent surface of the internal cuneiform.

Nerve.—The musculo-cutaneous.

Action.—It causes eversion of the foot, and continuing to act, aids in extension of the foot.

Peroneus Brevis. *Origin.*—From the outer surface of the fibula in its middle third; from the fascia covering it, and from the septa between it and the neighbouring muscles.

The tendon passes down in front of the longus at the lower end of the fibula, but above it as it passes round the external malleolus and peroneal tubercle.

Insertion.—Into the tuberosity of the fifth metatarsal bone.

Nerve and Action.—As the longus.

Muscles on the Front of the Leg, supplied by the Anterior Tibial Nerve.

Tibialis Anticus. *Origin.*—From the upper two-thirds of the external surface of the tibia; from its own half of the interosseous membrane; from the septa between it and the neighbouring muscles and the fascia covering. The muscle ends below in a thick tendon, which passes beneath the anterior annular ligament occupying its innermost compartment.

Insertion.—Into the lower aspect of the inner side of the internal cuneiform and base of the metatarsal bone of the great toe.

Nerve.—Anterior tibial.

Action.—Inversion of the foot, acting on the mid-tarsal articulation; it is chiefly made use of, however, as a flexor of the foot.

Extensor Proprius Pollicis. Origin.—From the middle two-fourths of the internal surface of the fibula, in front of the interosseous line, and from a piece of the interosseous membrane. The muscle ends in a stout round tendon, which passes beneath the annular ligament on its way to the foot.

Insertion.—Into the base of the distal phalanx of the great toe.

Nerve.—Anterior tibial.

Action.—An extensor of the great toe, and a flexor of the foot.

Extensor Communis Digitorum. Origin.—From the anterior part of the internal surface of the fibula, for the upper three-fourths of its extent; from the anterior aspect of the head of the fibula; from the anterior superior tibio-fibular ligament; from the front part of the external tuberosity of the tibia; from the intermuscular septa around and the fascia covering it.

The fibres end in a tendon which at the ankle splits into first three and then four slips; these emerge from beneath the annular ligament to reach the dorsum of the foot.

Insertion.—Opposite the proximal phalanx of the four outer toes each tendon expands to form the dorsal expansion, which is joined upon its inner side by an interosseous muscle and one lumbricalis, on its outer side by the tendon of the extensor brevis digitorum (except the little toe), and an interosseous muscle. The expansion then narrows and splits into three, the central slip being inserted into the base of the middle phalanx, the two lateral into the base of the distal.

Nerve.—Anterior tibial.

Action.—An extensor of the toes, and a flexor of the foot.

Peroneus Tertius. Origin.—From the anterior part of the internal surface of the fibula, for the lower one-fourth of its length, in a line with the extensor longus digitorum; the tendon passes beneath the annular ligament to its *insertion* into the dorsal aspect of the fifth metatarsal bone, near its base.

Nerve.—Anterior tibial.

Action.—A flexor of the foot.

The Dorsum of the Foot.

Extensor Brevis Digitorum. Origin.—From the outer aspect of the greater process of the os calcis; from the interosseous, *i.e.*, the calcaneo-astragaloid ligament; and from the lower border of the anterior annular ligament.

The muscle ends in four muscular slips, each of which is prolonged by a tendon to the dorsum of the toes.

Insertion.—Into the four inner toes, the innermost slip going to be inserted into the outer side of the proximal phalanx of the great toe; the others into the dorsal expansions of the second, third, and fourth toes, reaching the outer side of the expansions.

Nerve.—Anterior tibial.

Action.—An extensor of the toes; at the same time giving power of individual action to each toe it goes to, owing to its being a common muscle and not a common tendon.

The Sole of the Foot.

The First Layer of Muscles.

Abductor Pollicis. Origin.—From the inner border of the inner tuberosity of the os calcis; from the lower border of the internal annular ligament; and from the fascia covering it.

Insertion.—Into the inner side of the base of the proximal phalanx of the big toe, along with the short head of the flexor brevis pollicis.

Nerve.—Internal plantar.

Action.—As its name implies, it can abduct, although slightly; it chiefly acts as a flexor of the great toe.

Flexor Brevis Digitorum. Origin.—By a pointed origin from the tip of the internal tuberosity of the os calcis; from the septa on its sides and the plantar fascia covering it.

The muscle ends in four slips, each of which possesses a tendon which is split opposite the first phalanx to allow a tendon of the longus digitorum to pass through.

Insertion.—By lateral slips into the under surface of the bases of the middle phalanges of the four outer toes.

Nerve.—The internal plantar.

Action.—Flexor of the second phalanx, and continuing its action it will act on the metacarpo-phalangeal articulation. It continues to act after the longus has ceased, and corrects the obliquity of its action.

Abductor Minimi Digiti. Origin.—From the outer part of the inner tuberosity; from the notch between the tuberosities; and from the whole of the external tuberosity, from the septa adjacent and the fascia covering it.

Insertion.—Into the outer side of the base of the proximal phalanx of the little toe, along with the flexor brevis minimi digiti.

Nerve.—External plantar.

Action.—Abducts but slightly; flexes chiefly.

The Second Layer of Muscles.

The flexor longus pollicis and the flexor longus digitorum tendons, with the accessorius and the lumbricales, form this layer. The tendons have been described with the muscles.

The Accessorius. Origin.—By two heads: the *inner*, fleshy, arises from the hollow on the inner aspect of the os calcis; the *outer*, tendinous, arises from the ridge in front of the external tuberosity of the os calcis. Between the two heads is seen the long plantar ligament. The two heads converge, and are *inserted* into the outer side and upper surface of the tendon of the flexor longus digitorum, before it divides into its terminal slips.

Nerve.—The external plantar.

Action.—Aids in the action of the outer tendons of the flexor longus digitorum, and corrects the tendency of that muscle to draw the toes inwards across the sole of the foot during flexion.

The *Lumbricales muscles* are four in number.

Origin.—The first arises from the inner side of the innermost tendon of the flexor longus digitorum; the second, third, and fourth arise from the angle formed by the adjacent tendons of the flexor longus digitorum.

Insertion.—The muscles pass upwards on the tibial sides of the toes to reach the dorsal expansion of the four outer toes.

Nerve.—The two inner are supplied by the internal, the two outer by the external, plantar nerve.

Action.—Flexion of the toes at the metatarso-phalangeal articulations, and, by pulling on the extensor tendon, produces extension of the middle and distal phalanges.

The Third Layer of Muscles

Consists of the small muscles of the big and little toes.

Flexor Brevis Pollicis. Origin.—By a pointed process from the under surfaces of the cuboid and the external cuneiform; also from the tendons and ligaments adjacent.

The muscle splits into two heads, between which passes the tendon of the flexor longus pollicis muscle.

Insertion.—On either side of the base of the proximal phalanx of the big toe, the inner head being associated with the abductor, the outer with the adductor, pollicis.

Nerve.—The internal plantar.

Action.—Flexes the big toe, pulling it outwards.

Adductor Pollicis. Origin.—From the under surfaces of the bases of the second, third, and fourth metatarsal bones; from the expansion of the tibialis posticus which goes to these bones, and from the sheath of the peroneus longus.

Insertion.—Into the outer side of the base of the proximal phalanx of the big toe, along with the outer head of the flexor brevis.

Nerve.—The external plantar.

Action.—An adductor and flexor.

Transversus Pedis.—A transverse muscle running across the foot.

Origin.—From the inner aspects of the ligaments connecting the heads of the metatarsal bones, with the proximal phalanges, all the way from the fifth to the second toe.

Insertion.—Into the outer side of the base of the proximal phalanx of the great toe, along with the flexor brevis and adductor pollicis.

Nerve.—External plantar.

Action.—What slight action it has is devoted to adduction.

Flexor Brevis Minimi Digiti. Origin.—From the base of the fifth metatarsal bone on its under aspect, and from the sheath of the peroneus longus.

Insertion.—Into the outer side of the base of the proximal phalanx of the little toe, along with the abductor.

Nerve.—The external plantar.

Action.—Abducts and flexes the little toe.

The Fourth Layer of Muscles.

Consists of the interossei, arranged in a plantar and dorsal set.

The *Plantar Interossei* are three in number.

Origin.—Each muscle arises from the inner and under aspect of the shafts of the third, fourth and fifth metatarsal bones. Each muscle passes forwards to end in a fine tendon, which reaches its insertion by passing up the tibial side of the toes towards the dorsum.

Insertion.—Into the dorsal expansion of the extensor tendon, and the base of the proximal phalanx, of the same toe from which each muscle arises.

Nerve.—The external plantar.

Action.—All the muscles cause adduction of the three outer toes towards the second; they also flex slightly.

The *Dorsal Interossei* are four in number.

Origin.—From the adjacent sides of the metatarsal bones; from the outer side of the first to the inner side of the fifth. Each muscle has two heads, between which a perforating artery passes from the sole to the dorsum of the foot, or *vice versâ.*

The *first* muscle arises from the adjacent sides of the first and second metatarsal, and passes to be inserted into the dorsal expansion and the base of the first phalanx of the second toe upon the tibial side. It transmits the communicating artery.

The *second* arises from the adjacent sides of the second and third metatarsals, and passes to be inserted in a similar way on the fibular side of the second toe. The *third* muscle arises from the adjacent sides of the third and fourth metatarsals, and passes to be inserted on the fibular side of the third toe. The *fourth* arises between the fourth and fifth metatarsals, and passes to be inserted into the fibular side of the fourth toe.

Nerve.—The external plantar.

Action.—The two inner muscles steady the second toe, the others abduct from the second.

PLATE XXXVIII.

Posterior and Deep Muscles of the Leg and Sole of Foot.

Fig. 1.—1. External lateral ligament of knee.—2. Tendon of semimembranosus.—3. Popliteus.—4, 4. Origins of soleus.—5. Flexor communis digitorum.—6. Flexor longus pollicis.—7. Tendon of tibialis posticus.—8. Peroneus longus.—9. Peroneus brevis.—10. Flexor accessorius.—11. Abductor pollicis, cut.—12. Flexor brevis pollicis.—13. Abductor minimi digiti.—14. Flexor brevis minimi digiti.

Fig. 2.—1. Tendo-Achillis, cut and turned down.—2. Tendon of flexor communis digitorum, cut.—3. Superior part of flexor longus pollicis.—3′. Inferior extremity of the same.—4. Tibialis posticus.—5. Peroneus brevis.—6. Cut extremity of peroneus longus appearing at ankle.

Fig. 3.—1. Tendon of flexor communis digitorum.—2. Tendon of flexor longus pollicis.—3. Tendon of tibialis posticus.—4. Tendon of peroneus longus.—4′. Tendon of peroneus brevis.—5. Tendon of abductor pollicis, cut.—6. Flexor brevis pollicis.—7. Abductor pollicis.—8. Transversus pedis.—9. Interossei.

Fig. 4.—1. Tendon of peroneus longus.—2. Plantar interossei. The inferior portions of the dorsal interossei are also seen.

Fig. 5.—1, 1, 1, 1. Dorsal interossei.—2, 2, 2. Plantar interossei; the tendons only seen.

Classification of Muscles.

The necessity for brevity precludes any discussion of the morphological relation of muscles, nor is this relation sufficiently understood; therefore, only a very imperfect classification can be attempted.

In vertebrates there are two great classes of muscles, viz., *Dermal* and *Skeletal.*

Of the Dermal system, the platysma, and perhaps some of the muscles of expression, are the only remnants possessed by man of a class which has important functions, particularly in some of the mammalia and reptilia.

Pl. 38.

Fig. 1.

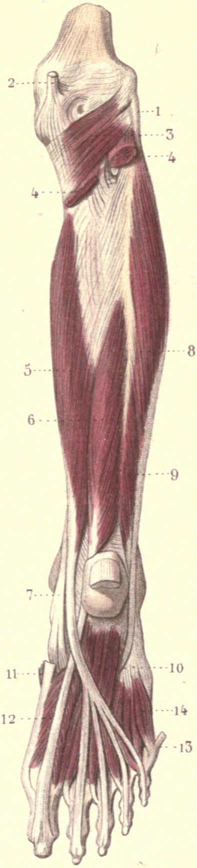


Fig. 2.

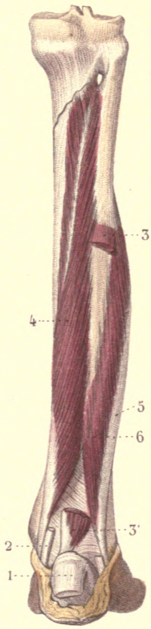


Fig. 3.

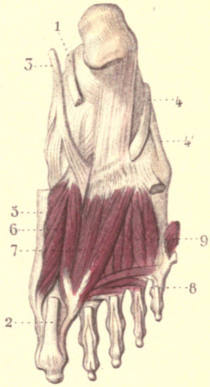


Fig. 4

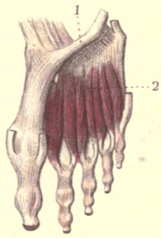
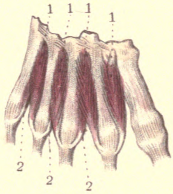


Fig. 5.



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The Skeletal muscular system increases in importance and complexity with the greater differentiation of the skeleton, so that whilst in the lowest vertebrates there is only a trunk musculation, consisting of dorsal and ventral muscular masses, there is differentiation in the highest vertebrates (besides the trunk muscles) into cephalic and appendicular groups.

In man the dorsal musculation is represented by the muscles of the back, supplied by the posterior primary division of the spinal nerves.

The ventral group is differentiated into abdominal, thoracic, and a special group, pre- or sub-vertebral, each having their nerve-supply from the anterior primary division of the spinal nerves.

The appendicular systems are divided into those passing from the trunk to the limbs, or to the limb girdles, and the intrinsic muscles of the limbs. Generally the muscles have been grouped in this work as much as possible according to their nerve-supply.

It is necessary to say a few words about the muscular system generally.

Two kinds of muscular tissue are found—one consisting of cells simple in form (plain muscle), the other consisting of fibres derived from the development and differentiation of small aggregations. It is the latter kind which belongs to this section. A muscle is a machine through which motor force is evolved. By contracting it approximates its two ends; there is then some movement of the bones or other structures to which the ends of the muscle are connected. The extent, celerity, and force (power) of movements vary, having an inverse relation the one to the other. They may be grouped under three classes, corresponding to the three kinds of lever described in mechanics.

The *first kind* is that in which the power is at one end, the weight at the other, and the fulcrum between the two, *e.g.*, the balance, the pump, scissors, etc. In animal mechanics the examples are the extension of the head on the vertebral column, the latter being the fulcrum, the face the weight, or resistance, and the occipital muscles the power. So also in the movements of the pelvis on the hip, and extension of the elbow-joint.

In the *second kind* the weight (resistance) is between the power and the fulcrum, *e.g.*, the oars of a boat, nut-crackers, etc.; and in man the lifting of the body by the calf muscles, the power being at the heel, the resistance (the body-weight) at the ankle-joint, and the fulcrum (the toes) resting on the ground. Depressing the lower jaw is another example.

In the *third kind* the power is between the weight and the fulcrum, *e.g.*, the foot-lathe, tongs, pushing a gate open with the hand; and in man flexion of the elbow and knee joints, extension of the arm by the deltoid, etc.

In all these examples the bones are the levers, the power is the muscles attached to them, the fulcrum (a fixed point) generally the joint, sometimes the ground, as in walking, or the resistance of the limb moved. The portion of bone (lever) between the attachment of the muscle (power) and the resistance is the weight-arm of the lever; the portion between the power and the fulcrum is the power-arm of the lever. When the power-arm is the longer, less force is needed to move the resistance; but the movement is proportionately slow and limited. When, on the other hand, the power-arm is the shorter, greater force is needed, but velocity and extent of movement are gained.

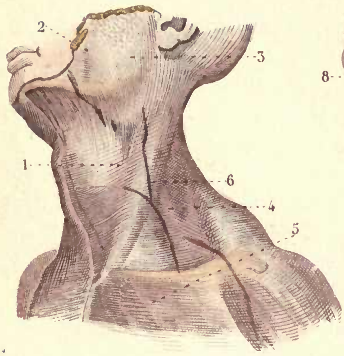
In animal mechanics power is generally sacrificed for velocity and extent of movement, as is proved by the many examples of the third kind of lever. In flexion of the forearm by the biceps, for example, the power-arm is between the elbow-joint and the insertion of the muscle (say about one inch long); the weight-arm is from the insertion of the biceps to the hand (say eight inches long). Then if the power-arm move one inch, the hand will move eight inches; and as the movement takes place in the same space of time, the hand must move eight times as rapidly.

Further, muscular fibres are so arranged on their tendon of origin, or insertion, that they rarely exceed one and a half inches in length. When great power is needed special arrangement of the tendon is found as in the deltoid and masseter muscles. Further advantages are gained by muscles taking origin from eminences, or changing their direction by being reflected over prominences or through pulleys, as the obturator internus and superior oblique, so that they join their osseous, or other, insertion, in a line approaching a right angle. The force of a muscle is in direct proportion to its size; the rapidity and extent of motion to the length.

A classification of voluntary muscles according to the arrangement of their fibres may also be made thus: 1. A penniform arrangement as in the semi-tendinosus, where the fibres are arranged to the tendon as are the feathers on the writing quill. 2. A bipenniform arrangement, as in the rectus femoris, where the fibres are on both sides of a central tendon as are the feathers of the quill in a natural state. 3. A multipenniform, as in the obturator internus and the subscapularis. 4. Long-fibred (fasciculated) long muscles, as the sartorius. 5. Short-fibred long muscles, as the gastrocnemius. 6. Muscles with intermuscular septa.

Pl. 39.

Fig. 1.



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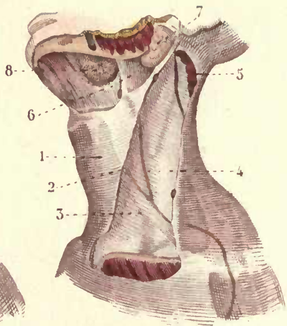

Fig. 3.

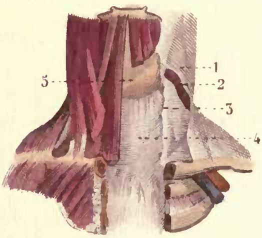

Fig. 4

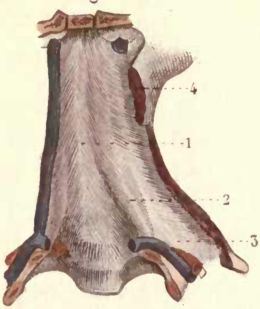

Fig. 5.

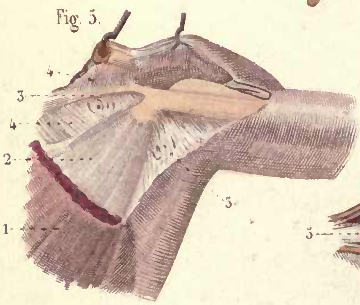

Fig. 6.

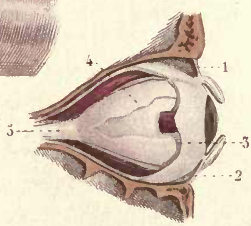

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PLATE XXXIX.

Fig. 1.—Fasciæ of the Neck.

1. Superficial layer of cervical fascia.—2. Masseteric fascia.—3. Covering of parotid gland, continuous with the cervical fascia.—4. Portion of cervical fascia called supra-clavicular.—5. Continuation of cervical fascia over the pectoralis major.—6. External jugular vein seen through the fascia, and resting on the sterno-cleido-mastoid muscle.

Fig. 2.—1. Middle portion of cervical fascia.—2. Superficial layer, cut.—3. Middle layer, passing under the sterno-mastoid, and forming a pulley for the tendon of the omo-hyoid muscle.—4. Sheath of vessels.—5. Sterno-mastoid, cut.—6. Part of deep cervical fascia attached to the lower jaw and separating.—7. The parotid, and—8. The sub-maxillary glands, and forming capsules for them.

Fig. 3.—1. Superficial cervical fascia, cut.—2. Sterno-cleido-mastoid, cut.—3. Middle layer of cervical fascia.—4. Deep layer of cervical fascia, prolonged into the chest, and attached to the lower border of the thyroid body.—5. Thyroid body.

Fig. 4.—1. Pre-vertebral fascia.—2. Scalenus anticus muscle, seen through the fascia, and—3. Scalenus medius.—4. Sterno-mastoid, cut.

Fascia.

Fascia of the Neck and Head.

The *Superficial fascia* of this region is but ill-developed. Over the scalp it forms a layer between the skin and the occipito-frontalis, which extends downwards over the temporal fascia, and down the back of the neck, covering the muscles of that region. In the face it is broken up by some fat, and the attachment of the muscles of expression to the skin, so that it can hardly be said to exist. Over the platysma the fascia is very thin, and contains fat-cells but sparsely.

The *Deep Cervical fascia*, commencing behind at the spinous processes of the cervical vertebræ and the ligamentum nuchæ, extends forwards over the trapezius muscle, across *the posterior triangle* of the neck to the posterior border of the sterno-mastoid. At the upper part of the triangle the fascia is attached to the superior curved line of the occiput and the mastoid process of the temporal; at the lower part the fascia is attached to the clavicle. *On reaching the sterno-mastoid* the fascia splits, part goes superficial to, and part deep to, the muscle. The part passing in front of the muscle meets its fellow, so to speak, in the middle line of the neck. The part behind the muscle gives off processes to the cervical vessels and pharynx, but the main part is continued forwards from beneath the anterior border of the sterno-mastoid across the sterno-hyoid and sterno-thyroid muscles to reach the middle line. The deep part in the middle line of the neck is separated from the superficial by some areolar tissue, which increases in quantity towards the sternum, but diminishes in the upward direction; in this tissue is the anterior jugular vein, and the anterior edge of the sterno-mastoid appears at the lateral aspects. Tracing the layers downwards one is attached to the front, and the other to the back of the top of the sternum; tracing them upwards the layers become closely blended, and are firmly attached to the hyoid bone.

The fascia, whilst underneath the sterno-mastoid, as already indicated, encloses the carotid, etc., in a sheath, and advances in front and behind the pharynx. Around the carotid vessels it forms a stout though loose sheath below to enclose the common carotid artery, the internal jugular vein and pneumo-gastric nerve. Tracing the sheath upwards, it forms but a thin layer over the internal carotid artery, getting thinner as the skull is approached, until at the base of the cranium it can scarcely be said to exist. In the sheath is a partition separating the artery and vein. The carotid artery in addition possesses its own special sheath, with vasa vasorum developed therein.

From the inner aspect of the carotid sheath two processes pass inwards: (1) one beneath the sterno-hyoid and upon the trachea and thyroid gland; it is this process of fascia which forms an investment of the thyroid gland, and extends downwards upon the trachea and over the great vessels at the root of the neck to join the fibrous pericardium. (2) The other process from the carotid sheath passes behind the pharynx and œsophagus and in front of the vertebræ forming the pre-vertebral fascia. Tracing this fascia upwards, it reaches the base of the skull; whilst following it downwards, it is seen to descend into the thorax with the œsophagus.

It is this fascia also which ensheathes the scalene muscles and the cervical nerves at their exit; abiding by the nerves, the fascia descends with the cords of the brachial plexus beneath the clavicle, where, after fixing the subclavius muscle to the clavicle, it passes onwards as the clavi-pectoral fascia and the sheath of the axillary vessels.

In addition to the general fascia, special fascia exist, which, in some instances, are prolongations from the deep.

The *Parotid fascia* is that met with covering the parotid gland; below, it is continuous with the cervical fascia; above, it is attached to the zygoma; and in front, it is continued over the masseter.

The *Masseteric fascia* covers the masseter muscle; it is attached, below, to the angle of the jaw; above, to the zygoma; and in front, to the buccinator fascia. From it arises the risorius muscle.

The *Buccal fascia* covers the buccinator muscle; behind, it is continued backwards, beneath the ramus of the jaw and the internal pterygoid muscle, and over the pterygo-maxillary ligament to the superior constrictor, where it forms the post-pharyngeal aponeurosis.

The *Temporal fascia* is a special fascia, altogether separate from the cervical.

It is attached circumferentially thus: To the temporal ridge on the temporal, parietal and frontal bones; to the posterior superior border of the malar bone; and to the upper border of the zygoma. At the zygomatic attachment it consists of two layers, one attached to the outer, the other to the inner border of the bone; between the two is a quantity of fat and a small artery, the orbital branch of the temporal. The under surface has the temporal muscle attached; the superficial surface is covered by the lateral epicranial prolongation, by the anterior auricular muscles, and by the temporal vessels and nerves.

The *stylo-maxillary ligament* stretches between the tip and outer side of the styloid process of the temporal bone and the inner aspect of the angle of the jaw. It is broad below, separating the parotid from the sub-maxillary gland.

The *internal lateral ligament* of the lower jaw may be regarded as a special piece of cervical fascia.

Bursæ.—In the head and neck the following bursæ are met with: (1) Over the symphysis menti; (2) just behind the angles of the lower jaw; (3) between the genio-hyoid and genio-hyoglossi muscles of the tongue; (4) between the back part of the body of the hyoid bone and the thyro-hyoid membrane; (5) over the front of the pomum Adami.

Fig. 5.—Fascia of the Axilla.

1. Pectoralis major, cut.—2. Pectoralis minor.—3. Aponeurotic fasciculus, to which is attached—4, 4. The costo-coracoid membrane. —5. Suspensory ligament of the axilla.

Fig. 6.—Fasciæ of the Orbit.

1 and 2. Fascia of the eyelids, continuous with the tarsal fibro-cartilages.—3. Aponeurotic expansion, uniting the muscles of the eyeball, and splitting to form sheaths for each of them.—4. Aponeurotic expansion, covering the sclerotic, and terminating where the optic nerve pierces this coat.—5. Optic nerve.

PLATE XL.

Figs. 1, 2, 3, and 4 are transverse sections of limbs to show the aponeurotic sheaths of muscles, and the relations of these sheaths and muscles to the bones, the vessels and the nerves.

Fig. 1.—SECTION OF THE RIGHT ARM AT ABOUT THE INFERIOR THIRD OF THE DELTOID.

Fig. 2.—SECTION OF THE RIGHT FOREARM THROUGH ITS MIDDLE.

Fig. 3.—SECTION OF THE RIGHT THIGH THROUGH ITS MIDDLE.

Fig. 4.—SECTION OF THE RIGHT LEG THROUGH ITS SUPERIOR THIRD.

Fig. 5.—SUPERFICIAL FASCIA OF THE ABDOMEN.

1. Superficial fascia.—2. Prolongation of this fascia into the thigh.—3. Its continuity with the dartos.—4. Suspensory ligament of penis.

Fig. 6.—1. Superficial fascia, turned down.—2. Portion of superficial fascia, attached to the crural arch.—3. Aponeurosis of the external oblique.—4. External abdominal ring, through which passes the spermatic cord.—5. Inter-columnar fascia.—6. Linea alba.—7. Abdominal aponeurosis.

Fasciæ of the Abdomen.

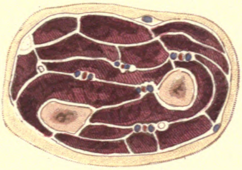
The Wall of the Abdomen.—The subcutaneous or *supra-parietal* fasciæ are divided into superficial and deep.

The *superficial* consists of two layers: (1) One containing fat, and continuous with that over the chest, loins, and thighs; (2) A deeper, called the deep layer of the superficial fascia, or Scarpa's fascia. This fascia is distinguished from that covering it by being destitute of fat, and by its connections; above it is thin and unimportant, but below and in the region of the groin and the pubes, it is a stout membrane, affording support to the lower part of the abdominal wall, to the penis and scrotum. In the region of the groin it is continued over Poupart's ligament to join the fascia lata immediately beyond. It forms a thin membranous investment to the penis, and in it as it covers the scrotum the dartos is developed. Urine reaching the abdominal wall from the perineum, finds its way beneath this membrane.

The *interparietal* layers of fasciæ, viz., those between the muscles

Pl. 40.

Fig. 2.



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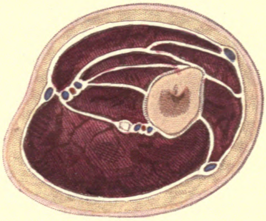

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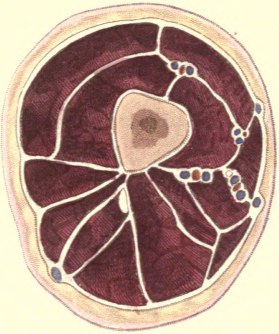

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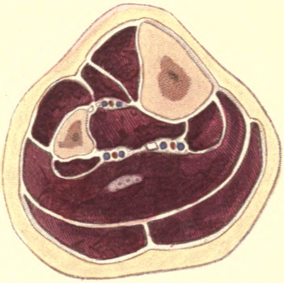

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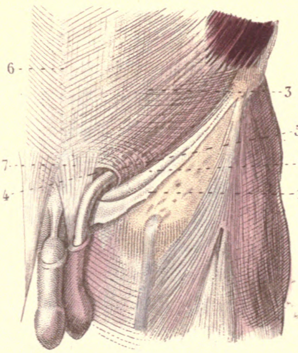

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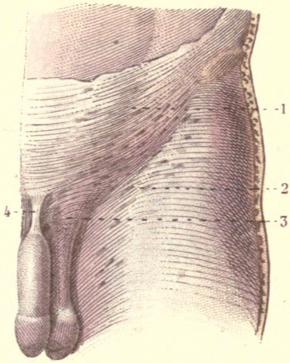

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of the abdominal wall, are those usually met with amongst muscles; the fascia is especially thin between the internal oblique and transversalis.

The *intraparietal* layers of fasciæ, the *transversalis* and *iliac*, remain to be described. Lining the whole of the lower, and especially the anterior wall of the abdomen, is a stout sheet of fascia, whose primary object it is to support the viscera; it receives different names according to the different regions in which it is found.

The *transversalis fascia* receives its name from the muscle beneath which it lies. At the upper part of the wall it becomes thin and cellular, until upon the under surface of the diaphragm it can be said scarcely to exist. Laterally, it is continuous with the tissues around the kidneys. Below, and especially in front, is the fascia well developed, where, spread across the abdomen, it acts as a means whereby to support the weight of the viscera.

At the crest of the ilium the fascia is blended with the periosteum, and at Poupart's ligament it is attached to the outer half; but opposite the inner half it escapes beneath Poupart's ligament and upon the femoral vessels to form the anterior part of the *crural sheath.* At its passage beneath Poupart's ligament—the *superficial crural arch*, the fascia has developed in it a number of strong fascial bands constituting the *deep crural arch.* These fibres are connected with the back of the pubes and the aponeuroses found there. One half inch above Poupart's ligament, and midway between the anterior superior spinous process and the symphysis pubis, is an opening in the transversalis fascia—the *internal abdominal ring.* Through this the testicle and spermatic cord pass, and the lower margin of the ring is prolonged down over these as a funnel-shaped prolongation—the *infundibuliform fascia.* It is one of the coverings of an oblique inguinal hernia.

The *Iliac fascia* covers the iliacus muscle, and sends upwards a prolongation on the psoas muscle—the sheath of the psoas. Externally the fascia is attached to the inner lip of the iliac crest, where it blends with the periosteum. Internally it embraces the psoas, and is attached firmly to the periosteum along the brim of the pelvis, and is there adjacent to, or actually continuous with, the pelvic fascia.

Above, the fascia is prolonged over the front of the aponeurosis covering the quadratus lumborum muscle, and is firmly attached to the ilio-lumbar ligament. Below, the fascia is attached to Poupart's ligament along the outer half, but internally it escapes beneath the femoral vessels to form the posterior part of the *crural sheath* (see below). The *sheath of the psoas* is a well-developed enclosure to the muscle; it is attached laterally to the lumbar vertebræ and the intervertebral discs on the inner side, and the tips of the transverse processes of the lumbar vertebræ externally. Traced upwards, it ends at the ligamentum arcuatum internum, which stretches from the body of the twelfth dorsal vertebra to the transverse process of the first lumbar. Traced downwards, the sheath continues beneath Poupart's ligament to blend with the tendinous insertion of the psoas muscles shortly before it reaches the trochanter minor. The sheath of the external iliac vessels is firmly blended with the iliac fascia and the sheath of the psoas.

The crural sheath is a funnel-like prolongation of the intraparietal fasciæ over the external iliac vessels as they escape beneath Poupart's ligament. It is said to be formed in front by the transversalis, and behind by the iliac fascia; this is of course a mere quibble of names, as these fasciæ, although possessing different names, are one and the same. The crural sheath possesses three compartments, separated by two septa. The outer compartment is for the artery, the central for the vein, and the inner, *the crural canal*, is occupied by a gland. The sheath is in all about $1\frac{1}{2}$ inches long, extending for that distance over the common femoral vessels. The *crural canal*, or innermost compartment, is funnel-shaped, with the apex below, base above. It is three quarters of an inch in length. Its base is circular—the *crural ring;* the ring is covered over by a piece of the subperitoneal fascia—the *septum crurale.*

In the canal lies a lymphatic gland. Inserting the finger into the canal and ring, the following parts are to be made out: Internally, Gimbernat's ligament; externally, the septum between the canal and the femoral vein; in front, *i.e.* above, Poupart's ligament; behind, the horizontal ramus of the pubis and the pectineus muscle.

Poupart's ligament is merely the lower bundle of fibres of the external oblique aponeurosis, as it stretches between the anterior superior spinous process of the ilium and the spine of the pubis. At the latter point a lateral prolongation from its inner end and under surface is attached for some distance along the ilio-pectineal line—viz., *Gimbernat's ligament.* This is a strong triangular piece of fibrous tissue, placed with its apex at the spine of the pubis, its upper or anterior border attached to Poupart's ligament, its lower or posterior border to the ilio-pectineal line for three quarters of an inch. Its outer border or base is semilunar in shape, forming the inner boundary of the crural ring. The surfaces, anterior or inferior, and posterior or superior, look towards the thigh and abdominal cavity respectively.

Pl. 41.

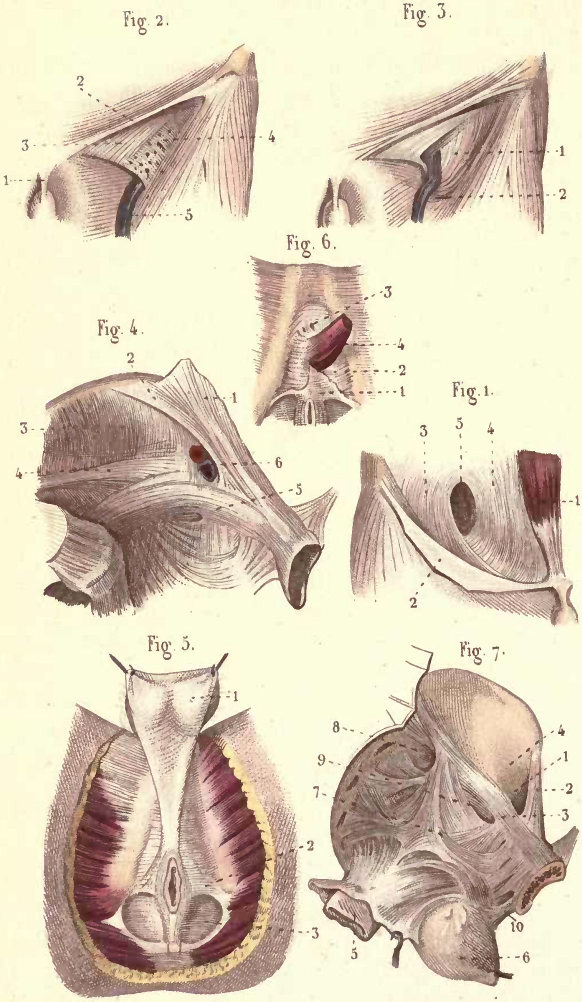

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PLATE XLI.

Fig. 1. Fascia Transversalis.

1. Rectus abdominis.—2. Aponeurosis of external oblique, turned down.—3. External part of fascia transversalis.—4. Internal portion. 5. Superior aperture of the inguinal canal.

Figs. 2 and 3. Fasciæ of Groin.

Fig. 2.—1. Suspensory ligament of penis.—2. Crural arch.—3. Gimbernat's ligament.—4. Cribriform fascia.—5. Internal saphena vein.

Fig. 3.—1. Aponeurotic fasciculi, covering the femoral vessels.—2. Falciform process of fascia lata.

Fig. 4. Iliac Fasciæ, etc., etc. (*Left side of pelvis.*)

1. Aponeurosis of external oblique.—2. Ilio-pubic band, or ligament of Hesselbach.—3. Iliac fascia.—4. Tendon of psoas parvus. —5. Cooper's ligament.—5′. Femoral vessels, in the femoral canal.

Fig. 5. Deep Layer of Superficial Fascia of the Perineum.

1. Scrotum raised, showing the posterior prolongation of the dartos.—2. Deep layer of superficial fascia.—3. Ischio-rectal fossa.

Fig. 6.—1. Deep layer of superficial fascia, cut.—2. Anterior layer of triangular ligament of perineum.—3. Foramina for dorsal vessels and nerves of penis.—4. Bulb of urethra, cut.

The Triangular Ligament and Perineal Fasciæ.

The anterior part of the outlet of the pelvis is closed in by a layer of fascia called the triangular ligament. This is, as its name implies, triangular in shape, with its apex forwards at the symphysis pubis; its base is semilunar in shape, with its concavity backwards towards the anus; its margins are attached to the pubic arch as far down as to within half an inch of the front of the tuberosity of the ischium. The ligament consists of two layers: a posterior, derived from the pelvic fascia, as it stretches across from one side of the pelvis to the other; an anterior, formed of a special fascia. The posterior layer is perforated by the urethra one inch below the symphysis, and by the dorsal vein midway between these. The anterior layer is perforated by the urethra, the dorsal vein in the middle line above the urethra, and by two dorsal arteries and two dorsal nerves arranged one artery and nerve on each side of the vein.

The two layers have between them the membranous portion of the urethra, with various other structures separating them for the distance of three quarters of an inch (see Perineum).

The *Superficial fascia* of the *scrotum* and *perineum* consists of two layers, the *superficial* continuous with the fascia over the front of the abdomen, the inside of the thighs, etc.; but the deep layer has distinct attachments. Over the scrotum the fasciæ blend, and have developed in them the *dartos,* a layer of striate but involuntary muscular fibres. The *deep* layer of the superficial fascia is a distinct tissue in the region of the perineum, with decided attachments to bone, etc. Thus on either side it is attached to the ramus of the pubis and ischium; behind, it turns backwards to join the anterior layer of the triangular ligament, hooking round the superficial transversus perinei muscle on its way. Between the two sides of the perineum a median raphe, with a corresponding septum underneath, divides the two sides completely; in consequence of these attachments, urine extravasated, or air blown in beneath the deep layer of the superficial fascia, cannot get down the inner side of the thigh, nor backwards around the anus, nor can it reach the opposite side of the perineum because of the septum. Its only course is upwards into the scrotum and penis, and on to the wall of the abdomen.

Fig. 7. Pelvic Fascia, etc.

1. Crural canal.—2. Gimbernat's ligament.—3. Cooper's ligament. —4. Fascia iliaca, forming the posterior wall of the crural canal.—5. Rectum, turned down.—6. Bladder, turned down.—7. Pelvic fascia, showing the recto-vesical fascia and *white line.*—8. Foramen for the passage of the gluteal vessels.—9. Foramen for the passage of the obturator vessels and nerve.—10. Pubo-prostatic, or anterior true ligament of the bladder, formed by a reflection of pelvic fascia.

The Pelvic Fascia.

At the brim of the true pelvis, the fascia, from the region of the false pelvis, changes its name to pelvic. It is there blended with the periosteum all around, but most intimately at the sides. On viewing the fascia from the inner side, it is seen to be deeper behind than in front, and at the lower part is a long white band—the *white line*—which stretches from the back of the body of the pubis to the spine of the ischium. Externally the fascia is in contact with the obturator internus muscle; internally is a quantity of loose cellular tissue with some fat between it and the peritoneum.

At the white line the fascia splits, one part passing inwards over the bladder and rectum—*the recto-vesical fascia;* the other—*the obturator*—passing downwards over the obturator internus muscle.

The *Rectro-vesical fascia* covers the lower four inches of the rectum, passes over the prostate forming its capsule, and from hence is continued over the bladder, covering its neck and lower part. It covers the parts of the pelvic viscera untouched by peritoneum. It forms, on its passage from the wall of the pelvis to the viscera, anterior and lateral ligaments to the prostate and bladder; the *anterior ligaments* of the bladder, or pubo-prostate, pass from the back of the pubes to the prostate as two rounded bundles, one on each side of the middle line; the two *lateral* are broad sheets which reach the side of the prostate and bladder.

The *Obturator fascia* is continued from the white line to the inner aspect of the tuberosity of the ischium, where it is attached to the bone, and to the falciform edge of the great sciatic ligament attached thereto. It appears on the outer wall of the ischio-rectal fossa, having the obturator internus externally to it, and having in contact with its inner surface the fat of the ischio-rectal fossa. At the white line arises the levator ani muscle, and from this line and along the under surface of the muscle the *anal* fascia extends. The anal fascia lines the ischio-rectal fossa internally, and blends below with the tissues around the anus.

The *obturator membrane* is the name given to the sheet of tissue which closes in the obturator or thyroid foramen. The membrane is attached circumferentially to the bony margins of the foramen, except above, where a gap exists for the passage of the obturator vessels and nerve. To the anterior or thigh aspect, and to the posterior or pelvic aspect, the obturator externus and internus are attached respectively. The membrane is flush with the inner wall of the foramen, hence there is deep fossa for the origin of the obturator externus.

PLATE XLII.

Fig. 1. FASCIÆ OF THE UPPER EXTREMITY.

1. Fascia, covering the deltoid. — 2. Brachial aponeurosis. — 3. Fascia of the forearm.—4. Bicipital fascia.—5. Palmar fascia.— 6. Palmaris brevis muscle.

Fig. 2.—1. Posterior annular ligament of carpus.—2. Dorsal aponeurosis of the hand.

Fasciæ of the Upper Extremity.

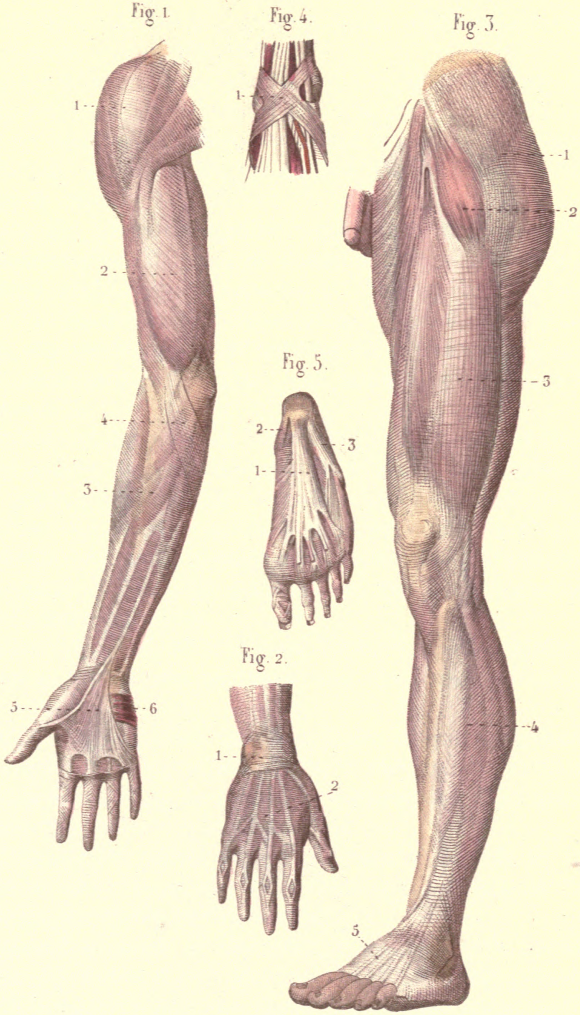
The *Superficial fascia* over the region of the shoulder is loose and movable; it accommodates the platysma muscle in front, but behind the outer border of this muscle it has a considerable quantity of fat developed therein.

The *Deep fascia* over the pectoralis major is continuous below with the sheath of the rectus abdominis, and it is fixed firmly around the points of the attachment of the muscle at the sternum and clavicle; it is thin over the upper part of the muscle, but thicker and more intimately connected below. At the outer border of the muscle it blends with the fascia derived from over the pectoralis minor to form the axillary fascia.

Beneath the large pectoral muscle is found a layer of fascia, which can be traced from beneath the clavicle downwards, to the pectoralis minor, which it ensheaths on its way to the axilla. Above the pectoralis minor is a triangular interval, bounded below by the pectoralis minor; above by the clavicle; internally by the first and second ribs and the first and second intercostal spaces; externally, at the apex of the space, is the coracoid process. This triangle is called the *sub-clavicular* or *clavi-pectoral*, and the fascia is called the clavi-pectoral where it is loose and areolar, but immediately beneath the clavicle, where it stretches between the first rib and the coracoid process, it is called the costo-coracoid membrane; it supports the shoulder, and ties the tissues to the clavicle by its connection with the sheath of the subclavius muscle.

The *Axillary fascia* is a strong dense sheet of fibrous tissue, with no openings in its centre for vessels or nerves of any size. It is attached in front to the anterior, and behind to the posterior, fold of axilla; internally it is fixed to the side of the chest, externally to the tissues around the sheath of the vessels and nerves as they

Pl. 42.



Léveillé del.

Corbié sc.

emerge from the axilla to the arm. Pus cannot perforate it, hence the axilla may be ransacked with pus before a natural vent can be established.

The fascia over the deltoid is coarse and cellular; behind, it is continuous with the dense glistening fascia which covers the infra-spinatus muscle like an aponeurosis.

The *fascia of the arm* is composed of a tight-fitting garb of fibres, which are arranged for the most part transversely, but with scattered oblique and longitudinal fibres developed therein. It is thin above, thicker below; and much thicker behind, over the triceps, than over the biceps in front.

Towards the elbow two intermuscular septa are developed. The *external* reaches from the apex of insertion of the deltoid muscle to the external condyle, and is attached all the way between these two points to the bony supra-condyloid ridge. Attached to its posterior surface is the triceps, and to its anterior the supinator longus and the extensor carpi radialis longior. The musculo-spiral nerve may be said to pierce it.

The *internal septum* extends between the attachment of the coraco-brachialis muscle and the internal condyle; it is attached to the internal supra-condyloid ridge of bone between these two points. Arising from its posterior surface is the triceps, and from its anterior the brachialis anticus; it is pierced by the ulnar nerve and its accompanying vessel—the inferior profunda, as well as by branches of the anastomotica magna artery.

The piece of fascia which passes between the brachialis anticus and biceps is continuous internally with the sheath of the brachial vessels.

At the *bend of the elbow* the deep fascia is firmly attached to the various prominent bony points; from it also muscles arise, and the aponeuroses of muscles blend with it, forming sheets of attachment for the muscles, and septa between each.

The fibres of the fascia proper are mainly circular in direction immediately below the elbow, but oblique and longitudinal fibres are derived from the aponeurosis of muscles.

An especial adjunct is the slip of tissue which comes from the biceps $1\frac{1}{2}$ inches above its insertion. This slip passes downwards and inwards to join the fascia over the pronators and flexors from the internal condyle. It goes by the name of the *bicipital* fascia; superficially to it lie the medio-basilic vein and internal cutaneous nerve; beneath it are the brachial vessels and the median nerve.

Fascia of the Forearm.

This is conveniently divided into an anterior and posterior layer, although, properly speaking, it is attached to the posterior or subcutaneous border of the ulna, and from hence it passes to encircle the limb. Its fibres are for the most part transverse or circular, with oblique and longitudinal fibres scattered throughout. It is intimately connected with the intermuscular septa of the muscles, and both front and back sends well-marked partitions between the superficial and deep layers of muscle. This is especially well marked below and in front. The fascia behind is much stronger and more tightly stretched than is the layer in front.

At the lower part of the forearm the fasciæ in front and behind are continued into the anterior and posterior annular ligaments.

The *anterior annular ligament* is a thick, stout band of transverse fibres stretching between the pisiform bone and the unciform hook internally, and the tubercle of the scaphoid and the ridge on the trapezium externally. It is about an inch in depth, and an inch in breadth. To its upper border is attached the fascia of the forearm, and below the palmar fascia.

The ligament is crossed by the palmaris longus tendon, perforated by the flexor carpi radialis, and has the flexor carpi ulnaris inserted into it. Beneath it pass the flexores, sublimis, profundus, and pollicis, and the median nerve. The ulnar vessels and nerve cross it superficially.

The *posterior annular ligament* is longer and more oblique than the anterior. It commences at the anterior border and outer aspect of the radius, and crossing obliquely over the back of the wrist, goes to be attached to the inner side of the unciform and cuneiform bones, and by a slip to the pisiform. On its way it touches the various bony ridges on the back of the lower end of the radius, thus forming compartments for the passage of tendons. Proceeding from without inwards, the tendons and compartments are as follow: In the outermost compartment, the extensor ossis metacarpi pollicis and the extensor primi internodii pollicis; next, the extensor carpi radialis, longior, and brevior; in the third, is the extensor secundi internodii pollicis; in the fourth, the extensor communis digitorum and the extensor indicis; in the fifth is the extensor minimi digiti; and in the last and sixth is the extensor carpi ulnaris. The minimi digiti tendon is between the ulna and radius; the extensor carpi ulnaris is on the back of the head of the ulna. All the others are on the radius.

The Palmar fascia, covering the hollow of the hand, is a triangular, strong piece of fascia, with its apex above at the anterior annular ligament, and its base at the root of the fingers. The fibres run both longitudinally and transversely. At its apex it is strongest, and receives the insertion of the palmaris longus. Laterally, it is continuous with thin areas of fascia, an outer and inner, which cover over the thenar and hypothenar eminences respectively.

At the root of the fingers it splits into four slips, each of which is continued onwards towards the finger-sheath. Opposite the metacarpo-phalangeal articulations each slip divides to embrace the flexor tendons passing beneath; and from this point processes are continued, downwards to the ligaments uniting the metacarpal bones, forwards and downwards to the glenoid ligament in front of the articulation, and forwards to the sheath of the tendon in the fingers where it is conterminous with the transverse fibres.

Between the slips to the fingers the digital vessels and nerves appear. The palmaris brevis muscle arises from the fascia over the hypothenar eminence. The superficial palmar arch lies immediately beneath the fascia; and the muscles of the thumb and little finger are largely attached to it.

Fascia of the Thorax.

The *Superficial fascia* in the region of the breast has the mamma developed between its layers; one layer passing over its front, the other behind between it and the pectoralis major. From the fascia processes advance into the gland dividing it into lobules, and at the same time forming a support to the gland as a whole, acting as a sort of suspensory ligament slinging it to its place. Above the gland the platysma muscle is developed in this fascia.

The *Deep fascia* over the pectoralis major is loose and areolar above, but below it becomes more dense where it is continuous with the aponeurotic sheath of the rectus abdominis. Towards the middle line it is fixed to the sternum, above to the clavicle, and at the outer edge of the muscle it joins with the fascia advancing from its under surface, and passes across the axilla as the axillary fascia (see p. 166). At the posterior boundary of the axilla it splits on the latissimus dorsi, and is conveyed over and under that muscle to the spinous processes of the dorsal vertebræ.

For clavi-pectoral and costo-coracoid fasciæ, see p. 166.

Intercostal Fasciæ.—Without, within, and between the intercostal muscles of each intercostal space a layer of fascia exists. Especially is it developed where the muscles are deficient, viz., in front, between the costal cartilages where the external intercostals are deficient, and behind, internal to the angles of the ribs where the internal intercostals are deficient.

Fig. 3. Fasciæ of the Lower Extremity.

1. Aponeurosis of the gluteus maximus.—2. Fascia enclosing

tensor vaginæ femoris.—3. Fascia lata of thigh.—4. Fascia lata of leg.—5. Dorsal aponeurosis of foot.

The Fasciæ of the Lower Extremity.

The *Superficial fascia* of the thigh is continuous with that of the abdomen. It is, immediately below the fold of the groin, divided into two layers; a *superficial*, containing fat and continuous with the fasciæ of the neighbouring regions; a *deep* layer of the superficial fascia, the *cribriform fascia*, spread over the saphenous opening and its immediate surroundings. Between the deep and superficial fascia at the groin lie the cutaneous vessels and the lymphatic glands.

The *deep fascia* encloses the thigh, and is prolonged downwards across the knee to the leg, as a strong, dense, aponeurotic-looking tissue—the *fascia lata.* It is fixed around the top of the thigh firmly to the following points: Poupart's ligament, the outer lip of the iliac crest, the posterior sacro-iliac ligament, the side of the sacrum and coccyx, the great sciatic ligament, the outer lip of the tuberosity of the ischium, the outer lip of the ramus of the ischium and pubis, the margin of the symphysis pubis, and the front of the crest of the pubis. Passing downwards over the thigh, and forming various enclosures and processes, the fascia comes to be fixed around the knee-joint, at the various bony prominences of the condyles of the femur, the tuberosities of the tibia, and the head of the fibula. Behind, over the popliteal space it is prolonged downwards over the muscles of the calf of the leg as a superficial covering. The deep fascia of the leg is looked upon as a separate fascia, and not as a prolongation of the fascia lata.

The *named* parts connected with the fascia lata are:

(*a*) The *saphenous* opening.

This is an opening in the fascia lata situated immediately below and external to the spine of the pubis. It transmits the internal saphenous vein on its way to join the common femoral. On either side the opening, the names iliac and pubic portions of the fascia lata are given to the fascia, owing to the bony connections. That upon the outer side—the iliac—is fixed above to Poupart's ligament and the iliac crest; that upon the inner side is prolonged upwards upon the pectineus muscle to the ilio-pectineal line, to which it is firmly attached.

The opening itself has a sharply cut outer edge—the *falciform* edge—with an upper and lower end, called the *superior cornu or Hey's ligament*, and the *inferior cornu*, respectively. It is covered over by the deep layer of the superficial fascia, called at this spot, on account of the number of openings in it, the *cribriform* fascia.

(*b*) The *ilio-tibial* band on the outer side of the thigh extends from the outer lip of the crest of the ilium to the outer tuberosity of the tibia. At its upper part it splits to enclose the tensor vaginæ femoris muscle, the deep portion being attached to the upper margin of the acetabulum. To this band the fibres of the gluteus maximus are attached posteriorly; the tensor vaginæ femoris acting as a tensor to the fascial insertion of that muscle.

(*c*) Two *intermuscular septa* exist, one above the inner, the other above the outer, condyle, on the lines leading from these to the linea aspera. The external, much the stronger, separates the vastus externus from the biceps; the internal, thin and incomplete, separates the vastus internus from the adductor magnus.

The fascia lata splits in various places to enclose muscles, notably the gluteus maximus, the sartorius, and the tensor vaginæ femoris. The gluteus medius and the vasti muscles avail themselves of the fascia at their origins.

(*d*) The *popliteal* fascia covers over the popliteal space binding its walls together, and protecting its vascular and nervous contents. It is perforated by the external saphenous vein on its way to join the popliteal vein.

The Fascia of the Leg.

Fixed firmly to the bony margins, this fascia gives extensive origin to the leg muscles. Over *the front* of the leg the fascia is stretched between the anterior borders of the tibia and fibula, reaching as high as the external tuberosity, where it is attached, and as low down as the anterior annular ligament. It gives attachment to the extensor muscles, sending septa between them. On *the outer* aspect of the leg, the fascia, stretching between the anterior and external borders of the fibula, covers over the peroneus longus and brevis muscles. *Behind*, the fascia is called *the deep fascia of the leg* where it binds down the flexor muscles. It stretches transversely beneath the soleus between the internal border of the tibia and the external border of the fibula, including in its substance the posterior tibial vessels and nerves. Above, it reaches as high as the soleus will allow it; and below, where it increases in thickness, it is continuous with the internal annular ligament.

The *Anterior annular ligament* consists of two parts, an upper and lower. The *upper* stretches between the anterior borders of the malleoli, and presents two compartments only, one, the innermost, for the tibialis anticus, the outer for all the other tendons.

The *lower* portion of the ligament is Y-shaped.

The stalk or foot of the Y is attached to the outer aspect of the greater process of the os calcis, then passing over the tendons in front of the ankle it divides into two, the upper going to be attached to the front of the internal malleolus, the lower to the tissues on the inner side of the foot over the scaphoid bone. It has three compartments lined by synovial sheaths, the inner for the tibialis anticus, the middle for the extensor proprius pollicis, the outer for the extensor communis digitorum and the peroneus tertius. The function of the ligament is to act as a point of resistance for the extensors, binding them down to the front of the ankle.

The *External annular ligament* is a thin piece of tissue which arches over the peronei tendons, enclosing them in a common synovial sheath; it is attached in front to the external, and behind to the posterior, border of the external malleolus.

The *Internal annular ligament* stretches from the internal malleolus to the tissues on the inner side of the heel. It is attached above to the deep fascia of the leg, below to the plantar fascia. Underneath it pass the tibialis posticus, the flexor longus digitorum, the posterior tibial vessels and nerve, and the flexor longus pollicis, in order from within outwards. Attached to the lower border of the ligament is the abductor pollicis; the plantar cutaneous nerve pierces it.

Fig. 4. Anterior View of Ankle.

1. Annular ligament of ankle.

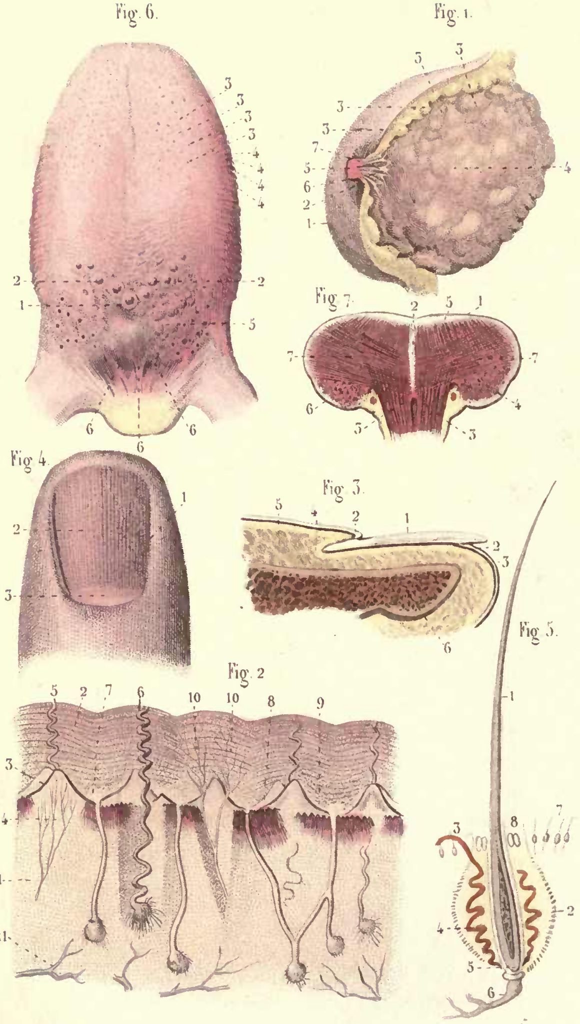
Fig. 5. Plantar Fascia.

1. Middle fasciculus and processes, between which pass the digital vessels and nerves.—2. Internal fasciculus.—3. External fasciculus.

The Plantar Fascia.

The sole of the foot has an extraordinary development of fascia for the purpose of protecting the tissues, and to maintain the antero-posterior arch of the foot. It presents three portions conterminous with the muscles of the first layer: The inner, covering—the abductor pollicis; the middle—the flexor brevis digitorum; the outer—the abductor minimi digiti. The inner and outer run from the origins of the muscles they cover to the inner and outer sides of the great and little toes respectively. The central portion extends from the apex of the internal tuberosity of the os calcis to the roots of the toes, where it splits and becomes attached, as does the palmar fascia (see Palmar Fascia, and also the Sheaths of the Fingers). Between the central and lateral portions, stout septa run down, which embrace the internal and external plantar vessels and nerves, and which become united along the upper surfaces of the muscles they separate by a fascial prolongation.

Pl. 43.



Léveillé del.

Corbié sc.

PLATE XLIII.

SPLANCHNOLOGY, PLATE I.

Fig. 1. MAMMARY GLAND.

1. Skin.—2. Areola.—3, 3, 3, 3. Fat lobes, of which the upper set belong to the skin, and the others are distributed amongst the lobes of the gland.—4. Mammary gland.—5. Nipple.—6. Lacteal ducts. —7. Lacteal sinus.

Fig. 2. MICROSCOPIC STRUCTURE OF THE SKIN, AFTER BRESCHET.

1. Cutis vera.—2. Epidermis, distributed in layers.—3. Papillæ.—4. Nerves of a papilla.—5. Duct of a sweat-gland.—6. Sweat-gland and its duct.—7. Epidermic gland and duct.—8 and 9. Pigment cells.—10, 10. Lymphatics.—11. Bloodvessels.

Fig. 3. SECTION OF THE EXTREMITY OF A FINGER.

1. Nail.—2, 2. Epidermis, continuous with nail.—3. Cutis vera.—4. Matrix of nail.—5. Subcutaneous fat.—6. Ungual phalanx.

Fig. 4. EXTREMITY OF A FINGER, WITH THE EPIDERMIS REMOVED.

1. Matrix of nail.—2. Papillæ.—3. White spot, called the *lunula*.

Fig. 5. SECTION OF THE SKIN OF THE CHEEK OF AN OX, AFTER GAULTIER.

1. Shaft of a hair.—2. Membrane of the hair follicle.—3. Vessel passing into the orifice of the follicle.—4. The same vessel passing along the follicle to the root of the hair.—5. The root sheath.—6. Root of the follicle, to which are distributed minute nervous filaments.—7. Smaller hairs.—8. Sebaceous glands.

Fig. 6. TONGUE (*dorsum*).

1. Foramen cæcum.—2, 2. Circumvallate papillæ.—3, 3, 3, 3. Fungiform papillæ.—4, 4, 4, 4. Filiform papillæ.—5. Glands at the base of tongue.—6. Glosso-epiglottidean folds or ligaments.

Fig. 7. VERTICAL SECTION OF THE TONGUE.

1. Mucous membrane.—2. Fibrous septum.—3, 3. Genio-hyo-glossi muscles.—4, 5, and 6. Superior and inferior linguales muscles.—7. Transverse linguales muscle.

PLATE XLIV. (*bis*).

SPLANCHNOLOGY, PLATE II. (*bis*).

Fig. 1. Front View of Eye.

1. Sclerotic.—2. Iris, seen through the cornea.—3. Pupil.

Fig. 2. Coats of the Eye.

1. Optic nerve.—2. Sclerotic.—3. Cornea.—4. External layer of choroid (*vasa vorticosa*).—5. Internal layer (*membrana Ruyschiana*).—6. Ciliary muscle.—7. Iris and pupil.—8. Ciliary nerves.—9. Retina.—10. Hyaloid membrane, through which is seen the pigmentary layer of the retina.

Fig. 3. Anterior part of the Eye, seen from behind.

1. Sclerotic.—2. Choroid.—3. Ciliary processes.—4. Uvea.

Fig 4. Posterior Aspect of the Retina.

1. Termination of optic nerve.—2. Folds of the retina.—3. Arteria centralis.—4. Yellow spot of Sœmmering.

Fig. 5.—1. Vitreous humour in its capsule.—2. Zonule of Zinn.—3. Lens.

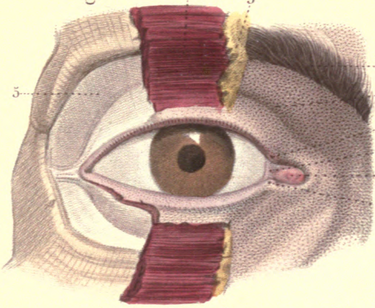
Figs. 6, 7, 8, and 9. Lens, showing its structure.

Fig. 10. Section of Eyeball.

1. Optic nerve.—2. Sclerotic.—3. Cornea.—4. Spaces of Fontana.—5. Choroid.—6. Ciliary muscle.—7. Ciliary processes.—8. Iris.—9. Retina.—10. Jacob's membrane.—11. Anterior chamber.—12. Posterior chamber.—13. Membrane of the aqueous chamber.—14. Aqueous humour.—15. Hyaloid membrane.—16. Canal of Stilling.—17. Canal of Petit.—18. Vitreous humour.—19. Capsule of the lens.—20. Fluid of Morgagni.—21. Lens.

Pl. 44.

Fig. 1.



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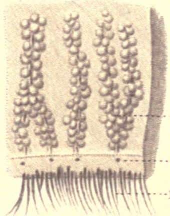

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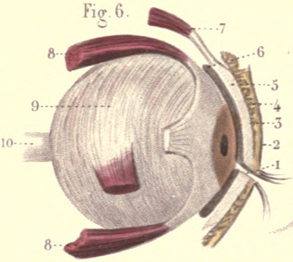

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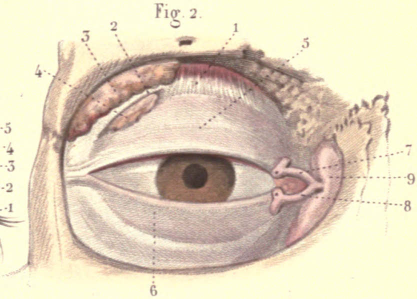

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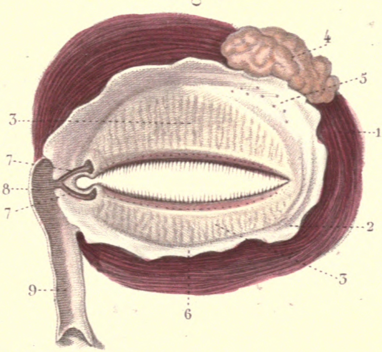

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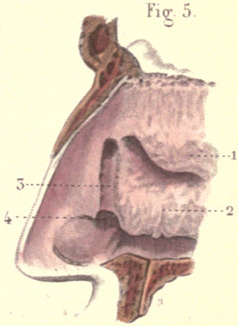
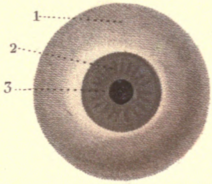


Léveillé del.

Davesne sc.

Pl. 44 bis.

Fig. 1.



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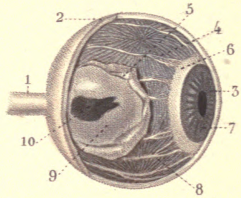

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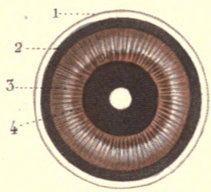

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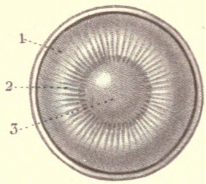

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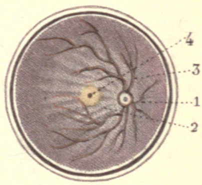

Fig. 6.

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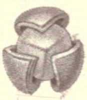

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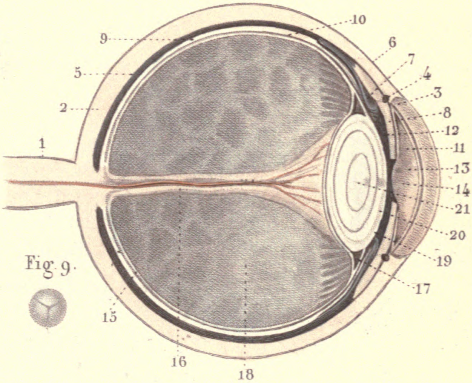


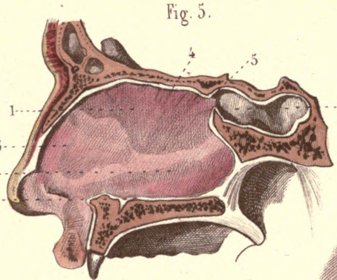
Fig. 8.

Fig. 9.

Léveillé del. *Davesne sc.*

Pl. 45.

Fig. 5.



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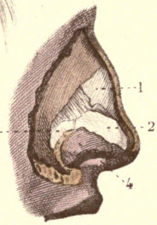

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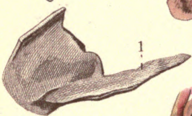

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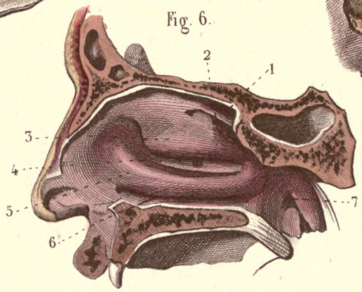

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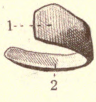
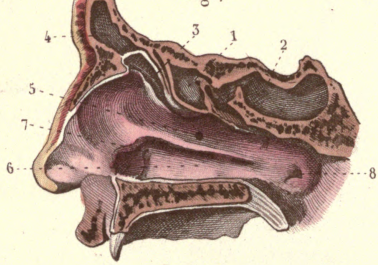


Fig. 3.

Fig. 7.



Léveillé del. *Corbié sc.*

PLATE XLV.

SPLANCHNOLOGY, PLATE III.

Fig. 1. Cartilages of the Nose.

1. Upper lateral cartilage.—2. Lower lateral cartilage.—3. Sesamoid cartilages.—4. Cellular tissue.

Fig. 2. Lower lateral Cartilages.

1. External lamina.—2. Internal lamina.

Fig. 3. Upper lateral Cartilage, detached.

Fig. 4. Cartilage of the Septum.

1. Posterior prolongation.

Fig. 5. Section of Nasal Fossæ, to show the Cartilage of the Septum.

1. Perpendicular plate of ethmoid.—2. Vomer.—3. Cartilage of septum.—4. Roof of nasal fossa.—5. Opening of sphenoidal cells.—6. Sphenoidal sinus.—7. Floor of nasal fossa.

Fig. 6. External Wall of Nasal Fossa: Turbinated Bones and Meatuses.

1. Superior turbinated bone.—2. Superior meatus.—3. Middle turbinated bone.—4. Middle meatus, showing the opening of the antrum.—5. Inferior turbinated bone.—6. Inferior meatus.—7. Orifice of Eustachian tube.

Fig. 7. The Turbinated Bones, broken away to show the communication of the Meatuses.

1. Ethmoidal cells, opening into the superior meatus.—2. Sphenoidal sinus.—3. Anterior ethmoidal cells, opening into the middle meatus. This also communicates with—4. The frontal sinus, and—5. The antrum.—6. Inferior meatus, having opening into it—7. The nasal duct; and behind it—8. Orifice of Eustachian tube.

PLATE XLVI.

SPLANCHNOLOGY, PLATE IV.

Fig. 1.—The Ear.—Pinna.

1. Helix.—2. Fossa of helix.—3. Antihelix.—4. Fossa of Antihelix.—5. Tragus.—6. Anti-tragus.—7. Concha.—8. Lobule.

Fig. 2.—Muscles of Pinna.

1. Process of the helix, to which is attached the anterior ligament of the pinna, and the attrahens aurem.—2. Helicis major.—3. Helicis minor.—4. Tragicus.—5. Anti-tragicus.

Fig. 3. Cartilage of Pinna (*internal aspect*).

1. Transversus auriculæ.

Fig. 4. External Ear.—Pinna and External Auditory Meatus.

1. Pinna in profile, seen from behind.—2. Osseous portion of auditory canal.—3. Cartilaginous portion.—4. Membranous portion.

Fig. 5.—1. Tympanic ring.—2. Membrana tympani.

Fig. 6. Internal Wall of Tympanum.

1. Bony projection, showing the position of the aqueductus Fallopii.—1′. Continuation of the aqueductus Fallopii.—2. Fenestra ovalis.—3. Promontory.—4. Fenestra rotunda.—5. Canal for tensor tympani.—6. Eustachian tube.—7. Orifices of mastoid cells.—7′. Mastoid cells.—8. Foramen of pyramid.

Fig. 7. Ossicles of Tympanum.

1. Malleus.—2. Incus.—3. Os orbiculare.—4. Stapes.—5. Base of stapes.

Fig. 8. Muscles of the Tympanum.

1. Tensor Tympani.—2. Laxator tympani.—3. Stapedius.

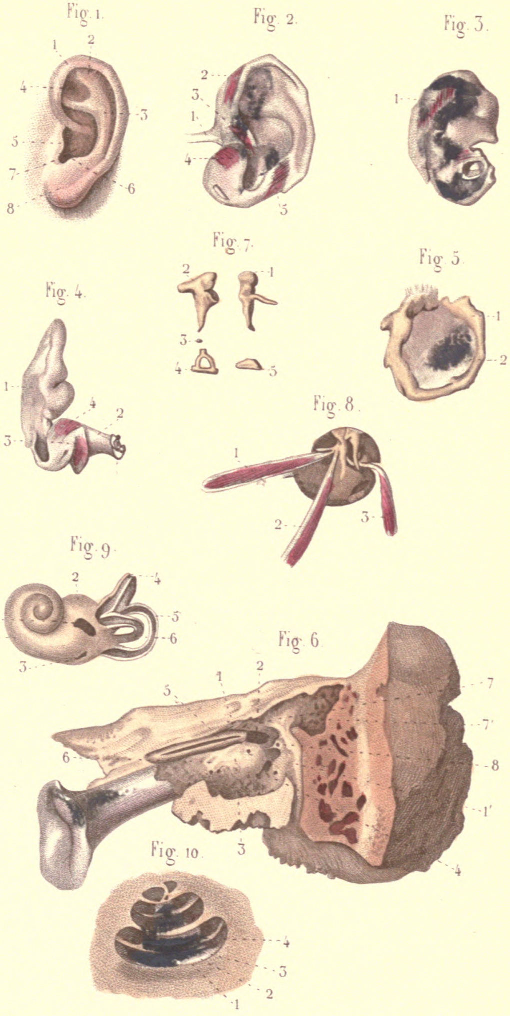
Fig. 9. Internal Ear, or Labyrinth.

1. Fenestra ovalis.—2. Vestibule.—3. Fenestra rotunda.—4. Superior semicircular canal.—5. Posterior semicircular canal.—5. External semicircular canal.—7. Cochlea.

Fig. 10. Cochlea laid open.

1. Outer wall of cochlea.—2. Lamina spiralis.—3. Scala tympani.—4. Scala vestibuli.

Pl. 46.

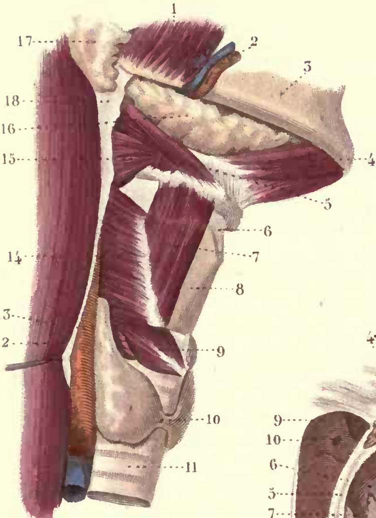


Léveillé del.

Corbié sc.

Pl. 47.

Fig. 1.



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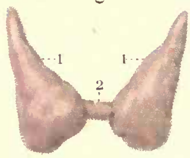

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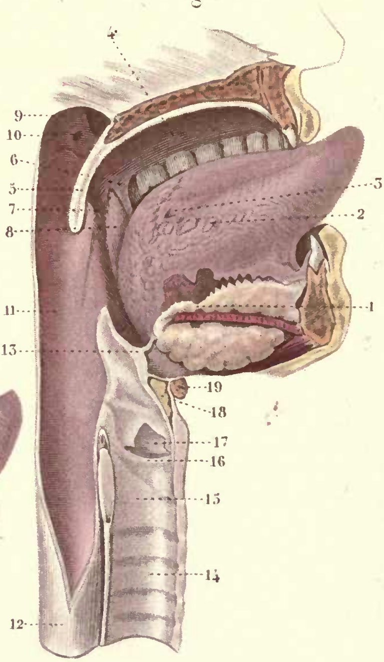

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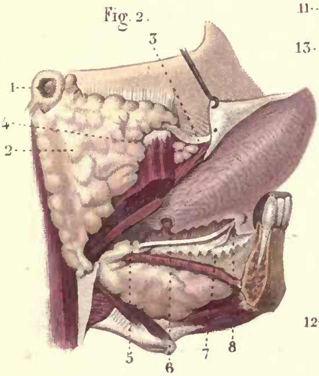

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PLATE XLVII.

SPLANCHNOLOGY, PLATE V.

Fig. 1. Salivary Glands. — Thyroid Body. — Mouth.— Pharynx, etc.

1, 1. Lower part of masseter.—2. Facial vessels.—3. Lower jaw.—4. Anterior belly of digastric.—5. Stylo-hyoid, at the lower border of which is seen part of the posterior belly of the digastric.—6. Thyro-hyoid membrane.—7. Thyro-hyoid muscle.—8. Thyroid cartilage.—9. Crico-thyroid muscle and membrane.—10. Thyroid body.—11. Trachea.—12. Sterno-cleido-mastoid drawn aside, showing—13. The common carotid artery.—14. Inferior constrictor of the pharynx.—15. Middle constrictor.—16. External portion of sub-maxillary gland.—17. Inferior part of parotid gland.—18. Process of deep cervical fascia, separating these two glands.

Fig. 2. Salivary Glands of the right side.

The body of the lower jaw is removed, and the tongue drawn forward.

1. External auditory meatus.—2. Parotid gland.—3. Steno's duct, its orifice on the mucous surface of the cheek is shown, the membrane being raised by a hook.—4. Buccal glands.—5. Sub-maxillary gland, divided by the mylo-hyoid muscle.—6. Wharton's duct.—7. Riviniani's duct.—8. The junction of these ducts and the papilla at which they end, on the floor of the mouth.

Fig. 3. Thyroid Body, removed from the Larynx.

1, 1. Lateral lobes.—2. Isthmus.

Fig. 4. Vertical Section, showing the left side of the Mouth, Pharynx, and Larynx.

The dorsum linguæ is turned towards the right side, and the sub-maxillary and sub-lingual glands are retained in position.

1. Limit of the sub-maxillary and sub-lingual glands; this last covers Wharton's duct.—2. Circumvallate papillæ.—3. Foramen cæcum.—4. Palatine arch.—5. Velum pendulum palati, terminating in the uvula.—6. Anterior pillar of fauces.—7. Posterior pillar.—8. Tonsil.—9. Posterior nares.—10. Orifice of Eustachian tube.—11. Pharynx.—12. Commencement of œsophagus.—13. Epiglottis, attached to the base of the tongue by a fold of mucous membrane (glosso-epiglottidean).—14. Trachea.—15. Larynx.—16. True vocal cord.—17. Ventricle of larynx (the false vocal cord is removed to show the depth of the ventricle).—18. Fatty mass, bounded by the epiglottis behind, thyroid cartilage and thyro-hyoid membrane in front, and hyo-epiglottidean membrane above.—19. Hyoid bone, cut.

PLATE XLVIII.

SPLANCHNOLOGY, PLATE VI.

Fig. 1. Pharynx opened behind.

1. Internal pterygoid muscle.—2. Stylo-pharyngeus.—3 and 4. Posterior openings of the nasal fossæ.—5. Velum pendulum palati and uvula.—6. Anterior pillar, and—7. Posterior pillar, forming together and with the base of the tongue—8. The fossa for the tonsil.—9. Posterior opening of the mouth.—10. Base of the tongue.—11. Superior opening of larynx.—12. Posterior surface of larynx.—13. Commencement of trachea.

Fig. 2. Thyroid Cartilage.

1. Oblique line.—2. Upper cornu.—3. Lower cornu.

Fig. 3. Cricoid Cartilage.

Fig. 4. Arytenoid Cartilage, seen from behind.

Fig. 5. Epiglottis.

Fig. 6. Vertical Section of Larynx, seen from the side.

1. Superior, or false vocal cord (*left side*).—2. Inferior, or true vocal cord.—3. Ventricle of larynx.

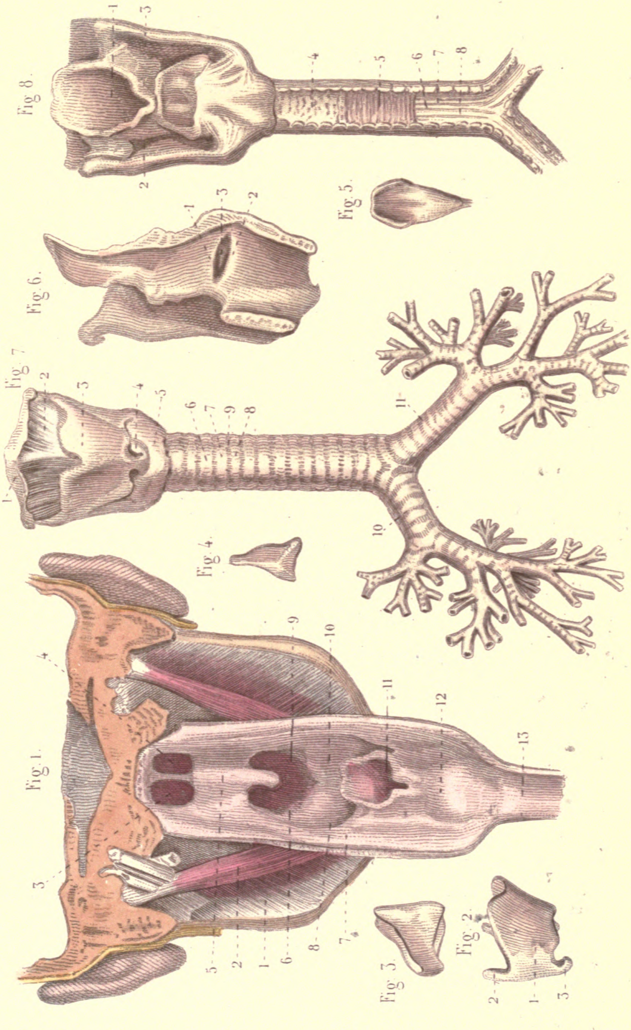
Fig. 7. Larynx, Trachea, and Bronchi, seen from the front.

1. Hyoid bone.—2. Thyro-hyoid membrane.—3. Thyroid cartilage.—4. Crico-thyroid membrane.—5. Cricoid cartilage.—6. Trachea.—7 and 8. Cartilaginous rings of trachea.—9. The membrane which separates them.—10. Right bronchus and its divisions.—11. Left bronchus.

Fig. 8. Larynx, Trachea, and Bronchi, seen from behind.

1. Superior opening of larynx.—2 and 3. Lateral sinuses of larynx. 4. Fibrous membrane of the trachea, studded with small glandular bodies, underneath which is seen—5. A muscular membrane (*trachealis*), beneath which are—6 and 7. Small fibrous bands, which support—8. The mucous membrane seen through these bands.

Pl. 48.



Léveillé del.

Annedouche sc.

Pl. 49.

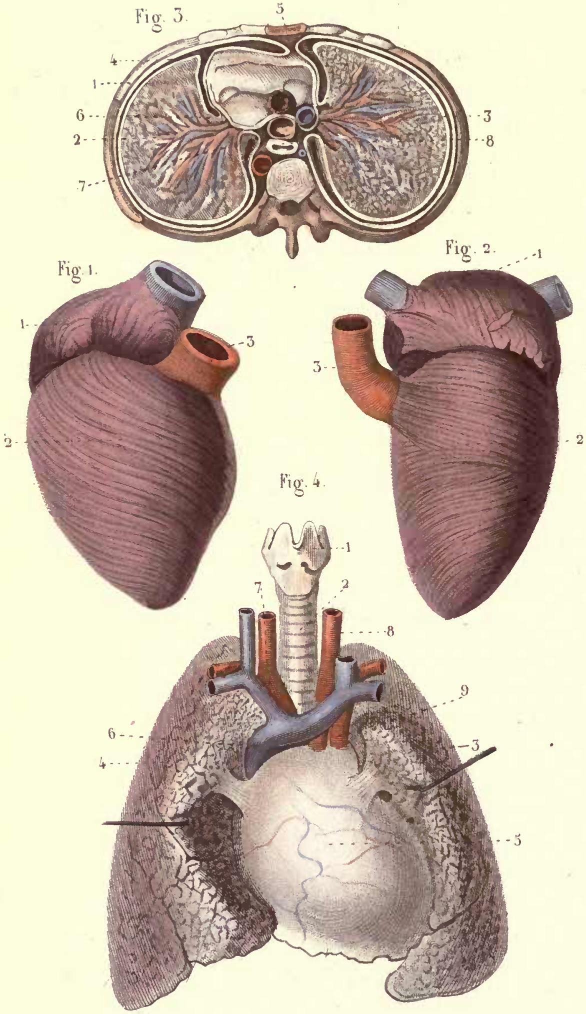


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PLATE XLIX.

SPLANCHNOLOGY, PLATE VII.

Fig. 1. Right side of Heart, seen from the front, showing its Fibres.

1. Right auricle, passing into the upper part, of which is seen the vena cava superior.—2. Right ventricle.—3. Pulmonary artery.

Fig. 2. Left side of the Heart, seen from the front, showing its Fibres.

1. Left auricle and pulmonary veins.—2. Left ventricle.—3. Aorta.

Fig. 3. Transverse Section of the Thorax, showing the reflexion of the Pleura, etc.

1. Heart in the pericardium.—2 and 3. Lungs.—4. The left pleura, reflected off the costal cartilages and border of sternum, forming, with the right pleura similarly reflected, the sternum in front and the pericardium behind—5. The anterior mediastinum. The pleura is next reflected over—6. The anterior part of the root of the lung, and all the surface of the lung; next, over—7. The posterior part of the root of the lung, and on to the sides of the vertebral column (*ligamentum latum pulmonis*), forming, with the pleura of the opposite side—8. The posterior mediastinum, containing the œsophagus, etc.; next, it lines the internal surface of the walls of the chest, and returning to the point from which its reflexion was first traced, makes a shut sac.

Fig. 4. Larynx.—2. Trachea, Pericardium, and Lungs, seen from the front.

1. Larynx.—2. Trachea.—3 and 4. Lungs.—5. Pericardium.—6. Vena cava superior, formed by the innominate veins.—7. Innominate artery.—8. Left common carotid artery.—9. Left subclavian artery.

PLATE L.

SPLANCHNOLOGY, PLATE VIII.

Fig. 1. HEART, SEEN FROM THE FRONT.

1. Right auricle.—2. Auricular appendix.—3. Superior vena cava.—4. Inferior vena cava.—5. Left auricle.—6. Auricular appendix. 7 and 8. Pulmonary veins.—9. Auriculo-ventricular groove, containing the coronary vessels.—10. Groove, separating the two ventricles.—11. Right ventricle.—12. Pulmonary artery.—13. Left ventricle.—14. Aorta.

Fig. 2. RIGHT SIDE OF HEART, OPENED TO SHOW ITS INTERNAL STRUCTURE.

1. Cavity of auricle.—2. Fossa ovalis.—3. Eustachian valve.—4. Coronary sinus.—5. Cavity of ventricle, showing the columnæ carneæ.—6. One of the flaps of the tricuspid valve.—7. Pulmonary artery, showing two of its semilunar valves.

Fig. 3. LEFT SIDE OF HEART OPENED.

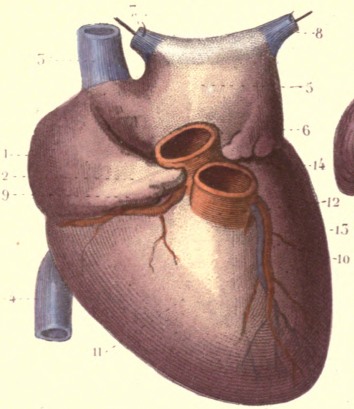
1. Cavity of auricle, showing the openings of the pulmonary veins.—2. Cavity of ventricle.—3. Mitral valve.—4. Aorta, showing two of its semilunar valves.

Fig. 4. HEART FROM WHICH THE SEROUS MEMBRANE AND FAT HAVE BEEN REMOVED IN ORDER TO SHOW ITS FLESHY FIBRES.

1. Fibres common to the two auricles.—2. Fibres of right auricle. 3. Fibres of left auricle.—4. Fibres common to the two ventricles.—5. Foramina, giving passage to coronary vessels.—6. Apex of heart, where are seen the fibres common to both sides, superficial at first, and spiral in their arrangements. These fibres then penetrate into the interior of the heart, and form a deep layer.—7. Raphé, where the superficial fibres, anterior and posterior, common to the ventricles, interlace and become deep.—8 and 9. Openings of the pulmonary artery and aorta.

Pl. 50.

Fig. 1.



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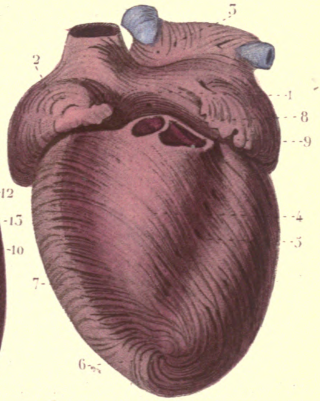

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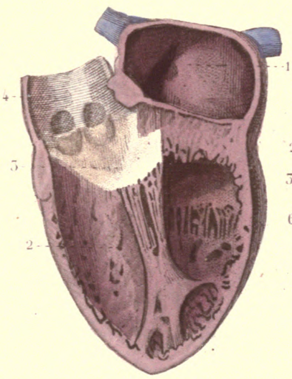

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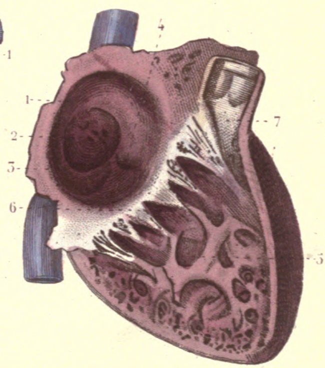

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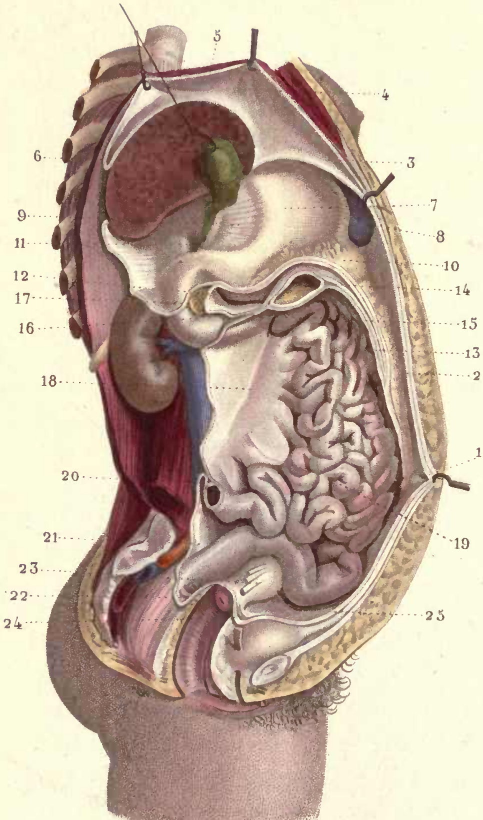
Pl. 51.



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Lebrun sc.

PLATE LI.

SPLANCHNOLOGY, PLATE IX.

PERITONEUM. SECTION OF ABDOMEN, SHOWING ITS REFLEXIONS.

1. Umbilicus.—2. Parietal layer of peritoneum.—3. Remains of umbilical vein.—4. Suspensory ligament of liver.—5. Diaphragm raised by hooks.—6. Reflexion of the peritoneum, from the under surface of the diaphragm on to the liver, forming the coronary ligament of the liver. The liver is cut vertically, and the gall-bladder raised.—7. Stomach, from the anterior surface of which the peritoneum is reflected over the spleen, forming—8. The gastro-splenic omentum.—9. The reflexion of peritoneum from the stomach over the liver, forming the gastro-hepatic omentum.—10. Great omentum. 11. Foramen of Winslow, bounded above by the lobulus Spigelli of the liver, below by the duodenum, in front by the lesser omentum, enclosing the vena portæ, hepatic artery and ductus communis choledochus, and behind by the vena cava inferior.—12. Cavity of lesser omentum.—13. Reflected portion of great omentum.—14. Reduplication of the great omentum to enclose the transverse colon.—15. Reunion of the two layers to form the transverse meso-colon; its superior layer covers partly—16. The duodenum, and—17. The pancreas, and ascends to the liver and the foramen of Winslow. Its inferior layer goes to form—18. The mesentery, which envelops—19. The small intestines.—20. The two layers of the mesentery and the small intestines, cut.—21. Meso-rectum.—22. Reflexion of the peritoneum, from the rectum over the vagina.—23. Large intestine, cut; below is shown the neck of the uterus and the vagina open.—24. Reflexion of the peritoneum from the uterus on to the posterior wall of the bladder.—25. Reflexion of the peritoneum over the remains of the urachus, forming the suspensory ligament of the bladder.

PLATE LII.

SPLANCHNOLOGY, PLATE X.

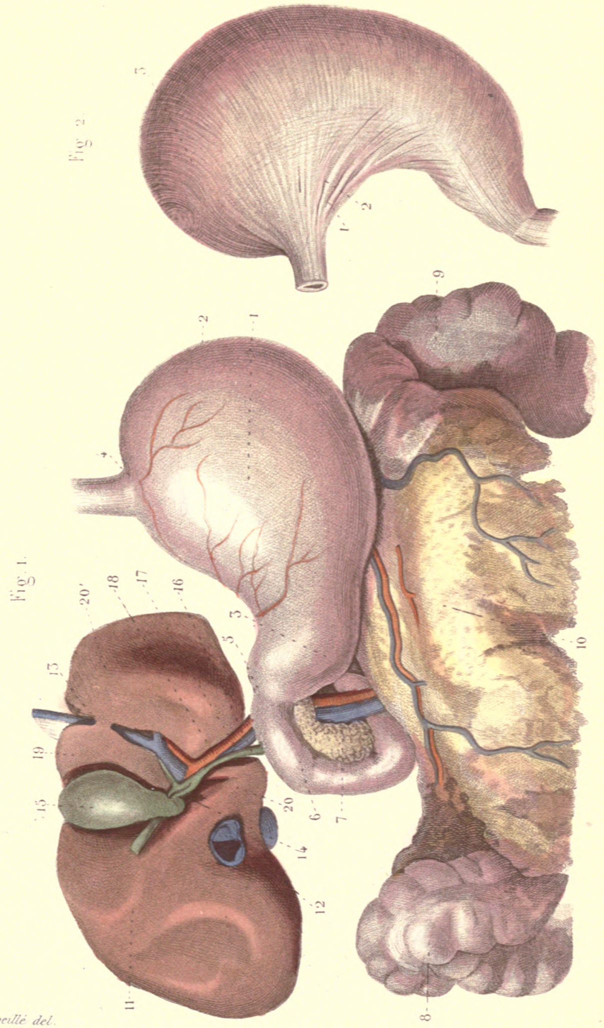
Fig. 1. Stomach and Duodenum seen in front, with the under Surface of the Liver.

1. Stomach.—2. Cardiac extremity.—3. Pyloric extremity.—4. Œsophageal orifice.—5. Pyloric orifice.—6. Duodenum.—7. Head of pancreas.—8 and 9. Portions of large intestine.—10. Portion of great omentum.—11. Inferior surface of right lobe of liver.—12. Fissure for vena cava inferior.—13. Fissure for the obliterated umbilical vein (longitudinal).—14. Fissure for the vena portæ (transverse), containing also the branches of the hepatic artery and duct.—15. Gall-bladder, terminating in the cystic duct, which afterwards unites with the hepatic duct, forming—16. The ductus communis choledochus.—17. Vena portæ.—18. Hepatic artery.—19. Lobulus quadratus.—20. Lobulus Spigelii.—20′. Left lobe.

Fig. 2. Stomach, from which the Serous Membrane has been removed to show the disposition of the Muscular Fibres.

1 and 2. Fibres descending from the œsophagus over the lesser curvature.—3. Muscular fibres distributed in various directions.

Pl. 32.



Léveillé del.

Corbié sc.

Pl. 53.

Fig. 3.

Fig. 1.

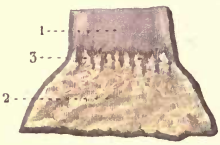


Fig. 2.

Léveillé del.

Corbié sc.

PLATE LIII.

SPLANCHNOLOGY, PLATE XI.

Fig. 1. PORTION OF ŒSOPHAGUS AND STOMACH, SEEN FROM THEIR INTERNAL SURFACE.

1. Mucous membrane of œsophagus.—2. Mucous membrane of stomach.—3. Line of separation between the stomach and œsophagus, marked by an irregularity in the folds of the mucous membrane at the œsophageal orifice.

Fig. 2. PYLORUS.

Fig. 3.—1. Convolutions of the small intestine.—2. Cæcum, receiving the termination of the small intestine, and having attached to it the appendix vermiformis cæci.—3. Ascending colon.—4. Transverse colon.—5. Descending colon.—6. Sigmoid flexure of colon.—7. Commencement of rectum.—8. Appendices epiploicæ.

PLATE LIV.

SPLANCHNOLOGY, PLATE XII.

Fig. 1. Portion of Small Intestine, opened to show the Vulvulæ Conniventes.

Fig. 2. Cæcum open.

1. Inferior extremity of ilium.—2. Appendix vermiformis.—3. Orifice of appendix vermiformis.—4. Opening of ilium, into the cæcum.—5 and 6. Portions of the ileo-cæcal valve.

Fig. 3. Spleen.

1 and 2. Indentations frequently seen in the margin of the spleen.—3 and 4. Hilus.

Fig. 4. Bile Ducts and Pancreatic Ducts, seen from behind.

1. Duodenum.—2. Gall-bladder open.—3. Crescentic folds of mucous membrane, disposed somewhat spirally.—4. Cystic duct.—5. Hepatic duct.—6. Ductus communis choledochus.—7. Pancreas.—8. Head of pancreas.—9. Pancreatic duct.

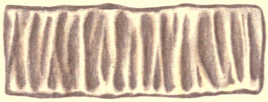
Fig. 5.—1. Kidney.—2. Supra-renal capsule.—3. Ureter.—4. Renal vein.—5. Renal artery.

Fig. 6. Section of Kidney.

1. Cortical substance.—2. Pyramid.—3. Calyx.—4. Pelvis of kidney.—5. Ureter.

Pl. 34.

Fig. 1.



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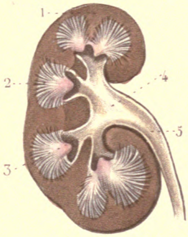
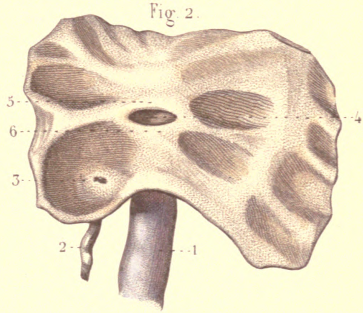


Fig. 2.



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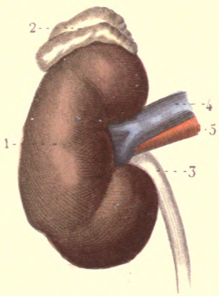


Fig. 3.

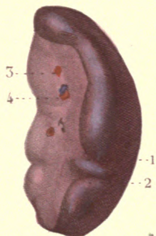
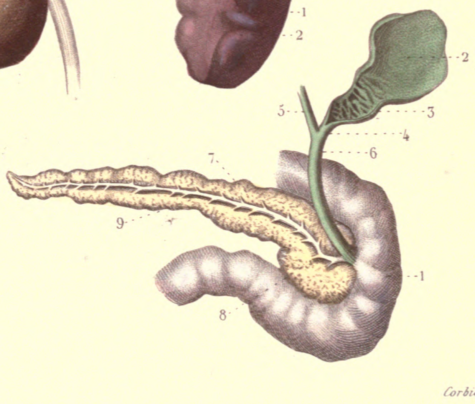


Fig. 4.



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Pl. 55.

Fig. 1.

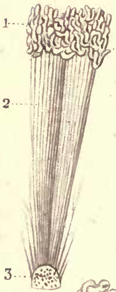


Fig. 4.

Fig. 3.

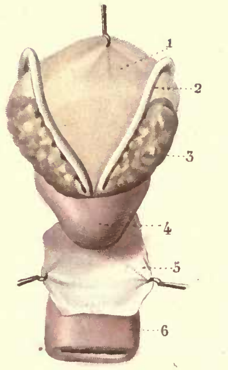


Fig. 5.

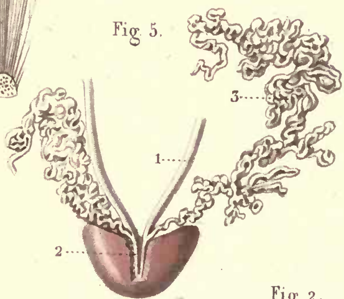
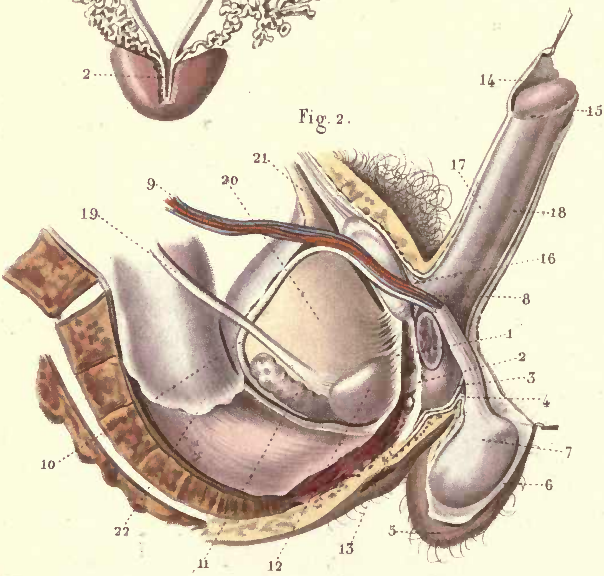


Fig. 2.



Léveillé del.

Giraud sc.

PLATE LV.

SPLANCHNOLOGY, PLATE XIII.

GENITO-URINARY ORGANS OF THE MALE, ETC.

Fig. 1. STRUCTURE OF KIDNEY.

1. Cortical substance.—2. Medullary substance.—3. Openings of the tubes at the summit of a pyramid into a calyx.

Fig. 2. SIDE VIEW OF PELVIC VISCERA.

The right side of the pelvis is removed by a section through the middle of the sacrum and symphysis pubis.

1. Pelvic fascia, forming the anterior true ligaments of the bladder (pubo-prostatic).—2. Triangular ligament (deep perinæal fascia).—3. Deep layer of superficial fascia.—4. Superficial layer of superficial fascia.—5. Scrotum.—6. Dartos.—7. Testicle enclosed in the tunica vaginalis.—8. Spermatic cord.—9. Spermatic vessels.—10. Vas deferens.—11. Vesicula seminalis.—12. Prostate. — 13. Cowper's gland.—14. Prepuce.—15. Frænum preputii.—16. Suspensory ligament of penis.—17. Corpus cavernosum penis.—18. Canal of the urethra. The membranous portion is seen behind, between the two layers of the triangular ligament (1 and 2) (pelvic fascia and deep perinæal), and the bulbous portion or bulb is seen in front of the anterior layer of triangular ligament (Fig. 2) covered by the deep layer of superficial fascia.—19. Ureter.—20. Bladder.—21. Urachus. —22. Rectum. The peritoneum is shown reflected from the bladder on to the rectum, and below is seen the anus and the external sphincter.

Fig. 3. THE BLADDER IS HOOKED FORWARD AND THE RECTUM PULLED BACKWARDS.

1. Inferior surface of bladder (base).—2. Vas deferens.—3. Vesicula seminalis.—4. Prostate.—5. Layer of fascia separating the bladder from—6. The rectum.

Fig. 4. THIS PLATE SHOWS THE POSITION OF THE OPENINGS INTO THE PROSTATIC URETHRA, AND THE EJACULATORY DUCTS.

1. Prostate.—2. Neck of bladder. The process of fascia reflected off the bladder and enveloping the gland (*capsule*) has been removed. —3. Entrance of ejaculatory duct.

Fig. 5.—1. Vas deferens.—2. Ejaculatory duct. The prostate is opened to show its position.—3. Vesicula seminalis partly unravelled.

PLATE LVI.

SPLANCHNOLOGY, PLATE XIV.

GENITO-URINARY ORGANS OF THE MALE.

Fig. 1. COVERINGS OF THE TESTICLE.

1. Scrotum.—2. Dartos.—3. Intercolumnar fascia (derived from the intercolumnar fibres of external oblique).—4. Cremaster muscle. —5. Inguinal canal, open.

Fig. 2.—1. Fibrous coat.—2. Spermatic cord.—3. Tunica vaginalis testis.—4. Right testicle.—5. Epididymis.

Fig. 3. SECTION OF TESTICLE.

1. Tunica albuginea.—2. Lobules of testicle.—3. Vasa recta.—4. Mediastinum testis, or corpus Highmoriani.—5. Vasa efferentia.—6. Epididymis.—7. Vas deferens.—8. Vessels of spermatic cord.

Fig. 4. VERTICAL SECTION OF TESTIS.

1. Testicle.—2. Epididymus.—3. Spermatic cord.

Fig. 5. BLADDER, SEEN FROM THE RIGHT SIDE.

1. Symphysis pubis.—2. Muscular coat of bladder, and urachus.—3. Ureter.—4. Vas deferens.—5. Vesicula seminalis.—6. Prostate.—7. Membranous portion of urethra.—8. Bulb.—9. Vascular plexus (prostatic).

Fig. 6. CORPUS CAVERNOSUM PENIS, SEEN FROM BELOW.

1. Urethra and bulb, cut.—2. Triangular ligament (anterior layer). —3, 3. Crura penis.—4. Corpus cavernosum.

Fig. 7. TRANSVERSE SECTION OF PENIS.

1. Skin; under the skin are seen the dorsal vessels and nerve of the penis.—2. Fibrous investment of corpus cavernosum.—3. Septum pectiniforme.—4. Urethra.—5. Corpus cavernosum.—6. Artery of corpus cavernosum.

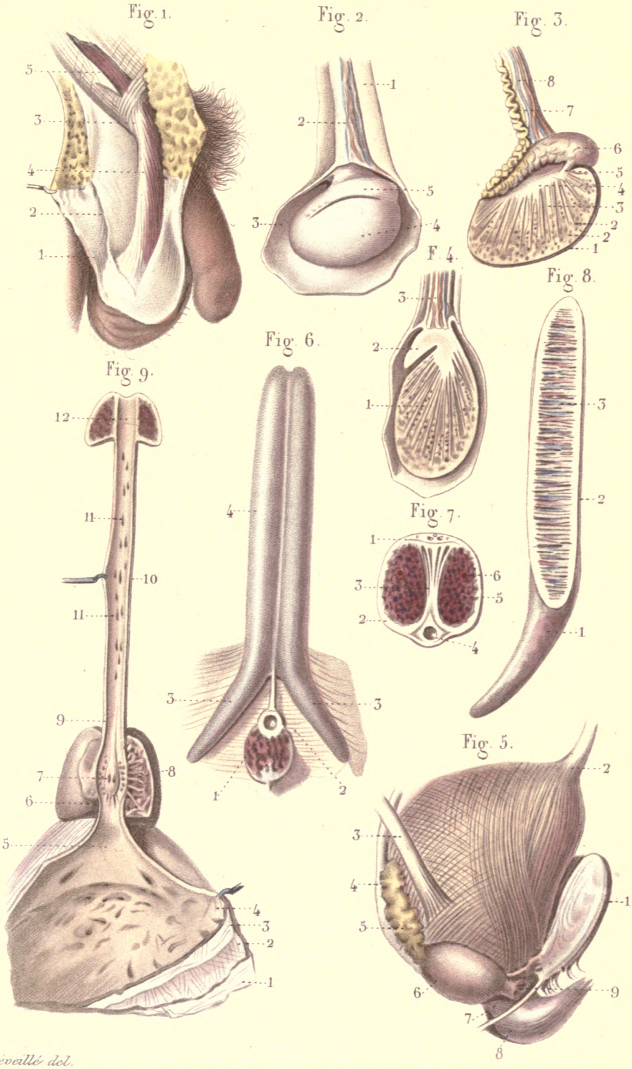
Fig. 8. THE RIGHT HALF OF THE CORPUS CAVERNOSUM IS REMOVED.

1. Left crus penis.—2. Fibrous investment of corpus cavernosum. —3. Septum.

Fig. 9. THE BLADDER AND URETHRA ARE SPLIT OPEN ABOVE.

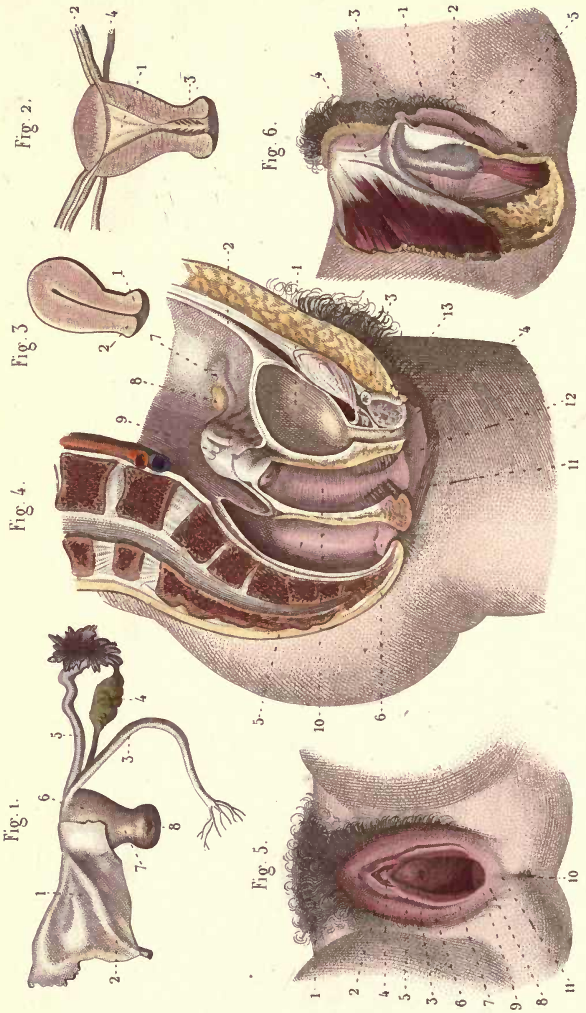
1. Peritoneum.—2. Muscular coat of bladder.—3. Cellular coat.—4. Mucous membrane of bladder.—5. Trigonum vesicæ, bounded by the orifices of the ureters and the opening of the urethra.—6. Prostatic portion of urethra.—7. Veru montanum, with the common ejaculatory ducts opening on its sides—8. Prostatic ducts. —9. Membranous portion of urethra.—10. Spongy portion.—11, 11. Lacunæ.—11. Fossa navicularis.

Pl. 56.



Léveillé del. *Giraud sc*

Pl 57.



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Corbié sc.

PLATE LVII.

SPLANCHNOLOGY, PLATE XV.

Fig. 1. Organs of Generation of the Female.

1. Broad ligament of the uterus.—2 and 3. Round ligament of uterus.—4. Ovary and its ligament.—5. Fallopian tube, terminated by a fimbriated extremity (*morsus diaboli*).—6. Uterus.—7. Neck of uterus.—8. Os tincæ.

Fig. 2. Section of Uterus (*posterior half*).

1. Cavity of uterus.—2. Fallopian tubes.—3. Neck of uterus, showing the *arbor vitæ.*—4. Ligament of ovary.

Fig. 3. Lateral Section of Uterus (*left half*).

1. Anterior lip of os tincæ.—2. Posterior lip.

Fig. 4. Side View of Female Pelvis.

1. Bladder.—2. Urachus.—3. Anterior ligament of bladder.—4. Urethra.—5. Rectum.—6. Folds at the inferior extremity of rectum.—7. Fallopian tube.—8. Ovary.—9. Uterus; the peritoneum, shown reflected from it over the bladder and rectum.—10. Vagina.—11 and 12. Anterior and posterior walls of vagina.—13. Clitoris.

Fig. 5. External Organs of Generation, Pudenda.

1. Mons veneris.—2. Labia majora.—3. Labia minora. As these converge towards the glans clitoridis, they divide into two folds, the superior forming the præputium clitoridis, and the inferior going to the base of the glans clitoridis, and forming the frænum.—4. Clitoris.—5. Vestibule.—6. Meatus urinarius.—7. Entrance to the vagina.—8. Fourchette.—9. Fossa navicularis.—10. Anus.—11. Perinæum.

Fig. 6.—1 and 2. Labia minora.—3. Clitoris, crus and glans.—4. Suspensory ligament of clitoris.—5. Bulb of vagina (*semi-bulb*), terminating in the glans clitoridis.

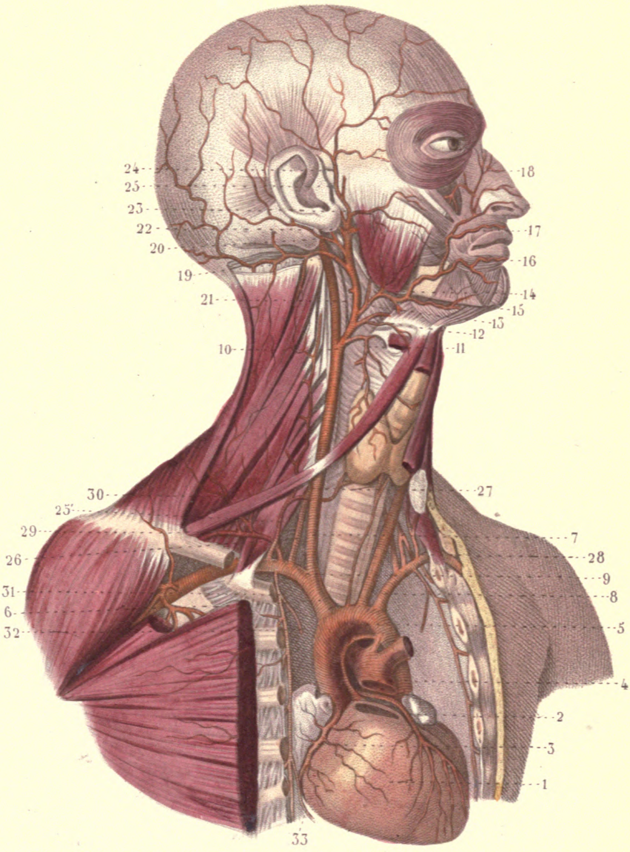
PLATE LVIII.

VASCULAR SYSTEM, PLATE I.

HEART; ARCH OF AORTA; INNOMINATE, CAROTID AND SUBCLAVIAN ARTERIES, ETC.

1. Heart.—2. Anterior coronary artery.—3. Posterior coronary artery.—4. Pulmonary artery, cut.—5. Arch of aorta.—6. Innominate.—7. Right common carotid.—8. Left subclavian.—9. Division of innominate into subclavian and common carotid.—10. Division of common carotid into external and internal carotid.—11. Superior thyroid and its principal branches.—12. Lingual.—13. Facial.—14. Inferior palatine.—15. Submental.—16. Inferior coronary.—17. Superior coronary.—18. Lateralis nasi.—19. Occipital and its mastoid branch.—20. Posterior auricular and its stylomastoid branch.—21. Ascending pharyngeal.—22. Division of external carotid into internal maxillary and superficial temporal.—23. Transverse facial.—24. Anterior auricular.—25. Middle temporal.—25′. Inferior thyroid and ascending cervical.—26. Vertebral.—27. Position of transverse process of sixth cervical vertebra, where the vertebral artery enters its canal.—28. Superior intercostal.—29. Supra-scapular.—30. Transversalis colli.—31. Internal mammary.—32. Anterior mediastinal.—33. Musculo-phrenic.

Pl. 58.



Léveillé del. *Choubard sc.*

Pl. 59.

Fig. 2.

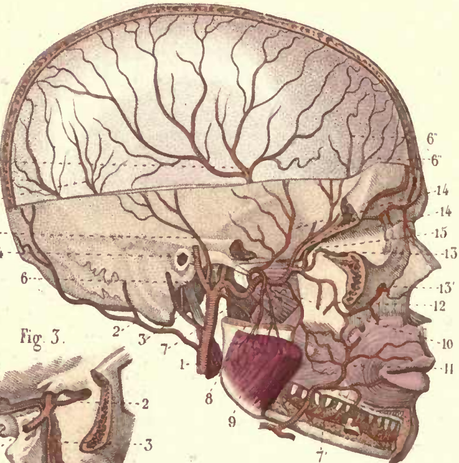
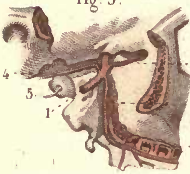


Fig. 3.



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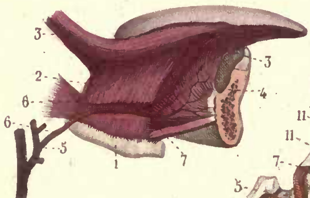

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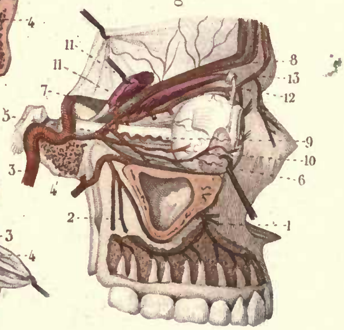
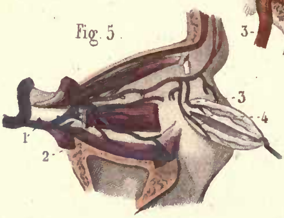


Fig. 5.



Léveillé del.

Choubard sc.

PLATE LIX.

VASCULAR SYSTEM, PLATE II.

Fig. 1. Lingual Artery.

1. Hyoid bone.—2. Hyo-glossus, cut to show the course of the lingual artery. — 3, 3. Stylo-glossus. — 4. Genio-hyo-glossus.—5. External carotid.—6. Lingual.—6′. Dorsalis linguæ.—7. Sublingual.

Fig. 2. Internal Maxillary.

The left side of the cranium, the superior part of the lower jaw, and the external wall of the orbit have been removed.

1. External carotid.—2. Occipital and its mastoid branch.—3. Posterior auricular and its stylo-mastoid branch.—4. Superficial temporal and anterior auricular branches.—5. Middle temporal.—6. Internal maxillary, middle meningeal, and lesser meningeal.—6′. Divisions of the middle meningeal.—6″, 6″. Anterior meningeal branches of the ophthalmic.—6‴, 6‴. Posterior meningeal.—7. Inferior dental.—8. Masseteric.—9. Pterygoid.—10. Buccal.—11. Facial, anastomosing with the buccal.—12. Alveolar and posterior dental branches.—13. Infra-orbital.—13′. Infra-orbital, emerging from the infra-orbital foramen.—14, 14. Deep temporal.—15. Internal maxillary, disappearing in the pterygo-maxillary fossa.

Fig. 3. Internal Maxillary in the Pterygo-maxillary Fossa.

1. External pterygoid plate.—2. Infra-orbital.—3. Descending palatine.—4. Vidian.—5. Pterygo-palatine.

Fig. 4. Ophthalmic Artery.—Side of orbit removed, and carotid canal opened.

1. Anterior dental artery in its canal.—2. Posterior dental branches.—3. Internal carotid.—4. Ophthalmic.—5. Arteria centralis retinæ.—6. Lachrymal.—7. Muscular.—8. Supra-orbital.—9. Long ciliary.—10. Anterior ciliary.—11, 11. Ethmoidal, giving off the anterior meningeal.—12. Palpebral.—13. Termination of ophthalmic in frontal and nasal.

Fig. 5. Ophthalmic Artery; the Eye-ball removed.

1. Ophthalmic.—2. Inferior muscular.—3. Superior palpebral.—Inferior palpebral.

PLATE LX.

VASCULAR SYSTEM, PLATE III.

Fig. 1. ARTERIES OF THE CEREBRUM, CEREBELLUM, ETC.

1. Anterior lobe of cerebrum.—2. Middle lobe.—3. Fissure of Sylvius.—4. Pons Varolii.—5. Cerebellum.—6. Medulla oblongata.—7. Internal carotid.—8. Posterior communicating.—8′. Anterior choroid.—9. Anterior cerebral.—10. Anterior cerebral.—11. Anterior communicating.—12. Vertebral.—13. Posterior inferior cerebellar.—14. Basilar.—15. Anterior inferior cerebellar.—16. Superior cerebellar.—17. Posterior cerebral.

Fig. 2. VERTEBRAL AND DEEP CERVICAL ARTERIES.

1. Subclavian.—2. Common trunk of the vertebral and deep cervical arteries.—3. Vertebral artery in its canal.—4. Vertical curvature of the vertebral artery.—5. Horizontal curvature.—6. Vertebral artery in the cranium.—7. Basilar and branches.—8. Deep cervical.—9 and 10. Anastomoses of this artery with the vertebral.—11. Inter-spinalis muscle.

Fig. 3. ARCH AND THORACIC PORTION OF AORTA.

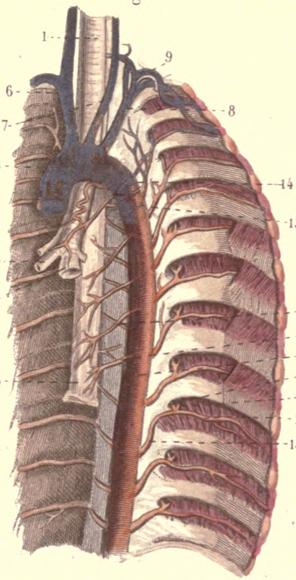
1. Trachea.—2 and 3. Bronchi.—4. Œsophagus.—5. Arch of aorta.—6. Innominata.—7. Left common carotid.—8. Left subclavian.—9. Superior intercostal.—10. Thoracic aorta.—11 and 12. Œsophageal branches.—13 and 14. Bronchial artery.—15 and 16. Aortic intercostals.—17. Dorsal branch, giving off—18. Spinal branches.

Fig. 4. SPINAL ARTERIES.—The bodies of the vertebræ and the vertebral canal are open in front.

1. Spinal cord and its membranes.—2. Intercostal artery.—3. Spinal branches.

Pl. 60.

Fig. 3.



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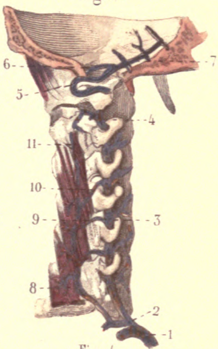
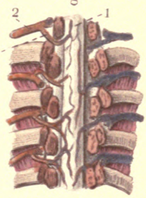


Fig. 4



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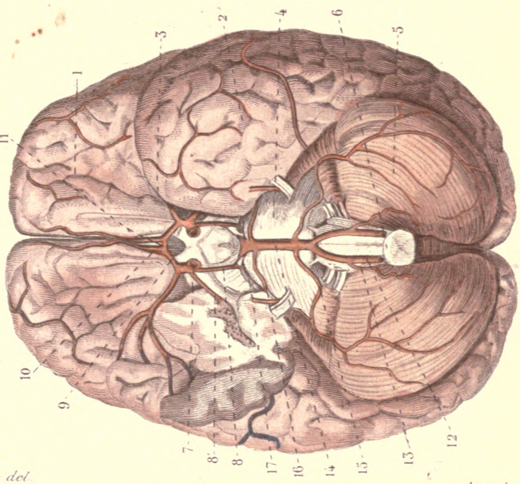


Léveillé del.

Annedouche sc.

Pl. 61.

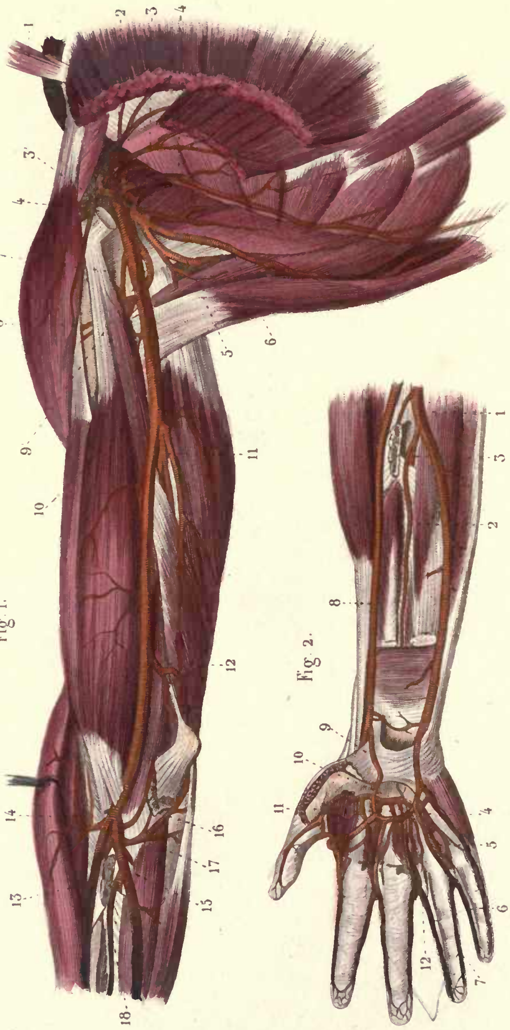


Fig. 1. Fig. 2.

Léveillé del. Corbié sc.

PLATE LXI.

VASCULAR SYSTEM, PLATE IV.

Figs. 1 and 2. ARTERIES OF THE AXILLA—ARM AND HAND.

Fig. 1.—1. Scalenus anticus muscle, passing in front of the subclavian artery.—2 and 3. Anterior thoracic.—3′. Acromio-thoracic. 4. Long thoracic, or external mammary.—5. Sub-scapular, giving off the dorsalis scapulæ.—6. Anterior division of the subscapular.—7 and 8. Anterior circumflex.—9. Posterior circumflex.—10. Brachial.—11. Superior profunda.—12. Anastomatica magna.—13. Radial.—14. Radial recurrent.—15. Ulnar.—16. Anterior ulnar recurrent.—17. Branch of anterior ulnar recurrent to pronator radii teres.—18. Anterior interrosseous.

Fig. 2.—1. Ulnar.—2. Anterior interosseous.—3. Posterior interosseous.—4. Superficial palmar arch.—5, 6, and 7. Digital arteries.—8. Radial.—9. Superficialis volæ.—10. Deep palmar arch.—11. Posterior perforating.—12. Anterior perforating.

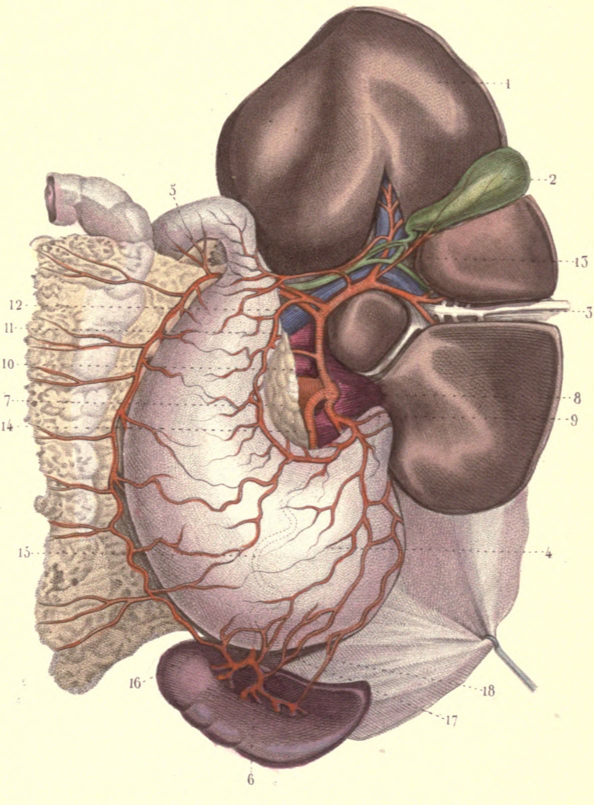
PLATE LXII.

VASCULAR SYSTEM, PLATE V.

Cæliac Axis.—The liver is turned up so as to show its inferior surface.

1. Liver.—2. Gall bladder.—3. Remains of umbilical vein.—4. Stomach.—5. Commencement of duodenum.—6. Spleen.—7. Pancreas.—8. Cæliac axis.—9. Gastric, or coronaria ventriculi, giving off œsophageal branches, and coursing along the lesser curvature of the stomach.—10. Hepatic.—11. Pyloric.—12. Gastro-epiploica dextra, descending behind the duodenum, and coursing along the greater curvature of the stomach.—13. Cystic.—14. Splenic.—15. Dotted line showing the course of the splenic artery behind the stomach.—16. Gastro-epiploica sinistra.—17 and 18. Vasa brevia.

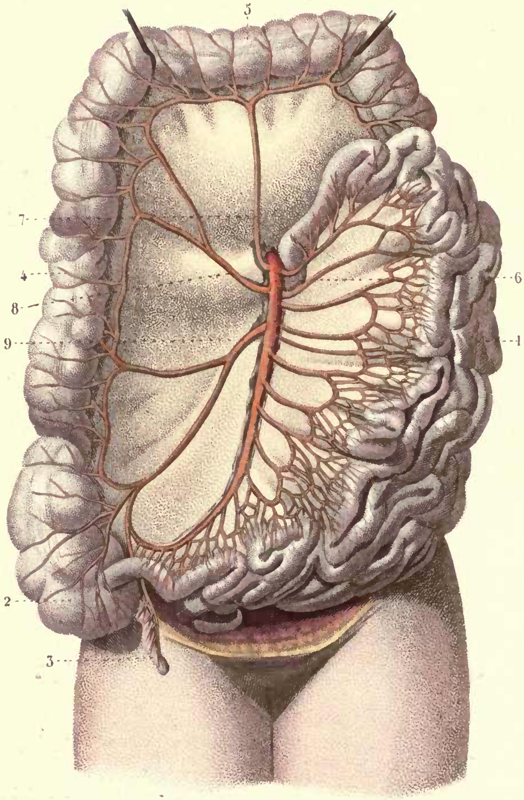
Pl 62.



Léveillé del.

Choubard sc.

Pl. 63.



Léveillé del. *Annedouche sc.*

LXIII.

VASCULAR SYSTEM, PLATE VI.

SUPERIOR MESENTERIC ARTERY.

1. Small intestine. — 2. Cæcum. — 3. Vermiform appendix.—4. Ascending colon.—5. Transverse colon.—6. Superior mesenteric artery, giving off branches.—7, 8, and 9. Colica dextra.

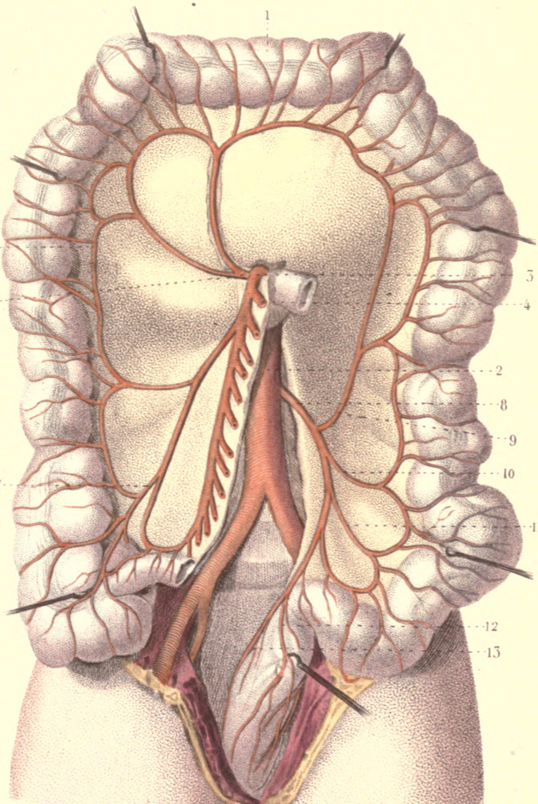
PLATE LXIV.

VASCULAR SYSTEM, PLATE VII.

DISTRIBUTION OF ARTERIES TO THE LARGE INTESTINE.

1. Large intestine. — 2. Aorta.—3. Superior mesenteric.—4. Branches to small intestine, cut close to origin.—5. Superior division of colica dextra.—6. Middle division of colica dextra.—7. Inferior division of colica dextra.—8. Inferior mesenteric.—9 and 10. Colica sinistra.—11. Sigmoidea.—12 and 13. Superior hæmorrhoidal.

Pl. 64.



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Pl. 65.

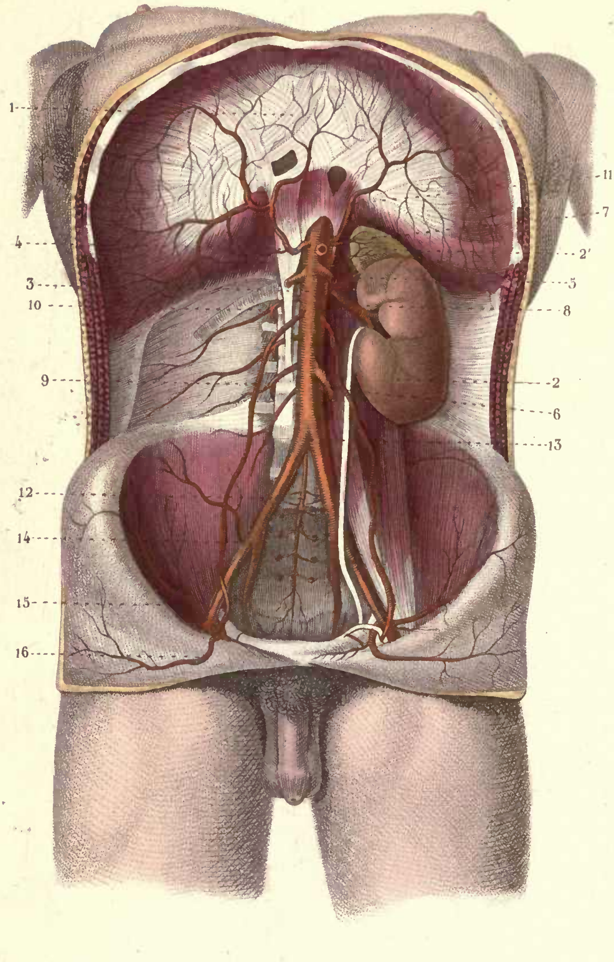

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PLATE LXV.

VASCULAR SYSTEM, PLATE VIII.

ABDOMINAL AORTA AND BRANCHES.

1. Diaphragm.—2. Kidney.—2′. Supra-renal capsule.—3. Aorta. —4. Cæliac axis, cut.—5. Superior mesenteric, cut.—6. Inferior mesenteric, cut.—7. Arterial supply of supra-renal capsule.—8. Renal. —9. Spermatic.—10. Lumbar.—11. Phrenic or diaphragmatic.—12. Middle sacral.—13. Division of aorta into the common iliacs.—14. Division of common iliac into external and internal iliac.—15. Circumflex iliac (*deep*).—16. Epigastric (*deep*).

PLATE LXVI.

VASCULAR SYSTEM, PLATE IX.

Fig. 1. TERMINATION OF AORTA; COMMON, EXTERNAL, AND INTERNAL ILIACS.—SIDE VIEW OF THE ARTERIES OF THE PELVIS.

1. Aorta.—2. Last lumbar artery.—3. Middle sacral.—4. Common iliac.—5. Right external iliac.—6. Deep circumflex iliac.—7. Epigastric.—8. Internal iliac.—9. Ilio-lumbar.—10. Lateral sacral.—11. Gluteal.—12. Obliterated hypogastric.—13. Obturator.—14. Middle vesical.—15. Inferior vesical.—16. Internal pudic.—17. Ischiatic.

Fig. 2.—1. Obturator artery, dividing into two chief branches circumscribing the obturator foramen.

Fig. 3. INTERNAL PUDIC.—The rectum is turned down, and the corpus cavernosum penis of the left side opened.

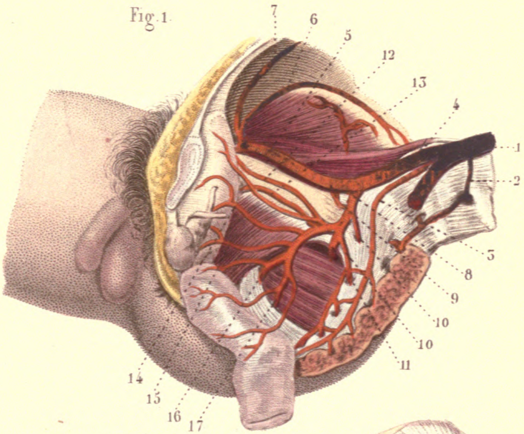
1. Internal pudic, re-entering the pelvis through the lesser sciatic notch, giving off—2. Perineal branches.—3. Artery to bulb.—4. Transverse artery of perinæum.—5, 5. Arteries of corpus cavernosum.—6. Dorsal artery of penis.

Fig. 4. GLUTEAL AND ISCHIATIC ARTERIES, SEEN AFTER THE REMOVAL OF THE GLUTEI AND HAMSTRING MUSCLES.

1. Gluteal artery.—2. Ischiatic.—3. Internal circumflex.—4, 4, 4, Perforating branches of profunda.—5 and 6. Terminal branches of profunda.

Pl. 66.

Fig. 1.



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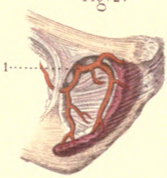


Fig. 4.

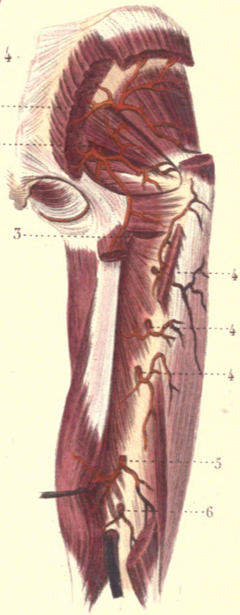
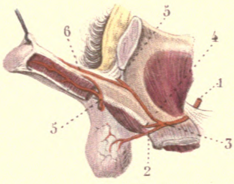


Fig. 3.



Léveillé del.

Davesne sc.

Pl. 67.

Fig. 2.

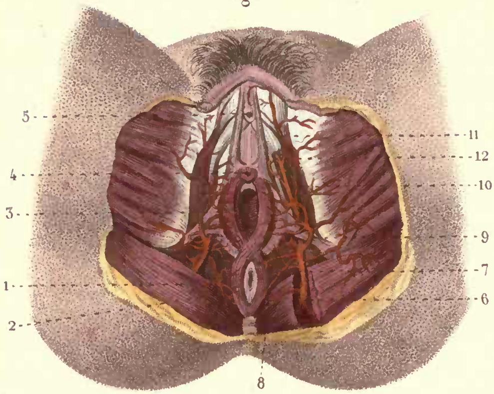
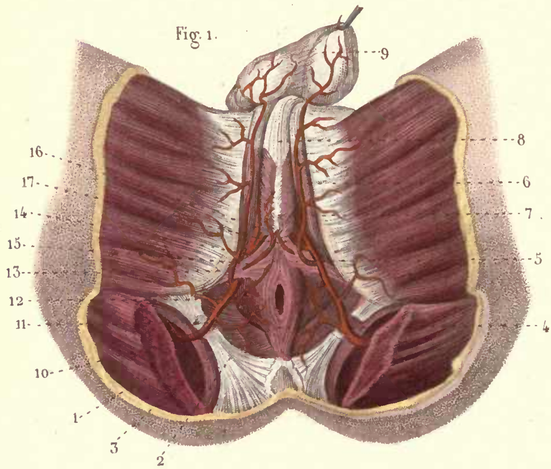


Fig. 1.



Léveillé del. *Annedouche sc.*

PLATE LXVII.

VASCULAR SYSTEM, PLATE X.

Fig. 1. Arteries of the Male Perinæum.

1. Gluteus maximus, cut.—2. Great sacro-sciatic ligament, cut.—3. Lesser sacro-sciatic ligament.—4. External sphincter.—5. Transversus perinei.—6. Erector penis.—7. Accelerator urinæ.—8. Urethra.—9. Dartos.—10. Trunk of internal pudic.—11 and 12. Inferior hæmorrhoidal.—13. Perineal branches.—14. Artery to bulb.—15. Transverse artery of perinæum.—16. Dorsal artery of penis.—17. Artery to corpus cavernosum.

Fig. 2. Arteries of the Female Perinæum.

1. Gluteus maximus muscle.—2. External sphincter.—3. Constrictor vaginæ.—4. Meatus urinarius.—5. Clitoris.—6. Internal pudic.—7 and 8. Inferior hæmorrhoidal.—9 and 10. Perineal.—11. Dorsal artery of clitoris.—12. Artery to corpus cavernosum clitoridis.

PLATE LXVIII.

VASCULAR SYSTEM, PLATE XI.

Fig. 1. ARTERIES OF THE THIGH.

1. Sartorius, cut.—2. Adductor opening in adductor magnus.—3. Superficial femoral.—4. Superficial epigastric.—5. Profunda, or deep femoral.—5′, 5′, 5′, 5′. Perforating branches.—6. Internal circumflex.—7. External circumflex.—8. Descending branch of external circumflex.—9 and 10. External pudic (superficial and deep).*—11. Popliteal.

Fig. 2. POPLITEAL AND POSTERIOR TIBIAL ARTERIES.

1. Popliteal.—2 and 3. Sural.—4 and 5. Superior internal articular.—6. Superior external articular.—7. Inferior internal articular.—8. Inferior external articular.—9. Division of popliteal into—10. Anterior tibial, and—11. Common trunk, giving off—12. Peroneal, and—13. Posterior tibial.

Fig. 3. PLANTAR ARTERIES.

1. Posterior tibial.—2. Internal plantar.—3. External plantar.—4. Plantar arch.—5. Perforating.—6. Digital.—7. Division of digital branches.—8. Confluence of these two divisions at the web of the toes.—9. Division of the anastomosis.—10. Anastomosis of two digital branches.—11. Ultimate distribution of digital arteries to the extremities of the toes.

* Separated by fascia lata.

Pl. 68.

Fig. 1.

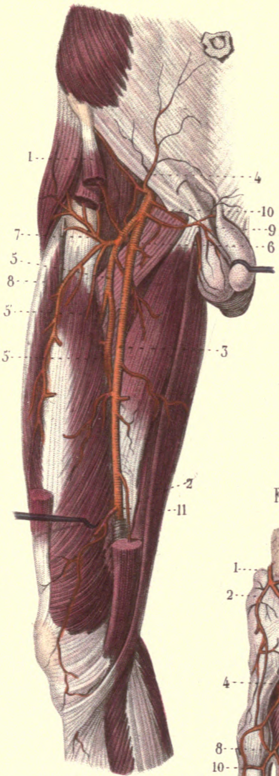


Fig. 2.

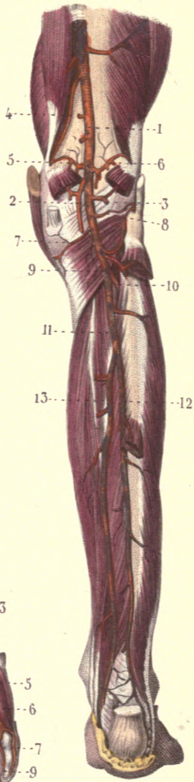
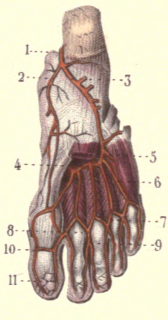


Fig. 3.



Léveillé del.

Choubard sc.

Pl. 69

Fig. 3.

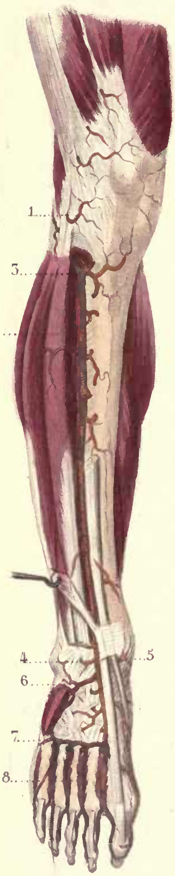
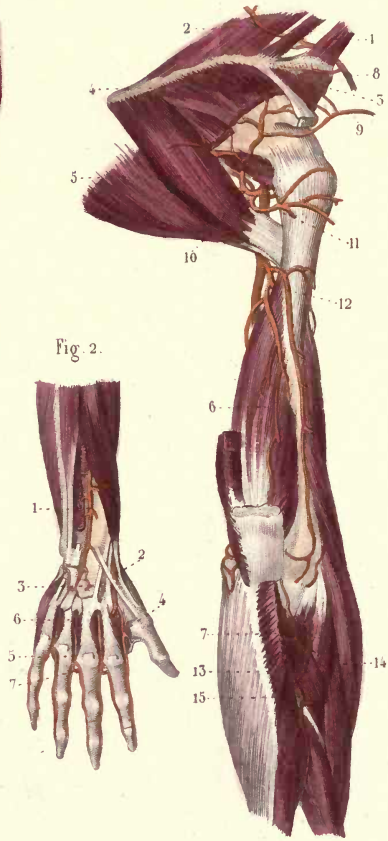


Fig. 1.

Fig. 2.



Léveillé del. *Davesne sc.*

PLATE LXIX.

VASCULAR SYSTEM, PLATE XII.

Fig. 1. Scapular Arteries.

1. Levator anguli scapulæ.—2. Rhomboideus major.—3. Supra-spinatus.—4. Infra-spinatus.—5. Teres major.—6. Outer heads of triceps.—7. Anconeus, cut.—8. Posterior scapular artery.—9. Supra-scapular. — 10. Dorsalis scapulæ. — 11. Posterior circumflex. — 12. Superior profunda.—13. Posterior interosseus.—14. Posterior interosseus recurrent.—15. Muscular branch of posterior interosseus.

Fig. 2.—1. Anterior interosseus artery.—2. Radial, passing through the first interosseus space.—3. Carpal branches.—4. Radialis indicis.—5. Digital branches, communicating superiorly with — 6. The posterior perforating, and inferiorly with—7. The anterior perforating.

Fig. 3. Anterior Tibial.

1. Branch of the superior external articular of popliteal.—2. Anterior tibial.—3. Anterior tibial recurrent.—4. External malleolar.—5. Internal malleolar.—6. Tarsal.—7. Metatarsal.—8. Digital.

PLATE LXX.

VASCULAR SYSTEM, PLATE XIII.

VEINS.

Fig. 1.—1. Right auricle.—2. Superior vena cava.—3. Right internal mammary vein.—4. Mediastinal vein.—5. Right subclavian. —6. Internal jugular.—7. External jugular.—8. Left subclavian.—9. Inferior thyroid.—10. Left internal mammary.—11. Left internal jugular.—12. Left external jugular.—13. Left superior intercostal.—14 and 15. Anastomosing branches, between two intercostal veins.—16. Azygos minor.—17. Inferior cava.—18. Hepatic.—19. Right spermatic. — 20. Supra-renal. — 21. Renal. — 22. Communication between a branch of the renal and common iliac veins.—23 and 24. Lumbar vein.—25. Common iliac.—26. External iliac.—27. Internal iliac.—28 and 29. Lateral sacral.—30. Middle sacral.

Fig. 2.—1. Superior cava.—2. Azygos major.—3. Left superior intercostal.—4 and 5. Branches taking the place of the lesser azygos. —6. Terminal branches of the azygos minor.—7. Inferior cava.—8, 9, and 10. Intercostal veins, opening, one into the azygos, a second into the left superior intercostal, and a third into the vein taking the place of the azygos minor.

Fig. 3. THE UTERINE SINUSES.

Fig. 1.

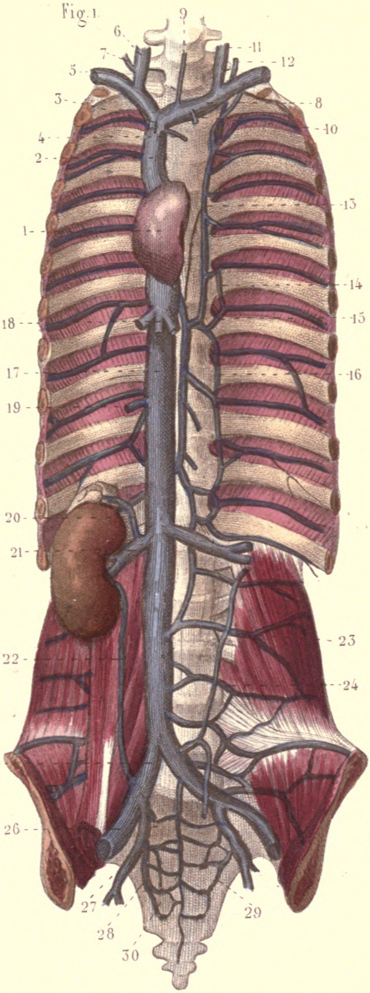
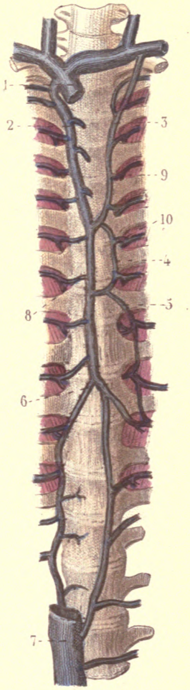


Fig. 2



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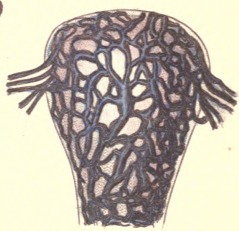

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Pl. 71.

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Annedouche

PLATE LXXI.

VASCULAR SYSTEM, PLATE XIV.

Veins.

Superficial Veins of the Head and Neck, Subclavian and Superior Cava, etc.

1. Pericardium, opened.—2. Right auricle.—3 Part of the vena cava superior, enclosed in the pericardium.—4. Superior cava, beyond the reflexion of the pericardium.—5. Azygos major.—6. Right internal mammary.—7. Right innominate vein.—8. Internal jugular.—9. Inferior thyroid and anterior jugular veins.—10. Common trunk of the supra, and posterior, scapular veins.—11. Facial.—12. Its anastomosis with the ophthalmic.—13. Frontal (*vena præparata*).—14. Occipital.—15. Superficial temporal.—16. Axillary.—17. Cephalic.

PLATE LXXII.

VASCULAR SYSTEM, PLATE XV.

VEINS.

Fig. 1. SUPERFICIAL VEINS OF THE UPPER EXTREMITY.

1. Axillary.—2. Cephalic.—3. Radial.—4. Median cephalic.—5. Basilic.—6. Posterior ulnar.—7. Anterior ulnar.—8. Median basilic.—2. Median.

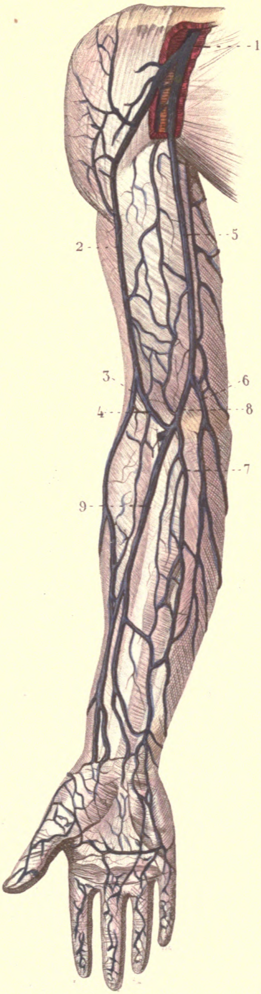
Fig. 2.—1. Radial.—2. Dorsal vein of thumb.—3. Posterior ulnar.—4. Vena salvatella.

Fig. 3. VEINS AT THE END OF THE ELBOW.

1. Opening made in the brachial aponeurosis, showing the brachial artery, its venæ comites, and the median nerve.—2. Cephalic. — 3. Radial. — 4. Median cephalic. — 5. Basilic. — 6. Posterior ulnar.—7. Anterior ulnar.—8. Median basilic.—9. Median.

Pl. 72.

Fig. 1.



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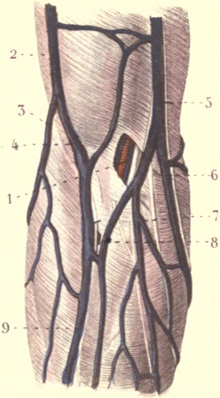

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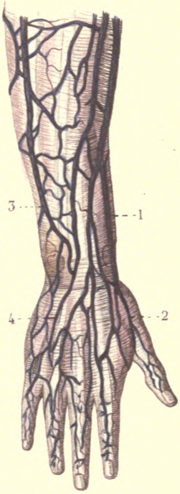

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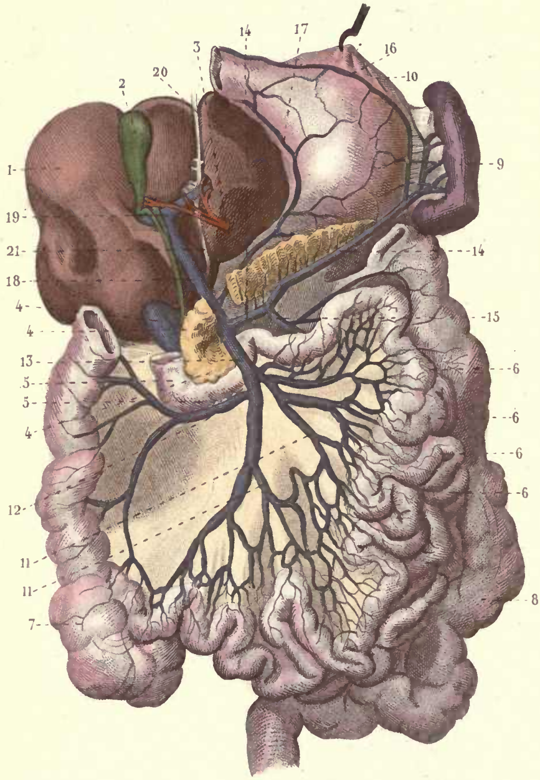

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PLATE LXXIII.

VASCULAR SYSTEM, PLATE XVI.

Veins.

Portal Vein.

1. Liver.—2. Gall bladder, showing its ducts and junction with the hepatic duct.—3. Hepatic artery.—4. Inferior cava.—4, 4. Pancreas, cut so as to show the position of the vena portæ.—5, 5. Duodenum.—6, 6, 6, 6. Convolutions of the small intestine.—7. Cæcum and ascending colon.—8. Descending colon, sigmoid flexure, and commencement of rectum.—9. Spleen.—10. Stomach, turned on one side.—11, 11. Veins of small intestine.—12. Colica dextra vein.—13. Superior mesenteric vein.—14, 14. Splenic veins.—15. Inferior mesenteric. — 16. Gastro-epiploica sinistra. — 17. Gastro-epiploica dextra, opening into—18. The trunk of the portal vein.—19. Fissure for the vena portæ —20. Umbilical vein.—21. Remains of ductus venosus.

PLATE LXXIV.

VASCULAR SYSTEM, PLATE XVII.

Veins.

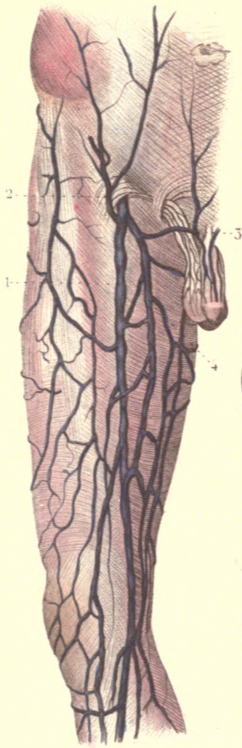
Fig. 1.—1. Internal saphena.—2. Superficial epigastric.—3. Dorsal vein of penis.—4. Accessory saphena.

Fig. 2.—1. Internal saphena, at the inner side of the leg.—2. Internal saphena, on the dorsum of the foot.

Fig. 3.—Commencement of internal saphena, by the dorsal venous arch.

Fig. 4.—1. External saphena.—2. Internal saphena.

Fig. 1.



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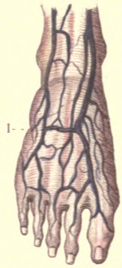

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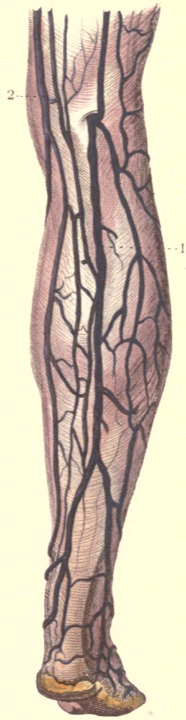
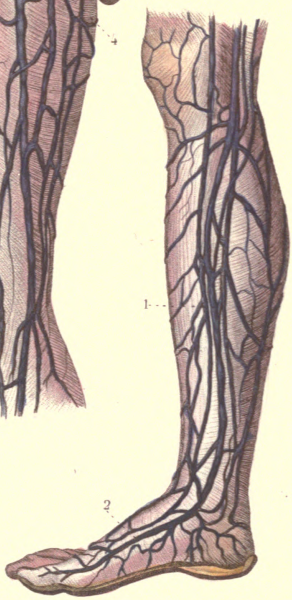


Fig. 2.



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Pl. 75.

Fig. 3

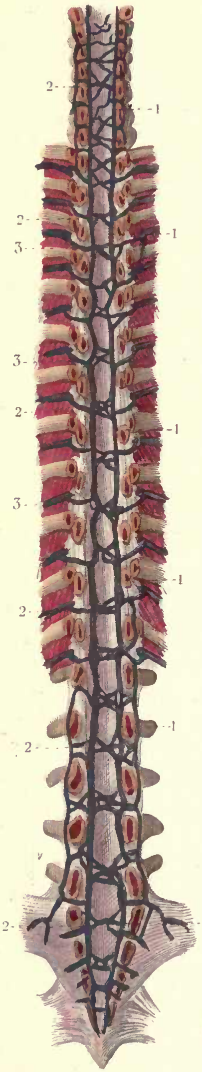

Fig. 1

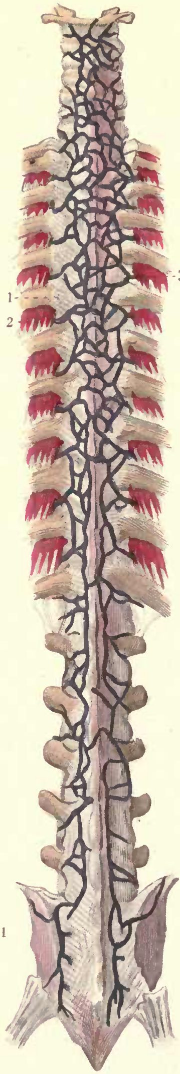

Fig. 2

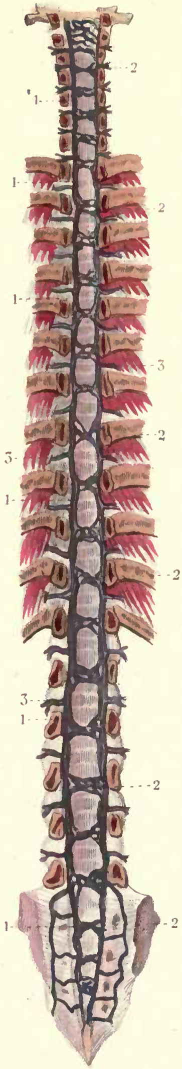

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PLATE LXXV.

VASCULAR SYSTEM, PLATE XVIII.

Veins.

Fig. 1. Posterior and Superficial Spinal Veins.

1. Superior costo-transverse ligament. — 2. External intercostal muscle.—3. Dorsal veins (*dorsi-spinal*), anastomosing with those above and below, and with those of the opposite side forming a plexus extending the whole length of the vertebral column.

Fig. 2. Anterior and Internal Spinal Veins.

The posterior surfaces of the bodies of the vertebræ are shown, the posterior half of the vertebral canal having been removed.

1, 1, 1, 1, 1, 1. Anterior longitudinal veins (*meningo-rachidian*).—2, 2, 2, 2, 2, 2. Transverse connecting branches.—3, 3, 3. Intercostal veins, communicating with the veins inside the vertebral canal.

Fig. 3. Posterior and Internal Spinal Veins.

The anterior half of the spinal canal has been removed.

1, 1, 1, 1, 1, 1. Posterior longitudinal veins (*meningo-rachidian*).—2, 2, 2, 2, 2, 2. Transverse connecting branches.—3, 3, 3. Intercostal veins, communicating with those internal to the spinal canal.

PLATE LXXVI.

VASCULAR SYSTEM, PLATE XIX.

Fig. 1. Fœtal Circulation.

1. Fœtal surface of the placenta, showing the ramifications of the umbilical artery and vein, covered on one side by the envelopes of the fœtus.—2. Chorion.—3. Amnion.—Umbilical cord.—5. Divergence of the vessels of the cord at the umbilicus.—6. Umbilical vein.—7. Anastomosis of the umbilical vein with the vena portæ.—8. Vena portæ.—9. Ductus venosus.—10. Anastomosis of the ductus venosus with the inferior cava.—11. Vena cava inferior at its junction with the right auricle.*—12. Right auricle.—13. Ventricles.—14. Ascending aorta.—15. Superior cava.—16. Pulmonary artery.—17. Branch of pulmonary artery, cut.—18. Ductus arteriosus.—19. Descending aorta. — 20. Abdominal aorta. — 21, 21. Common iliac arteries. — 22, 22. Umbilical arteries, continuous with the internal iliac.

Fig. 2. Heart and Great Vessels.

The right auricle has been opened.

1. Vena cava inferior.—2. Eustachian valve.—3. Foramen ovale (*Foramen of Botal*), forming a communication between the two auricles.—4. Superior cava.—5. Ventricles.—6. Pulmonary artery.—7. Ductus arteriosus.—8. Aorta.

Fig. 3. Thymus Gland.

* The inferior cava has no course in the thorax; it enters the right auricle immediately after it has passed through the diaphragm.

Pl. 76.

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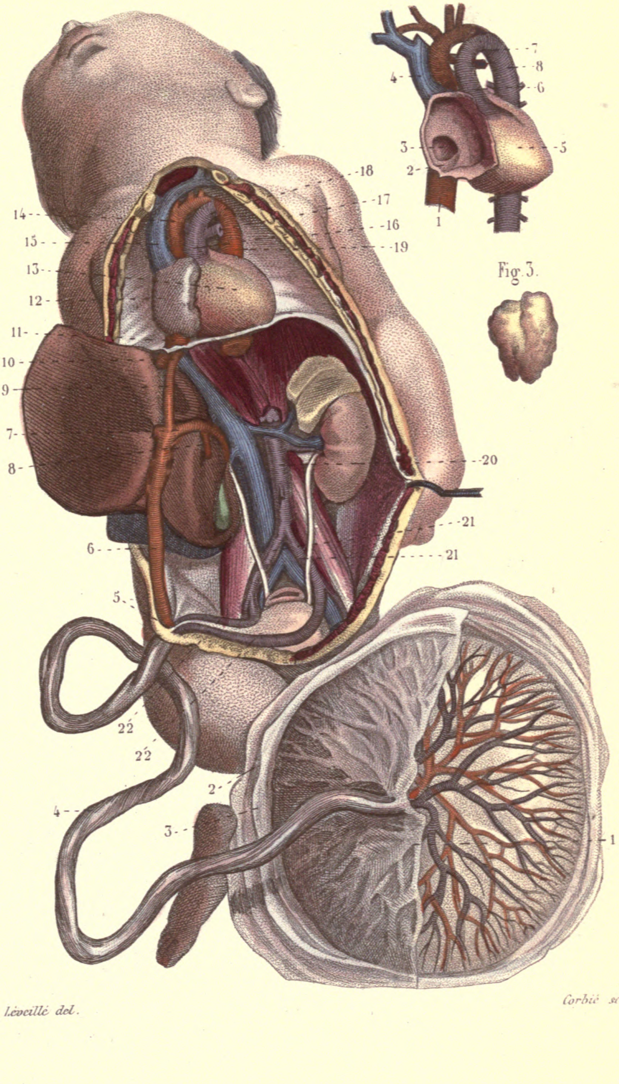

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Pl. 77.

Fig. 4.

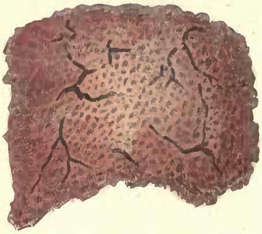

Fig. 5.

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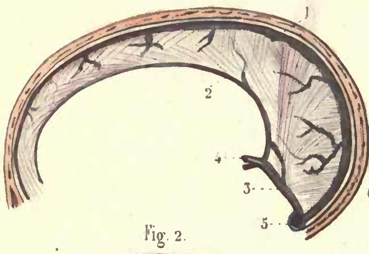
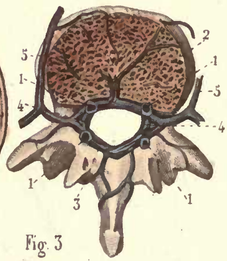


Fig. 7.



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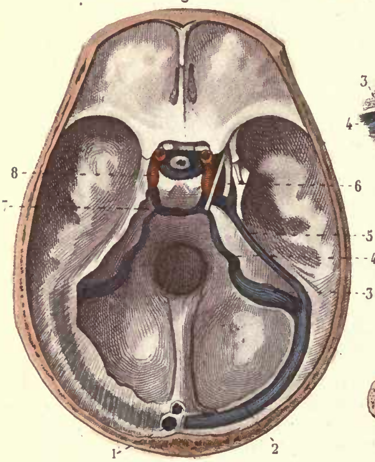

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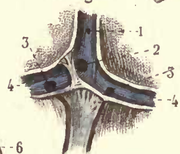

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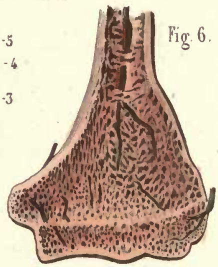

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PLATE LXXVII.

VASCULAR SYSTEM, PLATE XX.

VEINS.

Fig. 1. SINUSES OF THE FALX CEREBRI.

1. Superior longitudinal sinus.—2. Inferior longitudinal sinus.—3. Straight sinus.—4. Venæ Galeni.—5. Torcular Herophili (confluence of the sinuses).

Fig. 2. SINUSES OF THE BASE OF THE SKULL.

1. Opening of the superior longitudinal sinus in the torcular Herophili.—2. Horizontal portion of lateral sinus.—3. Oblique portion.—4. Commencement of internal jugular vein at the junction of the inferior petrosal and lateral sinuses.—5. Superior petrosal sinus.—6. Cavernous sinus.—7. Transverse sinus.—8. Circular sinus.

Fig. 3. TORCULAR HEROPHILI, OPENED FROM BEHIND.

1. Superior longitudinal sinus.—2. Opening of straight sinus.—3, 3. Orifices of the occipital sinuses.—4, 4. Lateral sinuses.

Fig. 4. PARIETAL BONE, FROM WHICH THE OUTER TABLE HAS BEEN REMOVED, SHOWING THE VEINS OF THE DIPLOE.

Figs. 5 and 6. VERTICAL SECTION OF THE SUPERIOR AND INFERIOR EXTREMITIES OF THE HUMERUS.

Fig. 7. VERTEBRAL SINUSES.

The body of the vertebra is cut horizontally.

1, 1, 1, 1. Longitudinal sinuses (*meningo-rachidian*), opened.—2. Anterior transverse sinus, opening into which is a sinus of the body of the vertebra (*vena basis vertebræ*).—3. Posterior transverse sinus.—4, 4. Lateral transverse sinuses.—5, 5. Veins external to the vertebra, communicating with the vertebral sinuses.

PLATE LXXVIII.

VASCULAR SYSTEM, PLATE XXI.

Lymphatics.

Fig. 1. Lymphatics of the Foot.

These vessels commence on the dorsum of the foot, and accompany the internal saphena vein.

Fig. 2. Superficial Lymphatics of the Inferior Extremity, and the lower half of the Abdominal Parietes.

1. Superficial lymphatics, which accompany the internal saphena vein.—2. Inguinal glands.—3. Lymphatics of the lower half of the abdominal parietes.—4. Lymphatics of the scrotum and penis.

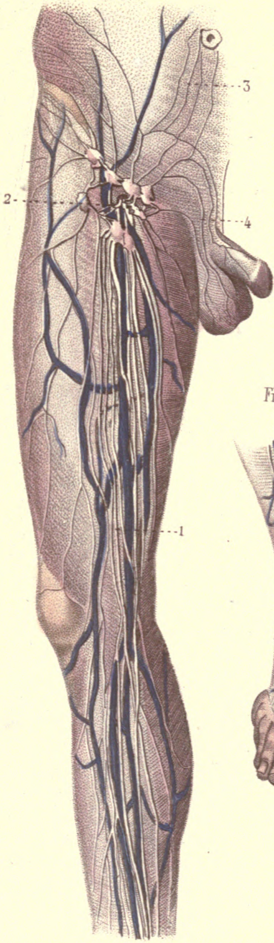
Fig. 3. Superficial Lymphatics of the back of the Leg.

The greater number of these accompany the external saphena vein.

Fig. 4. Superficial Lymphatics of the upper part of the Thigh, Buttocks, and Loins.

Pl. 78.

Fig. 2



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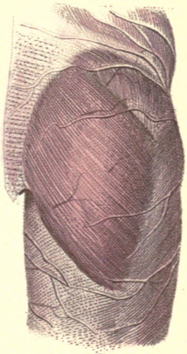

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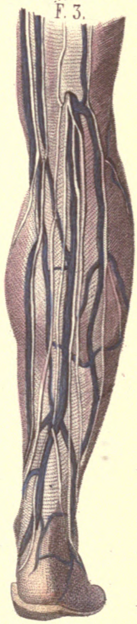

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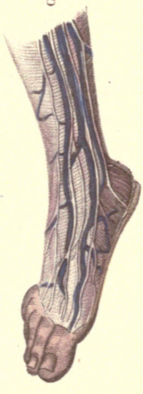

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Pl. 79.

Fig. 2.

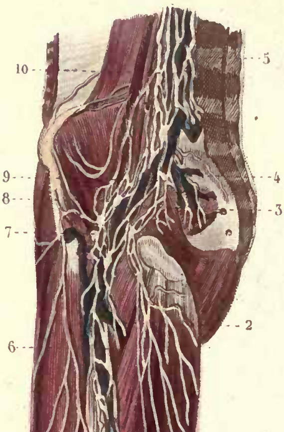

Fig. 1.

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PLATE LXXIX.

VASCULAR SYSTEM, PLATE XXII.

LYMPHATICS.

DEEP ANTERIOR LYMPHATIC VESSELS AND GLANDS OF THE LOWER LIMB, ETC.

Fig. 1.—1. Anterior tibial vein.—2, 2. Deep lymphatics.—3. Anterior tibial gland.—4. Superficial lymphatics of the thigh.

Fig. 2.—1. Femoral vein.—2. Profunda vein.—3. External iliac vein. — 4. Internal iliac vein. — 5. Inferior cava. — 6, 6. Deep lymphatics of the thigh.—7. Deep inguinal glands.—8. External iliac glands and ducts. — 9. Internal iliac glands and ducts.—10. Lumbar glands and ducts.

PLATE LXXX.

VASCULAR SYSTEM, PLATE XXIII.

LYMPHATICS.

DEEP POSTERIOR GLANDS AND DUCTS OF THE LOWER EXTREMITY.

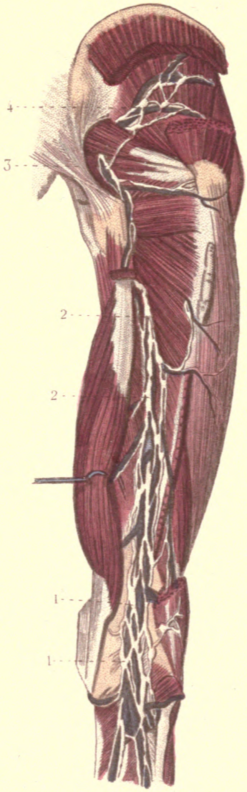
Fig. 1.—1. Posterior tibial vein.—2. Peroneal vein.—3. Popliteal vein.—4, 4.—Posterior tibial ducts.—5. Peroneal ducts.—6, 6, 6. Popliteal glands and ducts.

Fig. 2. THE SUPERFICIAL MUSCLES OF THE BUTTOCK AND BACK OF THIGH ARE RAISED OR TURNED ASIDE.

1, 1. Popliteal glands and ducts. — 2, 2. Deep lymphatics.—3. Ischiatic glands and ducts.—4. Gluteal glands and ducts.

Pl. 80.

Fig. 2.



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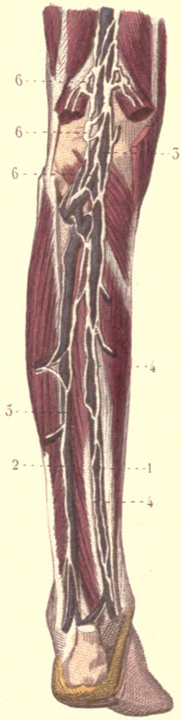

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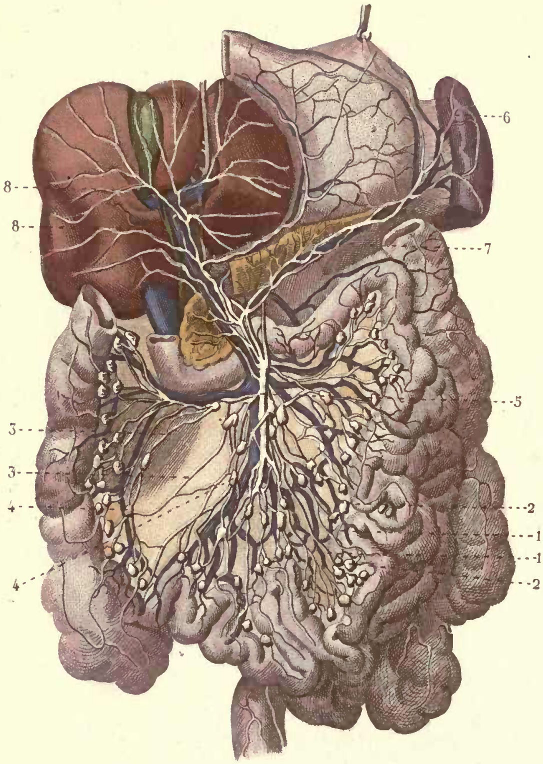

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PLATE LXXXI.

VASCULAR SYSTEM, PLATE XXIV.

LYMPHATICS.

GLANDS AND DUCTS OF THE ABDOMINAL VISCERA.

1, 1. Absorbents of the small intestine (lacteals or chyliferous ducts).—2, 2. Mesenteric glands.—3, 3. Lymphatics of large intestine.—4, 4. Meso-colic glands.—5. Common lacteal duct, opening into the thoracic duct.—6. Lymphatics of the spleen.—7. Lymphatics of the pancreas.—8, 8. Lymphatics of the inferior surface of the liver.

PLATE LXXXII.

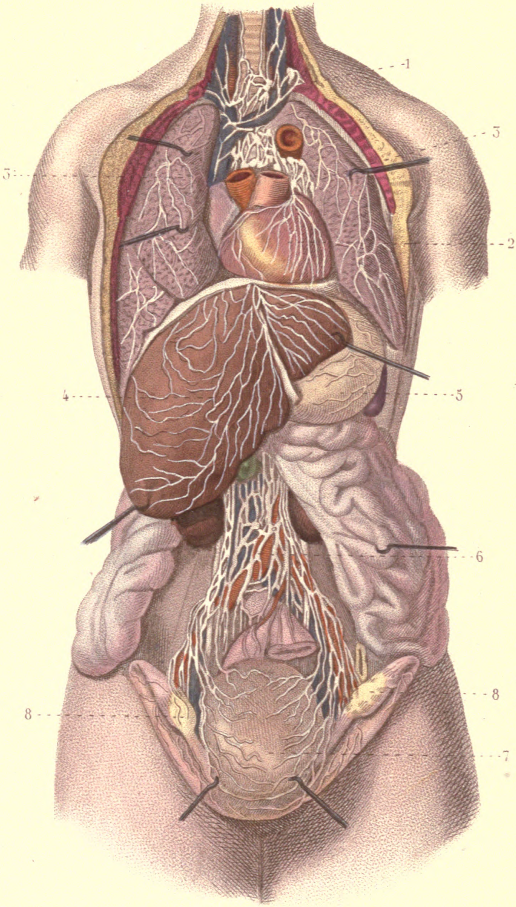
VASCULAR SYSTEM, PLATE XXV.

Lymphatics.

Lymphatics of the Thoracic and Abdominal Viscera.

1. Glands and ducts of the lower part of the trachea.—2. Heart, and its lymphatics.—3, 3. Lungs, and their superficial lymphatic vessels.—4. Lymphatics of the superior surface of the liver.—5. Lymphatics of the posterior surface of the stomach.—6. Lumbar glands and ducts.—7. Lymphatics of the uterus.—8, 8. Ovaries, and broad ligaments of the uterus, with their lymphatic vessels.

Pl. 82.



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Pl. 83.

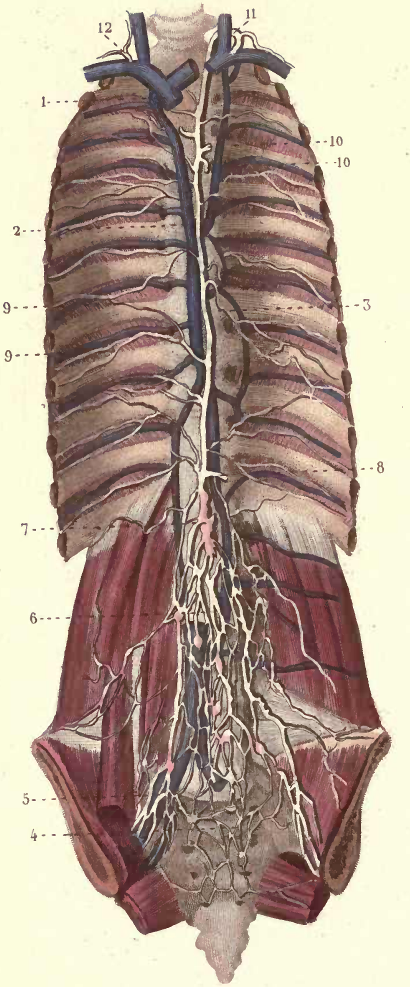

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PLATE LXXXIII.

VASCULAR SYSTEM, PLATE XXVI.

Lymphatics.

Thoracic Duct, etc.

1. Superior cava.—2. Azygos vein.—3. Thoracic duct.—4. Hypogastric glands and ducts.—5. External iliac ducts and glands.—6. Lumbar ducts and glands.—7. Commencement of thoracic duct, or receptaculum chyli.—8. Common duct of the chyliferous vessels opening into the thoracic duct.—9, 9. Intercostal ducts.—10, 10. Deep lymphatics of the lungs.—11. Thoracic duct, opening into the left subclavian vein at its junction with the internal jugular vein.—12. Right lymphatic trunk, opening into a corresponding point on the right side.

PLATE LXXXIV.

VASCULAR SYSTEM, PLATE XXVII.

Lymphatics.

Fig. 1. Superficial Lymphatics of the Upper Extremity.

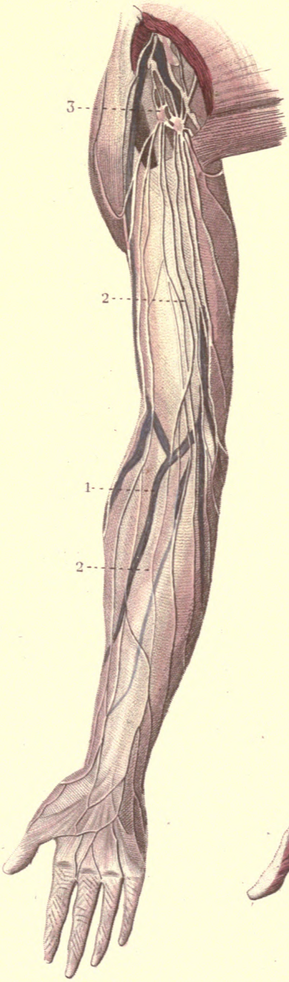
1. One of the superficial veins of the forearm.—2, 2. Superficial lymphatics of the forearm and arm.—3. Axillary glands.

Fig. 2. Deep Glands and Ducts of the Upper Extremity.

1, 1, 1. Deep veins of the forearm.—2, 2, 2. Lymphatics accompanying these veins.—3. Lymphatic glands at the bend of the elbow.—4, 4. Brachial veins.—5, 5.—Lymphatics accompanying them.—6. Gland situated in the course of the brachial vessels.—7. Axillary glands.

Pl. 84.

Fig. 1.



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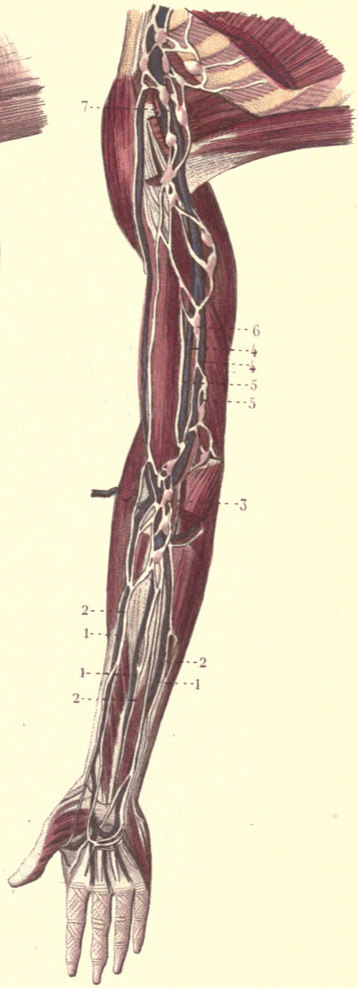

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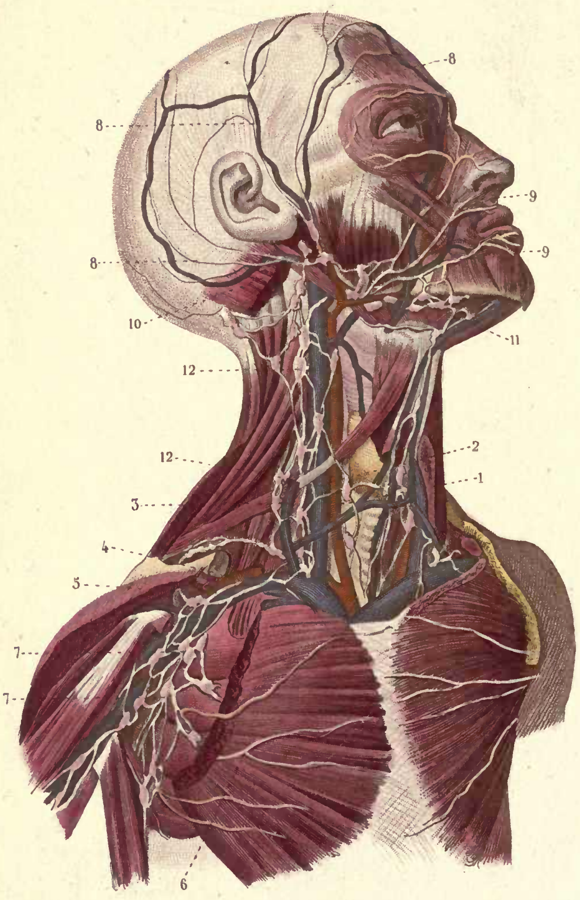

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PLATE LXXXV.

VASCULAR SYSTEM, PLATE XXVIII.

LYMPHATICS.

GLANDS AND DUCTS OF THE AXILLA, AND OF THE HEAD AND NECK.

1. Common carotid artery.—2. Internal jugular vein.—3. External jugular vein.—4. Axillary artery.—5. Axillary vein.—6. Lymphatics of the walls of the chest.—7, 7. Axillary glands and ducts.—8, 8, 8. Superficial lymphatics of the cranium.—9, 9. Superficial lymphatics of the face.—10. Parotid gland.—11. Submaxillary glands.—12, 12. Glandulæ concatenatæ.

The Blood-vascular System.

The circulation of the blood is maintained by the pulsations of the heart sending the blood into the arteries, and by them to the different organs and tissues of the body. In the organs and tissues the blood is distributed by capillaries—microscopic vessels which, collecting into large trunks, converge into veins and carry the blood back to the heart.

There are two such circulations—the pulmonary and systemic. The *pulmonary system* is that part of the circulation by which the venous blood is sent from the heart to the lungs, where it is rendered scarlet by the contact with air, and back again from the lungs to the heart to enter the systemic system.

The vessels of the pulmonary system are the pulmonary artery proceeding from the right ventricle to the lungs, and the pulmonary veins carrying the blood from the lungs to the left auricle.

The *systemic system* consists of the circulation of scarlet blood to the tissues and organs of the body by arteries and capillaries, and its return by veins. The scarlet blood leaves the left ventricle of the heart by the aorta; the veins return the blood to the right auricle, mainly by the superior and inferior venæ cavæ.

The Heart and Pericardium.

The heart is situated in the thorax in contact with the diaphragm, behind the sternum, in front of the vertebral column, and between the two pleuræ. It lies in the middle mediastinum. In outline it is conical, with its apex forwards and its base backwards, its surfaces being antero-superior and postero-inferior. The heart is placed obliquely with its apex three and a quarter inches to the left of the middle line, and its base backwards to the right. The further relations of the heart will be mentioned during the consideration of the position of the viscera relative to the chest-wall.

The *pericardium* is the fibro-serous sac which encloses the heart and the great vessels at its base. It is conical in shape, with the apex upwards embracing the great vessels, and with its base at the diaphragm.

The *fibrous pericardium* consists of a strong, fibrous, conical sac, lined internally by a serous layer. It is of use to protect the heart, and to keep it fixed in its place. It is attached *above* to the aorta at the junction of the first and second stages, to the superior vena cava, the pulmonary veins, and the right and left pulmonary arteries, and at its apex it is continuous with the deep cervical fascia; *below* it is firmly adherent to the diaphragm around the middle leaflet of the central tendon, and to a small part of the muscular substance in front of that leaflet. On *either side* of the pericardium are the two pleural sacs and the phrenic nerves; in *front*, is the space called the anterior mediastinum, in which ligamentous bands fix it to the sternum; and *behind* is the œsophagus as it lies in the posterior mediastinum.

The *serous pericardium* by its *parietal* layer lines the inner surface of the fibrous, and covers the central leaflet of the diaphragm. At the root of the heart it meets the great vessels passing to and fro, and as the visceral layer, or epicardium, is conducted by them on to the heart-substance, which it envelops. At the root of the heart eight vessels are found, and the epicardium forms imperfect reflexions over each; but as the pulmonary artery and aorta are enclosed in one, there are only seven serous reflexions met with.

On opening the pericardium from the front the following parts are seen: All *four* cavities of the heart, but in unequal amounts, and *three* great vessels—seven structures in all. The anterior surface presents for the most part the right ventricle; there is also to be seen the right auricular appendix and a bit of the right auricle, the left ventricle forming simply the apex, and the tip of the left auricular appendix. The three vessels seen are, from right to left, the superior vena cava, the aorta, and the pulmonary artery.

The HEART is an involuntary muscle by which the blood is driven onwards in its course. The arrangement of the fibres is complex, and but ill understood. Suffice it to say that the auricles possess a superficial transverse set common to both; a deeper set of looped fibres proper to each; and an annular set surrounding the appendices and inlets. The ventricular fibres run obliquely and spirally, and present on dissection seven planes of fibres having different directions. It is demonstrable that the superficial set is continuous with the musculi papillares in the interior; all other deductions are uncertain.

The line of attachment for the muscular fibres is around the auriculo-ventricular groove. Here is a dense mass of fibrous and tendinous tissue, which is in some animals (*e.g.*, the ox) even bony. The surface of the heart is marked by *grooves*. All around the heart is a deep groove—the auriculo-ventricular—between the auricles above and the ventricles below. Down the front and back of the heart, from the auriculo-ventricular, run the ventricular grooves, indicating the separation between the ventricles superficially, and upwards the auricular, between the auricles.

The *bloodvessels* to the heart's substance run mainly in the grooves. The *arteries* are the two coronary. The *right* coronary passes forwards from the aorta, between the pulmonary artery and the right auricular appendix, and runs along the right side of the auriculo-ventricular groove to the back of the heart, where it descends between the two ventricles. In its course it sends a large branch to the wall of the right ventricle, and posteriorly, a fair-sized branch is continued on to the left auriculo-ventricular groove. It supplies the parts adjacent to which it runs, including the roots of the aorta and pulmonary artery. The *left* coronary passes forwards from the aorta, between the pulmonary artery and the left auricular appendix, and gives off a large branch to the left side of the auriculo-ventricular groove, whilst the trunk of the artery descends in the groove between the ventricles in front. Like the preceding it supplies branches to the parts adjacent.

The *veins* of the heart are called *cardiac* or coronary :

1. The anterior or great cardiac. This vessel commences at the apex of the heart, runs upwards between the ventricles in front, turns back between the left auricle and ventricle in the left auriculo-ventricular groove, and ends behind in the coronary sinus. This vein, as do all the other cardiac veins, drains the parts adjacent to which it runs.

2. The posterior cardiac veins, usually three or four in number, run from the apex of the heart upwards upon the surface of the left ventricle behind ; they end in the coronary sinus.

3. The middle cardiac vein commences at the apex of the heart behind and runs upwards in the ventricular groove at the back of the heart to end in the coronary sinus.

4. The right or small cardiac vein collects blood from the posterior aspects of the right auricle and ventricle, and passes towards the left, to open into the coronary sinus.

5. The anterior cardiac veins collect blood from the front of the right ventricle, and open directly into the right auricle.

6. The veins returning from the substance of the right auricle open directly into the auricle by the foramina Thebesii. They are called the venæ cordis minimæ.

The *coronary sinus* is a channel about one inch long, which lies in the groove between the left auricle and ventricle behind. It is embedded in the heart substance, having muscular fibres from the auricles crossing it. It has valves at all the openings into it—viz., at the mouths of the great cardiac and the other cardiac veins, and at its opening into the heart. The sinus opens at the posterior part of the right ventricle low down on its left side. The valve guarding it (quite a mythical valve) is called the *valve of Thebesius*.

The *nervous* supply of the heart is complex, there being ganglia within the heart-substance, and cardiac plexuses without. (*See* Cardiac Plexuses.)

To ascertain the *position of the heart*, hold the apex forwards, and the base backwards; the difference in thickness of the two ventricles will at once tell the thin-walled right from the thicker left ventricle. The borders of the heart are the lines along which the anterior and posterior surfaces of the heart meet. The right border is the sharper, owing to the right side of the heart being the thinner; it is named the *margo-acutus*, whilst the corresponding part on the left is named the *margo-obtusus*, owing to its more rounded character. The posterior (or inferior) surface will be seen to be flat, owing to its resting on the diaphragm, and the anterior (or superior) surface will be found to be convex. The apex of the heart is formed by the left ventricle; at the base of the heart are placed the openings of the bloodvessels going to and fro the heart. The apex of the heart corresponds, on the surface of the chest, to the fifth intercostal space at the junction of the bones and cartilages of the adjacent ribs. The base of the heart corresponds to the dorsal vertebræ from the fifth to the eighth. While describing the heart it is necessary to give the means of examining and dissecting it, so as best to expose its parts.

1. The *right auricle* occupies the right side of the base of the heart. It presents for examination a main cavity or *atrium*, and a projection named the *auricular appendix*. The appendix is a conical-shaped projection bent around the right of the root of the pulmonary artery.

First examine the main inlets of the right auricle—viz., the superior and inferior venæ cavæ: the superior opens by an aperture about three-quarters of an inch in diameter, into the highest point of the right auricle; the inferior has an opening one inch in diameter, situated at the lower and back part of the auricle. Now open the auricles by cutting with scissors from the inferior caval opening forwards to the auricular appendix; this incision will disturb the relations of the parts less than any other.

There are four sets of *inlets* into the right auricle: the superior vena cava; the inferior vena cava; the coronary sinus; and the foramina Thebesii. The positions of all these have been already described. One large aperture, the *outlet*, allows the blood to escape into the ventricle—the *right auriculo-ventricular* opening. In this, one ought to pass the fingers to gauge its size; usually, in an adult heart, the tips of three of the fingers fill the aperture completely. The points further to be noted are: The *tubercle of Lower* on the right wall; this is simply a thickened part of the heart-substance placed midway between the openings of the cavæ; the *musculi pectinati* on the anterior wall and in the auricular appendix are bands of muscular bulgings arranged in a network in the appendix, but in the auricle they are arranged parallel to each other in a perpendicular direction; the *annulus*, and *fossa, ovalis* on the left wall. The annulus ovalis is a ring of heart-substance about three-quarters of an inch in diameter enclosing the fossa. In the fœtus the annulus encloses the foramen ovale; but in the adult a thin membranous septum, flush with the left side of the annulus ovalis, closes the opening. Covering over the coronary sinus is the *valve of Thebesius*, and stretching from the anterior part of the inferior vena cava to the anterior part of the fossa ovalis are to be seen the remains of the *Eustachian valve.* The latter valve is fully developed in the fœtus, where it directs the blood from the inferior vena cava into the *foramen ovale*, which exists in the septum between the auricles; at birth, the blood ceasing to pass in that direction, the foramen closes, and the valve becomes rudimentary.

2. The *right ventricle* occupies the right lower portion of the heart, reaching from the right auriculo-ventricular groove to near the apex of the heart. It seems a mere appendage to the thicker left ventricle, and its cavity is found to be encroached upon by the bulging of the septum, between the two ventricles, towards the right. At the spot where the pulmonary artery arises the ventricle becomes round and conical—the *conus arteriosus.*

The blood passes through the right auriculo-ventricular opening, from the auricle into the ventricle. In the right ventricle are seen *columnæ carneæ;* these are rods of heart-substance, some of which are mere bulgings on the walls, whilst others, attached at their ends, are free in the centre of their course. The *musculi papillares* are the small muscular cones, situated just below the auriculo-ventricular openings, to the apices of which the *chordæ tendineæ* are attached. The chordæ tendineæ are the round fibrous cords which pass from the muscular papillæ to the valves; they prevent the valves being driven back into the auricle when the blood shuts them. The cords to the muscular papillæ are so arranged, that those proceeding from one papilla go to be attached to the adjacent sides of two valves, so that no one muscular papilla presides over any one individual valve. A few cords arise from the ventricular wall directly.

Valves.—The *tricuspid* or right auriculo-ventricular valve consists of three valves or cusps. The valves hang towards the ventricle, and consist of reflexions of the endocardium, strengthened by the insertion of the chordæ tendineæ. The valves are placed so that one cusp intervenes between the auriculo-ventricular opening and the opening of the pulmonary artery—the *pulmonary* cusp, lying anteriorly and to the left. A second cusp is attached on the right wall of the ventricle—the *parietal cusp*, lying anteriorly and to the right. A third cusp—the *septal*—named likewise from its position, lies posteriorly and to the left, towards the ventricular septum. The contraction of the ventricle shuts the auriculo-ventricular valves, and sends the blood along the pulmonary artery to the lungs.

To prevent the back-flow, *valves* are placed at the root of the *pulmonary artery;* these are three in number, and are semilunar in shape. They are composed of reflexions of endocardium, with, between them, fibrous tissue to give consistence. The fibrous tissue is arranged in the following way: the lower part of the valve is occupied by a layer of fibrous tissue which reaches the centre of the margin of the valve as a hard round nodule called the *corpus Aurantii*, but which falls short of the lateral borders, leaving a semilunar edge, the *lunated* spots or lunulæ, formed only by endocardial tissue. The valves, when they close, meet at the edges of the fibrous tissue. Behind each cusp is the space called the *sinus of Valsalva*, in which the blood collects previous to the closure of the valve. The valves are placed thus: one anterior; one posterior and to the left; the third posterior and to the right. The blood now passes to the lungs by the pulmonary arteries, and returns by the four pulmonary veins to the left auricle.

3. The *left auricle* is placed so that only the tip of the auricular appendix is to be seen on the anterior aspect of the heart. The *inlets* are—*four pulmonary* veins, two on the right and two on the left; no valves cover their apertures. The *outlet* is the *left auriculo-ventricular* opening, capable of admitting two finger-tips easily. In the auricle besides the openings nothing except the musculi pectinati are to be seen. These prominences are confined to the auricular appendix, and are not spread along the anterior wall as on the right side.

The left auricular appendix is longer and more curved than the right, and has a position analogous to the position of the appendix on the right side. In the septum between the auricles the reverse side of the membranous partition, described in the right auricle, is to be seen in the left auricle; here, however, there is no fossa, as the membrane is flush with the left wall of the annulus ovalis.

4. The *left ventricle* is the most bulky and decided prominence met with in the heart. It shows only one-third of its extent on the anterior aspect of the heart. On section its cavity is found to be oval, in contradistinction to the crescentic appearance seen on section of the right ventricle; this is owing to the bulging of the septum towards the right cavity.

In the left ventricle columnæ carneæ, musculi papillares, and chordæ tendineæ are present as in the right ventricle. The columnæ carneæ are smaller, more closely interwoven, but more numerous than on the right side. The *inlet*, the left auriculo-ventricular opening, is guarded by the bicuspid or mitral valve; the *outlet* into the aorta, at the right front of the ventricle, is guarded by semilunar valves as in the pulmonary artery.

Valves.—The two cusps of the *mitral* valve are so arranged that one is placed between the auriculo-ventricular opening and the aortic orifice lying anteriorly and to the right—the *aortic cusp;* the other against the left wall of the heart lying posteriorly and to the left—the *parietal cusp.* The *semilunar* aortic valves, *three* in number, have behind them the sinuses of Valsalva, and from the upper part of the two anterior sinuses the right and left coronary arteries arise. The position of the semilunar aortic valves is, one anterior and to the right, another anterior and to the left, and the third posterior. The structure of the aortic valves is similar to those met with at the root of the pulmonary artery.

A different arrangement of the aortic valves is maintained in Quain's 'Anatomy;' the valves are described as being one anterior and two posterior (right and left); from the anterior the right coronary artery arises, and from the left posterior the left coronary.

The Bloodvessels.

The Pulmonary Artery arises from the upper part—the conus arteriosus or the infundibulum—of the right ventricle, and after a course of two inches divides into a right and left branch. It carries venous blood from the right ventricle to the lungs. Its course is upwards, backwards, and to the left. Commencing in front of the origin of the aorta, it passes upwards and to the left, gradually uncovering the aorta. Its relations are: in *front*, the pericardium; *behind*, the aorta; to the *right*, the aorta and the right auricle; to the *left*, the left auricular appendix. It is enclosed in the same sheath of serous tissue as the aorta, and the two coronary arteries pass forwards on either side. The root is guarded by valves already described. (*See* p. 221.)

The pulmonary artery bifurcates in the hollow of the aortic arch below the ending of the trachea. Here a diamond-shaped space is enclosed between the bifurcation of the trachea above and the bifurcation of the pulmonary artery below; in this space a number of bronchial glands containing dark pigment, so as to make them almost black, are met with. The *right* branch, the longer, passes behind the aorta and superior vena cava, and in front of the right bronchus, to the root of the right lung. The *left* passes over the descending aorta into the root of the left lung. Connecting the left pulmonary artery to the aorta is the *ductus arteriosus*, a fibrous cord in the adult, but which in the fœtus completed the circulation, by allowing the blood passing by way of the superior vena cava, right auricle, right ventricle, and pulmonary artery to pass through into the aorta. (*See* Fœtal Circulation.)

The Aorta.

The aorta is the trunk by which the arterial blood leaves the left ventricle of the heart to be distributed to the body. In its course the vessel arches over the root of the left lung, forming the *arch of the aorta.* It is then continued down along the left side of the vertebral column under the name of the *descending thoracic aorta,* until it passes through the diaphragm at the aortic orifice, opposite the twelfth dorsal vertebra. From hence to its bifurcation at the fourth lumbar it is called the *abdominal aorta.*

The Arch of the Aorta

is divided for convenience of description into three stages:

1. The *first stage* commences at the left ventricle, immediately behind the origin of the pulmonary artery, corresponding on the surface of the chest to the spot where the third left costal cartilage joins the sternum. From hence it curves upwards, forwards, and to the right, for a distance of two inches, coming up as high as the second costal cartilage on the right side. It is enclosed within the fibrous, and embraced along with the pulmonary artery in the serous, pericardium. The relations are: in *front,* at its commencement, the right auricular appendix, the pulmonary artery and the pericardium cover it; but higher up it comes close to the sternum, with the pericardium, and a thin slip of the right lung and pleura intervening on the right side; and in a plane anterior to these, loose areolar tissue containing the remains of the thymus gland. *Behind,* the right division of the pulmonary artery and the right auricle; to the *right,* the superior vena cava and right auricle; to the *left,* the trunk of the pulmonary artery.

2. The *second stage,* or transverse stage, passes upwards, backwards, and to the left in the first part of its course, and then directly backwards, reaching from behind the second costal cartilage on the right side to the left side of the fourth dorsal vertebra. Its highest point is opposite the middle of the manubrium sterni. The relations are: in *front,* sternum, sterno-hyoid and sterno-thyroid muscles, left lung and pleura, the trunks of the left phrenic and pneumogastric nerves, the left cardiac branches of the pneumogastric and sympathetic, and the left superior intercostal vein; *behind,* trachea, œsophagus, thoracic duct, and the recurrent laryngeal nerve; *above,* the vessels given off, and the left innominate vein; *below,* the bifurcation of the pulmonary artery, the remains of the ductus arteriosus, the root of the left lung, the cardiac plexuses, and the left recurrent laryngeal nerve.

3. The *third stage* passes along the left side of the vertebræ, from

the fourth to the sixth, towards the middle line. It has, *in front*, the root of the left lung; *behind*, the vertebral column; to the *left*, the left lung and pleura; and to the *right*, the œsophagus and thoracic duct and the other contents of the posterior mediastinum.

The Branches of the Arch of the Aorta.

From the first stage arise the right and left coronary arteries; from the second stage, from right to left, arise the innominate, the left common carotid, and the left subclavian arteries.

The Coronary Arteries, right and left, arise from the aorta at the sinuses of Valsalva, on a level with the upper margins of the semilunar valves. They run forwards, the right between the pulmonary artery and the right auricular appendix; the left between the pulmonary artery and the left auricular appendix. The distribution of the arteries is given with the anatomy of the heart.

The Innominate Artery.—This vessel commences opposite the middle of the manubrium sterni, from the highest part of the arch of the aorta, and extends upwards and to the right, as far as the right sterno-clavicular articulation. It there divides into right subclavian and right common carotid arteries. In length it is from one inch to one inch and a half. It has, in *front*, the left innominate vein and the top of the sternum, with the sterno-hyoid and sterno-thyroid muscles intervening; *behind* is the trachea and the right pleura; to the *left*, the left common carotid artery, and at its upper part the trachea; and to the *right*, the right innominate vein.

The Common Carotid Arteries.

In the neck, the anatomy of the right and left common carotids is almost identical; but owing to the right artery arising from the innominate, and the left from the arch of the aorta, there is a difference between the two at their commencement, the left having a thoracic course which it is necessary to describe separately.

The Left Common Carotid Artery in the thorax arises from the aortic arch immediately to the left of the innominate; so close are the innominate and the left common carotid at their origin, that they seem to belong to a common stem. The vessel then passes obliquely upwards and to the left until it reaches the level of the left sterno-clavicular articulation. The relations are: in *front*, the left innominate vein, the remains of the thymus gland, the left lung and pleura, and on a plane anterior to all these the manubrium sterni with the muscles attached; *behind*, the trachea below, and the œsophagus and thoracic duct higher up; to the *left*, the left lung and pleura; to the *right*, the innominate artery and the trachea.

The Common Carotid Arteries in the Neck.

The Common Carotid Artery appears in the neck on either side, opposite the sterno-clavicular articulation. The course of the vessel is indicated by a line drawn from hence to the lobule of the ear. The artery in question, however, extends no higher in that line than the upper border of the thyroid cartilage. It gives off no branches, but ends by dividing into the internal and external carotids. The vessel is placed deeply at the lower part of the neck, but comes nearer the surface above.

Relations.—The artery is enclosed in a sheath common to it, the internal jugular vein, and the pneumogastric nerve. The artery has in *front*, skin, superficial fascia, platysma, the descending branch of the superficial cervical nerve, the anterior jugular vein, and the deep fascia; at the level of the cricoid cartilage the anterior belly of the omo-hyoid muscle crosses it, the part below belonging to the inferior carotid triangle, the part above belonging to the superior carotid triangle. Below, the omo-hyoid the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles cover the artery; but above, the sterno-mastoid alone overlaps it. At the crossing of the omo-hyoid: the descending noni nerve, the sterno-mastoid branch of the superior thyroid artery, and the middle thyroid vein all lie in front. The superior thyroid vein crosses the artery at its bifurcation. *Behind*, the longus colli and rectus capitis anticus major muscles, the inferior thyroid artery, and the sympathetic and recurrent laryngeal nerves; to the *outside*, the internal jugular vein; to the *inside*, the trachea and larynx, the œsophagus and pharynx, and the thyroid gland.

The External Carotid Artery commences at the bifurcation of the common carotid artery at the upper border of the thyroid cartilage. Pursuing a course upwards, and with a curve forwards, it ends in the substance of the parotid gland opposite the neck of the condyle of the lower jaw by dividing into its terminal branches. The external carotid lies at first on a plane anterior to the internal; but at the angle of the jaw it runs on a plane immediately external to and parallel to it.

Relations.—Between the artery and the surface are the following: the skin, superficial fascia, platysma, deep fascia. These structures are common to the whole length of the vessel, but opposite the angle of the lower jaw, the posterior belly of the digastric and the stylo-hyoid muscles cross the artery; the part above the crossing disappears in the parotid gland; the part below, belongs to the superior carotid triangle. Above the crossing of the muscles, the parotid gland, the temporo-maxillary vein, and the pes anserinus of the facial nerve lie superficial to the vessel; below the crossing, the hypoglossal nerve, and the facial, lingual and superior thyroid veins lie athwart it. Hence between the artery and the surface the order of structures met with from above downwards are: parotid gland; external jugular, there called temporo-maxillary vein, and the facial nerve; stylo-hyoid and digastric muscles; hypoglossal nerve; facial, lingual and superior thyroid veins.

Deeply, the external carotid below the digastric rests on the pharynx, the hyoid bone, and the superior laryngeal nerve; above the crossing of the digastric muscle, and between it and the internal carotid artery, are found: part of the parotid gland, the stylo-pharyngeus muscle, the styloid process and the glosso-pharyngeal nerve.

The Anterior Set of Branches.

1. The *superior thyroid artery* arises from the convexity of the external carotid just below the level of the hyoid bone. The vessel passes inwards, forwards, and downwards, to end in the thyroid gland. It lies on the side of the thyroid cartilage, and disappears beneath the anterior belly of the omo-hyoid on its way to the gland.

The *branches* are: (1) The hyoid, a small twig, which runs below the lower border of the hyoid bone. (2) The sterno-mastoid branch curves downwards and backwards across the trunk of the common carotid artery on its way to the sterno-mastoid muscle. It crosses the carotid under cover of the omo-hyoid muscle, *i.e.*, on a level with the cricoid cartilage. (3) The superior laryngeal artery enters the larynx by perforating the thyro-hyoid membrane along with the nerve. It supplies the muscles and soft parts in the larynx. (4) The crico-thyroid artery runs on the crico-thyroid membrane, and there meets the fellow of the opposite side.

2. The *lingual artery* arises from the external carotid immediately above the superior thyroid, on a level with the greater cornu of the hyoid bone. It runs inwards and upwards to the tongue, resting on the middle constrictor of the pharynx, the stylo-hyoid ligament and the genio-hyo-glossus muscle. It lies beneath the cutaneous structures, and disappears from the superior carotid triangle under cover of the digastric and stylo-hyoid muscles; in the tongue it lies beneath the hyo-glossus muscle. The artery runs at first parallel to the greater cornu of the hyoid bone, and below the level of the hypoglossal nerve.

The *branches.*—(1) The hyoid artery runs parallel to the upper border of the hyoid bone. (2) The dorsalis linguæ ascends to the mucous membrane of the back of the tongue; it sends branches also to the tonsil. (3) The sublingual supplies the sublingual gland, the muscles and the mucous membranes of the tongue and the gum.

(4) The ranine artery is the continuation of the lingual forwards; it runs on the lower aspect of the tongue between the genio-hyo-glossus and the hyo-glossus muscles, and below the level of the inferior lingualis. The artery near the tip becomes almost superficial.

3. The *facial artery* arises above the lingual from the external carotid. It is divided into two stages. (*a*) *Below the jaw.* The artery runs forwards beneath the digastric and stylo-hyoid muscles to reach the submaxillary triangle, where it is imbedded in a groove in the upper surface of the submaxillary gland. It lies deeply on the middle constrictor, the stylo-hyoid ligament and the mylo-hyoid muscle. It crosses the lower jaw two fingers'-breadth in front of the angle, just touching the anterior and lower edge of the masseter. There is a groove in the bone for the passage of the artery. The facial vein at this point is behind the artery.

Branches.—(1) The tonsillitic artery ascends upon the stylo-glossus muscle, and pierces the pharynx to supply the tonsil. (2) The ascending palatine ascends beneath the stylo-glossus, lying between it and the stylo-pharyngeus; opposite the angle of the jaw and upwards it lies between the internal pterygoid muscle and the pharynx, and finally turns over the upper border of the superior constrictor with the levator palati; it sends branches to the Eustachian tube, tonsils and palate. (3) The submaxillary arteries, from four to eight in number, enter the submaxillary gland. (4) The submental artery runs parallel to the lower jaw upon the under surface of the mylo-hyoid muscle: it sends a branch—the mental—over the jaw, a thumb's-breadth from the middle line, to anastomose with the mental branch of the inferior dental and supply the chin.

(*b*). *Above the jaw, i.e.*, in the facial region, the artery ascends obliquely inwards to near the angle of the mouth; winding around that, it runs inwards to the nose, along the side of which it ascends until it ends at the inner canthus of the eyelids. It lies upon the lower jaw, the buccinator muscle, the levator anguli oris, the upper jaw and the levator labii superioris alæque nasi. It is covered by the skin, superficial fascia and platysma, and finds its way beneath the risorius, the zygomatici major and minor, and the levator labii superioris proprius muscles.

Branches.—(1) The inferior labial artery runs beneath the depressors of the lower lip; it supplies the cutaneous structures, and anastomoses with the mental branches of the submental and inferior dental arteries. (2) The inferior coronary to the lower lip. (3) The superior coronary to the upper lip. Both these vessels run in contact with the mucous membrane on the inner aspect of the lips. From the upper coronary a branch—the *artery of the septum*—runs along the nasal septum to the tip of the nose. (4) The lateralis nasi artery supplies the side of the nose. (5) The angular branch is the terminal twig of the facial artery; it anastomoses with the nasal branch of the ophthalmic artery at the inner canthus of the eye.

The Ascending Set.

The *ascending pharyngeal artery* is described usually as arising from the bifurcation of the common carotid artery; but more often it comes from the external carotid about one inch above its commencement. The artery runs upwards on the wall of the pharynx, parallel to the trunk of the internal carotid, as far as the base of the skull.

Branches.—(1) The pharyngeal arteries are small variable twigs which supply the pharynx, the Eustachian tube, the tonsil and palate. (2) The prevertebral branches supply the prevertebral muscles and tissue. (3) The meningeal arteries are usually two; one passes through the middle lacerated foramen, the other through the jugular foramen, to reach the middle and posterior cranial fossæ respectively.

The Posterior Set.

1. The *occipital artery* arises from the concavity of the external carotid artery opposite the facial. It has three directions: first, upwards and backwards to the interval between the transverse process of the first cervical vertebra and the mastoid process; secondly, backwards, nearly horizontally, touching the temporal and occipital bones; thirdly, it reaches the surface of the scalp, penetrating the aponeurosis between the trapezius and the sterno-mastoid muscles on the superior curved line of the occiput.

Relations.—In the *first* part of its course the artery is covered by the cutaneous structure and the sterno-mastoid muscle; the hypoglossal nerve winds round the artery at its origin. *Deeply,* the artery rests on the internal carotid, the internal jugular, the pneumogastric and spinal accessory nerves. In the *second* part of its course the artery lies beneath the trachelo-mastoid, the splenius capitis, and the sterno-mastoid muscles, and upon the rectus capitis lateralis, the superior oblique, and the complexus. In the *third* stage the artery is subcutaneous in the scalp.

Branches.—(1) The sterno-mastoid branches to the upper end of the muscle. (2) A mastoid branch enters the skull by the mastoid foramen. (3) A meningeal branch entering the cranium by the jugular fossa. (4) The arteria princeps cervicis descends from the second stage of the artery, and splits upon the complexus muscle into a superficial and deep branch. The superficial runs upon the complexus supplying the neighbouring muscles; the deep branch runs between the complexus and semi-spinalis colli muscle to anastomose with the arteria profunda cervicis from the superior intercostal.

The third or scalp stage of the occipital artery supplies branches named according to the tissues to which they go: cutaneous, muscular, anastomosing, periosteal, and to the bones.

2. The *posterior auricular artery* arises from the external carotid in the substance of the parotid gland. It runs upwards in the depression between the cartilage of the ear and the mastoid process, and ends by giving off terminal cutaneous branches to the scalp behind the ear. The facial nerve winds round the artery on its way to the face.

Branches.—(1) Parotid branches to the gland. (2) The stylo-mastoid artery accompanies the facial nerve, and entering by the stylo-mastoid foramen, finds its way along the aqueduct of Fallopius to end by anastomosing with the petrosal branch of the middle meningeal. It supplies mastoid, tympanic, and muscular branches. (3) The terminal branches are: the *auricular*, which ascends beneath the retrahens aurem muscle, and supplies both the front and back of the ear; the branches reach the front by perforating the cartilage: the other terminal branch is the *mastoid*, which crosses the insertion of the sterno-mastoid superficially to reach the region of the occipital artery, with which vessel it anastomoses freely.

The Terminal Branches of the External Carotid.

1. *The Temporal Artery.*—This artery, sometimes called the superficial temporal artery, arises from the bifurcation of the external carotid in the substance of the parotid gland opposite the neck of the condyle of the jaw. It leaves the parotid region by crossing the zygoma half an inch in front of the tragus of the ear, and ascends on the temporal fascia as high as the level of the top of the ear. There it divides into its terminal branches.

Branches.—Below the zygoma: (1) Parotid, to the gland. (2) Articular, to the lower jaw articulation. (3) Auricular, to the lower part of the ear. (4) The transverse facial branch runs across the masseter muscle above Stenson's duct, accompanied by branches of the facial nerve. It ends in muscular and anastomosing branches.

Above the zygoma the branches are: (1) The orbital artery runs between the layers of the temporal fascia where they are attached to the upper border of the zygoma; it reaches the outer border of the orbicular muscle.

(2) Auricular branches to the upper part of the ear.

(3) The middle temporal artery perforates the temporal fascia in front of the temporal artery; it communicates in the temporal muscle with the deep temporal vessels.

The *terminal* branches of the temporal artery are:

(4) The anterior temporal, which winds forwards with a tortuous course, following the limit of the hair in front; in the forehead it changes direction and passes straight back. It anastomoses with the arteries of the forehead, and with the following.

(5) The posterior temporal artery is continued onwards and upwards in the course of the main trunk, its terminal filaments reaching the top of the head, where it anastomoses with the terminal branches of the occipital, posterior auricular, and the other temporal arteries of the same and of the opposite sides.

The branches of the anterior and posterior temporal arteries in the scalp are named: cutaneous, muscular, anastomosing, periosteal, and to the bone.

2. The *Internal Maxillary Artery* commences at the bifurcation of the external carotid artery, opposite the neck of the condyle of the lower jaw. It is divided into three stages by its relation to the external pterygoid muscle. The first reaches from the commencement to the lower border of the external pterygoid muscle; the second stage is whilst the artery is in contact with the muscle; and the third, after it has passed between the two heads of the muscle.

A. The *first* stage has the ramus of the jaw external to it; the internal pterygoid muscle internal to it, with the gustatory nerve, the inferior dental nerve, and the internal lateral ligament intervening.

Branches.—(1) The tympanic branch passes through the Glaserian fissure to the tympanum; a branch of this vessel (sometimes from the parent trunk)—*the deep auricular*—enters the external auditory meatus and supplies it.

(2) The inferior dental artery descends on the internal lateral ligament of the lower jaw; it enters the inferior dental foramen to run forwards in the inferior dental canal. It gives off the following: (*a*) The mylo-hyoid artery is given off before the artery enters the canal—it descends in a groove in the jaw to the submaxillary region; (*b*) the dental branches to the fangs of the teeth; (*c*) the terminal branches are: the *mental*, which emerges through the mental foramen to anastomose with the mental branch of submental and the inferior labial and coronary arteries; the *incisive* branch continues in the canal to supply the incisor teeth.

(3) The middle meningeal artery passes straight upwards at right angles to the parent trunk. It lies beneath the external pterygoid muscle, behind the trunk of the inferior maxillary nerve, and upon

the side of the pharynx. It passes through the roots of the auriculo-temporal nerve on its way to enter the cranium at the foramen spinosum. *Within* the cranium the artery runs outwards upon, first, the sphenoid, then the squamous portion of the temporal, and dividing into two branches passes on to the parietal bone; the anterior and larger branch grooves the anterior inferior angle of the parietal bone, whilst the posterior reaches the parietal bone half-way along its lower border. The artery runs between the dura mater and the bones reaching to the vertex, and forwards and backwards on to the frontal and occipital bones respectively. It gives branches to the dura mater, the bones, the Gasserian ganglion, and a *petrosal* branch enters the hiatus Fallopii to anastomose with the stylo-mastoid branch of the posterior auricular, and the auditory branch of the basilar.

(4) The small meningeal artery usually comes from the middle meningeal (sometimes from the parent trunk); it enters the skull by the foramen ovale to supply the dura mater, etc.

B. The *second* stage of the artery passes either wholly beneath the external pterygoid muscle, or lies superficial to the lower half of the muscle and dips down between its two heads. If it goes deeply, a knuckle of the artery shows between the two heads.

The *branches* are muscular to the masseteric, temporal, buccal, and pterygoid muscles. The masseteric artery passes over the sigmoid notch of the lower jaw to reach its muscle. The deep temporal arteries, anterior and posterior, pass outwards, and then hook round the pterygoid ridge of the great wing of the sphenoid to ascend beneath the temporal muscle in the temporal fossa. The buccal artery descends to the buccinator muscle; the pterygoid branches pass both outwards and inwards to the pterygoid muscles.

C. The *third* stage of the artery commences after the artery has passed between the two heads of the external pterygoid muscle; it enters the pterygo-maxillary fossa through the pterygo-maxillary fissure.

Branches.—Before it enters the fossa it gives off (*a*) the posterior superior dental or alveolar branch. This vessel quickly divides into branches, which penetrate the posterior dental canals in the zygomatic surface of the superior maxillary bone, to supply the molar and bicuspid teeth and the cavity of the antrum of Highmore. One special branch, the alveolar proper, refuses to enter the canals, but runs forwards to the face on the zygomatic ridge of the superior maxilla to join the infra-orbital artery. (*b*) The descending or superior palatine artery enters the posterior palatine foramen, and emerges from its lower end at the back of the hard palate. Running forwards in a groove between the alveolar border and palate process, it supplies the gum, palate, tonsils, etc., and mounts upwards in a lateral anterior palatine foramen, *i.e.*, Stenson's foramen, to the septum of the nose. (*c*) The pterygo-palatine artery passes backwards through the canal of the same name to reach the Eustachian tube and pharynx. (*d*) The Vidian artery passes backwards in the Vidian canal to the Eustachian tube and the pharynx. (*e*) The naso- or spheno-palatine artery enters the spheno-palatine foramen, and gains the superior meatus of the nose. There it supplies mucous membrane, ethmoidal, frontal, and sphenoidal sinuses, and the antrum; whilst one long branch, the artery of the septum or naso-palatine, descends along the side of the septum, running downwards and forwards, until it reaches a lateral anterior palatine, *i.e.*, Stenson's, or the incisor foramen, where it communicates with the vessel ascending from the roof of the mouth. (*f*) The infra-orbital artery seems to be the continuation of the internal maxillary. It runs forwards in the infra-orbital groove, canal, and foramen, emerging on the face a finger's-breadth below the centre of the bony margin of the orbit. It gives off the following: (α) Small orbital branches to the lower muscles and lachrymal sac. (β) An anterior dental branch passes down in the anterior wall of the antrum, and supplies the incisor and canine teeth, the mucous membrane of the antrum, and the lower part of the nose. (γ) The terminal branches are named palpebral, nasal, and labial, according to their distribution; they anastomose with the transverse facial and facial arteries.

The Internal Carotid Artery.

From the bifurcation of the common carotid artery at the upper border of the thyroid cartilage, this vessel ascends to the base of the skull; it there passes through the carotid canal in the petrous portion of the temporal bone, gains the cranial cavity, and passes along the groove by the side of the body of the sphenoid, to end at the anterior clinoid process in branches to the brain. Hence the vessel is best divided into regions.

A. *In the neck* the artery is continued in a line with the common carotid, of which it seems the natural continuation. It appears in the superior carotid triangle on a plane posterior to the external carotid; it has the sterno-mastoid muscle overlapping it, and the hypoglossal nerve, and the occipital artery crossing. Higher up it passes beneath the posterior belly of the digastric and stylo-hyoid muscles, and beneath the parotid gland, the styloid process and stylo-pharyngeus muscle; the glosso-pharyngeal nerve goes forward, and the spinal accessory backwards over the artery, near the base of the skull. *Externally* are the internal jugular vein and the hypoglossal nerve; *internally*, the pharynx, with the ascending pharyngeal artery, and the superior laryngeal nerve ; *behind*, the rectus capitis anticus major, the pneumogastric nerve, and the superior cervical ganglion of the sympathetic.

The internal jugular vein and the internal carotid artery part company at the base of the skull, the artery going forwards and the vein backwards. In the interval, the eighth and ninth pair of nerves appear, and behave thus : the glosso-pharyngeal runs forwards over the artery ; the spinal accessory runs backwards over or under the vein ; the hypoglossal descends for some distance between the vein and the artery, and then turns forwards over the artery ; the vagus continues the whole way down the neck between the artery and vein. Between the external and internal carotid arteries are placed—the styloid process, the stylo-pharyngeus muscle, the glosso-pharyngeal nerve, and a bit of the parotid gland. No branches are given off from the artery in the neck.

B. *In the carotid canal* of the temporal bone the artery forms a sudden curve after it has ascended for the distance of half an inch, and turns forward to emerge near the apex of the bone. The branches given off in this stage are small branches to the tympanum.

C. *In the cranium* the artery lies upon the cartilage which closes in the middle lacerated foramen ; then runs on the cavernous groove on the side of the body of the sphenoid, being internal to the cavernous sinus ; and finally mounts up between the anterior and the middle clinoid processes to end opposite the anterior perforated spot of the brain, at the inner end of the fissure of Sylvius.

The *branches* of the last stage are numerous and important.

(1) The *ophthalmic artery* comes off just before the termination of the vessel at the anterior clinoid processes. It runs forward to enter the optic foramen below and external to the optic nerve. When it arrives within the orbit it is placed on the outer side of the nerve ; it then crosses the optic nerve, and gaining its inner side it runs forward to end in branches at the inner angle of the orbit.

The branches are arranged according to the stage of the artery from which they arise. (A) On the *outer* side of the nerve the ophthalmic gives off: (α) The lachrymal ; this artery runs forward on the upper border of the external rectus muscle to the lachrymal gland; it supplies the gland, and runs beyond it to give branches to the eyelids and conjunctiva ; small branches accompany the temporo-malar nerve, through the temporo-malar foramina, to the temple and face. (β) The arteria centralis retina comes off from the parent trunk or from the lachrymal, and enters the outer side of the optic nerve half-way forwards. (γ) Muscular branches in this region supply the muscles. (B) On the *top* of the optic nerve the artery gives off: (α) The supra-orbital branch, which passes upwards to the inner side of the levator palpebra muscle, and then forward along its upper surface to the supra-orbital foramen, through which it passes to the forehead, giving off at the same time branches to the eyelid. (β) The posterior ciliary arteries are divided into two sets, long and short. The *long*, two in number, pass forward on either side of the optic nerve to penetrate the sclerotic coat a little behind the centre, and are continued forward to the iris. The *short* ciliary arteries arise as three or four branches, but dividing into about twelve, they pierce the sclerotic coat just outside the entrance of the optic nerve. They are distributed to the choroid coat. (γ) Muscular branches. (C) On the *inner* side of the optic nerve the branches are; (α) Posterior, and (β) anterior ethmoidal. These vessels run through the posterior and anterior ethmoidal foramina respectively, and reaching the upper surface of the cribriform plate of the ethmoid supply to a small extent the dura mater and the olfactory lobe and tract. (γ) Muscular. (D) The *terminal* branches are (α) the frontal, (β) the palpebral, and (γ) the nasal. These vessels run, as their names imply, to the forehead, the eyelids, and the nose respectively, and with them the facial artery, by its angular branch, freely anastomoses.

(2) The *anterior cerebral artery* runs from the termination of the internal carotid artery forward between the optic nerve and olfactory tract to reach the longitudinal fissure. At the entrance thereof the arteries of the opposite sides are connected by the *anterior communicating*, a vessel about two lines in length. The anterior cerebral artery then adheres to the inner aspect of the hemisphere, turns round the genu of the corpus callosum, and gaining the upper surface of that body, breaks up into branches, which supply the inner aspect of the hemisphere as far back as the parieto-occipital fissure. (*See* below.)

(3) The *middle cerebral artery* passes outwards in the fissure of Sylvius, where it embraces the island of Reil, and divides on the outer side of the hemisphere into vessels which supply nearly the whole of the outer surface. (*See* below.)

(4) The *anterior choroid artery* comes, sometimes directly from the internal carotid, sometimes from the middle cerebral, and enters the apex of the descending cornu of the lateral ventricle to supply the choroid plexuses of that ventricle.

(5) The *posterior communicating artery* passes backwards to join the posterior cerebral, and helps to complete the circle of Willis.

The Cerebral Arteries are interesting in their ultimate distribution, owing to the facts which may be compiled from the study of the parts of the brain to which they proceed. In the first place, two sets of vessels may be recognised: (α) those which dip into the brain-tissue at its base—*the central system of arteries;* (β) those which run upon the surface of the brain and finally dip into it—*the cortical system of arteries.*

Each vessel in these sets proceeds to distinct and fairly constant areas, and but few anastomoses exist even in their capillary terminations.

Each of the *anterior* cerebral arteries supplies the following parts: the corpus callosum; the orbital surface of the frontal lobe within the olfactory sulcus; the superior frontal convolution; the upper two-thirds of the middle frontal convolution; the anterior and upper portion of the inner aspect of the hemisphere as far back as the parieto-occipital fissure; and the nucleus caudatus of the corpus striatum at its anterior part.

Each *middle* cerebral artery supplies: the inferior frontal convolution; the lower extremity of the middle frontal convolution; the ascending frontal convolution; the orbital surface of the frontal lobe outside the olfactory sulcus; the outer surface of the parietal lobe; the upper and part of the middle convolutions of the temporo-sphenoidal lobe; the posterior part of the nucleus caudatus, and the whole of the nucleus lenticularis of the corpus striatum.

Each *posterior* cerebral artery supplies: the crus cerebri in part; the corpora quadrigemina; the corpora geniculata; the optic thalamus, except in front; the lower convolution of the temporo-sphenoidal lobe; the occipito-temporal convolutions; the occipital lobe; the medulla oblongata, and the pons varolii in part.

The *anterior communicating* supplies a few twigs to the anterior part of either optic thalamus.

Each *posterior communicating* distributes branches to the crus cerebri and the anterior and inner portions of the optic thalamus.

The Arteries of the Upper Extremities.

The arteries devoted to the supply of the upper extremities are the right and left subclavian. At their commencements the vessels of the two sides are not symmetrical, coming as they do the one on the right side from the innominate, the other on the left from the arch of the aorta.

The *left subclavian artery* in its first part differs from that on the right side, from its origin at the arch of the aorta until it reaches the inner border of the first rib. Commencing from the arch of the aorta about half an inch to the left of the left common carotid, the artery ascends almost vertically to the inner border of the first rib. *Relations.*—In *front*, the pleura and left lung, the left innominate vein; the left common carotid is also on a plane anterior to it; the pneumogastric and phrenic nerves, and the sympathetic cervical cardiac nerves run parallel to and in front of the left subclavian. *Behind* is the œsophagus, the thoracic duct and the longus colli muscle, in order from before backwards. To the *right* or inner side is the trachea, œsophagus, and at the upper part the thoracic duct; to the *left* or outer side, the left lung and pleura.

The *first part of the right* subclavian has to be described separately, as it has no exact counterpart on the left side. It comes from the innominate opposite the right sterno-clavicular articulation, and curves upwards and outwards to end at the inner border of the anterior scalene muscle. Its *relations* are: in *front*, the sterno-mastoid, sterno-hyoid and sterno-thyroid muscles; the internal jugular and vertebral veins cross it, running from above downwards, as also do the pneumogastric nerve and cardiac branches of the pneumogastric and cervical sympathetic. *Behind* the artery is the right longus colli muscle and the recurrent laryngeal nerve. To the right and *below* is the right pleura and lung; to the *left*, the common carotid artery.

The second and third stages of the subclavian artery are similar upon the two sides.

The *second* stage of either artery lies behind the anterior scalene muscle on a groove posterior to the scalene tubercle. *Relations.*—In *front*, the anterior scalene muscle and the scalene tubercle, the phrenic nerve, the subclavian vein, and the structures around the clavicle; *behind*, and above, the cords of brachial plexus; *below*, the pleura. It gives off no branches, unless the superior intercostal be counted as one. The vessel at this stage reaches the highest point of the arch which it describes.

The *third* stage of the subclavian reaches from the outer border of the anterior scalene muscle to the outer border of the first rib. The artery lies in the subclavian triangle bounded by the clavicle below and the posterior belly of the omo-hyoid above. The *relations* are: in *front*, the clavicle, the subclavius muscle, the supra-scapular artery, the nerve to the subclavius, the external jugular vein, and the subclavian vein; *behind*, and *above*, the cords of the brachial plexus and the middle scalene muscle; *below*, the first rib, and the first serration of the serratus magnus. It gives off no branches usually; but should one be given off, it is usually the posterior scapular.

The Branches of the Subclavian Artery.—All the branches belong to the first stage of the subclavian on the left side, but on the right side the right superior intercostal is regarded as coming off from the second.

1. The *vertebral artery* is the first branch given off from the first stage of the subclavian; it passes upwards and backwards from the upper and back part of the artery to enter the vertebral foramen of

the sixth cervical vertebra. It ascends in the transverse processes of the cervical vertebræ, until it reaches the foramen in the second, in which it bends horizontally outwards, and again ascends to pass through the transverse process of the first cervical vertebra. Gaining the upper surface of the last-named vertebra, it turns horizontally backwards, winding behind and grooving the lateral mass of the atlas. It now pierces the occipito-atloid ligament and the dura mater between the occiput and the atlas, and enters the cranium through the foramen magnum.

In the neck the artery passes into the sixth vertebra between the longus colli and anterior scalene muscles, and under cover of the nternal jugular vein; on the left side the thoracic duct arches forward over it. Between the transverse processes, the artery lies between the intertransverse muscles, with the anterior primary division of the spinal nerves between it and the posterior intertransverse muscles. Accompanying the artery in the vertebral foramen are the vertebral vein (existing as a plexus) and a bundle of sympathetic nerves.

Within the cranium the artery separates the first cervical from the hypoglossal nerve as it ascends to reach the anterior aspect of the medulla oblongata, and finally joins with the fellow of the opposite side to form the basilar at the lower border of the pons.

Branches.—In the *neck:* (1) The lateral spinal arteries run inwards with the spinal nerves to the spinal cord. (2) Muscular branches.

In the *cranium:* (1) Posterior meningeal branches to the posterior cranial fossa. (2) The posterior spinal arteries, two in number, run down the back of the spinal cord as two separate branches. (3) The anterior spinal arteries commence as two, then unite to form one trunk, which descends on the linea splendens in front of the cord.

The *arteries to the spinal canal* are as follows: (α) Anterior and posterior spinal from the vertebral. (β) Lateral spinal from the vertebral artery in the neck. (γ) Branches from the superior intercostal at the root of the neck. (δ) Branches from the aortic intercostals; (ε) from the lumbar arteries; (ξ) from the ilio-lumbar; (η) and from the lateral sacral.

(4) The posterior inferior cerebellar to the posterior part of the under surface of the cerebellar hemisphere.

The *basilar artery* results from the union of the vertebrals, and runs from the lower to the upper border of the pons along its central groove. The branches are: (1) The anterior inferior cerebellar artery, supplying the anterior part of the under surface of the cerebellum. (2) Transverse arteries to the pons; one of them, the *auditory* artery, enters the internal auditory meatus to reach the internal ear. (3) The superior cerebellar winds round the pons and the crus cerebri to reach the upper surface of the cerebellum. (4) The posterior cerebral artery corresponds to the bifurcation of the basilar; it passes outwards parallel to the artery just mentioned, and turns round the crus cerebri to be distributed upon the under surface of the cerebrum. To this vessel the posterior communicating from the internal carotid is joined, and thus the circle of Willis is completed.

The circle of Willis is mentioned with the description of the brain. It is a circlet of vessels bounded in front: by the anterior communicating and the anterior cerebral arteries; at the sides are the trunks of the internal carotid arteries, and the posterior communicating; posteriorly the bifurcation of the basilar, and the posterior cerebral arteries on either side.

The parts of the brain supplied by the vertebral and basilar arteries are as follows:

The *spinal arteries*, especially the anterior, supply branches to the medulla oblongata.

The *posterior inferior cerebellar* supplies the under surface of the cerebellum at the back part; the choroid plexuses of the fourth ventricle; and the posterior part of the superior surface of the cerebellum.

The *anterior inferior cerebellar* supplies the anterior part of the upper surface of the cerebellum.

The *superior cerebellar artery* is distributed to the upper surface of the cerebellum at its anterior part; to the valve of Vieussens; the superior peduncle of the cerebellum and the inferior corpora quadrigemina.

2. The *thyroid axis* arises from the upper part of the first stage of the subclavian artery. It is a thick trunk, about a quarter of an inch in length, which suddenly breaks up into terminal branches. The branches are:

(1) The *inferior thyroid* runs upwards and inwards, crossing the front of the vertebral artery at its commencement, and then behind the carotid sheath to reach the thyroid gland.

The branches are: (α) Muscular, to prevertebral muscles. (β) The inferior laryngeal enters the larynx with the nerve of the same name, to supply the mucous membrane and muscles. (γ) Tracheal; and (δ) œsophageal to the trachea and larynx. (ε) The ascending cervical runs upwards, parallel, but internal to, the phrenic nerve, in the groove between the longus colli and the rectus capitis anticus major; it supplies muscular, spinal, and anastomosing branches.

(2) The *supra-scapular*, or transversalis humeri artery, passes outwards from the thyroid axis lying in front of the anterior scalene muscle and the phrenic nerve; it pursues a course backwards and outwards parallel to the clavicle, in the subclavian triangle, until it

reaches the upper border of the scapula in company with the supra-scapular nerve. The artery then passes over the supra-scapular ligament to reach the supra-spinous fossa; here it burrows beneath the supra-spinatus muscle, and winds round the base of the spine of the scapula to enter the infra-spinous fossa underneath the infra-spinatus muscle.

Branches.—(α) Muscular to the muscles in its path. (β) A branch to the subscapular fossa before it crosses the ligament. (γ) Branches to the scapula and clavicle. (δ) Anastomosing branches about the scapula, where it joins with branches of the subscapular and dorsalis scapulæ from the axillary, and with the posterior scapular from the thyroid axis. (ε) Offshoots to the shoulder-joint.

(3) The *transversalis colli artery* runs in a similar manner, but above the level of the supra-scapular; on reaching the subclavian triangle, it dips under the omo-hyoid muscle to reach the under surface of the trapezius, where it divides into two: (α) the superficial cervical artery supplies the trapezius, levator anguli scapulæ, etc.; (β) the posterior scapular passes backwards under cover of the levator anguli scapulæ, and descends along the vertebral border of the scapula beneath the rhomboid muscles. It gives off muscular and anastomosing branches very similar to the supra-scapular.

3. The *internal mammary artery* arises from the lower aspect of the first stage of the subclavian opposite the thyroid axis. The artery runs downwards on the pleura and behind the subclavian vein to reach the posterior surface of the cartilage of the first rib. Pursuing its downward course it lies behind the cartilage of the ribs about half an inch from the sternal border, until it reaches the sixth intercostal space, where it divides..

Relations.—In *front*, the subclavian vein, the costal cartilages, and the internal intercostal muscles; *behind*, the pleura above, the triangularis sterni below. The phrenic nerve crosses it from without inwards and above downwards at its commencement.

Branches.—(α) The comes nervi phrenici, superior phrenic or diaphragmatic artery, arises from the parent trunk shortly after its commencement, and sends branches to the pleura, pericardium, phrenic nerve, and diaphragm. (β) Mediastinal branches to the anterior mediastinum. (γ) Pericardial branches. (δ) Sternal branches. (ε) Anterior intercostal arteries, two to each space; these anastomose with the anterior termination of the aortic intercostals. (ζ) Perforating arteries go forward to the skin with the terminal branches of the intercostal nerves. The *terminal* branches are the following: (η) The *musculo-phrenic* runs outwards above the diaphragm in contact with the rib cartilages, ending about the tenth cartilage. It supplies muscular branches to the diaphragm, pleural branches, and anastomosing to the intercostals. (θ) The superior epigastric artery seems to be the continuation of the vessel; it passes through the diaphragm between its sternal and costal attachments, and enters the sheath of the rectus muscle above the upper border of its aponeurotic sheath; in the substance of the muscle it anastomoses with the deep epigastric from the external iliac, and with the intercostals.

Branches.—Muscular and anastomosing to the deep epigastric and to the intercostals.

4. The *superior intercostal artery* comes from the extremity of the first stage, or from the commencement of the second stage of the subclavian. Passing backwards, it bends down in front of the neck of the first rib to reach the first and second intercostal spaces. In front of the neck of the rib it lies between the inferior cervical ganglion in front, and the first dorsal nerve behind.

Branches.—The chief-named branch is the *deep cervical artery*, which passes from the superior intercostal, backwards, between the neck of the first rib and the transverse process of the seventh cervical vertebra. Posteriorly it appears between the complexus and the semi-spinalis colli, to anastomose with the arteria princeps cervicis from the occipital, and to supply the muscles and articulations of the cervical region.

The Axillary Artery extends from the outer border of the first rib to the lower border of the teres major. It runs along the upper and posterior part of the axilla, and is divided into three stages by the pectoralis minor, part being above, part beneath, and part beyond that muscle. According to the position of the limb, so does the position of the artery vary; when the limb is hanging, the artery is curved downwards; when the hand is raised above the head, the artery curves upwards; when the limb is abducted at a right angle, the artery is nearly straight.

I. The first stage extends from the outer border of the first rib, to the upper border of the pectoralis minor. It is very deeply placed, and is affected by the position of the clavicle, according as it is depressed or not. The *relations* are: in *front*, the cutaneous structures, the pectoralis major, the costo-coracoid membrane, the axillary and cephalic veins; *behind*, the cords of the brachial plexus, and the posterior thoracic nerve on its way to the axilla; *internally*, the first serration of the serratus magnus, and the first intercostal space. The position of the axillary vein is peculiar. When the limb is hanging, the vein is on a plane anterior to the artery, slightly below the level of the artery all the way along, and on a plane internal to it—that is to say, it is possible to see the artery from the front, just peeping over the vein all the way along its three stages.

II. The second stage corresponds to the breadth of the pectoralis minor. It has—in *front*, the pectoralis minor; *internally* and in front, the vein; *externally*, *internally*, and *posteriorly* are the three cords of the brachial plexus.

III. The third stage extends from the outer border of pectoralis minor to the lower border of the teres major. It has—in *front*, pectoralis major for about two-thirds of its length, and beyond that the superficial structures only; *behind*, the subscapularis, the latissimus dorsi and the teres major muscles, in the order mentioned; *internally* and in *front*, the vein; *externally*, the coraco-brachialis muscle. The cords of the brachial plexus are all around, including the median nerve on a plane anterior and external to the artery.

The BRANCHES of the axillary are:

A. From the *first* stage.—(1) The superior thoracic runs to the first intercostal space to anastomose with the superior intercostal. (2) The acromio-thoracic arises from the front of the axillary artery, runs forwards through the clavi-pectoral fascia, and at the upper border of the pectoralis minor in the subclavicular triangle breaks up into thoracic, acromial, and humeral branches. (α) The thoracic branch runs inwards to the chest and anastomoses there with the upper intercostals. (β) The acromial branch runs beneath and partly through the deltoid to the acromion process; it anastomoses with the supra-scapular and circumflex arteries. (γ) The humeral branch runs down with the cephalic vein, between the deltoid and pectoralis major, supplying these muscles and the skin. A small branch is given off from the acromio-thoracic trunk to the subclavius muscle.

B. From the *second* stage.—(1) The alar thoracic branches supply the glands and fat of the axilla. (2) The long thoracic—the external mammary artery, runs along the anterior wall of the axilla under cover of the pectoralis minor to supply the thoracic muscles and mamma; it anastomoses with the intercostal arteries.

C. From the *third* stage.—(1) The anterior circumflex passes outwards opposite the surgical neck of the humerus, passing beneath the coraco-brachialis and short head of the biceps muscle, until it reaches the bicipital groove, in which it sends a branch to the joint. (2) The posterior circumflex, a much larger vessel, passes backwards behind the surgical neck in company with the circumflex nerve. It traverses the quadrilateral space behind the humerus; which is bounded by the teres minor above, the teres major below, the long head of triceps internally, and the humerus externally. At the back of the shoulder, the artery supplies the skin, the muscles, and the joint; it anastomoses with the anterior circumflex, acromio-thoracic and superior profunda arteries.

(3) The subscapular artery arises at the lower border of the subscapularis muscle. It runs downwards and backwards along the

axillary border of the scapula, where it ends by giving numerous muscular branches all around; and by anastomosing with the long thoracic, the intercostals, and the posterior scapular. A constant branch, the *dorsalis scapulæ*, arises from the artery shortly after its origin, and runs round the border of the scapula, grooving it between the attachments of the long head of the triceps and the teres minor. It anastomoses freely with the supra-scapular and posterior scapular arteries.

The Brachial Artery, the continuation of the axillary, reaches from the lower border of the teres major muscle to the neck of the radius; it there ends by dividing into radial and ulnar.

The artery gradually passes from the inner side of the arm to the front; therefore, to compress the artery in the upper part, pressure outwards, but in the lower part pressure backwards, must be made.

The *relations* are: in *front*, skin; superficial and deep fasciæ with the bicipital fascia at the head of the elbow; the median nerve crosses it, half-way down, from without inwards; and the median basilic vein crosses it at the elbow, the bicipital fascia intervening. *Behind*, the long and the internal heads of the triceps, insertion of the coraco-brachialis, the brachialis anticus, and the musculo-spiral nerve. *Internally*, the ulnar nerve above, the median nerve below. *Externally*, the coraco-brachialis with the external cutaneous and median nerves for a short distance above; the biceps below. Venæ comites accompany the artery.

Branches.—(1) The *superior profunda artery* is given off from the inner side of the brachial as soon as it commences. It passes downwards and backwards between the outer and inner heads of the triceps to reach the musculo-spiral groove. Accompanied by the musculo-spiral nerve in the groove, it winds round the humerus, reaching its outer side about four inches above the external condyle. There it divides into two branches; (α) the *anterior* continues to accompany the nerve, pierces the external intermuscular septum, and, between the supinator longus externally and the brachialis anticus internally, anastomoses with the radial recurrent. (β) The *posterior* descends behind the external condyle; it anastomoses directly with the interosseous recurrent, and laterally with the anastomotica magna and inferior profunda arteries.

(2) The *inferior profunda artery* accompanies the ulnar nerve. It passes with the ulnar nerve to the back of the internal condyle, where it anastomoses directly with the posterior ulnar recurrent, and with the other arteries around the elbow.

(3) A *nutrient artery* to the humerus is given off about the middle of the arm; it runs downwards in its canal in the bone.

(4) The *anastomotica magna artery* arises about two inches above

the elbow; it passes inwards upon the brachialis anticus, and winding round the bone, perforates the internal intermuscular septum. Behind the humerus it forms an arterial arch above the level of the olecranon fossa, and anastomoses there with the superior profunda. A small branch of the anastomotica magna descends parallel to the median nerve, and anastomoses in front of the internal condyle with the anterior ulnar recurrent.

(5) Numerous unnamed muscular branches pass from the outer side of the brachial to the muscles and cutaneous structures.

The ULNAR ARTERY—the larger of the two divisions of the brachial —reaches from the ending of the brachial at the neck of the radius to the hand, where, at the outer side of the pisiform bone, it divides to form or join the palmar arches.

I. *In the forearm* the artery runs between the superficial and deep layers of muscles. In the upper third of its course it runs beneath the sublimis, and upon the profundus digitorum muscle, forming a slight curve with the convexity inwards. In the lower two-thirds of the forearm it still lies upon the profundus, but immediately beneath the deep fascia, pursuing a straight course. The guide, at the lower part, is the tendon of the flexor carpi ulnaris, on the outer side of which the artery lies. The median nerve lies at first on its inner side, but crosses the artery immediately after its commencement, the two being separated by the deep head of the pronator radii teres, the artery lying the more deeply; the ulnar nerve lies internal to the ulnar artery in the lower two-thirds of its course.

The BRANCHES of the ulnar artery are:

(1) The *anterior ulnar recurrent artery* arches inwards and upwards in front of the internal condyle beneath the pronator radii teres, and anastomoses chiefly with the anastomotica magna.

(2) The *posterior ulnar recurrent* runs backwards and inwards beneath the flexor sublimis; it then passes up, along with the ulnar nerve between the two heads of the flexor carpi ulnaris, to meet the inferior profunda artery.

(3) The *interosseous trunk*, above one-third of an inch in length, arises from the ulnar artery one inch beyond its commencement. It is directed straight backwards, where it divides into two—(*a*) The *anterior interosseous* artery, accompanied by the nerve, runs down in front of the interosseous membrane supplying the flexor longus pollicis and flexor profundus digitorum muscles on either side. At the upper border of the pronator quadratus it passes back, through the membrane, to join the posterior interosseous. It gives off: (α) muscular branches; (β) nutrient arteries to the radius and ulna—these vessels pass upwards in the bones towards the elbow; (γ) branches which descend beneath the pronator quadratus to join the

anterior carpal arch. (δ) The comes nervi mediani usually arises from the common trunk; it accompanies the median nerve and supplies the muscles adjacent; it is sometimes very large, and then passes with the median nerve to the hand.

(*b*) The *posterior interosseous artery* goes directly backwards between the two bones above the interosseous membrane, and appears posteriorly between the supinator brevis and the extensor ossis metacarpi pollicis. It passes down between the superficial and deep layers of muscles, receives the anterior interosseous artery just above the wrist, and finally joins the posterior carpal arch. The *interosseous recurrent*, its only named branch, passes upwards under the anconeus to the posterior part of the external condyle; it anastomoses chiefly with the posterior branch of the superior profunda, but also with the other vessels around the elbow.

II. *At the wrist* the ulnar artery touches the anterior annular ligament, and gives off anterior and posterior inner carpal branches to the front and back of the wrist, to form, with the carpal branches from the radial, the anterior and posterior carpal arch.

The *anterior carpal arch* lies on the anterior aspect of the wrist-joint, being formed laterally by the anterior carpal branches from the radial and ulnar arteries. It is joined above by the anterior carpal from the interosseous; below, it gives off branches to the carpal articulations.

The *posterior carpal arch* is much larger than the anterior; it lies on the back of the wrist. Laterally it is formed by the posterior carpal arteries from the radial and ulnar arteries; whilst from above, the terminations of the anterior and posterior interossei arteries join the arch. From the arch, pass downwards branches to the back of the hand, viz., the second and third metacarpal or dorsal interossei arteries, running along the third and fourth metacarpal spaces.

III. *In the hand* the ulnar artery lies at first on the anterior annular ligament external to the pisiform bone, having the ulnar nerve between it and the bone. It speedily divides into two branches, a superficial to form the superficial palmar arch, and a deep to join the deep palmar arch.

The *superficial palmar arch* runs along the root of the thumb, forming an arch, with its convexity forwards and inwards; the completion of the arch by the superficialis volæ of the radial is little more than an anatomist's fancy. *Relations.*—It lies from its commencement to its end on the flexor brevis minimi digiti, the tendon of the sublimis and the branches of the ulnar and median nerves. Superficially it has the skin, superficial and deep or palmar fascia; the palmaris brevis overlies it at the commencement.

Branches.—(1) Muscular and cutaneous branches to the hand. (2) The digital arteries, four in number, run from the convexity of the arch towards the fingers. That to the inside of the little finger is accounted the first. The second, third, and fourth branches of the arch run parallel to the fourth, third and second inter-metacarpal spaces respectively; at the root of the fingers they receive the endings of the interossei arteries, and divide into branches—the *collateral* to supply the adjacent sides of the fingers. The arteries in the fingers lie behind the level of the digital nerves. As they pass forwards the branches on either side form arches immediately behind and in front of the extremities of the phalanges. Finally the vessels anastomose in the pulp of the fingers and beneath the nail.

The *deep palmar arch* is formed mainly by the radial artery, but it is completed by the deep branch of the ulnar artery. The deep branch of the ulnar passes down between the flexor brevis, and abductor, minimi digiti; it then turns sharply outwards beneath the opponens minimi digiti, and below the level of the unciform hook, and runs outwards on the bases of the metacarpal bones to meet the radial artery and so complete the arch. *Relations.*—The deep arch rests on the bases of the metacarpal bones, and on the interossei muscles; it lies beneath the deep flexor tendons.

Branches.—(1) The recurrent, ascend to the carpus. (2) The perforating arteries, three in number, pass back between the heads of the three inner dorsal interossei muscles, and arriving on the dorsum of the metacarpus join the metacarpal or dorsal interossei from the posterior carpal arch. (3) Palmar interossei arteries run forwards on the interossei muscles, as far as the root of the fingers, where they divide into three branches: the central runs forward to join the digital branches of the superficial arch before they bifurcate; the two lateral branches supply the adjacent sides of the metacarpo-phalangeal articulations.

The end of the radial artery in the hand is described with that artery.

The Radial Artery.

Commencing at the bifurcation of the brachial, opposite the neck of the radius, the radial artery runs downwards in the line of continuation from the brachial. It is best arranged into stages, according as the artery is met with in the forearm, wrist, or hand.

I. *In the forearm* the radial artery corresponds to a line from the middle of the bend of the elbow to the front part of the styloid process of the radius. The artery is crossed by no muscle or nerve, and, but for its being overlapped by the supinator longus above, it is subcutaneous throughout its course.

Relations.—In *front*, skin, fasciæ, and the supinator longus in its upper half. *Behind*, it rests on the tendon of the biceps, the supinator brevis with fatty tissue intervening, the insertion of the pronator radii teres, the origin of the flexor sublimis, the flexor longus pollicis, the pronator quadratus, and the radius at the wrist. *Externally*, the supinator longus muscle, with the radial nerve in the middle third. *Internally*, the pronator radii teres above, and the flexor carpi radialis below.

Branches.—(1) Muscular branches.

(2) The radial recurrent artery passes upwards and outwards on the supinator brevis to anastomose with the superior profunda.

(3) The anterior carpal branch to the anterior carpal arch, already described with the ulnar artery.

(4) The superficialis volæ passes from the lower end of the artery in the forearm, and runs on, through, or beneath the muscles of the thenar eminence to end in them, or in some instances to complete the superficial palmar arch.

II. *At the wrist*, the radial artery turns sharply backwards on the external lateral ligament of the wrist joint, to mount on the back of the carpus. *Relations: superficially*, the skin; fasciæ with a plexus of cutaneous veins and nerves; the ossis, primi and secundi muscles of the thumb. *Deeply* it rests on the external lateral ligament of the wrist, the scaphoid and trapezium bones. This course of the vessel ends by passing between the first and second metacarpal bones, between the two heads of the first dorsal interosseous muscle.

Branches.—(1) Posterior carpal to the posterior carpal arch.

(2) The first dorsal interosseous, or metacarpal artery, runs in the interval between the second and third metacarpal bones, *i.e.*, in the second intermetacarpal space.

(3) The dorsalis indicis to the radial side of the forefinger.

(4) The dorsalis pollicis, usually consisting of two branches, mounts on either side of the dorsal aspect of the thumb.

III. *In the hand* the radial artery enters the palm between the two heads of the first dorsal interosseous, and continues forwards between the flexor brevis pollicis and the adductor pollicis to form the deep palmar arch.

Branches.—(1) Muscular. (2) To the deep arch.

(3) The arteria princeps pollicis passes outwards to the thumb; at first a single trunk, it divides at the metacarpo-phalangeal articulation into two, one vessel running on either side of the palmar aspect of the thumb to the point.

(4) The radialis indicis descends to the forefinger, upon the first dorsal interosseous muscle and beneath the adductor pollicis, to the radial side of the forefinger.

The Thoracic Aorta.

The *descending* part of the *thoracic aorta* is the name given to that portion of the aorta within the thorax; it passes from the end of the arch of the aorta, at the fifth or sixth dorsal vertebra, downwards along the spine to the aortic orifice in the diaphragm opposite the twelfth dorsal vertebra. It commences on the left antero-lateral aspect of the spine, and gradually coming more forwards reaches the middle line at the diaphragm. It is contained in the posterior mediastinum, and has the following *relations:* in *front*, the pericardium, and at the lower part the œsophagus; *behind*, the vertebral column, the vena azygos minor, and the splanchnic nerves; to the *left*, the left lung and pleura; and to the *right*, the œsophagus, the thoracic duct, the vena azygos major, and the right lung.

Branches.—(1) Two bronchial arteries, an upper and lower, arise behind the root of the left lung. The *upper* vessel divides into two branches, one going to the right, the other to the left lung; the *lower* artery goes wholly to the left lung. Both vessels reach the lungs on the posterior part of their respective bronchi. In the lung, the branches supply the mucous membrane of the bronchi, and the lung-tissue.

(2) Five or six œsophageal branches to the back part of the œsophagus.

(3) Pericardial branches to the pericardium.

(4) Mediastinal branches to the glands, etc., in the posterior mediastinum.

(5) Nine pairs of aortic intercostals supplying the intercostal spaces below the second. The right intercostal arteries are longer than the left, owing to the aorta lying on the left of the vertebral column. The upper branches ascend to reach their places, owing to the shortness of the aorta compared with the chest.

Each *intercostal artery* arises from the postero-lateral aspect of the aorta, and passes outwards on the vertebral column. It lies at first beneath the sympathetic chain and the splanchnic nerves, and the venæ azygos of the respective sides. The right vessels have also to pass behind the thoracic duct and the œsophagus. Arriving at the intercostal space the main trunk is continued outwards beneath the pleura and upon the external intercostal muscles. Opposite the tubercle of the rib, the artery enters a groove in the lower border of the rib above, and getting between the internal and external muscles runs forwards and outwards. Half-way along the side of the chest the artery leaves the cover of the rib, and ends in two terminal branches. In the upper spaces the nerve lies above the artery, whilst it occupies the groove in the rib; but below the sixth, the nerve is below its accompanying artery.

Branches.—(1) The posterior or *dorsal* branch is given off opposite the head of the rib, and passes backwards internal to the superior costo-transverse ligament. Behind, the vessel splits on the longissimus dorsi muscle, one branch passing to the inner side of the muscle to reach the spinous processes; the other, the external, passes to the outer side of the muscle to supply the lateral dorsal muscles. The *spinal* branch, entering the spinal canal with the spinal nerves, comes off from the dorsal branch between the heads of the ribs. (2) The terminal branches run from the bifurcation of the intercostal artery half-way along the chest wall, and pursuing a course along the upper and lower borders of the intercostal space, anastomose in front with the anterior intercostals from the internal mammary. (3) Branches supply the muscles, pleura and skin; and the arteries in the third, fourth, and fifth spaces reach the mammary gland. (4) Lateral intercostal branches accompany the nerves of the same name to the side of the chest.

The Abdominal Aorta.

The continuation of the thoracic aorta into the abdomen is called the abdominal aorta. It lies immediately upon the vertebral column extending from the opening in the diaphragm, opposite the twelfth dorsal vertebra, as far as the fourth lumbar vertebra, on the left side of which it bifurcates to be continued as the two common iliacs. On the surface of the body its course is represented by a line drawn from the left of the middle line, at a point two inches below the xiphoid cartilage, to a spot three-quarters of an inch below and to the left of the umbilicus, on a level with the highest point of the crest of the ilium. In length it is about five inches.

Relations.—In *front,* and touching it from above downwards, are: the solar plexus of nerves, the splenic vein, the pancreas, the left renal vein, the third portion of the duodenum, and the mesentery; *behind,* the bodies of the vertebræ, the anterior common ligament, the commencements of the thoracic duct and of the venæ azygos major and minor; to the *right,* the inferior vena cava, and the right crus of the diaphragm at the upper part; to the *left,* the left crus, and the viscera on the left side of the abdomen.

Branches.—I. The inferior phrenic or diaphragmatic arteries, right and left, leave the aorta immediately it enters the abdomen. The *right* phrenic passes up behind the inferior vena cava to the under surface of the diaphragm, where it divides into two, one running inwards and forwards, the other outwards and forwards. It supplies the *superior capsular* artery to the supra-renal capsule, and anastomoses, with the left artery, with the superior phrenics, with the lower intercostals and the musculo-phrenic arteries. The *left* phrenic passes to the left behind the œsophageal opening in the diaphragm, and behaves in a manner similar to the right.

II. The cœliac axis, a short thick stem, arises from the front of the aorta, and passes above the upper part of the pancreas, where it divides into its terminal branches. In length it is about three-quarters of an inch. The solar plexus of the cœliac glands surround its trunk.

Branches.—A. The *gastric* artery runs first to the left, and then curving round, passes to the right along the lesser curvature of the stomach, between the layers of the lesser omentum to the pyloric end of the stomach. There it anastomoses with the pyloric branch of the hepatic. The artery supplies the upper part of the stomach, and sends an œsophageal branch through the œsophageal opening.

B. The *hepatic* artery is directed to the right above the pancreas towards the pyloric end of the stomach; from the pylorus it passes up in the gastro-hepatic omentum, lying with the common bile-duct to its right and the portal vein on a plane posterior to it. In the gastro-hepatic omentum it reaches the liver at the transverse fissure.

Branches.—(1) The pyloric branch curves from right to left to anastomose at the upper curvature of the stomach with the gastric artery.

(2) The gastro-duodenal artery descends behind the first part of the duodenum and upon the portal vein, and coming in contact with the pancreas divides into two. (*a*) The superior pancreatico-duodenal artery anastomoses with the inferior pancreatico-duodenal between the head of the pancreas and the second portion of the duodenum. (*b*) The gastro-epiploica dextra runs to the left, about one inch below the greater curvature of the stomach, between the two anterior layers of the great omentum. It sends branches upwards to the stomach, downwards to the omentum, and terminates by anastomosing with the gastro-epiploica dextra from the splenic artery.

(3) The right and left branches of the hepatic artery each enter the liver at the transverse fissure as two or three vessels. Enclosed in Glisson's capsule they accompany the portal vein and hepatic duct, and supply *capsular*, *vascular*, and *lobular* branches.

(4) The cystic artery comes off from the right hepatic; it passes along the cystic duct and divides into two, the upper branch running above the gall-bladder, between it and the liver; the lower runs along the under surface of the gall-bladder.

C. The *splenic artery* passes from the cœliac axis towards the left, and is conducted by the upper border of the pancreas to the spleen. It is peculiarly tortuous in its course.

Branches.—(1) The pancreatic branches, large and small. (*a*) The pancreaticæ parvæ are numerous small branches which supply the pancreas. (*b*) The pancreatica magna is a single branch, distinguished by its great size.

(2) The vasa brevia are four or five fair-sized vessels, which supply the cardiac end of the stomach.

(3) The gastro-epiploica sinistra curves round from left to right and runs along the greater curvature of the stomach; it has similar relations to the gastro-epiploica dextra, with which it anastomoses.

(4) The terminal branches enter the spleen as four or five large trunks.

III. The superior mesenteric artery arises from the anterior aspect of the aorta, about half an inch below the cœliac axis. It comes forwards between the pancreas above, and the lesser pancreas and the third portion of the duodenum below; crossing the duodenum, it gets between the layers of the mesentery. It pursues a curved course with the convexity to the left, and tapers off towards the right iliac fossa. The vein lies on the right of the artery.

Branches.—(1) The inferior pancreatico-duodenalis runs to the right above the third part of the duodenum to anastomose, between the pancreas and duodenum, with the superior pancreatico-duodenalis. It supplies the viscera adjacent.

(2) The vasa intestini tenuis, usually twelve in number, arise from the convexity of the artery and run parallel to each other towards the small intestine. Before reaching the gut, however, numerous arches (usually three) are formed, and from these the arteries run to the intestine, where they divide into branches to embrace it; they possess an arborescent appearance on the surface of the gut.

(3) The ileo-colic artery seems to be the bifurcation of the parent trunk; its branches supply the lower end of the ileum and the cæcum, and anastomose with the intestinal vessels on the one hand, and with the following:

(4) The colica dextra comes from the concavity of the parent trunk, and runs to the right beneath the peritoneum to the ascending colon, where it sends downwards a branch to join the ileo-colic, and upwards a branch to join the colica media.

(5) The colica media artery runs forwards between the layers of the transverse meso-colon, it supplies the transverse colon and divides into anastomosing branches to the right and left colic arteries.

IV. The middle capsular arteries pass from the right and left sides of the aorta to the supra-renal capsule. They arise on a level with the superior mesenteric.

V. The renal arteries are two short trunks which arise at right angles from the sides of the aorta, about half an inch below the superior mesenteric, and pass almost straight out to the kidneys. They are in diameter about one-third of an inch. The right is slightly longer than the left, owing to the aorta being on the left side of the middle line. Each passes across the corresponding crus of the diaphragm and the psoas muscle. The right passes behind the inferior vena cava, and both arteries are behind their corresponding veins.

The *branches* are: (α) inferior-capsular to the supra-renal capsule; (β) to the ureter; (γ) to the tissue around the kidney; (δ) the terminal vessels enter the hilus of the kidney as four or five branches.

VI. The spermatic arteries arise from either side of the aorta, three-quarters of an inch below the renals. Each vessel passes downwards and outwards upon the psoas, crosses the ureter, and enters the internal abdominal ring. From hence it accompanies the vas deferens along the inguinal canal, and downwards to the scrotum and testicle. Dividing into four or five branches, it enters the testicle at the back part, and piercing the corpus Highmorianum, supplies the testicular tissue. It is tortuous in the abdomen and in the scrotum. The right artery differs only from the left inasmuch as it crosses the inferior vena cava anteriorly, shortly after its commencement.

The *ovarian artery* in the female pursues at first a similar course to the spermatic; but at the brim of the pelvis it passes inwards to the pelvis, and entering the broad ligament of the uterus, is conducted by it to the ovary, into which it enters at the anterior surface. It also sends branches to the uterus, the Fallopian tube, and one upwards along the round ligament of the uterus.

VII. The lumbar arteries, four pairs, arise from the postero-lateral aspects of the aorta, and pass nearly horizontally outwards. Each vessel passes beneath the sympathetic cord, and opposite the hollow on the side of a vertebra takes advantage of the fibrous arches formed by the origin of the psoas muscle, to run backwards beneath the psoas to reach the transverse processes. Beneath the fibrous arches of the psoas are a lumbar artery, a lumbar vein, and two sympathetic nerves, on their way from the lumbar ganglia to the anterior primary divisions of the lumbar nerves. The upper lumbar arteries also pass beneath the respective crura of the diaphragm.

Branches.—(1) The abdominal branch of the artery runs outwards, from the region of the transverse processes, beneath the quadratus lumborum muscle; passing to the posterior part of the muscles of the abdominal wall, it anastomoses with the lower intercostal, the ilio-lumbar, the circumflex iliac and the epigastric arteries.

(2) The dorsal branch supplies the muscles of the loin, and gives

off a *spinal* artery to enter the spinal canal with the trunk of the nerves.

VIII. The sacra media, the real continuation of the aorta, runs down from behind the bifurcation of the aorta, along the middle line, on the last lumbar and the sacral vertebræ, to end in front of the coccyx. It anastomoses with the lateral sacral and the hæmorrhoidal arteries. At its commencement it is hidden by the left common iliac vein as it crosses the middle line.

The Common Iliac Arteries.

The common iliac arteries are really branches of the aorta. They commence at the bifurcation of the aorta on the left side of the fourth lumbar vertebra, and run downwards and outwards, dividing opposite the lumbo-sacral articulation of either side into their terminal branches. The right, two inches long, is slightly longer than the left.

Relations common to both arteries: In *front*, peritoneum, small intestines, ureter and sympathetic nerves; *behind*, the body of the fifth lumbar vertebra; *outside* are the psoas muscles; and *inside*, the hypogastric plexus of nerves. The relations of the two differ slightly. The right has—in *front*, the structures just mentioned; *behind*, the fifth lumbar vertebra, and the commencement of the inferior vena cava by the junction of the two common iliac veins; *internally*, the hypogastric plexus; *externally*, the psoas muscle, separated by the right common iliac vein and the inferior vena cava. The left has—in *front*, the structures mentioned, with, in addition, the rectum crossing it and the superior hæmorrhoidal artery; *behind*, the fifth lumbar; *internally*, the plexus mentioned with the left common iliac vein; *externally*, the psoas.

The External Iliac Artery extends from the bifurcation of the common iliac to Poupart's ligament. In length it is usually four inches; a line from just below the left of the umbilicus, to the centre of a line at the groin drawn midway between the anterior superior spinous process of the ilium and the symphysis pubis, indicates in its upper third the course of the common, and in its lower two-thirds that of the external, iliac artery. The artery passes just above the brim of the pelvis, first on the inner side, and then upon the psoas muscle. It is enclosed in a sheath derived from the iliac and psoas fasciæ, which encloses the vein and artery. It is important to notice that in the sitting posture, the external iliac is the artery which is bent, the flexure affecting it about the middle of its course. There are some differences between the right and left vessels.

1. The *right* artery has—in *front*, the peritoneum, the ileum crossing

it to enter the cæcum, the genito-crural nerve descending on it, the ureter touching it at its commencement, the deep circumflex iliac vein and the vas deferens crossing it close to Poupart's ligament. *Behind*, the psoas below, and above the external iliac vein passing from within outwards; *externally*, the psoas with the external iliac vein appearing above; *internally*, the external iliac vein below.

2. The *left* artery has—in *front*, peritoneum, the rectum crossing it, the genito-crural nerve, the ureter, the deep circumflex iliac vein, and the vas deferens (*see* Right Artery). *Behind*, the psoas below; *externally*, the psoas above; *internally*, the external iliac vein the whole way along. Numerous lymphatic glands accompany the external iliac arteries.

Branches.—(1) The deep epigastric artery arises from the external iliac immediately above Poupart's ligament; it passes upwards and inwards in the subperitoneal fat on the inner side of the internal abdominal ring, and piercing the transversalis fascia it enters the rectus abdominis muscle below the fold of Douglas. At its commencement the vas deferens hooks round it on its way from the inguinal canal to the pelvis. It is accomplished by venæ comites. *Branches.*—(*a*) Cremasteric, to the cremaster muscle and the coverings of the cord.

(*b*) The pubic branch runs to the posterior part of the body of the pubis, and joins there a branch from the obturator.

(*c*) Muscular branches.

(*d*) Anastomosing branches with the superior epigastric of the internal mammary, and with the lower intercostal arteries.

(2) The deep circumflex iliac artery runs outwards parallel to Poupart's ligament in the subperitoneal fat. It pierces the transversalis fascia just within the anterior superior iliac spine, and the transversalis muscle just above and behind; between the transversalis and internal oblique it is continued backwards about a finger's-breadth above the iliac crest until it breaks up in the abdominal wall into its terminal branches. *Branches.*—Muscular, and anastomosing to the lumbar, ilio-lumbar, and lower intercostal arteries.

The Internal Iliac Artery.—Commencing at the bifurcation of the common iliac, this vessel descends in front of either sacro-iliac synchondrosis for about the distance of an inch or an inch and a half. Reaching the upper border of the pyriformis muscle it divides into an anterior and posterior division.

Relations.—In *front* of either artery lies the peritoneum, the intestine, the ureter, and the rectum on the left side; stretching away in front is the obliterated hypogastric artery and the posterior false ligaments of the bladder. *Behind*, the external iliac vein, the lumbosacral cord, and the sacrum. *Externally* is the psoas above, and the great sciatic foramen below. *Internally*, and on a plane posterior, is the internal iliac vein.

BRANCHES.—The artery divides into two sets of branches, an anterior and posterior division.

A. The *anterior division* gives off the following: (1) The superior and middle vesical arteries arise from the unobliterated part of what in the fœtus was the hypogastric artery. They supply branches to the top, sides, and back of the bladder.

(2) The inferior vesical arises from the internal iliac below the preceding, and runs along the lower part of the bladder in the groove between it and the rectum, to end in the prostate. It supplies the bladder, prostate and vesiculæ seminales.

(3) The middle hæmorrhoidal artery resembles the inferior vesical, and has a course parallel to, but below the level of that artery; it supplies similar regions.

(4) The obturator artery comes from the anterior division, about an inch after its commencement. It runs forwards beneath the peritoneum, upon the pelvic fascia, and below the level of the brim of the pelvis. It has the obturator nerve above, and the vein below.

On arriving at the obturator foramen it passes over the fibrous arch formed for the origin of the obturator internus muscle, and grooving the under surface of the horizontal ramus of the pubis, divides, on gaining the femoral aspect of the foramen, immediately into an internal and external branch to embrace the origin of the obturator externus.

Branches.—Inside the pelvis: (*a*) Muscular to the iliacus and psoas. (*b*) Pubic branches to the posterior part of the body of the pubis anastomosing with the branch to the pubis from the deep epigastric.

Outside the pelvis the internal and external terminal branches surround the origin of the obturator externus, and meet below the muscle, on the outside of the tuberosity of the ischium. The external branch supplies the hip-joint by a vessel which passes through the cotyloid foramen to reach the fat in the bottom of the hip-joint, and from which a twig ascends in the round ligament. Both branches give off muscular branches which anastomose with the internal circumflex from the femoral, and with the sciatic artery.

The *terminal* branches of the anterior set are the sciatic and internal pudic.

(5) The sciatic artery, in its descent to the great sciatic foramen, has behind it the sacral plexus of nerves and the pyriformis muscle. In company with the pudic vessels and nerves it emerges from the pelvis beneath the pyriformis muscle, to reach the gluteal region. Under cover of the gluteus maximus the artery continues down the

back of the hip-joint upon the great sciatic nerve, and in company with the small sciatic nerve; it ends by anastomosing with the superior perforating.

Branches.—(*a*) Muscular to the muscles at the back of the hip-joint.

(*b*) Coccygeal branches, three or four in number, pierce the great sacro-sciatic ligament and supply the back of the sacrum, the coccyx, and the gluteus maximus.

(*c*) The comes nervi ischiadici runs down in the substance of the great sciatic nerve supplying it. This artery is interesting, as being the homologue of the femoral artery in some animals—*birds.*

(*d*) Cutaneous branches to the gluteal region.

(*e*) Anastomosing branches to the gluteal, the internal circumflex, and the superior perforating.

(6) The *Internal Pudic Artery.*—This vessel runs in the pelvis parallel to the sciatic, and on a plane internal to it. Emerging at the great sciatic foramen, it reaches the gluteal region; but turning down over the spine of the ischium, it re-enters the pelvis by the lesser sciatic foramen, to gain the ischio-rectal fossa. Here it lies in the outer wall of the fossa, enveloped in a compartment of the obturator fascia, one and a quarter inches above the lower and internal edge of the ischial tuberosity, *i.e.*, about two and a half from the surface. From the ischio-rectal fossa, the artery runs forwards, gradually approaching the perineal margin of the ramus of the ischium, and, finally, running between the layers of the triangular ligament, penetrates the anterior layer of that ligament, and divides into its terminal branches.

Relations.—In the pelvis, the artery lies behind the rectum and upon the sacral plexus and pyriformis muscle, *on the spine of the ischium;* the pudic nerve lies above, *i.e.*, internal to it. In the *ischio-rectal* region, the dorsal nerve of the penis is above it, and the perineal below it.

Branches.—(1) Muscular branches are given off by the artery to the muscles in all the regions in which it passes.

(2) The inferior hæmorrhoidal artery crosses the ischio-rectal fossa as a bunch of vessels, and supplies the muscles at the lower end of the rectum as well as the rectum itself.

(3) The superficial perineal arteries arise at the front part of the ischio-rectal fossa, and passing over, under, or through the superficial transversus perinei muscle, run forwards as two long branches which supply the cutaneous structures of the perineum and the under aspect of the scrotum. This vessel frequently gives off the following.

(4) The transverse perineal artery passes inwards, parallel to the transverse perineal muscle, and supplies the cutaneous and muscular structures around the central tendinous point of the perineum.

(5) The artery to the bulb lies between the layers of the triangular ligament. It runs inwards, parallel to, but half an inch in front of, the base of the triangular ligament; it is almost on a level with the membranous portion of the urethra. It drops down a branch to *Cowper's gland.*

The *terminal* branches of the internal pudic are 6 and 7.

(6) The artery to the corpus cavernosum enters that body about one inch in front of the attachment of the crus penis to the bone.

(7) The dorsal artery of the penis runs forwards from between the two layers of the triangular ligament, by piercing the anterior (inferior) layer immediately external to the dorsal vein. Reaching the dorsum of the penis it is embraced between the layers of the suspensory ligament; it is continued forwards to the glans and prepuce, supplying on the way branches to the corpus cavernosum, which anastomose with the artery to the corpus cavernosum.

In the female there are various special branches of the internal iliac according to the viscera.

(1) The vaginal artery is given off from the anterior division of the internal iliac; it sends branches to the vagina, the bladder, the rectum, and the glands of Kobelt in the labia minora.

(2) The uterine artery passes from the internal iliac, between the layers of the broad ligament of the uterus, where it sends branches to the anterior and posterior surfaces to penetrate the uterine substance. The arteries are peculiarly tortuous. A well-marked anastomosis takes place between this vessel and the ovarian artery from which offsets proceed to the Fallopian tube and the round ligament of the uterus. The uterine artery also supplies the upper end of the vagina.

(3) The branches of the internal pudic artery in the female are smaller, but have a corresponding distribution to those met with in the male. The terminal branch is named the dorsal artery of the clitoris.

B. The *posterior division of the internal iliac* is on a plane external and posterior to the anterior division. Its relations are really those of its continuation to form the gluteal artery (*q. v.*).

Branches.—(1) The *ilio-lumbar artery* represents a fifth lumbar branch; it ascends from the pelvis between the obturator nerve and the lumbo-sacral cord in front of the base of the sacrum, and on touching the psoas muscle divides into lumbar and iliac branches. (α) The lumbar branch runs upwards beneath the psoas to end in the quadratus lumborum muscle. It supplies a spinal branch like other lumbar arteries. (β) The iliac branch passes beneath the psoas to the iliac fossa, where it sends branches into, and beneath, the iliacus muscle, and a nutrient branch to enter the ilium just above the brim of the pelvis. It anastomoses with the deep circumflex iliac artery, and the lumbar arteries.

(2) The *lateral sacral arteries*, two on either side, pass inwards, and run on the bodies of the sacral vertebræ internal to the anterior sacral foramina and the nerves emerging therefrom. They supply branches to the nerves, and anastomose with the sacra media.

(3) The *gluteal artery* seems to be the continuation of the posterior division of the internal iliac. It passes backwards and outwards between the lumbo-sacral cord and the first sacral nerve; hence, above the pyriformis, it passes through the great sciatic foramen to the gluteal region. There it runs but for a short distance, as, between the adjacent borders of the gluteus minimus and the pyriformis, it breaks up into its two terminal branches—the superficial and deep gluteal.

It gives off—(*a*) Muscular branches to the muscles before it leaves the pelvis. (*b*) The *superficial* gluteal artery runs from the bifurcation of the gluteal, onwards, past the lower border of the gluteus medius, and gaining the under surface of the gluteus maximus breaks up into branches which supply that muscle, and anastomose with the sciatic. (*c*) The *deep* gluteal runs between the gluteus medius and minimus as two branches. The *superior* curves forwards and outwards along the middle curved line of the ilium; the *inferior* crosses the middle of the gluteus minimus. Each artery gives off muscular branches, and in front ends by anastomosing with the ascending branch of the external circumflex iliac. Branches also proceed upwards, to anastomose over the iliac crest with the deep circumflex iliac, and downwards to join the sciatic.

THE COMMON FEMORAL ARTERY.—The external iliac artery at Poupart's ligament changes its name to the common femoral. The artery lies in the groin at a point midway between the symphysis pubis and the anterior superior iliac spine. The perpendicular course of the common, as well as that of the superficial femoral artery, is indicated by taking a line (when the hip and knee joints are semi-flexed, and the limb is slightly abducted and rotated out) from the spot indicated in the groin, to the most prominent point of the internal condyle of the femur or the adductor tubercle.

Relations of the Common Femoral.—In *front*, skin, superficial fascia, fascia lata, and femoral sheath. *Behind*, the psoas muscle, which separates it from the horizontal ramus of the pubis and the inner portion of the head of the femur. The nerve to the pectineus from the anterior crural passes behind the sheath. *Internally* lies the femoral vein. *Externally*, the sheath, with the anterior crural nerve about one-third of an inch to its outer side.

Branches.—(1) The superficial circumflex iliac artery arises from

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the outer side of the artery, and running on the iliacus muscle, penetrates the iliac portion of the fascia lata. It runs below the level of the iliac crest to supply the cutaneous structure of the hip. It supplies branches to the glands in the groin.

(2) The superficial epigastric artery arises from the front of the common femoral, and penetrating the iliac portion of the fascia lata, passes upwards on Poupart's ligament to the superficial fascia in the lower part of the abdominal wall.

(3) The superior and inferior external pudic arteries. The *superior* finds its exit through the saphenous opening, and crossing the spermatic cord, supplies the lower part of the central abdominal wall and the sides of the penis. The *inferior* artery runs on the pectineus and adductor longus muscle to penetrate the fascia lata at the anterior margin of the gracilis; it supplies the side of the scrotum. It anastomoses with the superficial perineal arteries, and with the cremasteric in the coverings of the cord.

The SUPERFICIAL FEMORAL ARTERY is the directed continuation of the common femoral. According as the common femoral is one and a half or four inches long, so is the superficial femoral longer or shorter. Its guiding-line is mentioned above with the common femoral. The artery ends below at a spot three inches above the most prominent point on the internal condyle of the femur, and passes from the inside of the thigh, through the opening in the adductor magnus, to be continued as the popliteal.

Relations.—At first the artery lies in Scarpa's triangle, and then in Hunter's canal. In *front*, skin, superficial and deep fasciæ with the internal cutaneous nerve, the sartorius muscle, the internal saphenous nerve, and a special aponeurosis which passes between the vastus internus to the adductors longus and magnus. *Behind*, the superficial femoral vein, separating the artery from the pectineus, adductor brevis, the adductor longus, and the tendon of the adductor magnus. *Internally*, the superficial femoral vein at the upper part, and the adductor longus below. *Externally*, the anterior crural nerve above, the vastus internus lower down. In Hunter's canal are the superficial femoral artery and vein, the internal saphenous nerve and the nerve to the vastus internus.

The opening in the adductor magnus is bounded as follows: the bone externally, and the adductor magnus and a few fibres of the adductor longus internally and above; the superficial femoral artery and vein alone pass through the opening.

Branches of the Superficial Femoral.—(1) Muscular branches to the adjacent muscles.

(2) The anastomotica magna artery arises from the superficial femoral immediately above the opening in the adductor magnus; it divides

into a superficial and deep branch. (*a*) The superficial branch passes through the aponeurosis of the roof of Hunter's canal along with the internal saphenous nerve, and supplies branches to the neighbouring muscles, and to the skin over the inner and upper part of the leg. (*b*) The deep branch passes outwards, without coming through the aponeurosis, into the substance of the vastus internus; there it sends one branch down to the knee, parallel to the tendon of the adductor magnus, whilst another passes outwards across the femur, just above the level of the patella. Anastomosing branches join with the internal and external superior articular.

The DEEP FEMORAL, or PROFUNDA ARTERY, comes also from the common femoral. It passes at first slightly to the outside of the superficial, forming a gentle curve towards the outer side, but in the lower part of its course it lies on a plane immediately behind the superficial. It is separated above from the superficial femoral by the superficial and deep femoral veins, and below by the adductor longus.

Its *relations* are: in *front*, the superficial and deep femoral veins at the upper part, the adductor longus at the lower part of its course; *behind*, it rests from above downwards on the psoas, iliacus, pectineus, adductor brevis and adductor magnus muscles.

Branches.—1. The external circumflex artery arises from the outer side (the convexity of the curve) of the profunda, about three inches below Poupart's ligament. It speedily divides into branches, which pass beneath the sartorius, upon the rectus femoris, and amongst the branches of the anterior crural nerve. It has three named branches: (*a*) The ascending runs beneath the tensor vaginæ femoris to the front part of the gluteal region, to anastomose with the gluteal. (*b*) The transverse branch runs beneath the vastus externus and upon the crureus; it perforates the former muscle near the femur, and anastomoses behind with the perforating and internal circumflex arteries. (*c*) The descending branch runs down upon the crureus, and supplies the muscles on the outside of the femur. It anastomoses at the knee with the superior external articular.

2. The internal circumflex artery arises from the inner side (the concavity of the curve) of the profunda, opposite the artery just described. It passes backwards between the psoas and pectineus muscles, and between the upper border of the adductor brevis and the obturator externus, until it reaches the tendon of the obturator externus, where it splits into its terminal branches.

Branches.—(*a*) Muscular to the muscles adjacent.

(*b*) Articular to the hip-joint, entering through the cotyloid foramen.

(*c*) An ascending branch anastomoses with the obturator.

(*d*) A transverse branch runs backwards with the tendon of the obturator externus, and appears posteriorly between the quadratus femoris and the adductor magnus, where it sends a branch upwards and downwards to anastomose with the sciatic and superior perforating arteries respectively.

(*e*) A descending branch runs amongst the adductor muscles, supplying them and anastomosing with the perforating.

3. The perforating arteries are three in number, or, counting the termination of the profunda as a perforating artery, four.

These vessels, each as big as the radial artery, pass back from the profunda, perforating the adductor muscles to reach the hamstrings. The superior and middle penetrate the adductor brevis and magnus on their way, but the inferior artery goes through the latter muscle only. At the passage through the adductors, fibrous arches are provided between the muscles and the femur, like miniature Hunter's openings. Posteriorly the arteries give off branches to the hamstrings, but the trunks are continued onwards, the upper penetrating the origin of the gluteus maximus, the lower the short head of the biceps, to reach the crureus and vastus externus muscles. Anastomosing vessels join all the set one to another; whilst the uppermost joins the sciatic; the lowermost, the branches from the popliteal; and the terminations in the crureus and vastus externus, the external circumflex. The fourth perforating penetrates the adductor magnus a little above the opening in the adductor magnus.

The POPLITEAL ARTERY lies in the popliteal space. The vessel reaches from the opening in the adductor magnus, down to the lower border of the popliteus muscle. In length about seven inches, it lies on the lower fourth of the tibia, and reaches two inches down upon the tibia. It is at first on the inner side of the space; hence it runs at first downwards and outwards, but at the back of the joint it descends vertically.

The *relations* are: *behind*, that is superficially, it has skin, superficial fascia, deep fascia (called here popliteal), the internal popliteal nerve, and the popliteal vein; in *front*, the lower end of the femur, the posterior ligament of the knee-joint, and the popliteus muscle covered by the popliteus fascia; the two last, the fascia and the ligament, are derived from the insertion of the semi-membranosus. On either side of the artery are the muscular boundaries of the space: *externally*, the biceps, the outer condyle, the outer head of gastrocnemius and plantaris; *internally*, the semi-membranous, semi-tendinous, the inner condyle, and the inner head of the gastrocnemius. It is well protected by the projection backwards of the two condyles. The popliteal vein is on a plane posterior to the artery, and gradually passes from rather on the outer side above, to rather on the inner side below. It is not disengaged from the artery. The popliteal nerve is at first without, and distinct from the artery, but on a plane posterior to both artery and vein; opposite the knee-joint, the nerve crosses to lie along the inner side.

Branches.—1. Muscular; the superior group goes to the hamstrings; the lower or sural group consisting of two trunks, which enter either head of the gastrocnemius.

2. A cutaneous branch accompanies the external saphenous vein and nerve; it is a fair-sized vessel which descends between the heads of the gastrocnemius as far as the middle of the calf. It is sometimes called the superficial sural.

3. The articular branches are the most important; they are arranged in two pairs—an upper and lower, and an azygos.

(*a*) The superior internal articular artery passes inwards above the inner head of the gastrocnemius, and beneath the tendon of the adductor magnus to reach the vastus internus, where it breaks up to anastomose with the anastomotica magna and the following.

(*b*) The superior external articular artery passes outwards above the origins of the plantaris and the outer head of the gastrocnemius, and beneath the short head of the biceps, where it reaches the crureus muscle. Above, it anastomoses with the external circumflex; below, with the inferior external articular; internally, with the superior internal articular and the anastomotica magna.

(*c*) The inferior internal articular artery arises below the knee-joint, and, passing downwards and inwards below the internal tuberosity of the tibia and upon the popliteus fascia covering the popliteus muscle, it gets beneath the internal lateral ligament of the knee; it there breaks up into branches to the knee and to anastomose with the upper internal and lower external articular, as well as with the anastomotica magna.

(*d*) The inferior external articular passes outwards and slightly upwards upon the popliteus and beneath the outer head of the gastrocnemius. It then passes beneath the external lateral ligament of the knee and the tendon of the biceps above the level of the head of the fibula. Reaching the front it breaks up into branches for the knee-joint, and anastomoses above with the superior external, across the tibia with the inferior internal articular artery.

(*e*) The azygos articular artery starts from the anterior aspect of the popliteal, and perforates the posterior ligament of the knee to supply the crucial ligaments and the intercondyloid region generally.

The Posterior Tibial Artery is the direct continuation of the popliteal. It extends along the back of the leg, from the end of the popliteal, down to the inside of the os calcis beneath the internal annular ligament, where it divides into internal and external plantar.

The points of division are described as those given, or : under cover of the abductor pollicis ; on the accessorius muscle ; below the sustentaculum tali ; or at a point midway between the internal malleolus and the tip of the heel.

Relations—in the leg.—Superficially, i.e., between the artery and the skin behind, lie, from above downwards and immediately in contact with it: the soleus muscle for the upper two-thirds, the fasciæ of the leg for the lower one-third, and the posterior tibial nerve all the way along. Still more superficial are the gastrocnemius and the cutaneous structures. *Deeply*, the artery lies from above downwards on the tibialis posticus, the flexor longus digitorum, and the tibia. Venæ comites accompany the artery. The posterior tibial nerve lies at first slightly to the inner side of the artery, then upon the nerve, and at the ankle to the outer side ; the crossing takes place about the junction of the upper and middle thirds.

At the ankle.—The artery lies on the ligaments at the back and inner side of the ankle and upon the flexor accessorius. Superficially is the internal annular ligament and the abductor pollicis. On the inner side is the tendon of the flexor longus digitorum ; on the outer side the flexor longus pollicis, separated by the posterior tibial nerve.

The *branches* are : 1. Cutaneous branches.

2. Muscular branches to the adjacent muscles.

3. Nutrient to the tibia ; this vessel runs in the tibia downwards towards the ankle ; it enters the bone at the junction of the upper and middle thirds by the largest nutrient canal in the body.

4. The communicating artery runs transversely about one and a half inches above the back of the ankle, from the posterior tibial artery, to join the peroneal artery before it divides.

5. The internal calcaneal runs downwards parallel to the inner border of the tendo-Achillis, and supplies the fat of the heel, anastomosing there with the external calcaneal from the peroneal.

6. The Peroneal Artery is given off one inch below the origin of the posterior tibial, *i.e.*, three inches below the knee-joint. The artery runs outwards from the parent trunk, and then descends under cover of the flexor longus pollicis, where it is contained in a fibrous sheath, which ties it down to the posterior part of the inner surface of the fibula. It ends one and a half inches above the ankle by dividing on the lower part of the interosseous membrane into its terminal branches.

Relations.—Superficially, i.e., on the artery, lie the soleus above, and the fascia below. The flexor longus pollicis and the tibialis posticus overlap the artery as it lies in the fibrous sheath which is between these two muscles. *Deeply*, the artery lies on the tibialis posticus for the first two inches; afterwards it is close under cover of the internal border of the fibula. Venæ comites accompany the artery; and the nerve to the tibialis posticus muscle accompanies it for a short distance.

Branches.—(*a*) Muscular to the adjacent muscles.

(*b*) The nutrient enters the fibula on a level with the similar artery to the tibia, and has a like direction.

(*c*) The communicating comes from the lower end of the artery to join the posterior tibial one and a half inches above the ankle.

The *terminal* branches are *d* and *e*.

(*d*) The anterior peroneal artery penetrates the lower part of the interosseous membrane one and a half inches above the ankle, and arrives at the front of the leg. There it descends upon the anterior inferior tibio-fibular ligament, and crossing the ankle-joint, anastomoses with the external malleolar from the anterior tibial, and the tarsal artery from the dorsalis pedis.

(*e*) The external calcaneal artery descends behind, being the continuation of the artery upon the posterior inferior tibio-fibular ligament; it supplies the pad of the heel, where it anastomoses with the external calcaneal from the posterior tibial and the calcaneal branches of the external plantar.

The Internal Plantar Artery arises from the bifurcation of the posterior tibial at the inner side of the foot; it runs forwards in the deep part of the septum between the abductor pollicis and the flexor brevis digitorum as far as the bases of the metatarsal bones, where it ends by dividing into anastomosing branches to the digital arteries.

The internal plantar nerve lies on the outer side of the artery.

Branches.—1. Muscular to the adjacent muscles.

2. Cutaneous to the inner side of the foot.

3. Periosteal to the tarsal and metatarsal bones.

4. Anastomosing to the digital arteries.

The External Plantar Artery is much the larger of the plantar arteries. Starting from the bifurcation of the posterior tibial, it runs outwards between the first and second layers of muscles of the sole of the foot to gain the base of the fifth metatarsal bone; from thence it changes direction, and turning sharply inwards, lies between the third and fourth layers of the muscles of the sole to reach the base of the first interosseous space, where it joins the communicating branch from the dorsal pedis and so completes the plantar arch.

Relations.—In the first part of its course the artery lies on the heads of origin of the accessorius muscle, and on the long plantar ligament between the heads. Superficial to the artery is the posterior tibial nerve (crossing from without inwards to gain the hollow of the plantar arteries), and the flexor brevis digitorum. The artery runs forwards in the deep part of the septum between the flexor brevis digitorum and the flexor brevis minimi digiti, with the external plantar nerve to its inside.

The *plantar arch* or deep part of the external plantar artery, has *above* it the bases of the metatarsal bones and the fourth or interosseous layer of muscles. The external plantar nerve accompanies it. Superficially—really *below*—the arch lies on the flexor tendons and the adductor pollicis.

Branches.—In the *first* part of its course the artery gives off: 1. Muscular branches to the neighbouring muscles.

2. Cutaneous to the outside of the sole.

3. Periosteal to the tarsal bone.

4. Anastomosing with the internal plantar, and with the tarsal artery round the outer side of the foot.

From the *arch* are given off: 1. Recurrent branches to the tarsus.

2. Posterior perforating branches pass upwards between the heads of the dorsal interossei muscles in the intermetatarsal spaces to join the dorsal interosseous arteries.

3. Digital arteries pass forwards from the convexity of the arch; the first, or outer, runs along the outer side of the little toe; the second, third, and fourth run forwards on the interossei muscles, towards the interval between the heads of the metatarsal bones. There they divide into two collateral branches to the adjacent sides of the four outer toes. At the bifurcation, *anterior perforating* arteries pass up in the web of the toes to join the dorsal arteries.

The Anterior Tibial Artery.—From the bifurcation of the popliteal at the lower border of the popliteus muscle this artery runs forwards at right angles to the posterior tibial vessel. It first passes over the upper forked extremity of the tibialis posticus; then above the upper curved border of the interosseous membrane in company with its veins. Arriving in front, it descends on the front of the interosseous membrane and then on the tibia to the ankle-joint.

Relations.—In *front*, the cutaneous structures, the anterior tibial nerve in the lower two-thirds of its course; and just above the ankle it is crossed by the extensor longus pollicis. *Behind*, the interosseous membrane for the upper three-fourths, and the tibia for the lower one-fourth of its course. *Internally*, the tibialis posticus the whole way, until at the ankle, where the tendon of the extensor longus pollicis reaches the inner side. *Externally*, the extensor longus digitorum, and the anterior tibial nerve in the upper third; the extensor proprius pollicis below. It will be seen that the artery, on arriving at the front of the interosseous membrane, is first between the tibialis anticus and the extensor longus digitorum; then between the tibialis anticus and the extensor proprius pollicis; and, finally, at the ankle between the extensor proprius pollicis and the extensor longus digitorum.

Branches.—1. Muscular to the adjacent muscles.

2. The posterior tibial recurrent is given off before the artery passes to the front of the leg. It runs upwards beneath the popliteus to the knee.

3. The anterior tibial recurrent comes off as soon as the artery comes over the interosseous membrane. It runs upwards on the anterior superior tibio-fibular ligament, and by its branches perforates the origins of the extensor longus digitorum and the tibialis anticus muscles to anastomose chiefly with the inferior external articular artery of the knee.

4. The internal and external malleolar arteries pass out on either side across the bases of either malleoli. The internal lies in its passage, beneath the tendon of the tibialis anticus; the external passes beneath the extensor proprius pollicis, the extensor longus digitorum and the peroneus tertius. Both divide over the malleoli, and anastomose with branches of the posterior tibial and peroneal.

The Dorsal Artery of the Foot is the direct continuation of the anterior tibial; it reaches from the ankle to the proximal end of the first intermetatarsal space, where it descends to the sole of the foot between the heads of the first dorsal interosseous muscle.

Relations.—*Superficially*, skin, fasciæ, the anterior annular ligament, and at its ending it is crossed by the innermost tendon of the extensor brevis digitorum. *Deeply*, it rests on the astragalus, scaphoid, internal and middle cuneiform bones, to which it is bound down by a strong band of aponeurotic tissue. *Internally* is the tendon of the extensor proprius pollicis. *Externally*, the extensor longus digitorum, and the anterior tibial nerve.

Branches.—1. The tarsal artery passes outwards beneath the extensor brevis digitorum and upon the bones to the outer side of the foot; there it breaks up into three sets of branches:—one set passes upwards to anastomose with the anterior peroneal artery; a second set runs forwards to anastomose with the metatarsal; and a third set runs outwards, round the outer side of the foot, to join branches from the external plantar.

2. The metatarsal artery runs outwards on the base of the metatarsal bones, and beneath the tendons, forming a dorsal arch. Externally it anastomoses with the tarsal and external plantar arteries. From the convexity or lower border of the vessel the *dorsal interossei* arteries arise. These vessels, three in number, run

on the dorsal aspects of the interossei muscles of the three outer spaces. At the roots of the toes each vessel divides into two to supply the adjacent sides of the two toes. The outermost interosseous artery gives off a branch to the outer side of the little toe. The anterior and posterior perforating arteries communicate with the plantar arch and the plantar interossei arteries as described with the plantar arch.

3. The dorsalis hallucis, or first dorsal interosseous artery, runs forwards from the dorsalis pedis before it descends between the bones. It supplies digital branches to the dorsal aspect of the adjacent surfaces of the first and second toe, and the inner side of the first toe.

4. The arteria magna pollicis, or the plantar digital artery, runs forwards on the plantar aspect of the muscles in the first interosseous space, and gives plantar digital branches to the adjacent sides of the first and second toes and the inner side of the big toe.

5. Anastomosing branches pass from the inner aspect of the artery on the dorsum of the foot to join the internal plantar; but the main trunk anastomoses terminally with the plantar arch on the plantar aspect of the first interosseous space, the trunk of the two vessels being continuous, whereby the deep plantar arch is completed.

General Consideration Affecting the Bloodvessels.

The bloodvessels, consisting of arteries, capillaries, and veins, constitute the series of structures by which the blood passes through the tissues and organs of the body.

The arteries start from the left ventricle by the aorta, and from this enormous central vessel branches pass to the limbs and body. The element of elasticity comes very strongly into play in the function of the arterial circulation, and it is seen on cutting into the aorta and some of its main branches that there is little else present than the yellow elastic tissue, tough and strong. On proceeding to the smaller arteries of both the trunk and limbs, muscular fibres come into play; and as the distance travelled from the heart becomes greater, so proportionately the amount of muscular fibres increase. On reaching the very minute arterioles again, it is found microscopically that the muscular fibres gradually diminish in amount until the capillaries are reached, which show only cellular elements in their walls.

On dissecting a large artery, such as the femoral or carotid, it is found that a connective-tissue sheath encloses the artery and the accompanying vein. This sheath, when dissected off the artery, shows a septum between the vessels of a variable thickness. The artery itself is still further enclosed in a special sheath exhibiting the vessels—the *vasa vasorum* supplying its coats. These small vessels are in the coats of the large arteries plainly to be seen, and may even be injected. Of the other coats of the artery, the muscular is usually represented in the dissecting-room, owing to the age of the bodies dissected, by a calcareous condition. In the large arteries, such as the femoral, the small, white, gritty patches are seen to run transversely to the arterial coat; in the medium-sized arteries, such as the tibials, the calcareous condition, if present, is found as a tubular coating.

Arteries pursue a course in those parts of the limbs which are most protected; this is readily understood when the positions of such arteries as the brachial and tibial are considered.

Arteries meet to form anastomoses in almost all organs and tissues. Such a condition was for a long time denied in the tongue and heart; but the vessels in these two organs have been, of late years, injected in such a way as to show that the vessels on opposite sides pretty freely anastomose.

One of the most remarkable anastomoses is that in the base of the brain, where the vessels are so united as to form a circle of anastomosing vessels—the circle of Willis.

The arteries are lined internally by a prolongation from the heart of the endocardial lining met with in the inner walls of that organ. The serous membrane is continued on into the arteries, and from them again it is prolonged into the capillaries or veins. Hence the whole of the blood vascular system is lined by serous membranes, giving a smooth surface for the blood to travel along.

The Veins.

All vessels which carry blood towards the heart are called veins. Venous blood is contained in veno-capillaries, veins, and sinuses; the last are met with only in the skull. Veins consist of two sets, superficial (or cutaneous) and deep. The *superficial* veins have but seldom accompanying arteries, as have the deep; they run in the superficial fascia, and are called cutaneous so long as they are superficial to the deep fascia. They drain the skin, and act as relief currents when the deep veins for any reason are blocked, and *vice versâ*.

The *deep* veins in the limbs accompany the arteries, but in the trunk there are many veins which pursue separate courses. The deep veins are in the limbs, mostly arranged as *venæ comites*—that is to say, two veins accompany each artery which by frequent anastomosing branches join each other. Venæ comites co-exist with the main arteries of the upper limb as high as the axilla, and in the lower limb as high as the popliteal space. Special venæ comites, other than those met with in the limbs, will be hereafter specially noticed.

Veins are found to contain blood after death in either a fluid or coagulated state; it is forced into the veins by the elasticity of the arteries. The calibre of veins is about a fifth or a quarter larger than the arteries they accompany. It is seldom one ever sees an injected vein and artery lying side by side, and as arteries are the only vessels injected in the dissecting-room, one is apt to despise the enormity of the veins and to forget them in application. Vein walls are thinner than arterial, and in the dissecting-room their naturally smooth and serous inner wall is stained and sodden by the colouring matter of the blood.

Valves are also met with, especially in the limb veins. They can be easily seen by opening a vein—say, the internal saphenous—where, if there is a slight varicosity in the vein, the bulging on the vein wall will be a guide to the seat of the valves. Again, there may be a clot of blood modelled to the sinus behind the valve; or, if neither of these circumstances are present to indicate the situation of the valves, a close ocular inspection whilst washing the vein wall, or passing one blade of the forceps from the proximal towards the distal opening in a vein, will reveal the situation and nature of the valves. The various sets of cusps constituting a valve are situated in the saphenous veins, about three inches apart. Two cusps are usually present, each consisting of merely the endothelial reflection.

The following veins are destitute of valves: the visceral veins of the chest and abdomen, and the sinuses of the brain; the cervical veins have but a few valves near the root of the neck. Valves in the veins of the upper limb end opposite the clavicle, in the lower limb opposite Poupart's ligament.

The veins of the body are divided into three sets. The systemic set are those which carry the blood to the right auricle; the pulmonary veins which carry blood to the left auricle; and thirdly, the veins of the portal circulation. The portal set are those veins whose function it is to carry blood from the viscera (the chylo-poetic viscera), to join in the large vein which enters the gate of the liver—the portal vein. The blood passes through the liver substance and emerges by the hepatic to join the inferior vena cava.

The Pulmonary Veins.

The *pulmonary veins*, four in number, two from each lung, carry the red blood from the lungs to the left auricle. The *right* veins emerge from the root of the right lung below the level of, but on a plane anterior to, the pulmonary artery; following the course of the artery they pass behind the superior vena cava, aorta, and pulmonary artery into the left auricle; the *left* veins descend in front of the aorta to the left auricle; they have a similar relation in the root of the left lung to those met with in the right side. No valves are found in the pulmonary veins.

Systemic Veins.

The description of the veins will be followed in the main from their commencements to their endings in the central veins of the chest and abdomen.

Veins of the Head and Neck.

The *veins of the scalp* resolve themselves into three sets: those running down the forehead to join the facial; those running down behind to join the post-vertebral, or deep cervical veins; and those descending on the sides to join the jugular veins.

The veins of the forehead are: the frontal and supra-orbital, which unite at the inner margin of the orbit to form the angular The posterior group of veins join to form the occipital, and descend, as already mentioned, in the deep cervical; whilst those running down the side of the head or the temporal region have to be more carefully considered.

The *temporal vein* commences by branches, which correspond for the most part with those of the temporal arteries. Two trunks, anterior and posterior, unite to form the *superficial* temporal in front of the ear and above the zygoma; there it is joined by auricular, middle temporal, and external palpebral branches. The vein, now called the common temporal, crosses the zygoma to enter the parotid gland, where it is joined by auricular, parotid and transverse facial veins, and finally, opposite the neck of the condyle of the jaw, unites with the internal maxillary vein to form the temporo-maxillary vein.

The *internal maxillary vein* gathers itself together to form a trunk from out of the pterygoid plexus of veins. This plexus, situated in the zygomatic fossa and between the pterygoid muscles, collects branches corresponding to the second and third stages of the artery, and passes back as the internal maxillary vein in one or two trunks to join the temporal vein opposite the neck of the condyle of the jaw. The branches corresponding to the first stage of the artery open into its trunk. The pterygoid plexus communicates in front with the facial vein by a branch called the deep facial vein, which runs forwards beneath the internal pterygoid muscle.

The *temporo-maxillary vein* is formed by the union of the common temporal and the internal maxillary veins, in the substance of the parotid gland opposite the neck of the lower jaw. The vein descends in the substance of the gland, having the facial nerve—the pes anserinus—superficial to it, and the external carotid deeply. At the lower part of the parotid gland the vein divides into two trunks, called the anterior and posterior division of the temporo-maxillary vein. The *anterior* division (the communicating branch to the internal jugular vein) runs forwards, either over or under the posterior belly of the digastric and stylo-hyoid muscles, to join the facial vein, and with it to form the common facial vein. The *posterior* division of the temporo-maxillary vein runs downwards over the sterno-mastoid muscle, where it is joined by the posterior auricular to form the external jugular vein.

The External Jugular Vein.

The *external jugular vein* commences opposite the angle of the lower jaw in the substance of the parotid gland, by the junction of the posterior division of the temporo-maxillary and the posterior auricular veins. It passes down the neck beneath the platysma, and crossing the sterno-mastoid, it perforates the deep fascia at the posterior border of this muscle in the roof of the subclavian triangle to end in the subclavian vein.

The vein forms a dilatation or sinus at its ending, with one pair of valves placed at the lower end of the sinus, where it joins the subclavian vein ; another pair, about one inch above.—(*Struthers.*)

According to the same authority, there are usually valves found in the transversalis colli and humeri veins. These valves are important, as being the nearest spot to the heart where valves exist in this region.

The *posterior auricular vein*, the other component of the external jugular, runs from the region of the mastoid process and the back of the ear to join the posterior division of the temporo-maxillary, whereby the external jugular vein is formed opposite the angle of the jaw and upon the surface of the sterno-mastoid muscle. Halfway down the neck the external jugular vein is joined by the *posterior external jugular vein ;* and at the lower part of the neck, in the roof of the subclavian triangle, it is joined by the *transversalis colli* and *humeri veins*, and sometimes by the anterior jugular.

The *posterior external jugular vein* comes from the region of the occiput and the back of the neck.

The *transversalis colli* and *humeri veins* correspond to the arteries of the same name. Most frequently, however, is there both a deep and superficial set of these vessels.

The *anterior jugular vein* commences by a plexus below the chin.

The vein runs down one side of the middle line of the neck until just above the head of the clavicle; it there perforates the deep fascia, and running beneath the lower end of the sterno-mastoid, joins either the external jugular or subclavian veins. The two anterior jugulars usually communicate by a cross branch one inch above the manubrium sterni.

The Internal Jugular Vein.

The *internal jugular vein* commences at the jugular foramen at the base of the skull, and ends by joining with the subclavian vein behind the inner end of the clavicle to form the innominate. The commencement of the vein is formed by the ending of the lateral sinus of the cranium.

A description of the cranial sinuses is given with that of dura mater.

Relations.—As the vein emerges from the jugular foramen the eighth and ninth cranial nerves separate the vein from the internal carotid artery. (*See* Internal Carotid.) Behind the vein is the rectus capitis lateralis. Internally, and on a plane posterior, is the superior cervical sympathetic ganglion and the loop between the first and second cervical nerves. The internal carotid is on a plane anterior and internal to the vein.

In the neck, the vein descends on the outer side of, first the internal, and then the common, carotid artery. It is enclosed in the common sheath with the carotid artery and the pneumogastric nerve, the latter lying behind and between the artery and vein. The vein possesses almost exactly similar structures between its trunk and the surface as have the internal and common carotid arteries, except that the tributary veins and the hypoglossal nerve do not cross the vein as in the case of the arteries.

The right and left veins are exactly symmetrical, except below, where their relation to the common carotid arteries differs. Thus both veins, as they descend, tend towards the right side of the neck; hence the right vein will depart from the right artery to the right side, and leave an interval between them; whilst the left vein, tending to the right side, will still further overlap the left common carotid artery at the root of the neck. In the interval on the right side the trunk of the right pneumogastric nerve is seen to descend on its way across the first stage of the subclavian to the thorax.

Branches joining the internal jugular vein: (1) The inferior petrosal sinus comes from the back of the cavernous sinus, and running in the groove between the tip of the petrous portion of the temporal and the basilar portion of the occipital bone, leaves the skull through the anterior part of the jugular fossa to join the internal jugular vein immediately below the foramen.

(2) The ascending pharyngeal vein, accompanying its artery, joins the internal jugular vein opposite the angle of the jaw.

(3) The facial vein drains the front of the forehead by the frontal and supra-orbital veins. These vessels unite at the inner angle of the orbit as the angular vein, passing down the side of the nose, and running outwards opposite the upper lip, beneath the zygomaticus major muscle; it then descends along the anterior margin of the masseter to cross the jaw with the artery. At the crossing the vein lies immediately posterior to the artery. Below the jaw the vein runs superficially over the submaxillary gland and digastric muscle to join with the anterior division of the temporo-maxillary vein (*i.e.*, the communicating branch to the internal jugular vein). The vein is now called the *common facial vein*, and crosses the external and internal carotid arteries opposite the hyoid bone to join the internal jugular.

The frontal and supra-orbital veins unite to form the angular, and that vein at the level of the lower margin of the orbit on the side of the nose changes its name to the facial.

Branches joining the facial vein: (α) The frontal, from the top of the head. (β) The supra-orbital, from above the eyebrow. (γ) The angular vein results from the union of the two previous veins; it is joined by the (δ) superior palpebral, superior nasal veins, and becomes the facial. (ϵ) The inferior palpebral. (ζ) The inferior nasal. (η) The superior labial. (θ) Buccal veins. (ι) The submental vein joins below the chin. (κ) The submaxillary veins from the gland. (λ) Inferior palatine and tonsilitic veins.

(4) The lingual vein commences below the tip of the tongue as the ranine vein. It is easily seen below the mucous membrane on raising the tip of the tongue. From hence the vein runs on the hyo-glossus muscle, which separates it from the artery. It joins the internal jugular vein immediately below the common facial; frequently it joins the common facial vein.

The *tributaries* are: (1) The ranine, which is simply the anterior part of the vein. (2) Venæ comites, from around the lingual artery. (3) Dorsal veins and veins from the tonsilitic.

(5) The superior thyroid vein, from the thyroid gland, crosses the common carotid artery at its bifurcation, on its way to join the internal jugular, or common facial vein. It has tributaries corresponding to the branches of the artery.

(6) The middle thyroid vein crosses the common carotid artery beneath the anterior belly of the omo-hyoid on a level with the cricoid cartilage, and joins the internal jugular.

The *occipital vein* joins the deep cervical, or posterior vertebral vein.

The veins at the posterior part of the neck commence by a plexus of veins in the suboccipital triangle; from this plexus proceed the vertebral vein, the posterior vertebral, or deep cervical vein, and the anterior vertebral vein.

The *vertebral vein* commences at the suboccipital plexus of veins, and accompanies the vertebral artery as two or three vessels through the transverse processes of the upper six cervical vertebræ. Emerging at the sixth, it is continued forwards in front of the subclavian artery to join the back part of the internal jugular vein or the commencement of the innominate.

The *tributaries* are: (α) Muscular; (β) spinal; (γ) anterior vertebral; (δ) posterior vertebral veins. Anastomosing branches communicate with the dorsi-spinal vein of the neck.

The *posterior vertebral*, or *deep cervical vein*, commences by the junction of the occipital vein with communicating branches from the suboccipital plexus of veins. It runs down with the artery of the same name between the complexus and semi-spinalis colli muscles, until it reaches the interval between the transverse process of the seventh cervical vertebra and the neck of the first rib, through which it passes to join the vertebral.

The *anterior vertebral vein* comes from the suboccipital plexus, and descends with the ascending cervical branch of the inferior thyroid to join the vertebral vein as it emerges from the foramina.

The *veins of the diploe* may be seen when the external table of the bones of the cranial vault has been carefully removed by the saw. The veins increase in size from the vault to the floor, and resolve themselves in the bones into pairs of veins, named frontal, temporal (two), and occipital, which join the following: (α) The frontal joins the supra-orbital and so the angular and facial vein, by emerging from a small foramen at the bottom of the supra-orbital foramen. (β) The temporal veins are in two sets, anterior and posterior. The *anterior* vein drains the side of the frontal and the anterior part of the parietal bone; it opens below in the zygomatic fossa into a deep temporal vein, by an aperture in the lower part of the great wing of the sphenoid. The *posterior* vein from the diploe of the parietal usually joins the lateral sinus. (γ) The occipital vein from the diploe joins the occipital vein or the lateral sinus.

Emissary Veins (*Quain*).

Emissary veins find their way through bony orifices which are well known to the careful osteological observer, and connect the cranial sinuses with the veins of the outside of the skull.

(1) The mastoid vein passes through the mastoid foramen,

connecting the lateral sinus with the occipital and the posterior auricular veins.

(2) The parietal foramen, when it exists, allows communication between the temporal veins and the superior longitudinal sinus.

(3) The posterior condyloid foramen, when it exists, transmits a vein from the suboccipital veins externally to the lateral sinus within.

(4) Foramina in the external occipital protuberance allow communications between the torcular Hierophili and the occipital vein.

(5) The foramen of Vesalius in the floor of the cavernous sinus on the sphenoid bone, allows communication between that sinus and the pterygoid plexus outside.

The Innominate Veins.

Formed by the junction of the internal jugular with the subclavian behind the inner ends of the clavicles, the innominate or brachio-cephalic veins carry the blood to the superior vena cava. Owing to the cava being on the right side of the body, it is evident there must be a difference in the anatomy of the right and left veins.

The *right innominate vein* passes from behind the inner part of the shaft of the right clavicle, down through the superior aperture of the thorax, to join the left innominate, on a level with the first right intercostal space. In length it measures about one and a half inches. Its *relations* are: in *front*, the chest-wall; *behind*, the right pneumogastric nerve; to the *left*, the innominate artery; and to the *right*, the phrenic nerve, the right lung and pleura.

The *left innominate vein* commences behind the inner end of the left clavicle, enters the superior aperture of the thorax, crosses the origin of the great vessels as they are given off from the aorta, and gradually descending, joins with the right innominate to form the superior vena cava at the inner end of the first right intercostal space. It is three or four inches long.

Relations.—In *front*, the manubrium sterni, the sterno-hyoid and sterno-thyroid muscles, and the remains of the thymus gland; *behind*, the left subclavian, the left common carotid and the innominate arteries, the left pneumogastric and phrenic nerves; *below* is the aortic arch, and *above*, the fasciæ of the neck on the under surface of the sterno-mastoids.

Tributaries.—The right vein is joined by the vertebral, the inferior thyroid and the internal mammary veins of the right side. The left is joined by corresponding veins of the left side, and in addition the left superior intercostal, mediastinal and pericardial veins. The thoracic duct on the left side and the lymphatic duct on the right side, enter at the junctions of the left and right internal jugular and subclavian veins respectively. The vertebral vein has been already described.

The *inferior thyroid veins* come from the lowest part of the thyroid gland, and enter the left innominate vein, or the right may enter the right innominate. They are joined by œsophageal and tracheal veins.

The *internal mammary veins* receive branches corresponding to the internal mammary arteries, and lying on the pleura, end in the innominatæ. They exist as venæ comites until just at their termination, where they unite to form single trunks.

The *superior intercostal veins* drain the two upper intercostal spaces. The right vein runs down to join the vena azygos major. The left runs forwards and upwards upon the arch of the aorta to join the left innominate.

The *superior vena cava* commences behind the inner end of the first right intercostal space, and passes downwards through the fibrous pericardium into the right auricle, on a level with the third right costal cartilage. It is about two and a half inches in length. The *relations* are: in *front*, the right lung and pleura above and the pericardium below; *behind*, the root of the right lung; to the *left*, the innominate artery above and the aorta below; and to the *right*, the right phrenic nerve, the right lung and pleura. It is joined, just before it pierces the pericardium, by the vena azygos major vein, which enters it from the right side; mediastinal and pericardial veins also join it.

The Veins of the Upper Extremity.

Venæ comites accompany the radial, the ulnar and the brachial arteries; but from the lower end of the axilla one venous trunk is continued upwards and inwards with the axillary and subclavian arteries, until the vein finally ends in the innominate. The venæ comites need no description. The *axillary* vein lies on a plane anterior to and below the level of the axillary artery. It is by some described as being internal to the artery. It is joined by tributaries corresponding to the branches of the artery, and by the cephalic vein at its upper and the basilic vein at its lower part. The cephalic and basilic veins result from the junction of the superficial veins in the forearm—the superficial radial, ulnar and median veins.

The *superficial radial vein* commences by a plexus on the back of the hand, and by the cephalic plexus on the thumb. It runs up the outer aspect of the forearm, getting larger as it ascends, until, just at the lower part of the external bicipital groove, it unites with the medio-cephalic vein to form the cephalic.

The *superficial ulnar veins* are two in number, anterior and posterior. Commencing from the inner end of the plexus on the back of the hand and the plexus salvatella of the little finger, the veins ascend on the ulnar aspect of the forearm, the anterior in front of, and the posterior behind, the ulnar border of the forearm. At the lower part of the internal bicipital groove the veins unite, and join with the medio-basilic to form the basilic vein.

The *median vein* usually commences by a plexus on the anterior aspect of the wrist. It runs upwards along the middle of the forearm in front, until it reaches the apex of the triangular space in front of the bend of the elbow, where it divides to form the medio-basilic vein internally, and the medio-cephalic externally. Just before it divides it is joined by the deep median vein, which comes from one of the deep veins, usually the interosseous.

The *medio-basilic vein*, the larger of the divisions of the median, passes inwards to join the ulnar; it lies on the bicipital or semilunar fascia, which separates it from the brachial artery. Some branches of the internal cutaneous nerve cross its trunk.

The *medio-cephalic vein* passes outwards to join the radial. It lies on the external cutaneous nerve.

The *basilic vein* commences just above the inner aspect of the front of the bend of the elbow, by the junction of the medio-basilic and ulnar veins. It ascends in the inner bicipital groove on a plane anterior to, but slightly internal to, the course of the brachial artery. It perforates the deep fascia about the middle of the arm, and joins either the venæ comites of the brachial, or the lower end of the axillary vein.

The *cephalic vein* commences just above the outer aspect of the front of the elbow, by the junction of the radial and medio-cephalic veins. It ascends in the external bicipital groove, and perforates the deep fascia between the pectoralis major and deltoid muscles. In the interval between these two muscles, it ascends until it dips down through the clavi-pectoral fascia; it joins the first part of the axillary vein in company with the acromio-thoracic vein. In some instances it ascends over the clavicle to join the subclavian.

The *subclavian vein* lies on a plane anterior to and below the level of its corresponding artery. It is separated from the artery in its second stage by the anterior scalene muscle and the phrenic nerve. The vein is joined by branches corresponding to the artery, and by the external jugular vein. Under cover of the clavicle are situated the highest pair of valves in the veins of the upper limb.

The Veins of the Thorax.

Several of these vessels have been already described, viz., the innominate veins and their thoracic tributaries, the internal mammary and the superior intercostal. The superior vena cava and the pulmonary veins have likewise been given in previous pages. There remain the following:

The *vena azygos major.* This vessel commences by the upper two lumbar veins on the right side and by a communication with the inferior vena cava. It passes up, generally, through the aortic orifice, and getting into the posterior mediastinum, ascends on the right of the aorta as high as the fifth dorsal vertebra, where it arches over the top of the root of the right lung and opens into the superior vena cava, just before that vessel enters the pericardium. It receives in the thorax the veins corresponding to the right aortic intercostals, the right superior intercostal vein, the right bronchial, and opposite the seventh dorsal vertebra, the vena azygos minor.

The *vena azygos minor* commences by the ascending lumbar vein and by the upper two left lumbar veins, passes up through the left crus of the diaphragm, receives the lower six left intercostal veins, and crosses at the seventh dorsal vertebra to join the major. In the thorax it lies in a plane posterior to the aorta. Frequently the azygos veins communicate with the renal and spermatic veins.

The *vena azygos minor superior* is an occasional vessel, which, formed by the junction of the fourth and fifth (or more) left intercostal veins, passes down behind the aorta to join the azygos major.

The *bronchial veins* open into azygos veins, the right into the vena azygos major, the left into the left vena azygos minor superior.

The *intercostal veins* are disposed as follows: The upper veins of the right side join the right superior intercostal, the lower the vena azygos major. The upper veins of the left side join the left superior intercostal, the central set the vena azygos minor superior, and the lower the vena azygos minor.

The Veins of the Lower Extremity.

The arteries of the foot and leg are accompanied by venæ comites. At the lower end of the popliteal space, however, the venæ comites of the anterior and posterior tibial veins unite to form the popliteal vein, and upwards from that point a single venous trunk accompanies the main arteries.

The *popliteal vein* lies on a plane posterior to its artery; it is joined by veins corresponding to the branches of the artery, and in addition, by the external saphenous vein.

The *external* or *short saphenous vein* commences by a plexus on the dorsum of the foot, from the inner side of which the internal saphenous arises, and from the outer side the external. It crosses the ankle behind the external malleolus, and ascends the back of the leg in the superficial fascia. At the popliteal space it perforates the popliteal fascia to join the popliteal vein. It communicates with the deep veins around the ankle.

The popliteal vein runs through the opening in the adductor magnus, in company with, but on a plane posterior and external to, the artery, and changes its name to femoral.

The *superficial femoral vein* ascends in Hunter's canal on a plane posterior and external to the superficial femoral artery; in Scarpa's triangle it passes from without inwards behind the artery, and being joined by the profunda vein forms with it the common femoral.

The *profunda vein* receives branches corresponding to the branches of the profunda artery, and appearing in Scarpa's triangle in front of the profunda artery and behind the superficial femoral vessels, joins the common femoral.

The *common femoral vein* is enclosed in the femoral sheath lying on the inner side of the artery; on its inner side is the crural canal.

The *internal saphenous vein* commences on the dorsum of the foot by a plexus, from which the external saphenous arises at its outer side and the internal at the inner. The vein crosses the ankle in front of the internal malleolus, and ascends on the inner side of the leg a finger's-breadth behind the internal border of the tibia. At the knee-joint the vein lies at the junction of the inner and posterior aspects of the knee. In the thigh the vein ascends on the inner side until above the centre of the thigh, when it gains the anterior aspect and dips down through the saphenous opening in the fascia lata to join the common femoral.

The named *branches* joining it are: (*a*) Communicating branches from the deep veins about the ankle; (*b*) the superficial epigastric; (*c*) the superficial circumflex iliac; (*d*) the external pudic veins. All these vessels exist as venæ comites upon their corresponding arteries, and join the internal saphenous before it enters the saphenous opening. In the thigh large branches join the vein on its outer and inner sides; these vessels are called the anterior and posterior accessory saphenous veins respectively.

The Veins met with in the Cavity of the Abdomen.

The *external iliac veins* are the continuation of the common femorals. The *right* vein lies first on the inner side, then behind, and finally appears slightly on the outer side of its corresponding artery. The *left* vein passes up internal to the left external artery; just at its ending it is crossed by the trunk of the internal iliac artery.

The *tributaries* are: (*a*) the deep epigastric; (*b*) the circumflex iliac, which crosses the artery just above Poupart's ligament, on its way to the vein. A pubic vein from the back of the body of the pubis also joins the external iliac vein.

The *internal iliac veins* lie on a plane posterior and internal to their corresponding arteries. The branches uniting to form the main trunk closely resemble the branches of the internal iliac artery.

The *dorsal vein of the penis* commences at the point of the penis as a plexus from whence the two veins emerge. These soon unite to form a single trunk, which receives veins from the substance of the penis, and passing backwards between the two dorsal arteries, and within the embrace of the suspensory ligament of the penis, penetrates the triangular ligament, both layers, to reach the *prostatic plexus of veins.* This plexus lies between the false and true capsule of the prostate, and communicates behind with the *vesical plexus,* and so its blood reaches the radicles of the internal iliac vein.

At the lower end of the rectum, the *hæmorrhoidal veins* communicate with both the portal and systemic veins, owing to the lowest hæmorrhoidal vessels opening into the radicles of the internal iliac; whilst the superior hæmorrhoidal joins the inferior mesenteric vein.

In the female the *vaginal* plexus communicates with both the vesical and hæmorrhoidal vessels. The *uterine* plexus of veins empties itself by way of the ovarian veins.

The *common iliac veins* commence at either sacro-iliac synchondrosis by the junction of the external and internal iliacs. The right, nearly vertical, ascends first behind and then on the right side of its artery. The left, longer than the right, crosses the middle line lying first to the inner side of its artery, then ascending below the bifurcation of the aorta it gains the posterior part of the right common iliac artery. The ilio-lumbar veins join either common iliac. The middle sacral vein joins the left common iliac.

The Inferior Vena Cava.

The *inferior vena cava* commences on the right side of the fifth lumbar vertebra and ascends to the diaphragm to reach the right auricle. The vein, at its commencement, is placed deeply against the bodies of the vertebræ; but as it ascends it gradually leaves the bones, and finally passes through the diaphragm some distance in front of the vertebral column. The opening in the diaphragm is on the right side; it is aponeurotic in character and quadrilateral in shape.

The veins in the cavity of the abdomen, both portal and systemic, lie on the right of the arteries; the inferior vena cava is on the right side; it commences lower down than, and on a plane posterior to, the arteries, but as it ascends it comes to be on a plane in front of them.

The *relations* are: in *front,* the liver, the first portion of the duodenum, the head of the pancreas, the third portion of the duodenum, the mesentery, and the small intestines; the right spermatic and the right common iliac arteries cross it, the former just below the renal vessels, the latter at its commencement. *Behind*, the right psoas and the right crus of the diaphragm; the right inferior phrenic, the right capsular, the right renal and the right lumbar arteries lie between it and the posterior abdominal wall. To the *right* is the liver, kidney, and right colon; to the *left*, the right crus of the diaphragm above, and the aorta below.

All the blood from the abdominal aorta does not return directly by the inferior vena cava. The blood which leaves by the cœliac axis and the superior and inferior mesenteric arteries, returns by the portal vein; but, roughly speaking, the inferior vena cava contains all the blood given off by the arteries below the diaphragm, with the exception of the vena azygos major and minor.

The *veins joining* the inferior vena cava after its formation by the common iliacs are: (1) The two lower pairs of lumbar veins. (2) Communicating branches with the azygos veins. (3) The right spermatic. (4) The right and left renals. (5) The hepatic veins join at the spot where the inferior vena cava touches the liver, and pass immediately into it. (6) The right inferior phrenic is the last vessel that joins the inferior vena cava.

The *lumbar veins*, four pairs, collect blood from the side of the abdominal wall and from the back by branches similar to those given off by the arteries. The veins find their way forwards beneath the fibrous arches of the origin of the psoas, along the sides of the bodies of the lumbar vertebræ to open in front, the two lower pairs into the back of the inferior vena cava, the two upper on the right and left side in the vena azygos major and the vena azygos minor respectively. Frequent union takes place between these vessels; one in particular is found beneath the psoas and upon the anterior aspects of the transverse processes of the vertebræ. A longitudinal channel is formed—*the ascending lumbar vein*—which communicates below with the lateral sacral, ilio-lumbar, inferior vena cava and lumbar veins, and ascends as the vena azygos of that side. This vein is more usually found on the left side.

The *spermatic veins* emerge from the testicle through the corpus Highmorianum. Above the testicle and epididymis, the vessels form the pampiniform plexus, which is very apt to become distended or varicose. From the plexus two veins pass upwards along with the spermatic artery, accompanying it along the inguinal canal, and along the posterior abdominal wall to near the origin of the artery. Here the two veins on either side unite, becoming a single trunk; that on the right side opening into the inferior vena cava, that on the left into the left renal vein.

The Renal Veins.—Emerging as four or five branches from the hilus of the kidney on either side, the renal veins unite to form a single trunk. They join the inferior vena cava at almost a right angle.

There is a difference in the relations of the right and left vessels.

The *right* renal vein is shorter than the left, owing to the cava being on the right side; it is joined above by a capsular vein from the suprarenal capsule. It lies on the psoas muscle, and has in front the second portion of the duodenum and the head of the pancreas.

The *left* vein joins the cava usually on a higher level than the right. It has the aorta behind, and the third portion of the duodenum in front, as it crosses to join the cava. It is joined by (1) the left spermatic vein below; the vein joins at almost a right angle. (2) The left inferior phrenic from the under surface of the diaphragm. (3) The left capsular from the suprarenal capsule.

The *hepatic veins* have no course beyond the liver-substance. Destitute of distinct walls and of the enclosing capsule, which is found with the portal vein, the hepatic veins are incapable of separate existence. Hence arises the necessity for the inferior vena cava, to come to touch and dig into the liver-substance, to receive the three or four open mouths of the hepatic veins.

The *suprarenal* or *capsular veins* have been noticed already as going into the right and left renals. The right, however, frequently joins the inferior vena cava.

The *inferior phrenic veins* have also been noted, the left joining the left renal, the right the inferior vena cava just before that vessel penetrates the diaphragm.

The *ovarian veins* correspond at their endings to the spermatic. An ovarian or pampiniform plexus is found on the ovary and in the broad ligament.

The Portal System.

The blood returning through the portal vein, is that which is given off from the aorta by the cœliac axis and the superior and inferior mesenteric arteries. The viscera drained by the veins are the stomach, small intestine, great intestine, the pancreas, and the spleen; it is a vexed question whether or not the liver also should be included in this category. With the exception of the spleen, all these viscera are named *chylo-poietic viscera.* The portal vein has no similar vein in the body, inasmuch as its trunk, after it has been formed, breaks up in the substance of the liver into fine plexuses which are again gathered together to form the hepatic veins. It is like a rete mirabile met with in the arterial system of some animals.

The *portal vein* commences behind the head of the pancreas on the right side of the middle line of the body, by the junction of the superior mesenteric and splenic veins. In length from three or four inches, it passes up behind the first portion of the duodenum, and entering the lesser or gastro-hepatic omentum, it is conducted upwards in it to end at the transverse fissure of the liver. Behind the pancreas and duodenum it is parallel to, almost in contact with, the inferior vena cava; it is separated from the duodenum by the gastro-duodenal artery. In the lesser omentum the vein lies immediately in front of the foramen of Winslow, with the ductus communis choledochus in front and to the right, and the hepatic artery in front and to the left. The vein after its formation is joined by the gastric, pyloric and cystic veins.

At the gate of the liver is a dilatation—the sinus of the portal vein—after which it immediately divides in two, right and left. Each branch is enclosed in a capsule—a prolongation of Glisson's capsule—and is accompanied by a branch of the hepatic artery and a radicle of the hepatic duct. The left vein has a longer course than the right, having to pass across the longitudinal fissure, where it is joined anteriorly by the round ligament of the liver (the umbilical vein of the fœtus), and posteriorly by what was once a communication between the portal vein and inferior vena cava—the ductus venosus.

The veins joining the portal are the following:

The *superior mesenteric vein* is formed by branches corresponding to the branches of the artery: (1) Vasa intestini tenuis; (2) ileo-colic; (3) colica dextra; (4) colica media; and by an extra branch, (5) the right gastro-epiploic. The vein lies on the right of the superior mesenteric artery, and ascends, in front of the third portion of the duodenum and lesser pancreas, and behind the head of the pancreas, to join the splenic.

The *splenic vein* runs behind the pancreas, and below the level of the splenic artery, to its ending at the portal vein. It crosses the aorta to reach its termination.

Branches joining the vein: (1) Four or five from the spleen; (2) vasa brevia from the stomach; (3) gastro-epiploica sinistra; (4) pancreatic, large and small; and an extra branch, (5) the inferior mesenteric vein.

The *inferior mesenteric vein* follows the course of the corresponding artery so far only as its branches are concerned. Formed upon the left side, the vessel ascends behind the peritoneum, over the ureter and beneath the pancreas to join the splenic obliquely. In some cases it joins the superior mesenteric.

Its *branches* are: (1) Superior hæmorrhoidal; (2) sigmoid; (3) colica sinistra.

The *pyloric vein* accompanies the pyloric artery and joins the portal. The *coronary vein* runs from left to right along the lesser curvature of the stomach; it also joins the portal.

The *cystic* joins either the trunk of the portal, or the right branch of the same vessel.

The Lymphatic System.

The lymphatic system consists of: Absorbent vessels scattered through the body, for the main part accompanying the veins; lymph-spaces in the tissues and organs; lymphatic glands grouped in well-understood regions; and of a central channel, the thoracic duct.

The lymph-spaces it is impossible to demonstrate by the naked eye, although the great serous sacs—the peritoneum, pleuræ, etc.—are frequently grouped in the category of lymph-spaces. The lymphatics—including those from the small intestine, named *lacteals*—are fine tubes, varicose in their outline and slightly wavy in their course. They are in size, as a general rule, about the thickness of a horse-hair, and possessed of numerous valves. They require specially injected parts and very careful dissection before they can be followed; by the ordinary dissector they are cleared away with the connective-tissue.

The lymphatic glands admit of naked-eye demonstration. In such regions as the neck or the groin, they are met with as small solid bodies, greyish-pink in colour, ranging from the size of a pea to that of an almond. On cutting into them with a knife, the firm consistence of their centre is found, and the presence of an investing capsule is easily shown. An artery and vein of fair size are found at what is called the hilus of the gland; and there also a vessel—the *efferent*—is found, leaving the gland-substance to proceed to either the central channel or a neighbouring gland. Opposite the hilus, that is on the convex border of the gland, a number of vessels—the *afferent*—are found entering the capsule; they come usually from the regions beyond the gland, and the fluid conveyed by the afferent set of vessels, after passing through the gland, is conducted to the centre by the efferent vessel, which leaves by the hilus. The thoracic duct will be first described.

The THORACIC DUCT is the channel by which the lymph gets into the venous blood. It is a small, slightly undulating, varicose-looking vessel, of a greyish-white colour. In size it is about the calibre of whipcord, and in length from fifteen to eighteen inches. Commencing opposite the second lumbar vertebra by a dilatation—the receptaculum chyli—it passes up in contact with the vertebræ, through the aortic orifice in the diaphragm, ascends in the posterior mediastinum until it reaches the fourth dorsal vertebra, where it crosses to the left, and ascends to the left of the œsophagus. At the top of the thorax on the left side, it emerges, and, reaching the level of the sixth cervical vertebra, arches forwards over the apex of the left pleura, the left subclavian artery, and in front of the anterior scalene, to end at the junction of the left internal jugular and subclavian veins. It possesses numerous valves which give rise to the varicose appearance of the outline of the thoracic duct.

The *relations* are: In the *abdomen* it is situated behind and to the right of the aorta, and between that vessel and the right crus of the diaphragm; in the *thorax* it has—in front, the œsophagus; behind, the right intercostal arteries and the vertebral column; to the left, the aorta; to the right, the vena azygos major. These are the relations as high as the fourth dorsal vertebra; above this point it is placed between the œsophagus and the trachea. Instead of a single duct there may be two or three ducts in the posterior mediastinum which, however, coalesce above before they reach the neck.

The *right lymphatic duct* lies on the right side of the neck, at a point corresponding to the ending of the thoracic duct on the left. In diameter about a line, and in length about half an inch, it conveys lymph from the right side of the head and neck, the right upper limb, the right side of the chest, the right side of the heart, the right lung, the upper surface of the liver and the diaphragm. It opens into the junction of the right subclavian and internal jugular veins.

The Lymphatic Glands of the Head and Neck.—The general course of the lymphatics is from the scalp, downwards to the root of the neck. The vessels from the back of the head pass through two or three *suboccipital* glands at the back of the neck just below the occiput; the vessels from the side of the head pass through two or three *mastoid* glands situated over the insertion of the sterno-mastoid muscle. The temporal lymphatics communicate below with the lymphatic gland, situated in and upon the *parotid* gland.

The *submaxillary* group of glands occupies the submaxillary region. They receive the superficial lymphatics of the face and forehead, with the exception of those of the outer part of the orbit, which go to the parotid group; also from the submaxillary and sublingual salivary glands, from the floor of the mouth, and from the front of the tongue. Lymphatic glands lie in the substance of the submaxillary salivary glands.

The deep lymphatics of the orbit, nose, temporal and zygomatic fossæ, palate, buccal region, and upper part of the pharynx, open into a group of glands, the *internal maxillary*, situated upon the side of the pharynx, beneath the parotid gland and the ramus of the lower jaw. All the glands and lymphatics mentioned descend in either the superficial or deep set of cervical glands.

The *superficial cervical glands*, about six in number, accompany the external jugular vein. They receive the efferent lymphatic vessels from the suboccipital and mastoid glands, and communicate with the ducts from the parotid and submaxillary lymphatic glands, also the lymphatics from the ear.

The *deep cervical glands* are the ultimate group through which the efferent vessels from all the previous groups, including the superficial cervical, send their vessels to the root of the neck. The term concatenate has been applied to the chain-like arrangement of the glands in the region of the sterno-mastoid.

The deep cervical glands are arranged for the most part along the internal jugular vein. The part above the level of the thyroid gland is sometimes called the superior set, the group below, the inferior; these two sets, however, are continuous.

Into the *superior* group, about ten in number, open the lymphatics from the cavity of the cranium, the back part of the tongue, the pharynx, the larynx, the upper part of the thyroid gland, and the deep suboccipital region. The efferent vessels from the internal maxillary and submaxillary groups of glands also open into the superior set of deep cervical glands.

Into the *inferior* group, about twenty in number, open: from *without*, the lymphatics of the shoulder, as far out as the suprascapular fossa and the axilla; from below, the lymphatics of the anterior mediastinum; from above, the efferent vessels of the superior group; from within, the lymphatics of the lower part of the neck; and from the surface, the efferent vessels of the superficial cervical glands.

What is called the jugular lymphatic trunk is the collection of the lymphatic vessels of the head and neck into a single trunk on either side, which opens into the thoracic duct on the left and the lymphatic duct on the right side.

Lymphatics of the Upper Limb.

The *superficial* series of lymphatics in the upper limb commences on the front and back of the hand by two sets of lymphatics from each finger. These unite to form an arch on the palm of the hand and a reticular plexus on the back of the hand. In the forearm the number of vessels increase, and become arranged into two groups, an outer accompanying the superficial radial, an inner the ulnar veins. The outer group pass up obliquely inwards across the forearm, elbow, and arm, and at the axilla open into the glands met with there. The inner group pass straight up along the ulnar aspect of the forearm, and crossing the elbow ascend with the basilic vein to the armpit. The *deep* lymphatics of the upper limb follow the main trunks of the arteries. The deep and superficial communicate around the wrist and at the elbow.

The lymphatic glands are mostly confined to the axilla, but a few small glands are situated on the brachial artery between it and the internal condyle of the humerus. The *axillary* glands drain an enormous region: in front of the body they receive lymphatics from the anterior surface of the body, including the mamma, as low as the umbilicus; from the lateral aspect of the chest, as low as the ilium; and from the back all the way from the lower part of the neck to the loins. The glands in the axilla lie chiefly along the axillary artery; the others are met with along the course of the long thoracic artery, parallel to the anterior wall of the axilla, *pectoral* glands; a third set, the *subscapular* group, lie along the posterior wall of the axilla parallel to the subscapular artery. Some few glands, infra-clavicular, are met with below the clavicle, and between the deltoid and pectoralis major. The efferent vessels from the axilla may form a single vessel beneath the clavicle—the axillary lymphatic trunk—to end in the terminal vessels of the right and left sides.

The Lymphatics of the Thorax.

The surface of the chest is drained by lymphatics, already mentioned, which proceed to the axillary glands. Within the chest, however, numerous important groups of glands are met with.

(1) The lymphatics of the thoracic wall accompany the blood-vessels of this region, the anterior intercostal arteries being accompanied by a separate set—the anterior lymphatics; the intercostal trunks being accompanied by the posterior lymphatics. The anterior set open into the *sternal glands*, which accompany the internal mammary artery, the posterior set communicating with the intercostal glands lying between the heads of the ribs on either side.

(2) The mediastinal lymphatic glands are arranged in chains, and are named the *anterior, posterior* and *superior mediastinal glands.* The anterior and posterior sets drain the viscera and parietes adjacent; and the superior set—named also the cardiac glands, about ten in number—receive especially the cardiac lymphatics as well as those from the thymus gland.

(3) A special group of glands—bronchial glands—are met with at the bifurcation of the trachea, and accompany the bronchi to the lungs. They are peculiar, inasmuch as in the adult they contain dark pigmentary matter—probably inhaled soot.

Lymphatics of the Lower Limb.

The *superficial lymphatics* of the foot are arranged as an inner and outer set on the dorsum, and accompany the internal and external saphenous veins respectively as they ascend the legs. The *inner* set ascend to the groin, and terminate there in the superficial glands at the groin. The *outer* set end opposite the back of the knee in the popliteal glands.

The *deep lymphatics* accompany the bloodvessels throughout the limb.

The *glands* of the lower limb consist of:

(1) Popliteal glands, four to six in number; sometimes a small gland exists on the anterior tibial artery, half-way down the leg.

(2) The superficial inguinal glands consist of an oblique and vertical set. The *oblique*, four or five in number, lie in the superficial fascia, having their long axes parallel to Poupart's ligament. These receive lymphatics: from above, from the lower part of the anterior abdominal wall as high as the umbilicus; from behind, the gluteal and lumbar lymphatics; from within, the superficial lymphatic of the penis, scrotum and perineum. The *vertical* inguinal glands, three or four in number, lie upon the upper end of the internal saphenous vein; they are joined by the superficial lymphatics of the lower limb.

(3) The deep inguinal glands, three or four in number, have their long axes parallel to the femoral vessels, on the upper part of which they lie. They receive the deep lymphatics of the lower limb, and communicate with the superficial glands.

The superficial and deep vertical glands are sometimes named femoral instead of inguinal glands, from their position in the thigh. The efferent vessels of both the superficial and deep lymphatics pass up with the common femoral vessels, a large number passing through the crural canal to join the lymphatics along the external iliac vessels.

The Lymphatics of the Abdomen.

The lymphatic glands of the abdomen are arranged in groups, for the most part along the path of the bloodvessels. The chief groups are:

(1) The external iliac.

(2) The internal iliac, including those met with on the front of the sacrum (sacral glands).

(3) The lumbar group arranged in three chains; a *mesial* chain surrounding the aorta and inferior vena cava; *lateral* chains which

lie behind the psoas muscle, between the transverse processes, in a line with the intercostal glands of the thorax.

(4) Cœliac glands, as many as twenty in number, surround the cœliac axis.

(5) The mesenteric glands, to the number of about 150, lie between the layers of the mesentery, mostly in the intervals between the loops of blood-vessels.

The lymphatics of the *bladder*, *prostate*, and *rectum* in the male communicate with the glands along the side of the internal iliac vessels and with the sacral glands. In the female, the lymphatics of the *uterus* accompany the uterine artery to the glands on the internal iliac vessels. The lymphatics of the *ovary* in the female and the *testicle* in the male follow the vessels supplying them, and open into the lumbar glands above. The lymphatics of the *kidney*, *supra-renal capsule*, and *ureter* unite near the hilus of the kidney, and are continued on to the lumbar glands on either side. The lymphatics of the *stomach*, *spleen*, *pancreas*, and the *deep lymphatics of the liver* open into the cœliac glands. The lymphatics of the stomach pass through a few gastric glands situated at the curvatures; the vessels pursue a course parallel to the arteries met with at the curvatures.

A special set of lymphatics—lacteals, ascends from the small intestine through the mesenteric glands to reach the thoracic duct, after being joined by the efferent vessels from the cœliac glands. They reach the receptaculum chyli either as a single trunk (the intestinal lymphatic trunk), or as three or four separate branches. The lymphatics from the great intestine, on the other hand, reach the lumbar glands, or open directly into the thoracic duct.

The liver lymphatics are the most complicated of all. They consist of a superficial set, subdivided into an upper and lower group, and a deep set.

(1) The lymphatics from the *upper* surface of the liver behave thus: (a) Those at either end join the cœliac glands; (β) those in the centre pass up in the falciform ligament, and perforate the diaphragm to join the group of glands in the anterior mediastinum. (γ) The lymphatics of the posterior surface descend upon the inferior vena cava.

(2) The lymphatics of the *under* surface join at the gate of the liver with the deep lymphatics, and together with them descend to the cœliac glands.

(3) The deep lymphatics of the liver emerge at the tranverse fissure, and joining with the previously mentioned group, reach the cœliac glands. Another set accompanies the hepatic vein, joins the lymphatics upon the inferior vena cava in company with the lym-

phatics from the posterior part of the upper surface of the liver.

The deep lymphatics of the abdominal wall pass downwards in front to reach the glands on the external iliac arteries; externally and behind, the vessels reach the lumbar glands; whilst above, the lymphatics from the upper part ascend with the superior epigastric and internal mammary artery, to the anterior mediastinum.

PLATE LXXXVI.

NERVOUS SYSTEM, PLATE I.

Fig. 1. Dura Mater.

The cranium is opened on the right side by a vertical and a horizontal cut.

1. Falx cerebri.—2. Superior longitudinal sinus.—3. Inferior longitudinal sinus.—4. Straight sinus.—5. Confluence of the sinuses, or torcular Herophili.—6. Tentorium cerebelli.—7 and 8. Lesser circumference of tentorium.—9. Termination of this circumference at the anterior clinoid process.—10. Termination of greater circumference at the posterior clinoid process.

Fig. 2. Dura Mater.

The right portion of the tentorium is removed.

1. Falx cerebri.—2. Superior longitudinal sinus, opened.—3. Torcular Herophili.—4. Left side of tentorium.—5. Falx cerebelli.

Pl. 86.

Fig. 1.

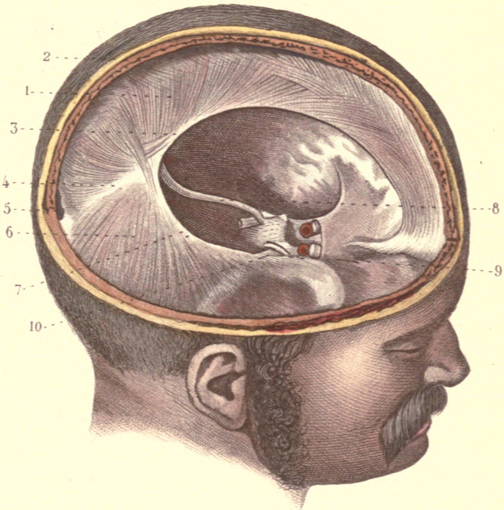
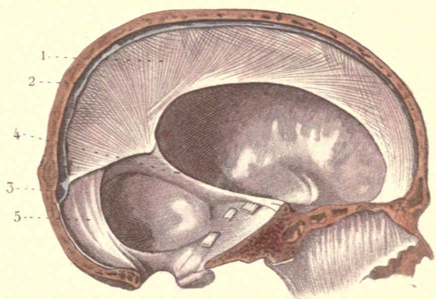


Fig. 2.



Léveillé del.

Corbié sc.

Pl. 87.

Fig. 1.

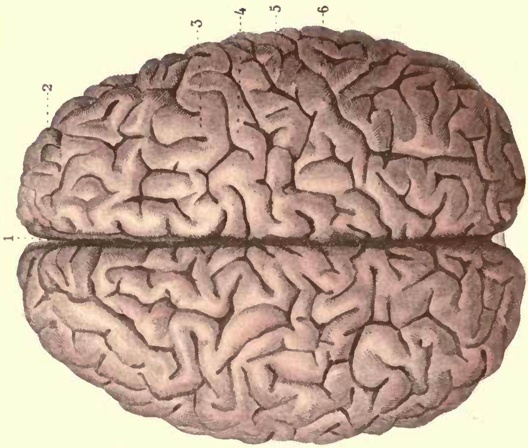
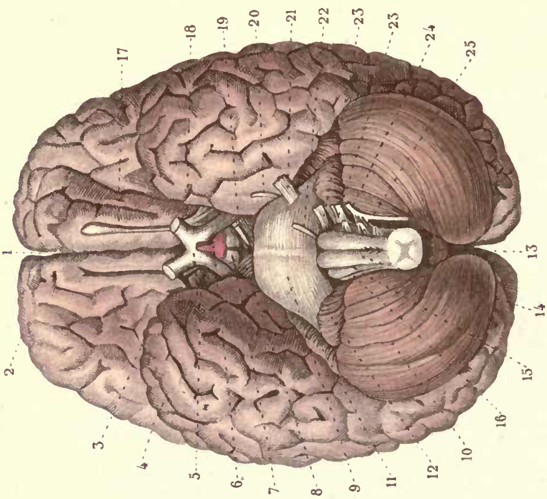


Fig. 2.



Léveillé del.

Corbié sc.

PLATE LXXXVII.

NERVOUS SYSTEM, PLATE II.

Fig. 1. CEREBRUM (*upper surface*).

1. Longitudinal fissure.—2. Right hemisphere.—3 and 4. Convolutions.—5 and 6. Sulci.

Fig. 2. CEREBRUM, PONS VAROLII, CEREBELLUM, AND MEDULLA OBLONGATA (*lower surface*).

1. Longitudinal fissure.—2. Frontal lobe.—3. Fissure of Sylvius.—4. Temporo-sphenoidal lobe.—5. Optic commissure.—6. Pituitary body and tuber cinereum.—7. Corpora mammillaria.—8. Crus cerebri.—9. Pons Varolii.—10. Cerebellum.—11. Superior lobes of cerebellum.—12. Pneumogastric lobe.—13. Inferior vermiform process.—14. Anterior pyramid.—15. Olivary body.—16. Restiform body.—17. Olfactory nerve.—18. Optic nerve.—19. Third, or motor oculi.—20. Fourth, or patheticus.—21. Fifth, or trigeminus.—22. Sixth nerve, or abducens.—23. Seventh, or auditory and facial (portio mollis and portio dura).—23 and 24. Eighth nerve (glossopharyngeal, pneumogastric, and spinal accessory).—25. Ninth, or hypoglossal, motor nerve of tongue.

PLATE LXXXVIII.

NERVOUS SYSTEM, PLATE III.

Fig. 1. CORPUS CALLOSUM.

The cerebrum has been cut horizontally to the level of the corpus callosum on the left side, and a little below it on the right.

1. The white matter separated from the corpus callosum and turned aside. — 2. Centrum ovale of Vieussens, formed by the superior surface of the corpus callosum, and by the masses of white matter in the hemispheres.—3. Corpus callosum.—4. Raphe and nerves of Lancisi.

Fig. 2. FORNIX, ETC.

1. Reflected portion of corpus callosum.—2. Laminæ, forming the septum lucidum and enclosing fifth ventricle, cut.—3. Fornix.—3′. Foramen of Munro, through which the choroid plexus of the lateral ventricle is continuous with that of the middle.—4. Choroid plexus.—5. Posterior extremity of corpus callosum.—6. Posterior cornu.—7. Hippocampus minor.—8. Corpus striatum.—9. Tænia semicircularis.—10. Optic thalamus.

Pl. 88.

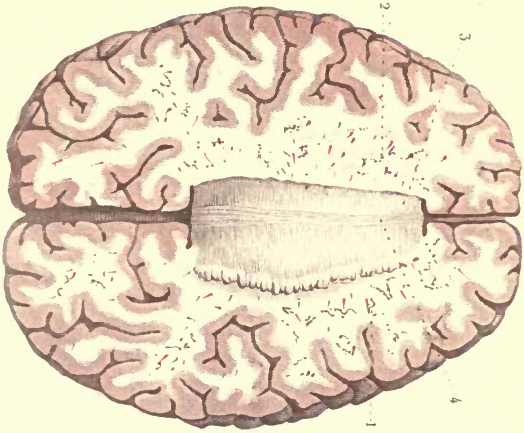


Fig. 1.

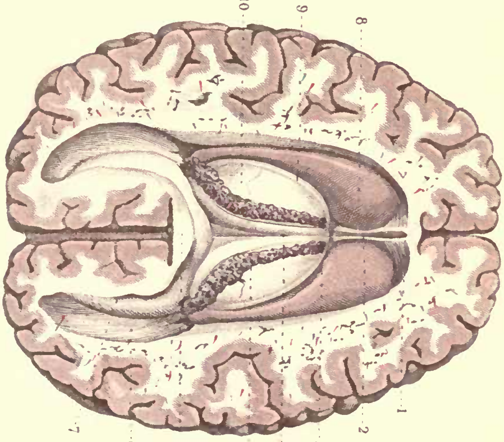


Fig. 2.

Léveillé del. Corbié sc.

Pl. 89.

Fig. 2.

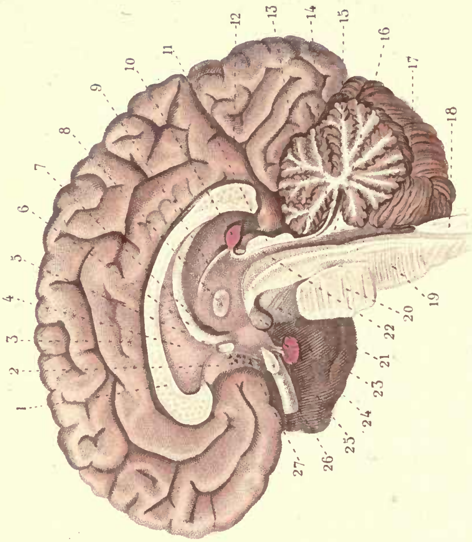
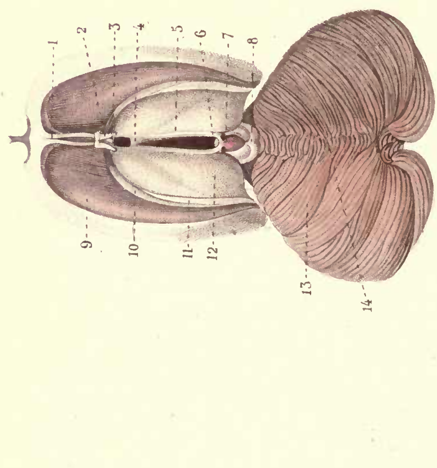


Fig. 1.



Léveillé del. *Davesne sc.*

PLATE LXXXIX.

NERVOUS SYSTEM, PLATE IV.

Fig. 1. THIRD AND FOURTH VENTRICLES.—SUPERIOR PART OF LATERAL VENTRICLES.—UPPER SURFACE OF CEREBELLUM.

1. The two laminæ of the septum lucidum enclosing the fifth ventricle.—2. Anterior pillars of fornix, cut and turned back.—3. Anterior commissure.—4. Middle commissure.—5. Third ventricle.—6. Posterior commissure.—7. Pineal gland and its peduncles.—8. Corpora quadrigemina, or *nates and testes.*—9. Corpus striatum.—10 and 11. Tænia semicircularis.—12. Optic thalamus.—13. Superior surface of cerebellum.—14. Superior vermiform process.

Fig. 2. VERTICAL SECTION OF THE BRAIN IN THE MESIAL LINE.

1. Corpus callosum.—2. Peduncle of corpus callosum.—3. Gyrus fornicatus.—4. Septum lucidum.—5. Anterior commissure.—6. Fornix.—7. Foramen of Munro.—8. Optic commissure.—9. Optic thalamus.—10. Pineal gland.—11. Nates and testes.—12. Fissure separating the posterior from the middle lobe.—13. Valve of Vieussens.—14. Linguetta laminosa.—15. Arbor vitæ.—16. Fourth ventricle.—17. Divergence of posterior pyramid.—18. Posterior pillar of spinal cord.—19. Antero-posterior fibres of anterior pyramids.—20. Pons.—21. Crus cerebri.—22. Aqueduct of Sylvius (*Iter a tertio ad quartum ventriculum*).—23. Corpora albicantia.—24. Tuber cinereum.—25. Pituitary body.—26. Optic commissure.—27. Lamina closing in the middle or third ventricle in front.

PLATE XC.

NERVOUS SYSTEM, PLATE V.

Fig. 1. Cerebellum.

1. Foramen between the third and fourth ventricles (*Iter a tertio ad quartum ventriculum*). — 2. Posterior commissure. — 3. Corpora quadrigemina (*nates and testes*).—4. Process of the testes to the optic thalamus.—5. Processus e cerebello ad testes.—6. Commissure of the valve of Vieussens.—7. Fourth nerve.—8. Valve of Vieussens.—9. Linguetta laminosa.—10. White central substance of cerebellum.—11. Posterior lobe.

Fig. 2. Cerebellum.

The fourth ventricle is opened by removing the central or vermiform process of the cerebellum and the upper part of the valve of Vieussens.

1. Processus e cerebello ad testes. The fibres of these two processes are seen reuniting under the corpora quadrigemina.—2. Valve of Vieussens divided, showing the two laminæ.—3. Free extremity of the inferior vermiform process in the fourth ventricle (*nodulus*).—4. The medulla oblongata.—5. Corpus dentatum.—6. Choroid plexus of fourth ventricle.—7. Interior of fourth ventricle.

Fig. 3. The Ventricles of the Brain.

1. Fifth ventricle.—2. Anterior pillars of fornix.—3. Anterior commissure.—4. Infundibulum.—5. Third ventricle.—6. Aqueduct of Sylvius.—7. Fourth ventricle.—8. Calamus scriptorius.

Fig. 4. Floor of Fourth Ventricle.

1. Roots of auditory nerve.—2. Processus clavatus.—3. Posterior pyramids.

Fig. 5. Posterior part of the Optic Thalamus and Mesencephalon, seen from the side.

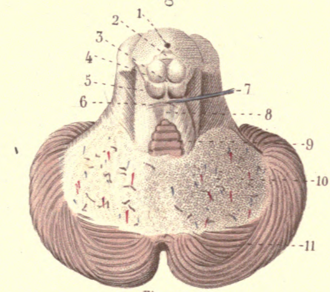
1. Tænia semicircularis.—2. Optic thalamus.—3. External geniculate body.—4. Process of white substance passing from the optic thalamus.—5. Internal geniculate body.—6. Tubercle situated near the geniculate bodies. — 7. Tubercula quadrigemina. — 8. Fourth nerve.—9. Crus cerebri.—10. Crus cerebelli, cut.—11. Restiform body.—12. Lateral fasciculi of isthmus.

Fig. 6. The Fibres of the Pons are cut in order to show the continuity of the lateral Fasciculus of the Crus Cerebri with the Spinal Cord.

1. Olivary body.—2. Lateral fasciculus of isthmus or crus.

Pl. 90.

Fig. 1



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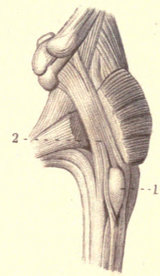

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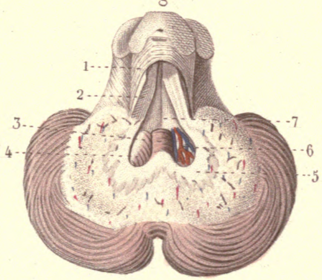

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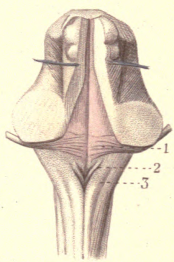

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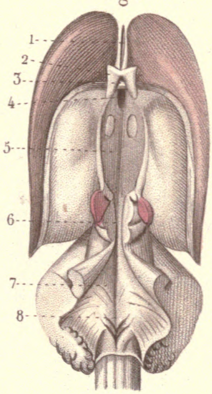
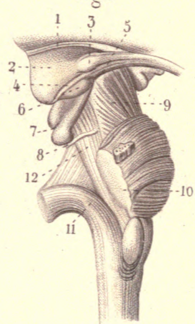
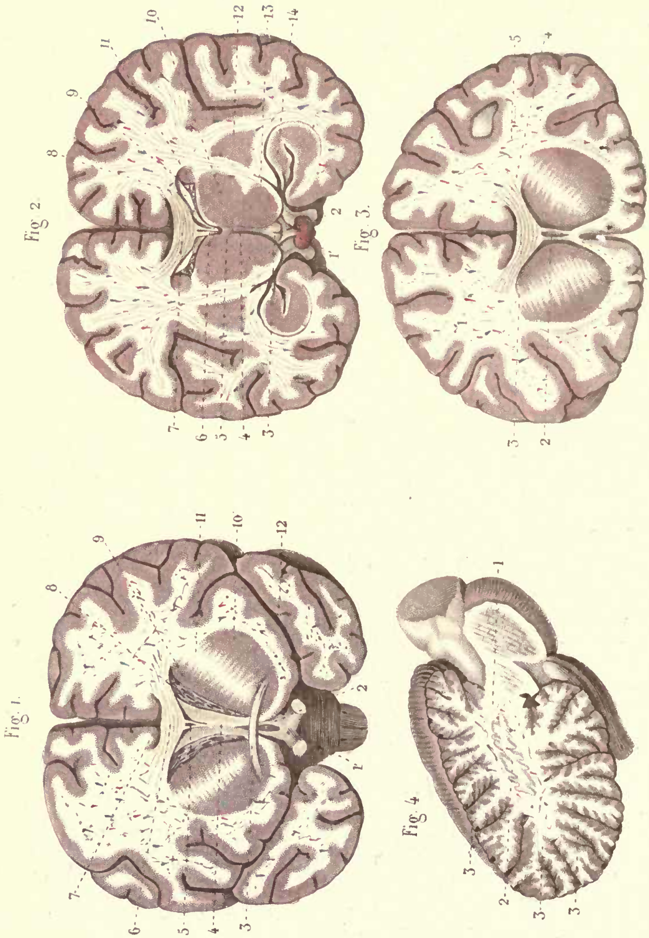


Fig. 5



Léveillé del. *Davesne sc.*

Pl. 91



Léveillé del.

Davesne sc.

PLATE XCI.

NERVOUS SYSTEM, PLATE VI.

Fig. 1. Transverse section of the Brain in front of the Anterior Commissure.

The anterior lobes are removed.

1. Optic commissure.—2. Lamina which shuts in the third ventricle in front.—3. Anterior commissure, perforating the corpus striatum.—4. Anterior part of fornix.—5. Remains of septum lucidum.—6. Corpus callosum.—7. Ventricle of corpus callosum.—8. Choroid plexus.—9 and 10. Superior and inferior portions of the corpus striatum, separated by the prolongation of the crura cerebri.—11. Continuation of this prolongation with the white substance of the lateral hemisphere.—12. Fissure of Sylvius.

Fig. 2. Transverse section of the Brain through the Optic Thalami.

The posterior part of the brain is removed.

1. Pituitary body.—2. Pedicle of pituitary body.—3. Corpora mammillaria.—4. Third ventricle.—5. Optic commissure.—6. Fifth ventricle.—7. Corpus callosum.—8. Lateral portion of roof of fornix.—9. Choroid plexus.—10. Optic thalamus.—11 and 12. Superior and inferior portions of the corpus striatum.—13. Section of the crus cerebri and of the optic nerve.—14. Group, composed of the hippocampus major and tænia hippocampi.

Fig. 3. Transverse section of the Brain in front of the Anterior Commissure.

The posterior part of the brain is removed.

1. Under surface of corpus callosum.—2. Fifth ventricle.—3. Corpus callosum.—4. Continuity of the corpus callosum with that prolongation of the crura cerebri which divides the grey substance of the corpus striatum.—5. White substance of the hemisphere.

Fig. 4. Vertical section of the Right Lobe of the Cerebellum, to show the Arbor Vitæ.

1. White substance of arbor vitæ.—2. Corpus dentatum.—3, 3, 3. Ramifications of the arbor vitæ.

PLATE XCII.

NERVOUS SYSTEM, PLATE VII.

Fig. 1. Base of Brain.

The middle lobes have been removed.

1. Olfactory nerve.—2. Anterior perforated space.—3. White matter of hemisphere, adjacent to the inferior part of the corpus striatum.—4. Group of convolutions corresponding to the inferior part of the corpus striatum.—5, 5. Convolutions in which they terminate.—6. Optic tract.—7. Crus cerebri.—8. Fibres crossing the pons, and continuous with the crus.—9. Anterior pyramid.—10. Decussation of portion of the anterior pyramids.—11. Tuber cinereum.—12. Inferior portion of corpus striatum.—13. Posterior perforated space.—14. Origin of the fifth nerve.

Fig. 2. Velum Interpositum and Choroid Plexus.

1. Velum interpositum.—2, 2. Choroid plexus of lateral ventricles.—3, 3. Choroid plexus of the inferior surface of the velum.—4. Pineal body.

Fig. 3. Corpus Callosum.—Fornix.

1. Corpus callosum.—2. Anterior commissure.—3. Fornix.—4. Anterior pillar of fornix.—5. Lyra.—6. Posterior extremity of corpus callosum.—7. Hippocampus major, cut.—8. Digital cavity.—9. Hippocampus minor.

Pl. 92.

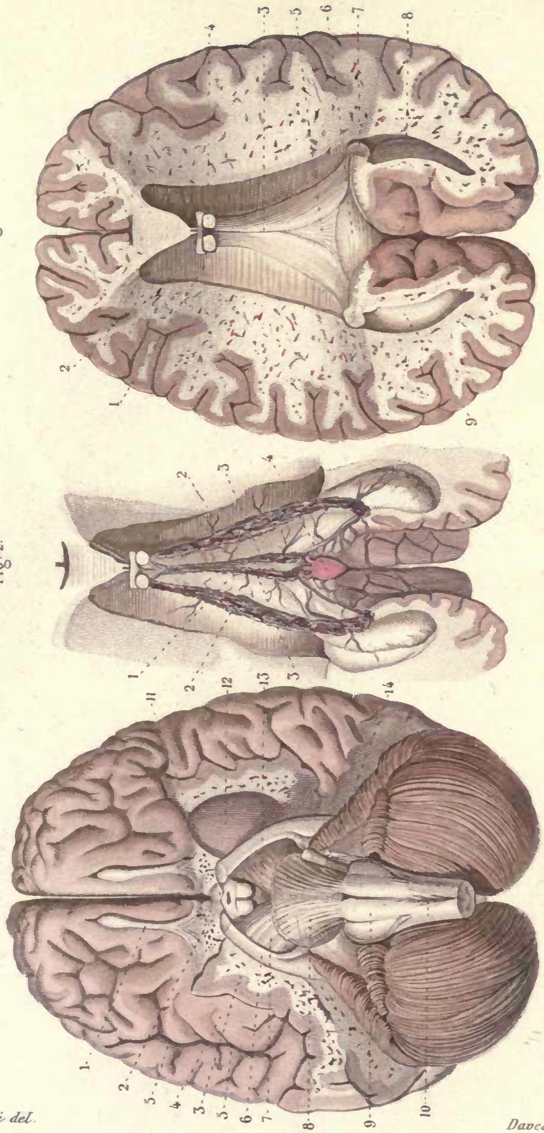


Fig. 3.

Fig. 2.

Fig. 1.

Léveillé del. *Davesne sc.*

Pl. 93.

Fig. 3.

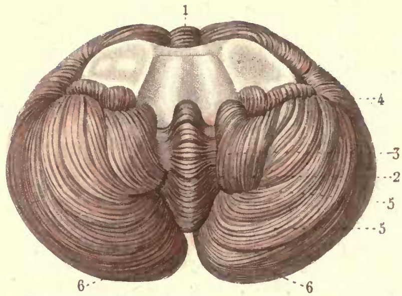
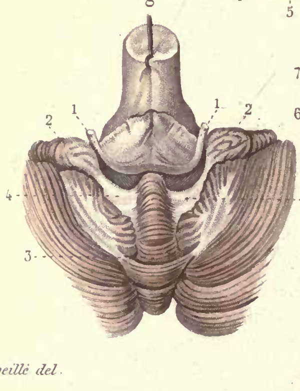


Fig. 2.

Fig. 4



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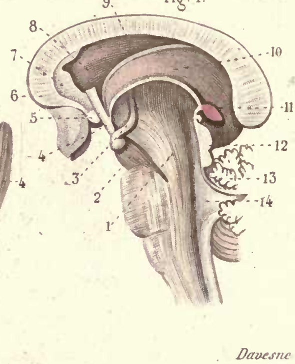

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PLATE XCIII.

NERVOUS SYSTEM, PLATE VIII.

Fig. 1. THE INTERNAL PART OF THE OPTIC THALAMUS IS SCRAPED AWAY AND REMOVED.

1. Fibres of the medulla spreading out in the optic thalamus.—2. Crus cerebri.—3. Continuation of anterior pillar of fornix into the optic thalamus.—4. Anterior pillar of fornix.—5. Anterior commissure.—6. Corpus callosum.—7. Septum lucidum, cut.—8. Corpus striatum.—9. Tænia semicircularis.—10. Superior portion of optic thalamus.—11. Pineal body and its crura.—12. Tubercula quadrigemina.—13. Valve of Vieussens.—14. Fourth ventricle.

Fig. 2. LATERAL VENTRICLE.

1. Roof of ventricle.—2. Digital cavity.—3. Hippocampus minor.—4. Descending cornu.—5. Hippocampus major.—6. Choroid plexus.—7. Corpus fimbriatum.

Fig. 3. INFERIOR SURFACE OF CEREBELLUM.

1. Superior vermiform process.—2. Inferior vermiform process.—3. Amygdala.—4. Pneumogastric lobe.—5, 5. Slender and digastric lobes.—6, 6. Inferior lobes.

Fig. 4. THE MEDULLA IS PULLED UP AND DRAWN FORWARDS.

1, 1. Auditory nerves.—2, 2. Vagi.—3. Inferior vermiform process.—4, 4. Valves of Tarini.

PLATE XCIV.

NERVOUS SYSTEM, PLATE IX.

Fig. 1.—1. Corpus callosum, turned aside.—2. White line situated at the meeting of the corpus callosum with the radiating fibres of the crura cerebri external to the corpus striatum.—3, 3. Laminæ of the septum lucidum, enclosing the fifth ventricle.—4. Anterior commissure.—5, 5. Anterior pillars of fornix, cut.—6. Optic commissure.—7. Third ventricle.—8. Pineal body, turned forward to show,—9. Its commissure.—10. Posterior commissure.—11. Corpora quadrigemina (*nates and testes*).—12. Process from the nates sinking into the white substance of the optic thalamus. The superficial part of the optic thalamus has been removed.—13. Tubercle, from which arise the underlying fibres of the process above named.—14. White substance of the optic thalamus.—15. Anterior peduncle of pineal body.—16. Tænia semicircularis.—17. Corpus striatum. The superior part has been removed.—18. White striæ of the crus cerebri, passing through the corpus striatum.

Fig. 2. Middle and Posterior Cornua of the Right Lateral Ventricles.

1. Hippocampus major.—2. Eminentia collateralis.—3. Tænia hippocampi.—4. Hippocampus minor and posterior cornu.

Fig. 3.—1. Tænia hippocampi drawn aside.—2. Fascia dentata.

Fig. 4. Mesencephalon and Medulla.

1. Pons.—2, 2. Crura cerebri.—3, 3. Crura cerebelli.—4. Fifth nerve.—5. Deviating fibres of the pons.—6. Anterior pyramid.—7. Olivary body.—8, 8. Arciform fibres.

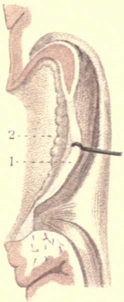
Fig. 5. Pons, from which the Superficial Fibres have been removed.

The deep white fibres are seen interspersed with the grey matter, forming a sort of median raphe.

Fig. 6.—1. Crus cerebri cut, passing under the optic thalamus.—2. Inferior portion of optic thalamus, continuous with,—3. The optic nerve.—4, 4, 4. Radiating fibres of Reil. The superior portion of the corpus striatum is removed.

Pl. 94.

Fig. 3.



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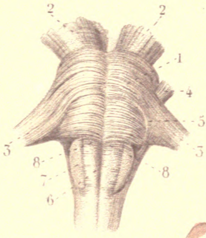

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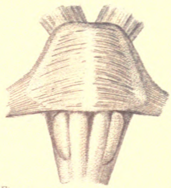

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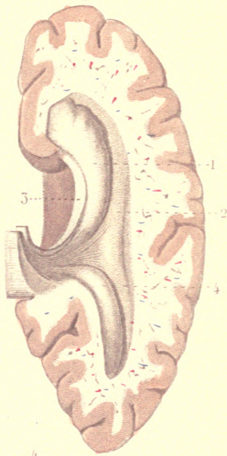

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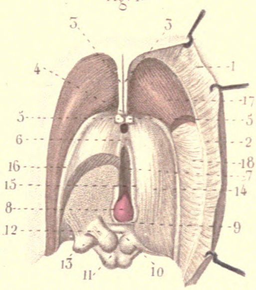
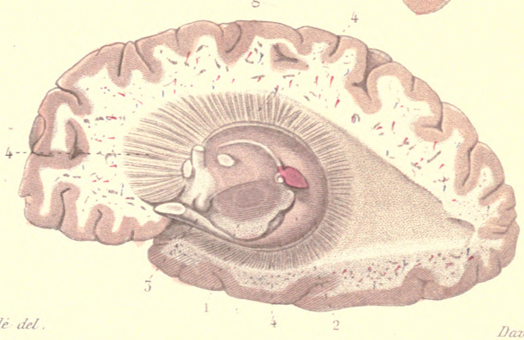


Fig. 6.



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Pl. 95.

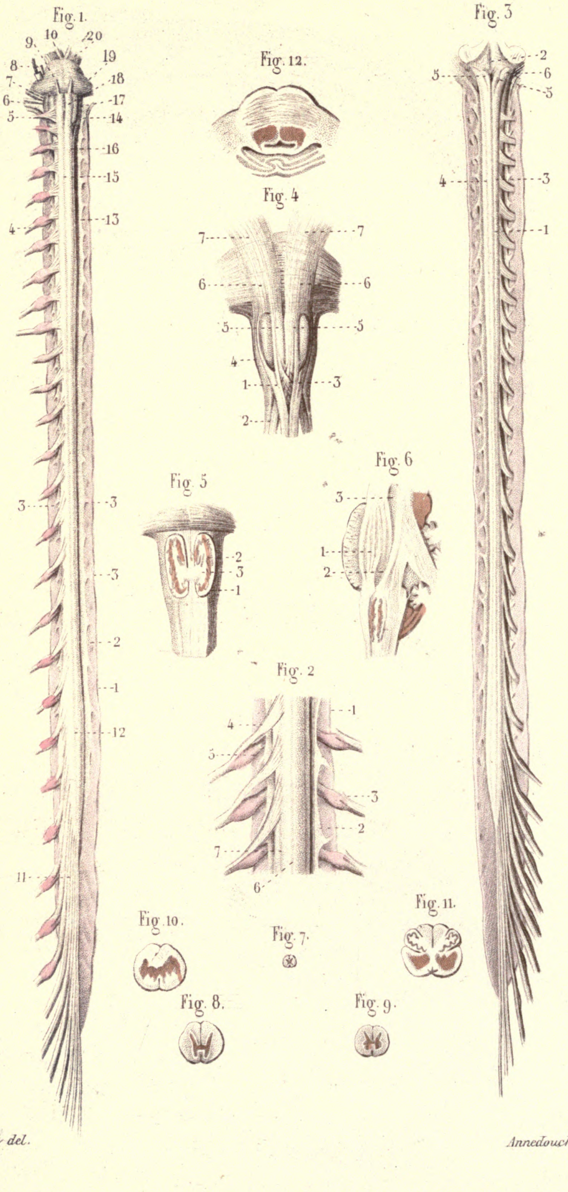

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PLATE XCV.

NERVOUS SYSTEM, PLATE X.

Fig. 1. ANTERIOR SURFACE OF THE PONS AND SPINAL CORD, DURA MATER, LIGAMENTUM DENTICULATUM, ETC.

1. Dura mater.—2. Ligamentum denticulatum.—3, 3, 3. Its serrations.—4. Spinal nerves.—5. Ninth nerve.—6. Eighth nerve.—7. Seventh nerve.—8. Fifth nerve.—9. Sixth nerve.—10. Third nerve.—11. Cauda equina.—12. Intumescentia lumbalis.—13. Intumescentia cervicalis.—14. Medulla.—15. Anterior median fissure.—16. Anterior lateral fissure.—17. Olivary body.—18. Anterior pyramid.—19. Pons.—20. Crura cerebri.

Fig. 2. SPINAL CORD.

1. Dura mater.—2. Ligamentum denticulatum.—3. Anterior root of a spinal nerve, cut.—4. Anterior root.—5. Posterior root and its ganglion.—6. Anterior median fissure.—7. Anterior lateral fissure.

Fig. 3. POSTERIOR SURFACE OF SPINAL CORD.

1. Posterior fissure.—2. Calamus scriptorius.—3. Posterior column.—4. Posterior lateral fissure.—5, 5. Divergence of posterior columns.—6. Restiform body.

Fig. 4. STRUCTURE OF THE MEDULLA OBLONGATA.

1. Anterior column of the spinal cord seemingly dividing to enclose the olive and reunite beyond it.—2. Lateral column divided into two portions, one of which passes behind the olive, and the other behind the anterior pyramid to decussate with its fellow on the opposite side.—3. The decussation.—4. Fibres posterior to the olive, coursing from the anterior and lateral columns.—5, 5. Anterior pyramids, formed by the decussating fibres and some fibres from the anterior pillars.—6, 6. Bands formed by the union of the anterior lateral columns of the cord, continuous with—7, 7. The crura cerebri.

Fig. 5. SECTION OF OLIVARY BODIES.

1. White substance.—2. Corpus dentatum.—3. Nucleus.

Fig. 6. SECTION OF PONS AND MEDULLA.

1. Longitudinal fibres of the pons.—2. White matter apparently passing from the olive.—3. Locus niger.

Figs. 7, 8, 9.—SECTIONS OF CORD BELOW THE MEDULLA.

Fig. 10. SECTION AT THE POINT OF DECUSSATION OF THE FIBRES.

Fig. 11. SECTION THROUGH THE MIDDLE OF THE MEDULLA.

Fig. 12. SECTION AT THE JUNCTION OF THE MEDULLA WITH THE PONS.

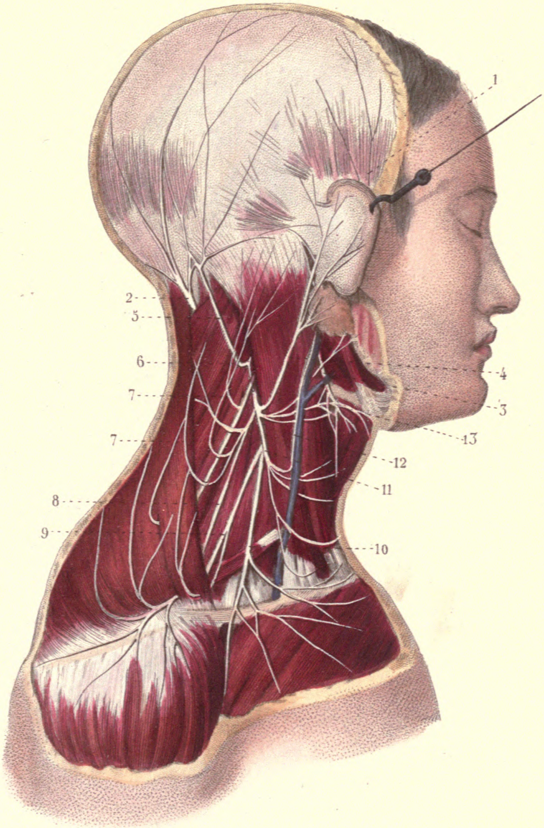
PLATE XCVI.

NERVOUS SYSTEM, PLATE XI.

CERVICAL PLEXUS (*superficial portion*).

1. Temporal branch of auriculo-temporal of fifth.—2. Great occipital.—3. Cervico-facial of seventh.—4. Great auricular (*auriculo-parotidean*).—5. Lesser occipital.—6, 7, 7. Cutaneous branches.—8. Spinal accessory of eighth.—9. Acromial branch of descending cervical.—10. Middle clavicular.—11. Superficial cervical.—12. Small branch accompanying the external jugular vein.—13. Superficial plexus, formed by the inosculation of the facial and superficial cervical nerves.

Pl. 96.



Léveillé del.

Corbié sc.

Pl. 97.

Léveillé del. Davesne sc.

PLATE XCVII.

NERVOUS SYSTEM, PLATE XII.

Deep Portion of Cervical Plexus and Brachial Plexus.—The chest is opened on the right side.

1. Facial.—2. Pneumogastric.—3. Internal carotid artery.—4. Spinal accessory.—5. Inosculation of the spinal accessory with the cervical plexus.—6. Hypoglossal (ninth), dividing into two portions, one supplying the motor muscles of the tongue, the other a descending branch uniting with the cervical plexus (*descendens noni*).—7. Anterior branch of first cervical, joining the hypoglossal and pneumogastric.—8. Communicantes noni.—9, 9. Phrenic.—10, 10. Deep branches of cervical plexus.—11. Brachial plexus.—12. Special branch to subclavius muscle.—13. Anterior thoracic.—14. External respiratory (*nerve of Bell*).—15, 16, and 17. Subscapular, supplying the subscapularis, latissimus dorsi, and teres major.—18. Axillary artery, embraced by the median nerve, the *inner* head crossing it.—19. Branches of the brachial plexus.

PLATE XCVIII.

NERVOUS SYSTEM, PLATE XIII.

Fig. 1. Cutaneous Nerves of Upper Extremity.

1. Basilic vein.—2. Cephalic vein.—3. Cutaneous branch of circumflex.—4. Cutaneous branch of musculo-cutaneous.—5, 5. Distribution of this nerve to skin of forearm.—6. Internal cutaneous.—7. External branch of this nerve.—8. Internal branch.—9. Lesser internal cutaneous (*nerve of Wrisberg*).—10. Palmar branch of median.—11. Digital branch of median.

Fig. 2.—1. Cutaneous branches of circumflex.—2, 2. Cutaneous branches of musculo-spiral.—3, 3. Branches of internal cutaneous.—4, 4. Branches of external cutaneous.—5. Inosculation of this nerve with the radial.—6. Dorsal branch of ulnar, dividing into two branches, one for the internal surface of the little finger, the other for the sides of the two inner fingers.—7. Posterior branch of radial, dividing into two branches, one for the external surface of the thumb, the other for the opposed surface of the thumb, first and second fingers.—8. Inosculation of the radial and ulnar nerves.—9. Digital nerves.

Pl. 98.

Fig. 1.

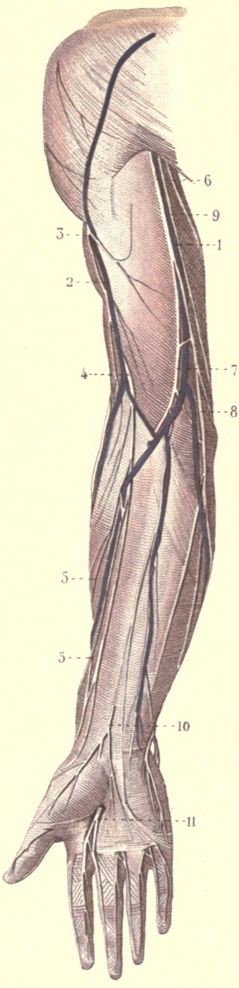
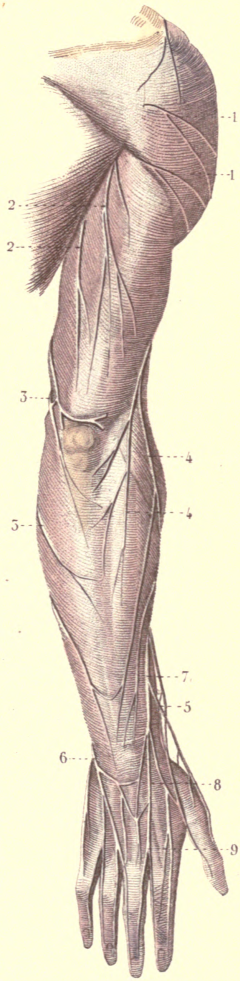


Fig. 2.



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Pl. 99.

Fig. 1.

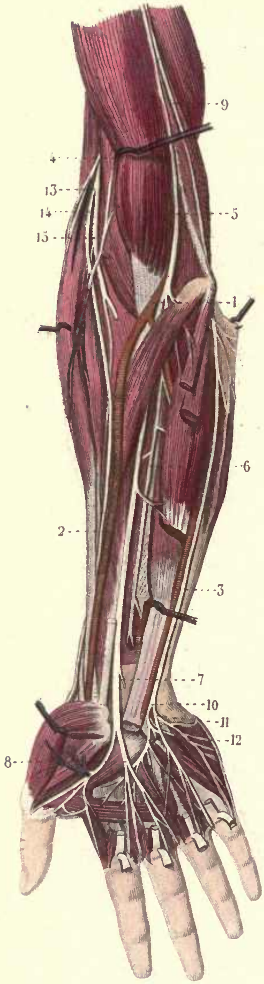


Fig. 2.

Léveillé del.

Corbié sc.

PLATE XCIX.

NERVOUS SYSTEM, PLATE XIV.

Fig. 1. Deep Nerves of the Upper Extremity.—The flexor carpi radialis, palmaris brevis, superficial and deep flexors are cut.

1. Brachial artery.—2. Radial artery.—3. Ulnar artery.—4. Musculo-cutaneous.—5. Median.—6. Anterior interosseous.—7. Cutaneous branch to palm.—8. Digital branches of median.—9. Ulnar. —10. Division of palmar branch of ulnar into—11. Superficial, and —12. Deep.—13. Musculo-spiral, dividing into—14. An anterior, and—15. A posterior branch.

Fig. 2. Musculo-spiral.—The triceps and the posterior superficial muscles of the forearm are cut to show its course.

1. Musculo-spiral.—2. Posterior interosseous branch, dividing into superficial and deep.

PLATE C.

NERVOUS SYSTEM, PLATE XV.

Fig. 1. FACIAL NERVE (*portio dura of seventh*) AFTER IT HAS LEFT THE AQUEDUCTUS FALLOPII, ETC.

1. Great occipital.—2, 2. Mastoid branches of cervical plexus.—3. Portion of cervical plexus, giving off branches to small occipital, great auricular, and superficial cervical.—4. Malar branch of superior maxillary of fifth.—5. Infra-orbital.—6. Frontal of fifth.—7. Lachrymal of fifth.—8. Buccal of fifth (*inferior maxillary*).—9. Auricular branch of auriculo-temporal of fifth.—10. Mental branch of inferior dental of fifth.—11. Hypoglossal.—12. Trunk of facial, giving off the posterior auricular, the branch to the posterior belly of the digastric and stylo-hyoid, and dividing into temporal, malar infra-orbital, buccal, supra- and infra-maxillary branches.

Fig. 2. FACIAL NERVE IN THE AQUEDUCTUS FALLOPII.—MECKEL'S GANGLION, OTIC GANGLION, AND GANGLION OF ANDERSCH, ETC.

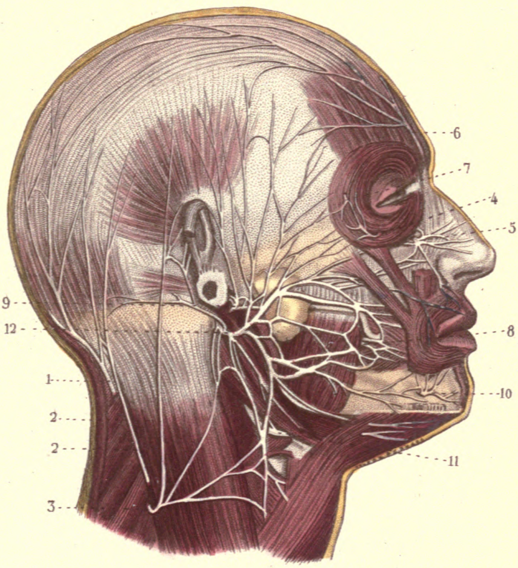
1. Gasserian ganglion of fifth.—2. Meckel's, or spheno-palatine ganglion.—3. Vidian and carotid branches of Meckel's ganglion.—4. Gustatory of fifth, receiving the Chorda tympani from the facial.—5. Otic ganglion, and communication with Jacobson's nerve (*tympanic branch of glosso-pharyngeal*) and with the facial.—6. Facial, and its branch of communication with the auditory.—7. Lesser petrosal (the nerve immediately above this is the greater petrosal).—8. Origin of chorda tympani.—9. Inosculating branch with glosso-pharyngeal.—10. Inosculating branch with pneumogastric.—11. Glosso-pharyngeal and its lower enlargement (*ganglion of Andersch*).—12. Superior branches of the superior cervical ganglion, forming the carotid plexus, from which proceed filaments inosculating with the Vidian, and with Jacobson's nerve.

Fig. 3. AUDITORY NERVE (*portio mollis of seventh*).—The bony labyrinth has been removed.

1. Facial nerve, and its union with the greater petrosal.—2. Chorda tympani, appearing between the incus and handle of malleus.—3. Auditory nerve.—4. Cochlear branches.—5. Branches to the vestibule and semicircular canals.

Pl. 100.

Fig. 1



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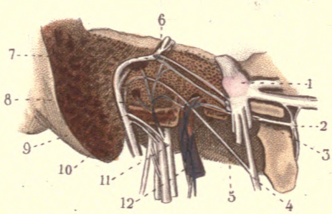
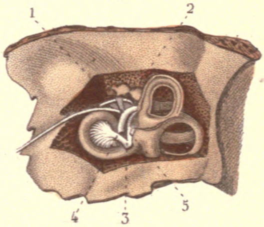


Fig. 3.



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Davesne sc.

Pl. 101.

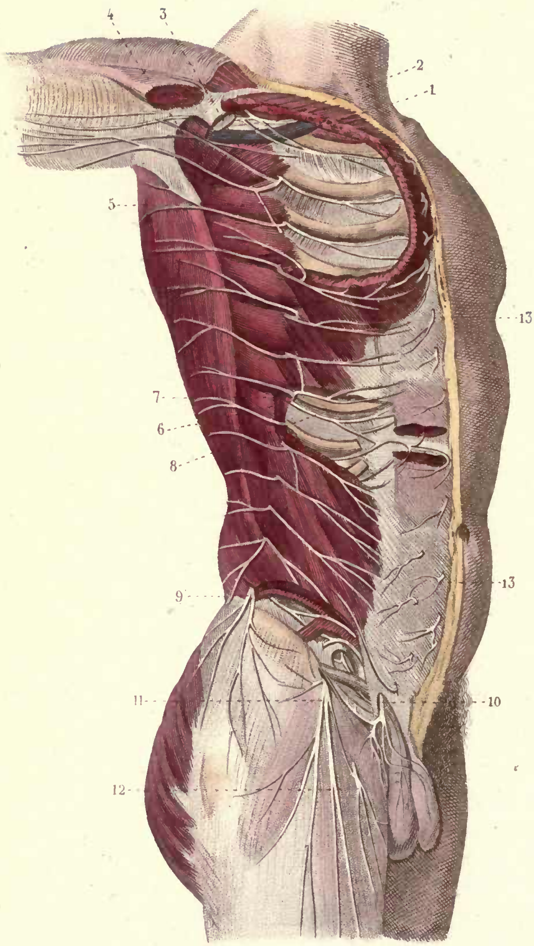

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PLATE CI.

NERVOUS SYSTEM, PLATE XVI.

INTERCOSTAL NERVES.—The pectorales, major and minor, are removed. The external oblique and the rectus abdominis are opened in places to show the distribution of the intercostal nerves.

1. Axillary vein; the artery is removed.—2. Part of brachial plexus and two of the thoracic branches.—3. First intercosto-humeral.—5. Inosculation between two intercostals.—6. Division of an intercostal nerve into,—7. A superficial and—8. A deep branch.—9. Cutaneous branch of last dorsal nerve.—10. Ilio-inguinal.—11. External cutaneous.—12. Crural branch of genito-crural.—13, 13. Muscular branches becoming cutaneous.

PLATE CII.

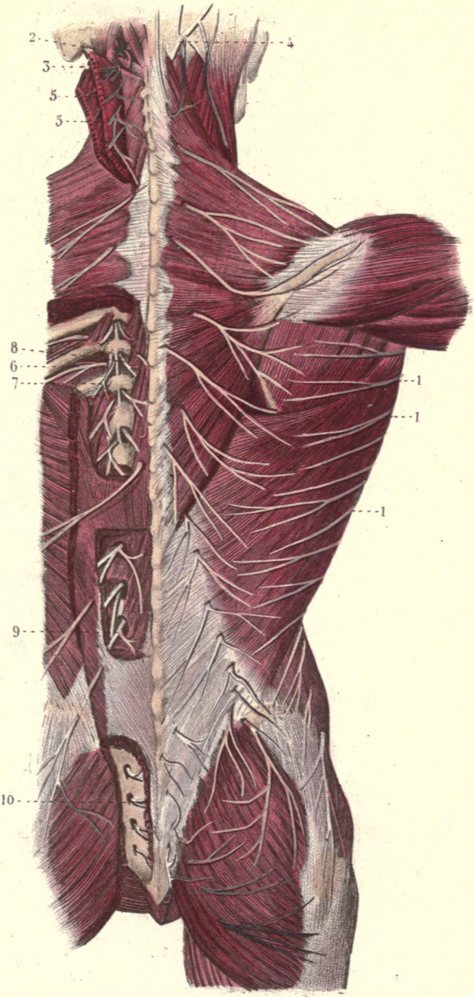
NERVOUS SYSTEM, PLATE XVII.

NERVES OF THE POSTERIOR PORTION OF THE TRUNK.

Parts of the trapezius, splenius, complexus, biventer cervicis, latissimus dorsi, glutæus maximus, etc., have been removed to display the distribution of the deep branches.

1, 1, 1. Superficial filaments of the posterior branches of the intercostals.—2. Sub-occipital (*first cervical*).—3. Great occipital.—4. Inosculation of this nerve with the lesser occipital.—5, 5. Posterior primary divisions of the cervical nerves.—6. Intercostal.—7. External branch of posterior primary division of intercostal.—8. Internal branch of the same.—9. Posterior primary divisions of the lumbar nerves.—10. Posterior primary divisions of the sacral nerves.

Pl. 102.

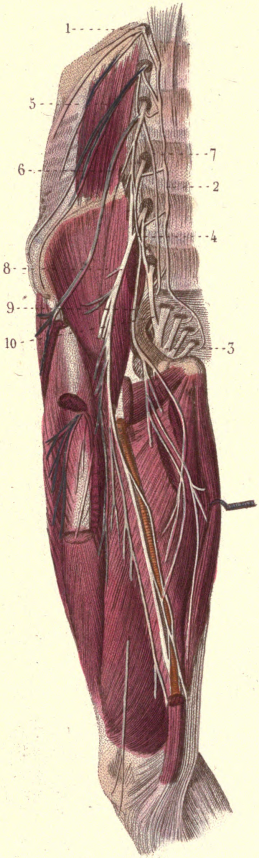


Léveillé del.

Corbié sc.

Pl. 103.

Fig. 1.



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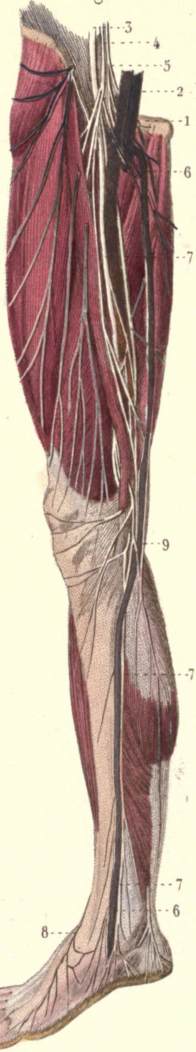


Léveillé del. *Corbié sc.*

PLATE CIII.

NERVOUS SYSTEM, PLATE XVIII.

Fig. 1. Lumbar Plexus.

1. Last dorsal.—2. Lumbar portion of sympathetic.—3. Sacral plexus.—4. Lumbar plexus.—5. Ilio-inguinal.—6. External cutaneous.—7. Genito-crural.—8. Anterior crural.—9. Obturator.—10. Lumbo-sacral.

Fig. 2. Anterior Crural and its Divisions.

1. Femoral vein.—2. Femoral artery.—3. Anterior crural nerve. 4. Middle cutaneous.—5. Branch, passing behind the sheath of the vessels supplying the pectineus.—6, 6. Internal saphenous vein.—7, 7, 7. Internal saphenous nerve.—8. Internal division of musculo-cutaneous of external popliteal.—9. Inosculation of obturator, internal saphenous, and internal cutaneous nerves.

PLATE CIV.

NERVOUS SYSTEM, PLATE XIX.

Fig. 1. The lower part of the Glutæus maximus is divided to show the lesser Sciatic Nerve.

1. External saphenous vein.—2. Cutaneous branch of small sciatic. —3. External saphenous nerve beneath the deep fascia.—4. External saphenous nerve having perforated the deep fascia, and inosculating with the ramus communicans fibularis or peronei.

Fig. 2.—1. Anterior tibial artery.—2. External popliteal nerve, dividing into,—3, 3. Musculo-cutaneous, and,—4. Anterior tibial.—5. Division of musculo-cutaneous into superficial branches, distributed to the dorsum of the foot, to the inner side of the first toe, and the adjacent sides of the second and third, and third and fourth toes.—6. Anterior tibial, dividing into two deep dorsal branches.—7. Termination of external saphenous nerve.

Fig. 3. Plantar Nerves.

1. Posterior tibial nerve, dividing into,—2. Internal plantar, and, —3. External plantar.—4. Internal plantar, dividing into four digital branches.—5. External plantar, dividing into a superficial and deep branch.

Pl. 104.

Fig. 1.

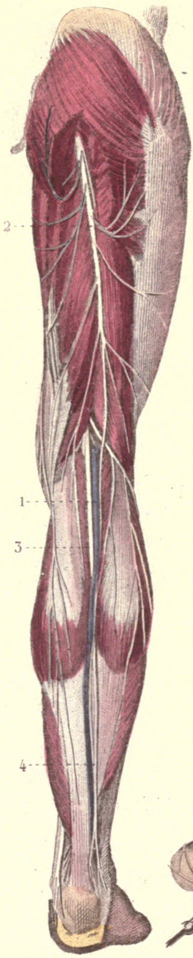


Fig. 2.

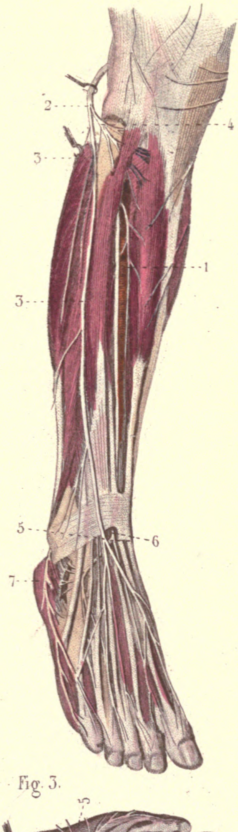
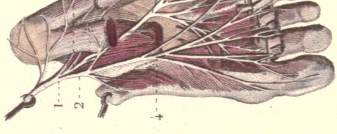


Fig. 3.



Léveillé del. *Corbié sc.*

Pl. 103.

Fig. 2.

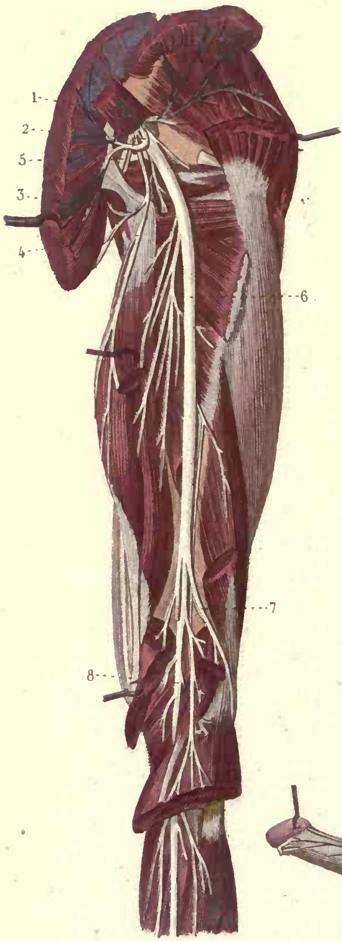


Fig. 3.

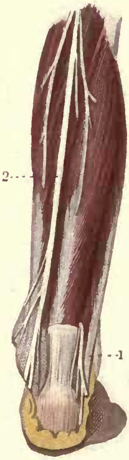
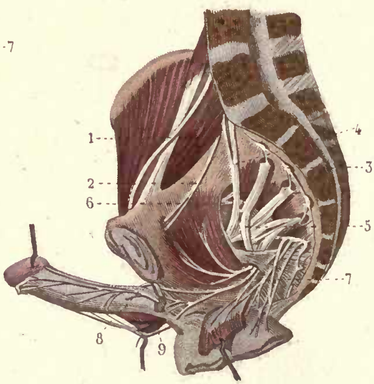


Fig. 1.



Léveillé del. *Corbié sc.*

PLATE CV.

NERVOUS SYSTEM, PLATE XX.

Fig. 1. Sacral Plexus.

The pelvis and vertebral column are divided in the mesial line, and the pelvic viscera cut and turned down.

1. Anterior crural.—2. Obturator.—3. Sacral ganglia of sympathetic, uniting with the plexus.—4. Lumbo-sacral cord.—5 and 6. Sacral plexus.—7. Internal pudic.—8. Dorsal nerve of penis.—9. Perineal nerves.

Fig. 2. Great Sciatic.

The glutæus maximus and medius, biceps, gastrocnemius, and soleus are cut and partly removed.

1. Superior gluteal. — 2. Inferior gluteal of lesser sciatic.— 3. Inferior pudendal or nerve of Sœmmering.—4. Cutaneous branch of lesser sciatic.—5. Pudic.—6. Great sciatic.—7. External popliteal.—8. Internal popliteal.

Fig. 3.—The soleus is removed.—1. External saphenous nerve, cut. —2. Posterior tibial nerve.

PLATE CVI.

NERVOUS SYSTEM, PLATE XXI.

Fig. 1. Brachial Plexus.

1 and 2. Anterior divisions of fifth and sixth cervical.—3. Cord formed by their union (*outer cord of plexus*), and dividing into,—4. Musculo-cutaneous or external cutaneous, and—5. Outer head of median.—6 and 7. Eighth cervical and first dorsal.—8. Cord formed by their union (*inner cord*), dividing into,—9. Inner branch of median.—10. Ulnar.—11. Internal cutaneous, and—12. Lesser internal cutaneous (*nerve of Wrisberg*).—13. Median nerve.—14, 14. Posterior cord (*musculo-spiral*).—15. External respiratory (*nerve of Bell*).

Fig. 2.—1. Trapezius, turned aside.—2. Rhomboidei.—3. Spinal accessory.—4, 4. Deep branches of cervical and brachial plexuses.—5. Supra-scapular.—6. Circumflex.

Fig. 3.—1, 1. Palmar digital nerves.—2. Inosculation of digital branches.

Fig. 4.—1. Dorsal digital nerves.—2, 2. Dorsal branches of palmar digital.

Fig. 5.—1. Palmar digital nerve.—2. Palmar branch sending dorsal twigs.—3. Inosculation of dorsal digital with dorsal branch of palmar digital.—4. Ungual branch of palmar digital.

Pl. 106.

Fig. 2.

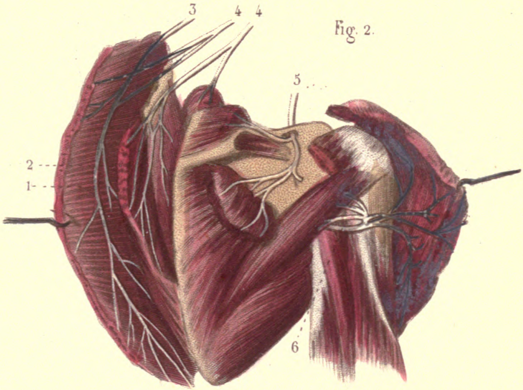


Fig. 1.

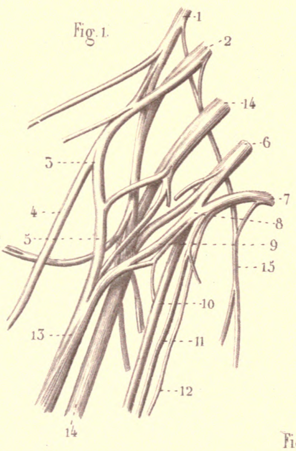


Fig. 3.

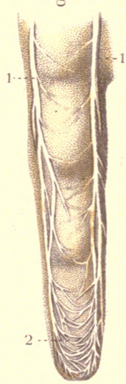


Fig. 4.

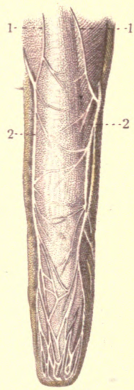
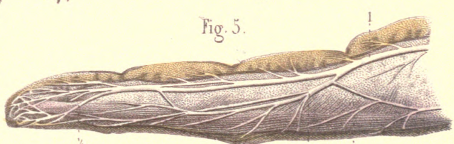


Fig. 5.



Léveillé del. *Annedouche sc.*

Pl. 107.

Fig. 1.

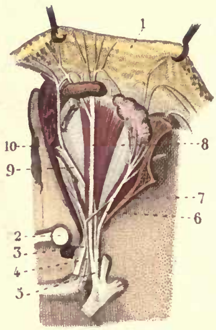


Fig. 3.

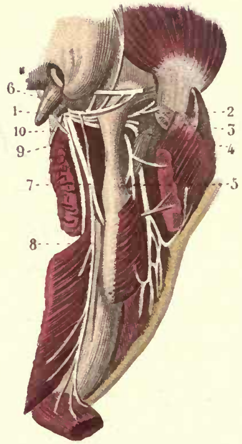
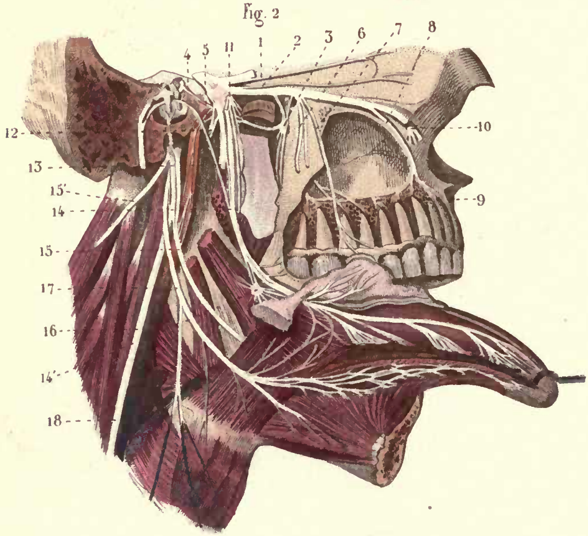


Fig. 2



Léveillé del.

Davesne sc.

PLATE CVII.

NERVOUS SYSTEM, PLATE XXII.

Fig. 1. OPHTHALMIC DIVISION OF FIFTH.

1. Skin of forehead, turned down.—2. Optic nerve.—3. Third nerve.—4. Fourth nerve.—5. Ophthalmic of fifth.—6. Lachrymal branch.—7. Union of fourth nerve with lachrymal of fifth.—8. Frontal.—9. Nasal.—10. Internal branch of nasal.

Fig. 2. SUPERIOR MAXILLARY DIVISION OF FIFTH, ETC.

1. Lachrymal branch of fifth.—2. Orbital branch of superior maxillary.—3. Meckel's, or spheno-palatine ganglion, receiving above two filaments from the superior maxillary, giving off below the palatine branches, and behind, the Vidian.—4. Greater petrosal.—5. Branch to carotid plexus from the Vidian.—6. Posterior dental.—7. Branches to the gums, etc.—8. Anterior dental.—9. Inosculation of dental branches.—10. Infra-orbital.—11. External branches of the inferior maxillary branch of fifth.—12. Auriculo-temporal.—13. Inferior dental, cut.—14. Gustatory and Chorda tympani.—14′. Sub-maxillary ganglion.—15. Glosso-pharyngeal.—15′. Spinal accessory.—16. Pneumo-gastric.—17. Hypoglossal.—18. Internal carotid artery.

Fig. 3. INFERIOR MAXILLARY BRANCH OF FIFTH.

1. Inferior maxillary nerve, emerging from the foramen ovale.—2. Temporal.—3. External pterygoid branch.—4. Buccal.—5. Masseteric. — 6. Auriculo-temporal, uniting with facial. — 7. Inferior dental.—8. Mylo-hyoid branch of inferior dental.—9. Gustatory and Chorda tympani.—10. Nerve to internal pterygoid.

PLATE CVIII.

NERVOUS SYSTEM, PLATE XXIII.

Fig. 1. POSITION OF NERVES AT BASE OF SKULL.

1. Tentorium cerebelli.—2. Branches to the tentorium.—3. Internal carotid.—4. Pituitary body and infundibulum.—5. Olfactory bulbs.—6. Optic.—7. Third, or motor oculi.—8. Fourth, or patheticus.—9. Fifth, or tri-facial.—10. Sixth, or abducens.—11. Facial, or portio dura of seventh.—12. Auditory, or portio mollis of seventh.—13. Glosso-pharyngeal of eighth.—14. Pneumo-gastric of eighth.—15. Spinal accessory of eighth.—16. Ninth, or hypoglossal.—17. Vertebral artery.—18. Foramen magnum.

Fig. 2. NERVES OF EYEBALL.

1. Outer wall of orbit.—Crista galli.—3. Cribriform plate of ethmoid.—4. Optic nerve.—5. Internal carotid artery.—6. Third nerve.—7. Its superior division.—8. Its inferior division.—9. Lenticular ganglion, showing its three roots and short ciliary branches.—10. Ciliary nerves, seen on the choroid.—11. Fifth nerve.—12. Ophthalmic division.—13. Nasal.—14. Long ciliary.—15. Division of nasal nerve.—16, 16. Sixth nerve.

Fig. 3. THIRD AND SIXTH NERVES.

1. Third nerve.—2. Its superior division, receiving a branch from the sixth.—3. Its inferior division.—4. Branch to inferior oblique muscle.—5. Sixth nerve, distributed to external rectus.

Pl. 108.

Fig. 1.

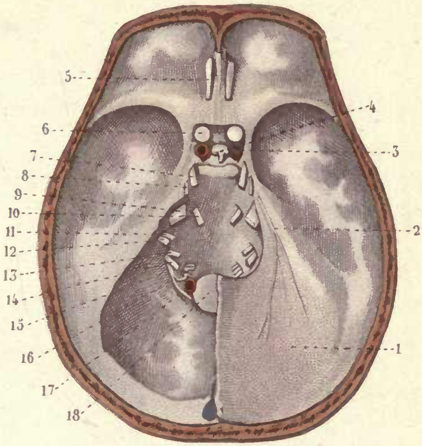


Fig. 2.

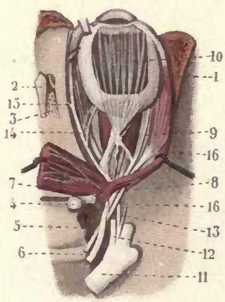
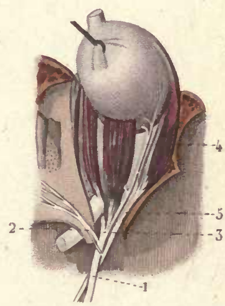


Fig. 3.



Léveillé del.

Davesne sc.

Pl. 109.

Fig. 1.

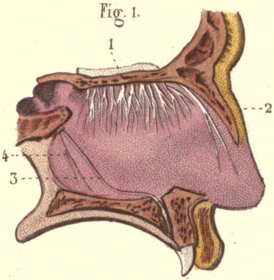


Fig. 4.

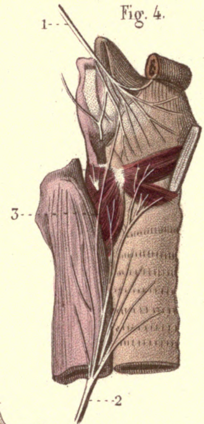


Fig. 2

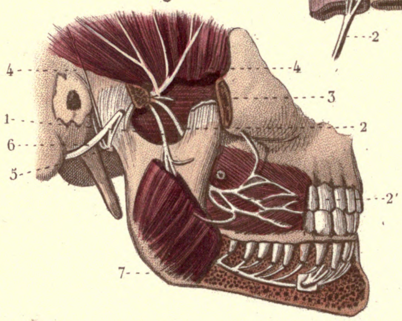
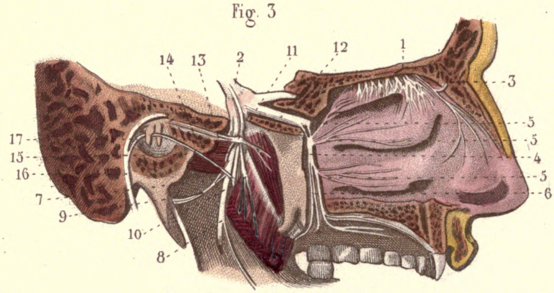


Fig. 3



Léveillé del. *Davesne sc.*

PLATE CIX.

NERVOUS SYSTEM, PLATE XXIV.

OLFACTORY NERVE.—FIFTH NERVE (*inferior maxillary division*).—LARYNGEAL NERVES.

Fig. 1. OLFACTORY, NASO-PALATINE NERVES, ETC.

1. Distribution of olfactory nerve to septum nasi.—2. Nasal branch of fifth to septum.—3. Naso-palatine (*nerve of Cotunnius*): the ganglion of Cloquet is shown in the anterior palatine foramen.—4. Other branches to the septum.

Fig. 2. INFERIOR MAXILLARY NERVE, SEEN FROM THE SIDE.

The zygomatic arch is removed.

1. Masseteric.—2. Buccal.—2′. Division of this nerve on the external surface of the buccinator.—3. External pterygoid branch.—4, 4. Deep temporal.—5. Auriculo-temporal.—6. Facial.—7. Inferior dental.

Fig. 3. OLFACTORY NERVE.—FIFTH NERVE, SEEN FROM ITS LATERAL SURFACE.—OTIC GANGLION.

1. External branches of olfactory.—2. Fifth nerve, Gasserian ganglion and branches.—3. External branch of nasal.—4. Spheno-palatine ganglion.—5, 5, 5. Nasal branch of spheno-palatine and palatine nerves.—6. Descending palatine.—7. Gustatory and Chorda tympani.—8. Inferior dental and its mylo-hyoid branch.—9. Auriculo-temporal.—10. Pterygoid branches.—11. Otic ganglion.—12. Branch of this ganglion to the Eustachian tube and tensor palati muscle.—13. Lesser petrosal nerve, uniting with the facial.—14. Branch to tensor tympani.—15. Filament to sympathetic nerve, on the middle meningeal branch of the internal maxillary artery, communicating with the auriculo-temporal.—16. Facial.—17. Chorda tympani, passing between the handle of the malleus and vertical process of the incus.

Fig. 4.—1. Superior laryngeal nerve.—2. Inferior or *recurrent* laryngeal.—3. Their inosculation.

PLATE CX.

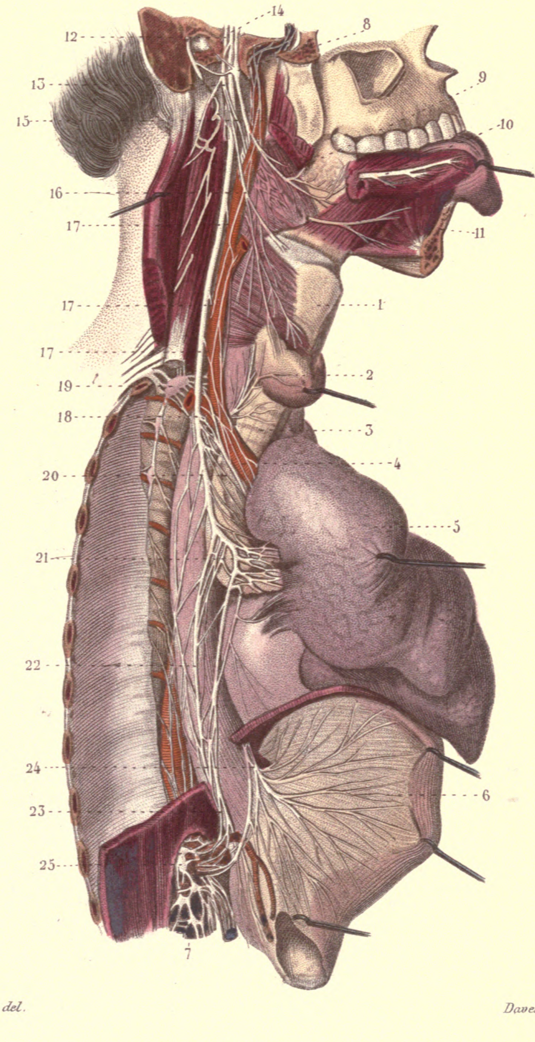
NERVOUS SYSTEM, PLATE XXV.

EIGHTH PAIR, GLOSSO-PHARYNGEAL, PNEUMO-GASTRIC, AND SPINAL ACCESSORY NERVES.

The walls of the chest are opened, the stomach and right lungs drawn forward, the internal jugular vein removed, and the jugular foramen opened and seen from the side.

1. Larynx.—2. Thyroid body.—3. Trachea.—4. Innominate artery. This vessel and its branches are shown covered with nervous plexuses. —5. Right lung.—6. Stomach.—7. Solar plexus.—8. Glosso-pharyngeal, ganglion of Andersch, Jacobson's nerve, and filament to facial.—9. Branches of glosso-pharyngeal to pharynx and base of tongue.—10. Gustatory.—11. Hypo-glossal.—12 and 13. Spinal accessory (12, *Spinal* portion, and 13, *the accessory*).—14. Vagus.—15. Pharyngeal branches, forming, with the glosso-pharyngeal and sympathetic, the pharyngeal plexus.—16. Superior laryngeal, giving off the external laryngeal to the crico-thyroid muscle.—17, 17, 17. Cardiac branches.—18. Origin of recurrent laryngeal (on the right side the nerve winds round the subclavian artery, and on the left round the arch of the aorta).—19. Inferior cervical ganglion of sympathetic.—20. Bronchial branches of vagus.—21. Pulmonary plexus, formed by the pneumo-gastric, recurrent laryngeal, and sympathetic.—22. Plexus gulæ.—23. Branch of right pneumo-gastric to the solar plexus.—24. Left pneumo-gastric, distributed to the anterior surface of stomach, and sending filaments to the solar plexus.—25. Solar plexus.

Pl. 110.



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Pl. III.

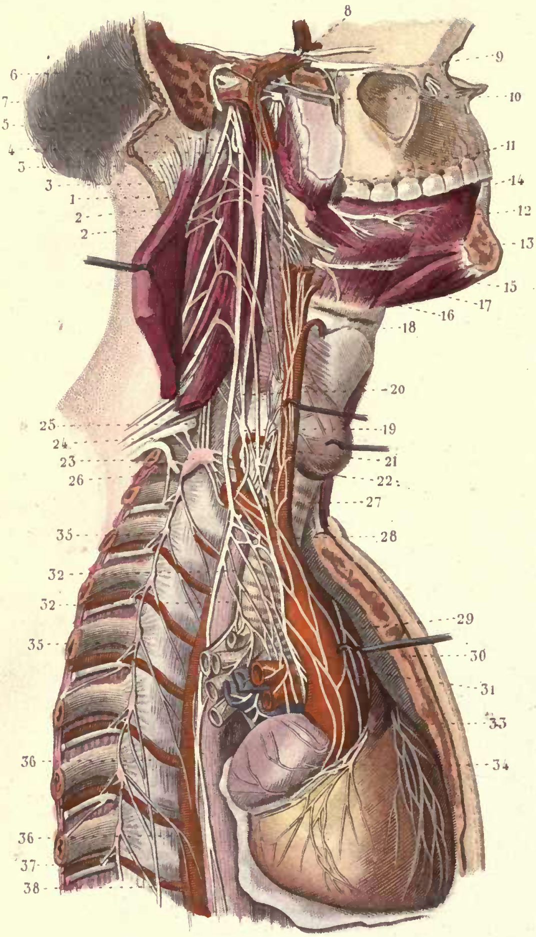

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PLATE CXI.

NERVOUS SYSTEM, PLATE XXVI.

SYMPATHETIC SYSTEM (*superior portion*).—CARDIAC NERVES AND PLEXUSES.

1. Superior cervical ganglion.—2, 2. Its connections with the spinal accessory.—3, 3. Its connections with cervical nerves.—4. Its connection with the pneumo-gastric.—5. Superior branches of the superior cervical ganglion.—6. Branch to Jacobson's nerve.—7. Branches to the otic ganglion.—8. Branches to the sixth nerve.—9. Branches to the Vidian nerve.—10. Spheno-palatine ganglion, giving off the Vidian, receiving two branches of communication from the superior maxillary nerve, and giving off palatine branches.—11. Pharyngeal and carotid branches.—12. Glosso-pharyngeal nerve.—13. Pharyngeal plexus.—14. Gustatory.—15. Hypoglossal.—16. Carotid branches.—17. Superior cardiac nerves.—18. Cardiac branch of vagus.—19. Middle cervical ganglion.—20. Superior branches of this ganglion, one continuous with the superior cervical ganglion, and the others uniting with the cervical nerves.—21. Middle cardiac nerve, arising from the inter-ganglionic cord, between the middle and inferior ganglia.—22. Inosculation of this nerve with the recurrent laryngeal.—23. Inferior cervical ganglion.—24. Inosculation with the brachial plexus.—25. Branches passing into the canal of the vertebral artery.—26. Branches inosculating with the middle cervical ganglion, passing, some in front and some behind the subclavian artery.—27. Superior cardiac nerve.—28. Union of pneumo-gastric with the cardiac nerves of sympathetic.—29. Cardiac nerves in front of aorta.—30. Cardiac nerves between the aorta and pulmonary arteries.—31. Cardiac nerves between the pulmonary artery and trachea.—32, 32. Tracheal branches of pneumo-gastric, and their inosculation with the cardiac nerves.—33. Anterior cardiac plexus.—34. Posterior cardiac plexus.—35, 35. Thoracic ganglia of sympathetic.—36, 36. Aortic branches from these ganglia.—37. Union of ganglia of sympathetic with spinal nerves.—38. Greater splanchnic.

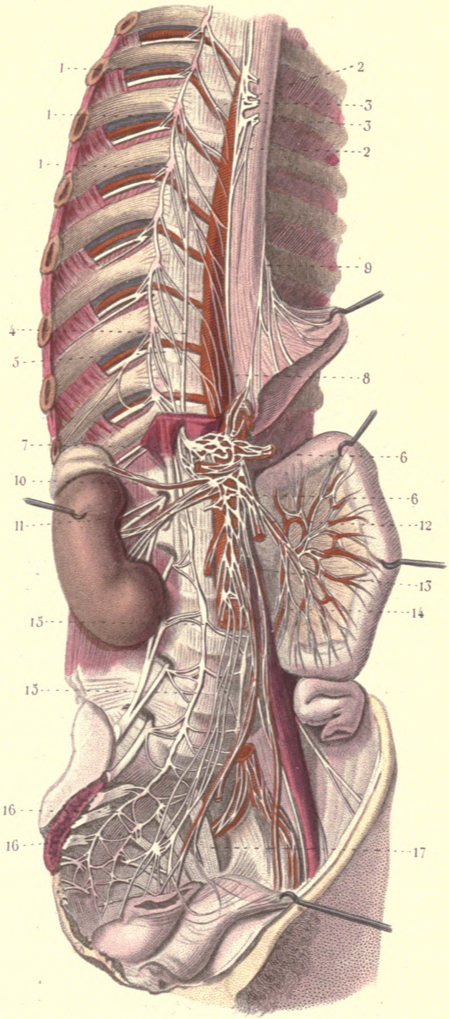
PLATE CXII.

NERVOUS SYSTEM, PLATE XXVII.

Fig. 1. SYMPATHETIC (*inferior portion*), THORACIC, LUMBAR, AND SACRAL GANGLIA.—SOLAR PLEXUS, ETC.

1, 1, 1. The thoracic ganglia of the sympathetic, and their branches of communication with the intercostals.—2, 2. Aortic branches.—3, 3. Branches of pulmonary plexus, cut, belonging to the right pneumo-gastric.—4 and 5. Greater splanchnic and lesser splanchnic.—6, 6. Solar plexus.—7. Semi-lunar ganglion.—8. Right pneumo-gastric.—9. Left pneumo-gastric, giving off branches to the anterior surface of the stomach.—10. Supra-renal plexus.—11. Renal plexus.—12. Nerves distributed to a fold of intestine.—13. Aortic plexus.—14. Spermatic plexus.—15, 15. Lumbar ganglia, showing their branches of connection with the lumbar nerves and aortic plexus.—16, 16. Sacral ganglia. These ganglia intercommunicate, and, with the sacral nerves, form plexuses which accompany the arteries of the pelvis.—17. Sacral plexus.

Pl. 112



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The Nervous System.

The nervous system is the mechanism whereby nerve-force is generated and distributed to the body.

It is divisible into two great systems, that of the cerebro-spinal and the sympathetic. The former is made up of the brain, spinal cord, cranial and spinal nerves. The sympathetic system is made up of a chain of ganglia, united by nerves, placed on each side of the vertebral column, and by branches proceeding from these ganglia to the bloodvessels and organs of the body; also plexuses. The cerebro-spinal system exhibits a central mass, by which nerve-force is originated; but the sympathetic has these masses lying diffused as separate entities along the side of the spine.

The cerebro-spinal system supplies the sense organs with their special nerves, and the muscles with powers of voluntary motion; the sympathetic system supplies vaso-motor and nutritive functions to the bloodvessels and organs of the body.

The Cerebro-spinal System.

The brain and its continuation, the spinal cord, represent the central mass of nervous tissue of this system, and the cranial and spinal nerves are the means by which their influence is distributed. The brain and spinal cord exhibit two kinds of tissue in their structure—grey and white.

The grey matter is met with on the surface of the brain, but in the spinal cord it is central. On examining the brain, however, more closely, it is seen that there are other processes of grey matter, found in quantity near the base, and collected into different masses, which are all important in the functions of the organ. The grey matter is seen, on microscopic examination, to be cellular in structure, and it is to the cells of this tissue that the power of originating nerve-force is assigned.

The white matter of the nervous system is met with in the brain in large masses, occupying, in the main, a central position; in the spinal cord, on the other hand, the white matter is external to the grey, appearing on the surface. The white matter acts as the conductor of nerve-force, the fibres of which it is composed running between different parts of the grey matter, and also proceeding into the nerve-roots.

Before proceeding to discuss the nerve-tissue itself, it is necessary to discuss the membranes of the brain and spinal cord.

The Membranes of the Brain.

The membranes or meninges are, from without inwards: the dura mater, necessary for protection; the arachnoid, a serous membrane to allow of motion without shaking; and the pia mater, the vascular covering of the brain.

The Dura Mater.—On removing the bony vault of the cranium, the dura mater is found firmly adherent to the inner aspect of the bone by thick fibrous filaments. A considerable amount of force is required to separate it from its bony connections, and after doing so the meningeal vessels are found between the bones and the membranes. The meningeal vessels are:

(*a*) In the anterior fossa: the anterior meningeals, from the anterior and posterior ethmoidal branches of the ophthalmic of each side. These are small and insignificant vessels: entering by the ethmoidal foramina, they are distributed for a short distance around the ethmoidal notch in the frontal bone.

(*b*) In the middle fossa: the middle meningeal, entering through the foramen spinosum; the small meningeal, entering by the foramen ovale; and the least meningeal, coming through the middle lacerated foramen. The middle and small meningeal come from the internal maxillary artery; the least from the ascending pharyngeal. The middle meningeal is the most important of all these: it supplies the whole of the side and vault of the cranium, grooving the squamous portion of the temporal bone slightly and the parietal bones deeply. (*See* Arteries.)

(*c*) In the posterior fossa: the meningeal vessels enter by the foramen magnum, the anterior condyloid foramen, and the jugular foramen; the trunks from which the vessels are derived being respectively, the vertebral, the occipital, and the ascending pharyngeal. The meningeal vessels supply the inner table of the skull with blood, as well as the dura mater.

The dura mater consists of an endosteal layer next the bone; a fibrous layer or dura mater proper, possessing numerous processes and sinuses for the blood; thirdly, an internal or serous layer.

The named processes are:

(*a*) The *falx cerebri*, a sickle-shaped process, with its apex at the crista-galli of the ethmoid, and its base on the tentorium cerebelli. It projects between the two hemispheres, in the longitudinal fissure of the brain. The back of the sickle is fixed along the vault of the skull to the frontal, parietal, and occipital bones; it contains the superior longitudinal sinus. The cutting edge is below, and looks towards the corpus callosum; it contains the inferior longitudinal sinus.

(*b*) The *falx cerebelli*, a triangular piece of fibrous tissue, projects between the lateral lobes of the cerebellum, with its apex at the foramen magnum, its base at the tentorium cerebelli, and with a free border in front and an attached border behind.

(*c*) The *tentorium cerebelli.* This is an horizontal piece of dura mater, separating the posterior part of the cerebrum from the cerebellum. Its attached border is external, and is fixed to the occipital, parietal, and petrous portion of the temporal bones; and in front reaches the posterior clinoid process of the sphenoid. Its free border projects between the cerebrum and cerebellum, and is attached in front to the anterior clinoid process of the sphenoid.

In intimate relation with the dura mater are small fleshy clusters of tufted appearance, the *Pacchionian* bodies. They are found at the vault, along the sides of the superior longitudinal sinus; they grow originally as villous tufts from the arachnoid, push their way outwards, carrying the dura mater in front of them, and scoop out the bone into numerous pits; they increase in number as age advances.

Formed in connection with the dura mater are the *cranial sinuses*. They run between the layers of the dura mater; they are lined internally by endothelial cells as in the veins. The sinuses are divided into three sets:

I. The POSTERIOR set is that connected with the *torcular Herophili*, or depression on inner aspect of the occipital bone. The sinuses leading towards it, are the *superior longitudinal*; the *straight*, made up of the *inferior longitudinal* and the *veins of Galen*; and the *two occipital*. The blood is carried away by the *lateral* sinuses, which leave the skull through the jugular foramina to become the internal jugular veins.

The *superior longitudinal* sinus, usually commences by a vein ascending from the nose, through the foramen cæcum of the ethmoid; gradually increasing in size, by the reception of the cerebral veins from the surface of the brain, the sinus ends behind, at the torcular Herophili. In the sinus are found: the chordæ Willisii, transverse bands of fibrous tissue which stretch across the current of the blood in the sinus; the Pacchionian bodies are frequently found protruding into the veins; and the mouths of the cerebral veins directed forwards. These peculiarities one and all are calculated to stay the too rapid passage of the blood on its way backwards.

The *inferior longitudinal* sinus is found along the free or cutting edge of the sickle-like falx cerebri; commencing near the superior sinus, it joins the straight sinus behind.

The *straight* sinus is found at the junction of the falx cerebri with the tentorium cerebelli. Into it opens anteriorly the inferior longitudinal sinus, and the veins of Galen formed in the pia matral reflection, the velum interpositum; behind, it opens into the torcular Herophili.

The *occipital* sinuses, two in number, commence on either side the foramen magnum, and ascend on the occiput to end separately at the torcular Herophili above.

The *lateral* sinuses run outwards from the torcular Herophili, grooving the arms of the occipital cross, the posterior inferior angles of the parietal bones, the mastoid processes of the temporals, and the jugular processes of the occipital bone, and finally terminate at the jugular foramina. On its way thither, each sinus is joined by the mastoid vein, the superior petrosal sinus, the vein from the aqueductus vestibuli, and the vein which (occasionally) enters by the posterior condyloid foramen.

II. The ANTERIOR sets are those connected with the *cavernous sinuses.* They are: the *ophthalmic veins*, joining in front; the *circular sinus*, surrounding the pituitary body; and the *transverse* or *basilar sinus*, crossing the back of the sphenoid, or the basilar portion of the occiput.

The *cavernous* sinus is situated on each side of the body of the sphenoid; it is bounded externally by the prolongation forwards of the tentorium cerebelli to the anterior clinoid process, and internally the internal carotid artery intervenes, between it and the cavernous groove of the sphenoid. In its outer wall run the third, fourth and ophthalmic division of the fifth cranial nerve, in order from above downwards; and internally between the sinus and the internal carotid artery, the sixth nerve runs forwards. When opened it is found to be reticulated—*i.e.*, it has fine fibrous processes stretching across its cavity, forming a lattice-work.

The *ophthalmic* vein leaves the orbit by the sphenoidal fissure between the two heads of the external rectus muscle, and enters either cavernous sinus anteriorly.

The *circular* sinus communicates at its sides with the cavernous sinuses; the parts in front and behind the pituitary body are sometimes spoken of as the anterior and posterior inter-cavernous sinuses.

The *basilar* sinus connects the back of the cavernous, or the inferior petrosal, sinuses.

III. The CONNECTING sets are on each side the *superior* and *inferior petrosal sinuses.*

Each *superior petrosal* sinus leaves the back of the cavernous sinus, runs backwards along the superior border of the petrous portion of the temporal bone, between the attachments of the tentorium cerebelli to that bone, to end behind, at the lateral sinus. Cerebral and cerebellar veins join the sinus and one special vein, issuing from the back of the petrous portion of the temporal.

The *inferior petrosal* sinus runs in the groove between the tip of the petrous portion of the temporal bone and the basilar portion of the occipital, and finally emerges through the jugular foramen, to end in the internal jugular vein. Besides others from the brain, the auditory veins join this sinus.

Beneath the dura mater is the *subdural space*, limited internally by: The ARACHNOID. The arachnoid is the serous membrane of the brain. It consists of a single sheet of membrane dividing the space between the dura mater and pia mater into two: one being superficial, the subdural; the other deep, the subarachnoid. This membrane passes from one cerebral convolution to the other without dipping into the sulci, allowing of brain movements. Beneath the arachnoid, and between it and the pia mater, is the *subarachnoid* space, containing the principal quantity of the cerebro-spinal fluid; a small quantity of fluid exists also in the subdural space.

The subarachnoid space is separated, by a wider interval at some parts than at others, from the tissues beneath it; thus, at the bottom of the longitudinal fissure it leaves a wide interval above the corpus callosum; again, at the base of the brain it stretches from the optic nerves to the middle of the pons, leaving the interpeduncular space between these two points untouched by arachnoid; so again at the interval between the medulla and cerebellum. At this latter point the subarachnoid space communicates by an opening—the foramen of Majendie—through the pia mater, with the fourth ventricle; and also at the sides of this ventricle, where the glosso-pharyngeal nerves find exit, two apertures allow of a similar communication.

The cavity of the subarachnoid presents numerous connective-tissue processes passing between the arachnoid and the pia mater.

The *pia mater* is the vascular membrane of the brain, dipping into its sulci and entering its fissures. It consists of delicate interwoven bundles of connective-tissue, lined on both sides by epitheloid cells. From its internal surface small vessels enter the brain; hence its under-surface looks flocculent when separated from the brain, and is named the *tomentum cerebri*. At the great transverse fissure of the brain (*see* below) a piece of pia mater dips in to form the velum interpositum and the choroid plexuses of the lateral and third ventricles. At the interval between the medulla and cerebellum the pia mater dips in to form the choroid plexus of the fourth ventricle.

On removing a brain, as at a post-mortem examination, the following structures would be cut through in order from before backwards. After removal of the vault of the cranium, cut through the dura mater on either side, separate the falx cerebri from the crista galli, raising it from between the hemispheres. Proceed to raise the frontal lobes, with the tracts and bulbs of the olfactory nerve adherent to them, from out of the anterior fossa. The optic nerves will now be seen entering the optic foramina, and when cut through, the trunk of the internal carotid arteries are exposed and divided. The third nerves, as they enter the roof of the cavernous sinuses, are now pulled upon and cut through. The infundibulum is seen running down to the pituitary body, which has to be dug from out the sella Turcica. The fourth nerves enter the apex of the tentorium cerebelli, and are there cut through. The knife is now run backwards through the tentorium cerebelli on either side, and the following nerves are exposed and divided: the sixth nerves, seemingly entering the basilar portion of the occiput; the fifth nerves, as they leave the brain and pass beneath the tentorium and over the apex of the petrous portion of the temporal bones; the seventh, as they enter the internal auditory meatuses; the eighth, leaving the cranium through the jugular foramina; and the ninth, as they run towards the anterior condyloid foramina. The knife is now pushed well down the spinal canal through the foramen magnum, and the spinal cord cut as low down as possible. When the cord is cut through, the trunk and branches of the vertebral arteries and the spinal accessory nerves are to be divided on either side. The brain is now turned out by passing two fingers through the foramen magnum and everting the cerebellum from its fossa.

At the base of the brain the bloodvessels first catch the eye. The vessels supplying the brain are the *internal carotid* and the *vertebral.* The former, enters the cavity of the cranium on each side through the carotid canal in the temporal bone, winds along the cavernous groove, and, forming a curve like the letter S, mounts up to end at the base of the brain at the anterior perforated spot. The latter, enters the cranium on each side between the occiput and atlas, and, passing up the side of the medulla, finally joins its fellow at the lower border of the pons varolii to form a single trunk—the basilar. The internal carotid and basilar now give off branches which unite in an anastomosing circle, the *circle of Willis.* This is formed in front by the anterior communicating and anterior cerebral; laterally, by the trunk of the internal carotid and the posterior communicating; and posteriorly, by the posterior cerebral and the bifurcation of the basilar. (*See* Arteries.)

The *anterior* cerebrals disappear in the longitudinal fissure, and supply, for the most part, the internal aspects of the hemispheres.

The *middle* cerebrals run outward in the fissure of Sylvius, embrace the island of Reil, and appearing on the outer aspect of the cerebrum supply the greater part of it.

The *posterior* cerebrals are confined almost wholly to the undersurfaces of the temporo-sphenoidal and occipital lobes. (*See* Arteries.)

The Brain.

The Cerebrum.

The cerebrum forms the upper part of the brain, covering over, in man, all the lesser brain-masses met with at the base. In outline it is ovoid or egg-shaped, the narrow pointed end of the egg being forward at the frontal bone, the broad end backwards at the occiput. The general arrangement of the nervous material is that of a central white mass, covered over by grey matter. As already explained, the grey matter is cellular, and is regarded as the originator of nerve-force. The cerebrum is cleft into two lateral masses—the *hemispheres*—by the longitudinal fissure. Each cerebral hemisphere presents: an outer convex surface, in contact with the bones of the vault and side of the cranium; an internal flattened surface looking to the opposite hemisphere, from which it is separated by a process of dura mater—the falx cerebri; an under surface, irregular and uneven, touching for the most part the bones of the base of the cranium. The frontal lobe rests in the anterior cranial fossa, the temporo-sphenoidal lobe in the middle, and the posterior lobe rests upon the tentorium cerebelli, a process of dura mater which separates it from the cerebellum. The surfaces of the hemisphere are divided on its upper and outer, inner and lower surfaces by fissures into lobes and lobules.

A. The FISSURES, sometimes called sulci, or anfractuosities, separate the cerebrum into lobes and lobules.

I. The *interhemispheric*, or great *longitudinal* fissure completely separates the hemispheres, the right from the left. On parting the margins of the longitudinal fissure, *i.e.*, the hemispheres, a broad white band, the corpus callosum, is seen at the bottom of the fissure, in front and behind which the hemispheres are seen to be quite apart. Occupying the fissure is the process of dura mater, the falx cerebri already described; it falls short of the corpus callosum in front, but behind just touches it.

II. The *interlobular* fissures divide each hemisphere into five primary regions or lobes, viz., the frontal, parietal, occipital, temporo-sphenoidal, and central or island of Reil.

(*a*) On the *outer* surface the following are found: the fissure of Rolando, the fissures of Sylvius and the parieto-occipital in part. (*b*) On the *inner* aspect, the calloso-marginal, and the parieto-occipital in part. (*c*) On the *lower* aspect, part of the Sylvian fissure.

1. The fissure of Sylvius commences at the Sylvian depression, opposite the anterior perforated spot; from hence it runs outwards between the temporo-sphenoidal and frontal lobes until it reaches the outer aspect of the cerebrum, where it divides into two, an ascending and a horizontal limb; the ascending, in length only about an inch, terminates in the substance of the frontal lobe; the horizontal limb continues backwards between the frontal and parietal lobes above, and the temporo-sphenoidal lobe below; it ends in the parietal lobe. The convolutions embraced by the limbs on the outer surface are termed collectively—the operculum. The fissure, between

the temporo-sphenoidal and frontal lobes, embraces the island of Reil.

2. The fissure of Rolando runs along the lateral aspect of the cerebrum, from near the longitudinal fissure above to near the horizontal limb of the fissure of Sylvius below. It separates the frontal from the parietal lobes, lying actually between the ascending frontal and the ascending parietal convolutions. In direction it is slightly oblique, passing from below upwards, and from before backwards. A large vein in the fœtus takes advantage of the sulcus, or the sulcus may be actually caused by it.

3. The parieto-occipital fissure is seen for about one inch on the outer aspect of the brain, separating the parietal from the occipital lobe near the posterior part of the longitudinal fissure.

It is best marked on the inner aspect of the cerebrum, and can be seen there to run, from the longitudinal fissure downwards between the quadrate and cuneate lobes, to near the corpus callosum behind.

Upon the *inner* aspect of the cerebrum are found, of inter-lobular fissures, the calloso-marginal and the parieto-occipital fissures. Before the sulci and convolutions of the inner aspect of the brain can be seen it is necessary to obtain a vertical section of the cerebrum through the corpus callosum.

4. The calloso-marginal commences beneath the corpus callosum, running first forwards, then upwards, backwards and finally upwards again, to end at the surface of the cerebrum, three-fourths of an inch behind the fissure of Rolando. As its name implies, it separates the callosal from the marginal gyrus.

5. The parieto-occipital sulcus is seen descending on the inner aspect of the hemisphere, separating the parietal and occipital lobes.

III. Of *intra-lobular* or *intergyral* sulci the following are the chief:

1. In the *frontal* lobe. (α) The orbital, or tri-radiate sulcus, is met with upon the under aspect of the frontal lobe; its limbs run—one forwards, one outwards, and a third backwards and inwards. (β) The olfactory sulcus runs parallel and about half an inch external to the longitudinal fissure; it accommodates the olfactory tract and bulb. (γ) On the outer aspect of the frontal lobe two sulci separate the horizontal lobes, and one perpendicular sulcus separates the horizontal convolutions in front, from the ascending frontal convolution behind them.

2. The *parietal* lobe exhibits: (α) The intra-parietal sulcus; it commences at the anterior inferior angle of the lobe, and runs upwards, at first behind the ascending parietal convolution, then turns horizontally backwards, dividing the superior from the inferior parietal lobules; it frequently extends into the occipital lobe.

3. The *occipital* lobe: (α) Upon the outer aspect two sulci separate the three horizontal convolutions. (β) Upon the inner aspect is seen the calcarine fissure; this fissure extends, from near the posterior extremity of the cerebrum, forwards in a curved line to join the parieto-occipital fissure; its depression causes the projection of the hippocampus minor in the posterior cerebral cornu.

4. The *temporo-sphenoidal* lobe exhibits sulci and convolutions on both its external and internal aspects. (α) On the external aspect, the temporo-sphenoidal presents three sulci, superior, middle, and inferior. They separate the convolutions of the outer aspect of the temporo-sphenoidal lobe. The superior, from the fact of its running parallel to the horizontal limb of the fissure of Sylvius, is named the parallel sulcus. (β) Upon the inner aspect of the temporo-sphenoidal lobe, a fissure separates the superior from the inferior occipito-temporal convolutions. It is named the collateral fissure, and runs parallel to and below the level of the dentate fissure.

IV. *Special fissures.* (α) The dentate, or hippocampal fissure, commences near the posterior extremity of the gyrus fornicatus; it is met with near the transverse fissure of the brain in the descending cornu of the lateral cerebral ventricle; it dips in beneath the fascia dentata and causes the elevation of the hippocampus major. Terminally, it ends beneath the uncinate convolution.

(β) The transverse fissure of the brain extends between the mass of the cerebrum above, and the structures met with in the base of the brain. It is caused by the backward growth of the cerebral hemispheres during development, which, as they advance in succession over the optic thalami, corpora quadrigemina and cerebellum, enclose a piece of pia mater—the velum interpositum and the choroid plexuses. The transverse fissure is seen to extend from the apex of one descending cornu across the middle line to the apex of the descending cornu of the opposite side. The developing cerebrum, as it advances backwards, descends upon the outer side of the crura cerebri; here a solution of continuity takes place, and the cavity of each ventricle is opened at the spot where the cerebral mass is applied to the crura. At the gap or fissure so created, the choroid vessels enter from the base of the brain, and join the choroid plexus of the descending cornu of the lateral ventricle. That is to say, the apex of the descending cornu is open, and the opening is the commencement of the transverse fissure. The fissure is bounded on either side above, by the optic thalami, and in the middle line by the corpus callosum and fornix.

B. The LOBES and CONVOLUTIONS of the cerebrum.

The *Lobes* are divided from each other by the interlobular fissures mentioned above. They are the frontal, parietal, occipital, temporo-sphenoidal, and the central or island of Reil. The first three-named correspond, more or less, to the bones covering them and after which they are named; the temporo-sphenoidal fills the middle fossa of the skull, and the central lobe, or island of Reil, is met with in the Sylvian fissure.

The *convolutions*, or *gyri*, are divided from each other by the intra-lobular fissures, and are described shortly with the different lobes to which they belong.

1. The *frontal lobe* is bounded below by the fissure of Sylvius; above, by the longitudinal fissure; and behind, by the fissure of Rolando. It presents, anteriorly, three gyri or *convolutions* placed horizontally one above the other, and named *superior*, *middle*, and *inferior frontal gyri.* Behind these, and parallel to, and in front of, the fissure of Rolando, is the *ascending frontal convolution.* The under surface of the frontal lobe, the orbital surface, presents a tri-radiate sulcus with limbs extending forwards, outwards, and backwards, separating the inner, anterior, and posterior or outer gyri of the orbital surface, one from the other; on the inner gyrus the olfactory tract and bulb lie in the olfactory sulcus.

2. The *parietal lobe* is bounded below by the fissure of Sylvius; above, by the longitudinal fissure; in front, by the fissure of Rolando; and behind, by the parieto-occipital fissure, and an imaginary line drawn from thence to the end of the fissure of Sylvius. The *ascending parietal* convolution runs parallel to the fissure of Rolando, which extends along the whole length of the lobe. Behind this convolution the intra-parietal sulcus extends at first perpendicularly, and then turns nearly horizontally backwards. Above the horizontal part is the *superior parietal lobule;* and below, the *inferior parietal lobule,* in which the fissure of Sylvius ends, subdividing it into the *supra-marginal* gyrus above and in front of its extremity, and the *angular* gyrus behind it.

3. The *occipital lobe,* pyramidal in shape, is bounded above by the longitudinal fissure; in front, by the parieto-occipital fissure and by a line drawn from this to the præoccipital notch. It has three prominent gyri—a *superior*, *middle*, and *inferior*, separated by two furrows. *Annectant* gyri, four in number, connect the occipital convolutions with the parietal lobe above, and the temporo-sphenoidal below; two going to each lobe.

4. The *temporo-sphenoidal* lobe projects downwards as a large lateral lump on either side of the under surface of the cerebrum. It is bounded *above* by the horizontal limb of the fissure of Sylvius; *behind,* it is continuous with the occipital lobe by the two lower annectant gyri, and with the angular gyrus of the parietal lobe; in *front,* its rounded end projects downwards into the middle fossa of the skull.

It presents two aspects, an external and internal. (*a*) The external or lateral aspect has upon it the *temporo-sphenoidal convolutions*, the *superior*, *middle*, and *inferior* lying parallel to each other and to the fissure of Sylvius above. The fissure separating the superior and middle has been already described as the parallel fissure.

(*b*) Upon the inner or under aspect are the *occipito-temporal convolutions*, *superior* and *inferior*, separated by the collateral fissure. The superior or uncinate convolution presents at its anterior extremity a sharp bend, and ends in a hook-like process or uncus. Above the superior convolution runs the hippocampal or dentate fissure, which ends in front beneath the uncus; behind, the convolution is continuous with the gyrus fornicatus and the occipital lobe. The inferior likewise is continuous behind with the occipital lobe.

5. The *central lobe*, *or island of Reil*. On separating the apex of the temporo-sphenoidal lobe from the frontal lobe, a group of convolutions in the Sylvian fissure are come upon, called the central lobe, island of Reil, or insula. It is bounded by sulci, anterior, posterior, and external, and presents five or six convolutions which radiate from the inner end of the body; they are named the *gyri operti*. The island of Reil has immediately above it the lenticular nucleus of the corpus striatum.

There are specially named *lobules* of the cerebrum viz.: (*a*) The *operculum* (Broca) is the name given to the group of convolutions immediately above the horizontal, and behind the ascending limb of the fissure of Sylvius; it is formed by the lower parts of the ascending frontal and parietal convolutions, and by part of the inferior frontal convolution. (*b*) The *quadrate* lobule, or præcuneus, is met with on the inner aspect of the parietal lobe; it is bounded—in *front*, by the calloso-marginal fissure; *behind*, by the parieto-occipital fissure; and reaches from the margin of the brain above, downwards towards the corpus callosum, where it is continuous with the gyrus fornicatus. (*c*) The *cuneate* lobule is met with behind the præcuneus on the inner aspect of the occipital lobe. It is wedge-shaped, as its name implies, with its apex forwards about an inch posterior to the corpus callosum, and with its base at the margin of the brain above; in *front*, is the parieto-occipital fissure; *behind* and *below*, the calcarine.

The special *convolutions* met with are: (*a*) The *marginal* convolution lies on the inner aspect of the cerebral hemisphere. It commences below at the anterior perforated spot, and follows the margin of the longitudinal fissure right round the anterior and superior aspects, reaching as far back as the spot where the calloso-marginal fissure attains the surface of the brain at the longitudinal fissure. (*b*) The *gyrus fornicatus* commences on the under surface of the brain at the anterior perforated spot, and extending around the anterior end of the corpus callosum runs parallel to it, and finally bending round its posterior extremity, becomes continuous with the uncinate gyrus. (*c*) The *dentate* convolution is met with at the inner aspect of the descending cornu of the lateral ventricle. At that spot is seen the dentate fissure, with the dentate convolution above and the corpus fimbriatum above that again. The dentate appearance is caused by the entrance of the choroid vessels at the apex of the descending cornu (*i.e.*, the transverse fissure) on their way to the choroid plexuses. (*d*) The *lingual* lobe is the name given to the mass immediately below the calcarine fissure on the inner aspect of the occipital lobe. (*e*) The *limbic* lobe is a name assigned to the gyrus fornicatus and its continuation.

The VENTRICLES of the brain are five in number.

The LATERAL VENTRICLES (first and second) are exposed by removing the brain-substance layer after layer, until the ventricles are reached. The arrangement of the brain-tissue will be seen during the slicing operation to consist of a layer of grey matter on the surface and white within, and to present on either side a white mass of brain-matter uninterrupted by grey. This has been named the *centrum ovale minus*, and when the incisions on the two sides have reached the level of the corpus callosum, the white masses on each side are seen to be connected by the white corpus callosum, when the whole is named the *centrum ovale majus*.

The lateral ventricles are exactly alike.

The boundaries are: the *roof* is formed by the corpus callosum; the *floor* is formed from before backwards by the (α) corpus striatum, a large rounded grey mass; (β) the tænia semicircularis, a band of white nerve-tissue; (γ) the optic thalamus, a mass of grey matter limited behind by (δ) the choroid plexus—a vascular fringe of villous tufts; (ε) the edge of the fornix, a couple of tape-like bands of white nerve-tissue uniting centrally to form the body, but parting front and back to form the anterior and posterior pillars—the anterior descend to form the corpora albicantia, and the posterior, the tæniæ hippocampi or corpora fimbriata, which pass down into the descending cornua with each hippocampus major; (ζ) the eminentia collateralis, a nervous eminence at the top of the descending cornu; (η) and the hippocampus minor, a projection in the floor of the posterior cornu. The *inner wall* is formed by the septum lucidum, which serves as a partition between the two ventricles, and between the two layers of which is the FIFTH VENTRICLE.

The lateral ventricles have three *cornua*—an anterior, posterior, and a descending. The *anterior* passes forwards and outwards; the *posterior*, backwards and inwards; and the *descending*, backwards, outwards, downwards, forwards, and inwards, curling round the crus cerebri. Each descending cornu presents:—on its floor, the hippocampus major, the tænia hippocampi, the choroid plexus and the fascia dentata; on its roof, is found the optic thalamus; and into its apex come the choroidal vessels, to enter the choroid plexus.

On removing the corpus callosum, the septum lucidum will be found connected with its under surface. On raising the fornix, the *velum interpositum* is seen. It consists of a reflexion of the pia mater containing in its substance the veins of Galen going back to join the straight sinus; it has at its sides the choroid plexuses—vascular fringes from which the ventricular fluid is secreted.

The THIRD VENTRICLE is exposed on raising the velum interpositum. The *roof* is formed by the velum interpositum; the *floor*, by the structures in the interpeduncular space, viz., the lamina cinerea, the tuber cinereum, the corpora albicantia and the posterior perforated space. The *sides* are formed by the optic thalami. In the ventricle are seen the anterior, middle, and posterior *commissures*. The *anterior* passes through the corpus striatum, and the *posterior* through the optic thalamus, to join the brain-tissue beyond; the *middle* commissure unites only the grey matter lining the optic thalami. The third ventricle *communicates* in front with the lateral ventricles through the *foramina of Monro*, and behind through the *aqueduct of Sylvius*, or *iter e tertio ad quartum ventriculum*, with the fourth ventricle. The aqueduct of Sylvius has above it the corpora quadrigemina, and below the crura cerebri. Through the foramina of Monro processes of the choroid plexus pass from ventricle to ventricle.

The FOURTH VENTRICLE is bounded *below and in front* by the back parts of the pons and medulla oblongata; *above*, by the cerebellum; and *behind*, by a reflexion of arachnoid passing from the cerebellum to the medulla.

The *sides* are formed by *peduncles*, named, from their position, superior, middle, and inferior; or from the parts they run between, processus e cerebello ad testes, processus ad pontem—*i.e.*, the pons Varolii itself, and the processus e cerebello ad medullam.

These names explain themselves. The result is a diamond-shaped space, with important functions and relations, inasmuch as most of the cerebral nerves proceed from its floor. The *roof* is formed by the valve of Vieussens and the inferior vermiform process of the cerebellum. The valve of Vieussens stretches between the superior peduncles; the inferior surface of the vermiform process shows from before backwards, the nodule, uvula, and pyramid. The *floor* of the ventricle shows a groove or furrow in its centre, continuous below with the central canal of spinal cord, and above with the aqueduct of Sylvius. On either side exists a ridge, the *fasciculus teres*, and again externally to that, and on either side, from above downwards, are to be seen the *locus cœruleus*, the *fovea anterior*, the *transverse striæ of the auditory nerve*, and the *fovea posterior*. Towards the lower end are to be seen small round elevations, which, as they correspond to nuclei of origin of cranial nerves, have to be considered more closely. To the floor of the fourth ventricle, six out of the nine cranial nerves are traced to their nuclear origin. The nuclei of some cause slight elevations on the floor, and it is these which are chiefly of importance.

The FIFTH VENTRICLE is found in the middle line of the brain between the two layers of the septum lucidum. It is bounded above and in front by the corpus callosum ; below and behind, by the fornix. Posteriorly it is narrow and pointed, but in front it is in depth about three-quarters of an inch.

The various *masses* met with at the BASE of the brain are : the under surface of the frontal and temporo-sphenoidal lobes, pons Varolii, medulla oblongata, and cerebellum. The parts which occupy the *middle line* are : from before backwards: part of longitudinal fissure, lamina cinerea, optic commissure, tuber cinereum, infundibulum, pituitary body, corpora albicantia, and the posterior perforated spot.

On *either side of the middle line* are found : the olfactory tract and lobe, fissure of Sylvius, anterior perforated spot, optic tract, crus cerebri, from the inner side of which the third nerve is seen to emerge, and over which the fourth nerve curves ; the motor and sensory roots of fifth nerve, appearing from the substance of the pons at its lateral aspect ; the sixth nerve at the point of junction of the pons and medulla. Behind all these lie the medulla and the structures connected therewith.

The CRURA CEREBRI, or the peduncles of the cerebrum, emerge from the pons, and, separating as they ascend, disappear in either hemisphere. On section they show a grey mass, the *locus niger* in the centre, with a bundle of white fibres below—the crusta, or fasciculated portion, and a bundle of fibres above—the tegmentum. The *crusta* is composed of the longitudinal fibres from the anterior parts of the medulla and pons on their way to the corpus striatum ; the *tegmentum* is composed of fibres arising from the grey matter of the medulla, pons, and cerebellum on their way to the optic thalami. Each crusta is quite distinct one from another, but the tegmenta have between them a median raphé.

Between the diverging peduncles is the *interpeduncular space* at the base of the cerebrum, already described. The parts met with are : from before backwards, the lamina cinerea, the tuber cinereum, the infundibulum and pituitary body, the corpora albicantia, and the posterior perforated spot. On the inner aspect of each crus the third nerve appears from a groove—the oculo motor sulcus, which serves to indicate the separation between the crusta below and the tegmentum above; at the sulcus the locus niger comes to the surface of the crus.

The structures met with at the base of the cerebrum are as follows :

The *tuber cinereum* is met with immediately behind the optic commissure, and in front of the corpora albicantia as a grey swelling. It is prolonged as a hollow funnel-shaped process, the *infundibulum*, to join the posterior lobe of the pituitary body. Its upper surface appears in the floor of the third ventricle.

The *pituitary body*, the hypophysis cerebri, occupies the sella turcica of the sphenoid. It is found protruding at the base of the brain in front of the tuber cinereum. It consists of two lobes—an anterior, concave behind, and a posterior globular; the posterior is connected by a stalk of brain-tissue, the infundibulum, with the tuber cinereum. This body is a sort of counterpart to the pineal gland, the former being situated below, and the latter above the third ventricle.

Both the pineal and pituitary bodies are very vascular, and may be classed with the vascular or ductless glands. The main mass of each body is composed of connective-tissue, the recesses in the pineal body being filled with brain-sand. (See pineal body.)

The *lamina cinerea* is a sheet of grey matter prolonged forwards from the tuber cinereum, underneath the optic commissure. It extends forwards and upwards, closing in the gap between the diverging peduncles of the corpus callosum in front, and also forming part of the floor of the third ventricle.

The *corpora albicantia* are two small round white masses immediately behind the tuber cinereum, one on each side of the middle line. They are formed by the inferior extremities of the anterior pillars of the fornix; hence they are called the bulbs of the fornix. The two pea-like bodies are united.

The *anterior perforated spots*, or spaces, are situated externally to the optic commissure, and opposite the commencement of the Sylvian fissure on each side. The internal carotid artery reaches the base of the brain at this spot, and from it and its branches vessels proceed upwards through the space in question to the corpus striatum. The perforations, therefore, are caused by the vessels on their way to the corpus striatum.

The *posterior perforated spot*, the locus perforatus posticus, is a piece of brain-tissue perforated by numerous bloodvessels on their way to the optic thalami. It is situated in a deep depression between the cerebral peduncles and behind the corpora albicantia.

The olfactory tract and bulb, and the optic tract and commissure, are all described with the cranial nerves.

The GREY MASSES met with during the dissection of the cerebrum are as follows:

The CORPORA STRIATA are two masses of grey matter met with on either side of the cerebrum, near its under surface. Each corpus striatum is seen to project into the floor of the lateral ventricle and to bulge forwards towards the anterior cornu. It lies in front of the optic thalamus, the separation presenting a groove occupied by the tænia semicircularis in the floor of the ventricle. In size about that of a pigeon's egg, and grey in colour, it receives the fibres of the crusta of the crus cerebri below, and above it gives out the white fibres of the corona radiata. The continuity of these fibres is made apparent on a perpendicular section taken through the corpus striatum. Above the white fibres the grey mass is kite-shaped, termed the caudate or intra-ventricular nucleus; below the fibres, it is lens-shaped, termed the lenticular or extra-ventricular nucleus.

The *nucleus caudatus* appears in the floor of the lateral ventricle; it is pyriform or kite-shaped, with its larger end forwards, and its narrow posterior end apparently pushed outwards by the intervening optic thalamus.

The *nucleus lenticularis*, or extra-ventricular portion, is found in the cerebral substance immediately external to the caudate nucleus and above the level of the island of Reil. On horizontal section it is seen to be biconvex; but by a transverse vertical section it appears triangular with its apex inwards. Its outer part or base is intersected by two white striæ, dividing the whole nucleus into three zones. Below the lenticular nucleus lies the grey sheet, the *claustrum*, which separates the nucleus from the island of Reil below. Part of the lenticular nucleus appears at the base of the brain at the anterior perforated spot.

The OPTIC THALAMUS is situated behind, but on a plane internal to, each corpus striatum. In size and colour it simulates the corpus striatum. The *upper* surface is only partly seen in the floor of the lateral ventricle, being covered at its posterior part by the fornix, the velum interpositum, and the choroid plexus. It is indented by the choroid plexus and fornix; the swellings in front and behind are called the *anterior* and *posterior tubercles* respectively. *Below and internally* the fibres of the tegmentum of the crus cerebri enter it; *externally* the fibres of the crusta separate it from the lenticular nucleus of the corpus striatum; *posteriorly* the optic thalamus bulges backwards into the roof of the descending cornu of the lateral ventricle; *internally* the two masses face each other, enclosing the third ventricle between them.

On section the optic thalamus shows an S-shaped thin white partition placed vertically, on the outer and inner sides of which are placed the *outer* and *inner nuclei* of grey matter. A small piece is cut off from the inner by a further white, nearly horizontal partition; the part so cut off is termed the *anterior nucleus*. The inner nucleus of each optic thalamus is united to its fellow by the middle, or grey commissure of the third ventricle.

The *pineal body*, or conarium, is situated upon and between the nates, and beneath the posterior part of the corpus callosum, where it is adherent to the under surface of the velum interpositum. It is reddish in appearance, conical or fir-cone shaped, about the size of a cherry-stone, and attached by peduncles to the parts in front and below. The front band of the peduncle runs forwards, from the anterior part or base along the side of the optic thalamus, as far as the corpora albicantia; the posterior band disappears in the posterior commissure of the third ventricle. In it a quantity of gritty matter, acervulus cerebri (brain-sand), composed mostly of the phosphate and the carbonate of lime, can be made out by the finger and thumb. Beneath the pineal gland is a mass of grey matter, the ganglion of the pineal gland—the tubercula. Its fibres join the neighbouring nervous masses.

The *corpora quadrigemina* are a group of four small masses of grey brain-substance covered by white, situated immediately above the Sylvian aqueduct. The two anterior, or *nates*, receive between them the pineal gland; they are continuous with the optic tract in both an anatomical and developmental sense. The two posterior, or *testes*, have but little to do with the optic tract; they are slightly more prominent and lighter in colour than the anterior. Laterally each anterior and posterior body is continued into a white tract—the brachium. That from either nates, the *anterior brachium*, is continued into the optic tract, passing between the inner geniculate body below, and the posterior part of the optic thalamus and the outer geniculate body above. The brachium from either testes, the *posterior brachium*, is lost in the inner geniculate body.

The *corpora geniculata* are four bodies, two on either side, placed just external to the corpora quadrigemina, and at the posterior part of the junction of the optic thalami and the crura cerebri. Between either inner and outer geniculate bodies is one of the roots of the optic tract; the outer body being placed above, the inner below the level of the same.

The CEREBRAL COMMISSURES are the means whereby the opposite sides of the brain are united.

Of the commissures, the most important are the corpus callosum and the commissures of the third ventricle.

I. The CORPUS CALLOSUM is the main means by which the hemispheres of the cerebrum are connected. Seen from above, it consists of a mass of white tissue, the fibres of which are distinctly transverse. It is nearer the anterior than the posterior part of the brain, and taking its position into consideration, it stands to reason that it is thinner in the centre than at either end, and thicker behind than in front. On its surface various longitudinal bands are seen: a median raphé centrally, on either side the nerves of Lancisi and outside these again the lateral longitudinal striæ. In front it forms a bend, the *genu*, which is continued down as a narrow ridge, or *rostrum*, and below its parts separate to form the peduncles, which run outwards to the anterior perforated spot on either side, enclosing between them the lamina cinerea. These are really the continuation of the mesial striæ. Behind, the corpus callosum forms a thickened border or *splenium*, the under surface of which fills up the gap between the posterior pillars of the fornix. From the under surface of the corpus callosum, the septum lucidum projects, and the fornix touches it.

II. In the third ventricle are seen the anterior, middle, and posterior commissures. The *anterior* commissure lies in front of the anterior pillars of the fornix; its fibres, white in appearance, pass below the corpus striatum to enter the central lobe of either hemisphere. The *middle* commissure is broad and grey; it unites the inner nuclei of the optic thalami. The *posterior* commissure lies immediately in front of the nates and above the anterior opening of the Sylvian fissure at the back of the third ventricle. Its fibres, white in appearance, connect the optic thalami and the crura cerebri with the optic thalami of the opposite sides.

The LONGITUDINAL OR COLLATERAL FIBRES are those which connect the different parts of a hemisphere, keeping to the same side of the mesial line. They are as follows:

I. The *fornix* consists of two flattened bands of white nervous tissue, the borders of which appear in the floor of either lateral ventricle. The two bands approach each other in the centre, but in front and behind they diverge to form the anterior and posterior pillars respectively. The central portion, where the bands touch each other, is called the *body* of the fornix; it is triangular in shape, with its base backwards and its apex forwards; at the base are the transverse fibres from the corpus callosum forming the *lyra Germanica*. The margins are in contact with the choroid plexuses of the lateral ventricles; the upper surface has attached to it in the mesial line, the septum lucidum, and the corpus callosum touches it behind; its under surface rests on the velum interpositum which intervenes between it and the third ventricle.

The *anterior pillars* of the fornix pass downwards and forwards as two rounded bundles to reach the corpora albicantia. Each pillar lies at first on the optic thalamus, but afterwards it leaves a gap, the foramen of Monro, between it and that body, of which it is the anterior boundary. In the corpora albicantia the fibres are twisted, and from thence they pass upwards and outwards into the optic thalami.

The *posterior* pillars of the fornix pass downwards and backwards from the body of the fornix as two flat bands. Reaching the upper end of the descending cornu, each pillar gives off fibres to the upper end of the hippocampus major, whilst the main tract is continued along the concavity of the hippocampus major, as the *tænia hippocampi* or *corpus fimbriatum*, reaching as low as the pes hippocampi; it is placed immediately above the fascia dentata, the former being the free edge of the white, the latter the free edge of the grey matter.

II. The *tænia semicircularis* is found in the floor of the lateral ventricle as a narrow white band lying between the corpus striatum and the optic thalamus. It commences in the roof of the descending cornu of the lateral ventricle and ends in the anterior pillar of the fornix.

III. The *striæ longitudinales* were described with the corpus callosum.

IV. The fibres of the *gyrus fornicatus* run from the anterior perforated spot on the base of the brain, around the genu of the corpus callosum, and pass backwards above the upper surface, and round the posterior border of the corpus callosum, to end in the temporo-sphenoidal lobe.

V. The *uncinate fasciculus* passes from the under surface of the frontal lobe, to the upper surface of the temporo-sphenoidal lobe across the bottom of the Sylvian fissure. Likewise the temporo-sphenoidal and occipital lobes are considered to be specially united by a band, the *inferior longitudinal fasciculus*, existing in the brain-tissue at the junction of the descending and posterior cornu of the lateral ventricle. *Association fibres* is the name given to these white fibres which connect individual convolutions.

The Cerebellum.

The Cerebellum, little brain, or hinder brain, occupies the posterior fossa of the skull; it is wholly overlapped by the cerebrum, from the occipital lobes of which it is separated by the tentorium cerebelli. It measures in its greatest breadth three and a half inches; in width, two and a half inches; and in depth, two inches.

The cerebellum consists of two lateral masses joined by a median or vermiform process. Taken as a whole, it presents an upper and lower surface, with various fissures and convolutions.

The *upper surface* presents, in the median line, the upper aspect of the *vermiform process*, appearing as an elevated ridge and exhibiting various folia. The anterior group of eight folia is called the central lobe. Laterally are found the antero-superior or quadrate, and the postero-superior lobes, separated about two-thirds of the way back by a deep sulcus. Posteriorly the surface is limited by the deep horizontal sulcus, which runs round the posterior border of the cerebellum, dividing the upper from the under surface.

The *under surface* shows a depression in the median line, the *vallecula.* At the bottom of the depression the inferior vermiform process is found exhibiting projections of brain-matter, which are named respectively the nodule, uvula, and pyramid, from before backwards. Laterally are the five named lobes of the under surface: (1) The flocculus or pneumogastric lobule, and (2) the amygdala, or tonsil-like lobule, are found on either side of the vallecula; the flocculus in front. The flocculus is connected with the nodule by the *inferior medullary velum*, and the amygdala with the uvula by the *furrowed band.* (3) The biventral lobe. (4) The slender lobe; and (5) the posterior inferior lobe, are found in the order mentioned from before backwards upon the under surface.

On section the cerebellum is seen to consist of lamina or folia of grey and white matter; vertical sections of the cerebellum presenting an arborescent appearance, named the *arbor vitæ.* In the centre is the white matter, in which is situated the corpus dentatum, a wavy band of grey matter enclosing white nerve-tissue. The corpus dentatum is open in front, and from it fibres proceed to the superior peduncles. The cerebellum is connected to the spinal cord below and to the cerebrum above, by the inferior and superior peduncles respectively, and the two lateral halves of the cerebellum are joined by the middle peduncle—the pons varolii.

The *superior peduncles*, processus e cerebello ad testes, or crura ad cerebrum, run upwards from the centre of the white tissue of the cerebellum disappearing underneath the corpora quadrigemina. They limit the fourth ventricle laterally at the upper part, and just at their upper ending actually form the roof of that ventricle. Between the two crura is the piece of brain-tissue called the valve of Vieussens, or the *superior medullary velum.*

2. The *middle* peduncles, the crura, or processus ad pontem, constitute the transverse fibres of the pons or commissure of the cerebellum.

3. The *inferior* peduncles, processus e cerebello ad medullam, or crura ad medullam, run downwards, to join the restiform bodies; they limit the fourth ventricle below and at the sides.

The Pons Varolii.

This prominence consists mainly of the transverse white fibres connecting the lateral lobes of the cerebellum, constituting its middle peduncle. In it also the longitudinal fibres from the medulla pass on their way to the crura cerebri; a large quantity of grey matter is developed in its substance. The centre is marked by a superficial groove; its anterior surface and its upper and lower borders are all convex.

The layers met with on section are:

(*a*) A superficial layer of transverse cerebellar fibres.

(*b*) Longitudinal fibres prolonged from the anterior pyramid of the medulla to the crura cerebri.

(*c*) Deeper transverse fibres, which are partly interspersed with the preceding, but below are collected into a distinct transverse bundle named the trapezium.

(*d*) The most posterior portion of the pons is composed, of grey matter continued from the medulla, of reticular nerve-tissue, and of some specially developed grey bodies, such as the superior olivary nucleus, the nuclei of origin of the facial nerve, and the motor part of the fifth nerve.

The nerves seen to emerge from and around the pons are:

(*a*) The third nerve arises from the inner aspects of the crus cerebri, immediately above the pons.

(*b*) The sixth nerve appears immediately below the pons, between it and the anterior pyramid of the medulla.

(*c*) The fifth nerve, however, finds its way from out of the side of the pons, a little nearer the upper than the lower border; the motor root arising above the sensory, and separated from it by a few transverse fibres.

The Medulla Oblongata.

This is a conical piece of nerve-tract, with the base upwards at the pons and its apex below at the spinal cord. The lower border of the foramen magnum is the spot opposite which the medulla and the cord are continuous. The fibres of the medulla are continued through the pons where they become partly dispersed, but are again collected above the pons to form the crura cerebri.

The medulla oblongata lies in the vallecula of the cerebellum. In length it is one inch; its breadth above three-fourths of an inch; and its thickness a little over half an inch. It presents fissures and elevations. The anterior and posterior median fissures of the cord are continued up on the medulla. The anterior ends just below the pons at the foramen cæcum; it is interrupted in the medulla by the crossing of the motor fibres. The posterior fissure expands above to form the fourth ventricle.

The *elevations* met with from behind forwards on either side are :

1. The posterior pyramid, or funiculus gracilis, is below continuous with the posterior median column of the spinal cord, and above diverges to limit the fourth ventricle at its lower part.

2. The posterior lateral column, or cuneate funiculus, expands as it ascends. This column, formerly known as the restiform body, is seemingly continuous below with the posterior column of the cord, and above is continuous with the corpus restiforme or rope-like body (proper), which passes directly to the cerebellum as its inferior peduncle.

3. The funiculus of Rolando is a streak of nervous matter peculiar to the medulla; it corresponds to the spot where the apex of the posterior cornu of the grey matter of the spinal cord, named the tubercle of Rolando, reaches the surface.

4. The lateral column of the medulla seems to be continuous below with the lateral column of the cord. The fibres of the one, however, do not pass simply into that of the other.

5. The olivary body, an olive-shaped eminence situated near the upper part of the medulla, near to, but not touching, the lower border of the pons.

6. The anterior column, or pyramid, bounds the anterior median fissure; it increases in breadth as it ascends. Below it corresponds in position to the anterior column of the cord, and above it is continued into the pons.

The cranial nerves seen to emerge from the medulla oblongata include all from the sixth to the ninth.

(*a*) The sixth appears between the pons and the upper border of the anterior pyramid.

(*b*) The facial and auditory appear immediately below the pons, in the recess between the olivary and restiform bodies.

(*c*) The glosso-pharyngeal, the pneumogastric, and the spinal accessory appear in a line with the facial, between the olivary body and the restiform body and posterior lateral column. The last-named nerve also arises from the lateral column of the cord as low down as the sixth cervical.

(*d*) The hypoglossal arises from between the olivary body and the anterior pyramid.

The Cranial Nerves.

According to various authors these nerves are enumerated as nine or twelve pairs. The numbers in either category correspond as far as the sixth cranial nerve, but beyond that they are arranged as follows :

When nine is the number accepted, the portio dura and portio mollis together form the seventh; but when twelve are recognised, the portio dura then forms the seventh and the portio mollis the eighth. The glosso-pharyngeal, the pneumogastric and spinal accessory are, when nine is the accepted number, grouped together as the eighth pair; but when twelve are received as the enumeration they are called the ninth, tenth, and eleventh respectively. The last or hypoglossal nerve will therefore be the ninth or twelfth pair.

The *relations* of the dura mater to the cranial nerves is the same as that described for the spinal nerves. (*See* Spinal Cord.) The pia mater is continued on to the nerves, forming a perineurial covering. The arachnoid is continued for some distance on the nerve, but at its ending it allows a communication between the subdural and subarachnoid spaces. Therefore, the perivascular canals of the nerve-trunks are continuous with the subarachnoid and subdural spaces, and through them with the ventricles of the brain.

I. The OLFACTORY PAIR OF NERVES, the first cranial, taken in a wide sense, includes the olfactory lobe made up of roots, tract, and bulb; but the nerves proper are the twigs which pass from the under surface of the bulb to the nose.

The *tract* arises from around the anterior perforated spot, by two white streaks or *roots* coming, the outer from the neighbourhood of the Sylvian fissure, the inner from the side of the longitudinal fissure; between these two roots lies a grey mass, the tuber olfactorium, or middle root. The tract—a prismatic bundle of grey and white fibres—passes forwards to the bulb, on the under surface of the frontal lobe in the olfactory sulcus. The *bulb* is a grey ovoid mass, about half an inch long and a quarter of an inch wide, lying on the cribriform plate on either side; it contains much grey matter. The *branches*, about twenty in number, pass from the under surface of the bulb through the cribriform plate to the nose; as they descend they are arranged in three rows, one row going to the septum of the nose, one to the roof, and a third to the outer wall of the nose where they descend as low as the middle turbinated bone. The distribution of the nerve in the mucous membrane is commensurate with the parts of the ethmoid bone met with in the nose. Each branch is enclosed in a tubular prolongation of the dura mater.

II. The OPTIC NERVES, the second cranial pair, comprehend in their widest sense the roots, the optic tracts, the optic commissure, the optic nerves, and the retinæ.

Each optic *tract* arises by the *roots* from the back part of the optic thalamus, the nates, and the inner and outer geniculate bodies. From hence the roots converge to form the tract, which is continued forward around the crus cerebri as a flattened band. As the tract approaches the commissure it becomes more rounded, and lies in contact with the tuber cinereum and lamina cinerea.

The *optic commissure* or *chiasma* represents the junction of the two optic tracts, and from it the optic nerves are continued forwards.

The chiasma rests on the sphenoid immediately in front of its olivary body. With minute and careful dissection after boiling, the bundles of fibres may be made out in the chiasma. They behave thus: the outer fibres of each tract keep to the same side in the chiasma, and go to the outer side of the same eyeball along the optic nerve. The inner fibres of each tract cross in the chiasma, and run forwards on the inner side of the opposite optic nerve to the inner side of the opposite eyeball. Besides these a small band of fibres cross at the back of the chiasma from one optic tract to the other; and in front a similar band is described, passing from one optic nerve to the other.

The *optic nerve* itself runs forwards and outwards through the optic foramen having the ophthalmic artery below and external to it. Enclosed in a strong sheath of dura mater and a delicate continuation from the arachnoid, it shows both the subdural and subarachnoid spaces when submitted to careful injection. The nerve is about an inch and a quarter long, and one-third of an inch behind the sclerotic it receives the arteria centralis retinæ. The nerve reaches the eyeball one-tenth of an inch internal to the antero-posterior axis of the eyeball.

III. The Motor Oculi, or third nerve, has its *origin* from the locus niger, in the crus cerebri, and from the grey matter around the aqueduct of Sylvius. It *emerges* from the brain at the oculo-motor groove on the inner side of the crus cerebri, and between the posterior cerebral and superior cerebellar arteries. In its *course* forwards, it pierces the dura mater, enters the roof of the cavernous sinus, and runs along the outer wall of the sinus, to enter the sphenoidal fissure between the heads of the external rectus muscle; as it enters, the nasal nerve lies between its two divisions. The nerve has two *branches;* an *upper*, supplying the levator palpebræ and superior rectus muscles, reaching their under aspects; and a *lower*, supplying the inferior rectus, the internal rectus and the inferior oblique muscles; the last, by a long branch of large size, which gives off the motor or short root to the inferior angle of the lenticular ganglion. The branches of the lower division reach the muscles upon their upper aspects, except in the case of the inferior oblique, which is supplied at its posterior border.

IV. The Trochlear Nerve, patheticus or fourth pair of nerves, *arises* from the grey matter between the under surface of the corpora quadrigemina and the upper wall of the Sylvian fissure, and from the valve of Vieussens. From hence it takes a long winding *course* outwards over the superior cerebellar peduncle and around the crus cerebri, to the under surface of the cerebrum; it perforates the dura mater at the apex of the tentorium cerebelli, runs along the outer wall of the cavernous sinus, below the level of the third nerve and above the ophthalmic, and enters the orbit through the sphenoidal fissure above the two heads of the external rectus. The nerve is *distributed* to the superior oblique muscle on its orbital aspect.

V. The Trigeminal Nerve, trifacial or fifth nerve, has two *roots*, a motor and a sensory. The nerve *arises* in the floor of the fourth ventricle; the *motor* root from the upper part of the ventricle near the middle line, under cover of the nucleus for the seventh; the *sensory* root arises from the superior sensory nucleus at the upper and outer part of the floor of the fourth ventricle, under cover of the substantia ferruginea, seen on the surface as an iron-grey mass —the locus cœruleus. Both the motor and sensory roots receive accessory bands; the motor receives the *descending root of the fifth* from the grey matter around the aqueduct of Sylvius; the sensory, the *ascending root of the fifth*, in close connection with the upper end of the tubercle of Rolando and the nucleus of the auditory nerve. The group of cells from which the ascending root arises is named the inferior sensory nucleus of the fifth.

The nerve-roots *emerge* from the pons midway between the upper and lower borders, and half-way along its lateral aspect. The smaller motor root is above the sensory, being separated from it by a few transverse fibres of the pons. In their *course* forwards the two roots run together over the upper aspect of the tip of the petrous portion of the temporal bone, and under cover of the tentorium cerebelli and the superior petrosal sinus. The fibres of the sensory root now spread out to enter the Gasserian ganglion, underneath which the motor root is continued onwards to emerge at the foramen ovale, on the inner aspect of the sensory trunk of the inferior maxillary division of the fifth.

The *Gasserian ganglion* is a mass of nerve cells and fibres lying in a hollow on the tip of the petrous portion of the temporal bone. It is semilunar in shape, the concavity behind receiving the filaments (about a hundred) of the sensory root of the fifth; whilst from the convexity proceed the ophthalmic, the superior and inferior maxillary divisions of the fifth.

A. The *ophthalmic*, or first division of the fifth, is directed upwards, inwards and forwards, from the inner end of the Gasserian ganglion, along the outer wall of the cavernous sinus. It there *courses* forwards below the fourth nerve and divides into three terminal branches, two of which, the frontal and lachrymal, enter the sphenoidal fissure above the two heads of the external rectus muscle; whilst the third, the nasal branch, passes through the sphenoidal fissure, between the two heads of the external rectus and between the upper and lower divisions of the third nerve.

The *branches* of the first division are:

1. The *frontal* nerve is the largest of the three branches. It enters the orbit above the external rectus and between the lachrymal and fourth nerves, and runs forwards above the levator palpebræ muscle. Just before reaching the margin of the orbit, it divides into terminal filaments: (*a*) The supra-trochlear passes inwards, and above the pulley of the superior oblique muscle it escapes from the orbit and ascends to the frontal region over the internal angular process; it drops down branches to the conjunctiva. (*b*) The supra-orbital nerve passes through the supra-orbital foramen and gains the forehead beneath the orbicularis palpebrarum muscle. Ascending on the forehead it divides into an inner and outer (the larger) branch, which perforate the occipito-frontalis muscle and supply the skin as far back as the lambdoid suture. The nerve drops down branches to the eyelid and conjunctiva.

2. The *lachrymal nerve* enters the orbit by the sphenoidal fissure, lying above the external rectus muscle, and to the outside of the frontal nerve; it runs forwards along the upper edge of the external rectus muscle to be distributed chiefly in the lachrymal gland. A few filaments are continued onwards through the palpebral ligament, to supply the eyelid, conjunctiva, and the skin over the external angular process of the frontal. (Orbital branch, see p. 343.)

3. The *nasal nerve* enters the orbit between the two heads of the external rectus muscle, crosses to the inside of the optic nerve, and divides into two filaments: (*a*) the *internal* or *nasal twig* enters the anterior ethmoidal foramen, runs along the cribriform plate of the ethmoid, and passing through the nasal slit by the side of the crista galli, enters the nose. It here grooves the back of the nasal bones, sends a few twigs to the nose, and finally emerging between the bone and the cartilage, supplies the skin of the nose from the root to the tip. (*b*) The *infra-trochlear* emerges beneath the superior oblique muscle, and supplies the skin and lachrymal apparatus. The nasal nerve, before it divides, gives off a branch to the ophthalmic or *lenticular ganglion* forming its long or sensory root; and *two long ciliary nerves* join some of the inner short ciliary nerves as they proceed to the eye.

The *lenticular ganglion* is situated between the external rectus muscle and the optic nerve, and below the level of the ophthalmic artery. The ganglion is pink in colour, about the size of a pin's head, and more or less quadrilateral in shape; it has entering at its posterior inferior angle a motor filament from the lower division of the third, at its posterior superior angle a sensory filament from the nasal of fifth, and at its posterior border sympathetic filaments from the cavernous plexus around the internal carotid. Ten or twelve short ciliary branches are given off from the ganglion in an upper and lower bundle; these perforate the sclerotic coat around the optic nerve and run forwards to supply the cornea and the muscles of the iris.

B. The *superior maxillary nerve*, the second division of the fifth, passes through the foramen rotundum, crosses the spheno-maxillary fossa, traverses the infra-orbital groove, canal and foramen, and is distributed on the cheek.

The nerve is wholly sensory, but Meckel's ganglion, with which it is associated, has motor filaments from the facial sent to it.

In the *foramen rotundum* of the sphenoid the nerve passes through without any companion structure. It gives off no branches in this stage.

In the *spheno* or *pterygo-maxillary* fossa the nerve runs across the upper part, and has a slightly oblique course outwards from its exit at the foramen rotundum behind, to the entrance of the infra-orbita groove in front. The branches given off in this stage are:

1. An orbital branch enters the orbit by the spheno-maxillary fissure, then runs along the outer wall of the orbit, and receiving a branch from the lachrymal, divides into malar and temporal branches. The *malar* branch passes through the malar bone to the face as the subcutaneus malæ; the *temporal* branch passes backwards in the malar bone to the temporal fossa, then runs upwards in the fat between the temporal muscle and the malar bone, and reaches the skin through the temporal fascia a finger's-breadth above the zygoma.

2. Two short, stout filaments drop perpendicularly downwards to Meckel's ganglion.

3. Posterior superior dental nerves, as two large branches (posterior and middle), pass downwards and forwards to enter the zygomatic surface of the superior maxilla, and supply the teeth as far forward as the canine; they also go to the antrum of Highmore and the gums.

In the *infra-orbital groove and canal* the superior maxillary nerve runs along the floor of the orbit in company with the infra-orbital artery and vein; it is at first covered merely by fascia, then dipping more deeply into the bone, it emerges about half an inch below the bony margin of the orbit at the infra-orbital foramen.

The branch of the orbital stage.

4. The anterior superior dental nerve descends in the anterior wall of the antrum of Highmore to the incisor and canine teeth. A few filaments find their way into the lower and anterior part of the

nostril. The nerve unites with the posterior dental branches over the canine tooth, where a minute ganglion, the ganglion of Bochdalek, is met with.

In *the face.* The superior maxillary nerve appears in the face, half an inch below the centre of the margin of the bony orbit, at the infra-orbital foramen. At its point of exit the levator labii superioris proprius lies above, and covers, the nerve ; below it, is the levator anguli oris. The infra-orbital branch of the facial nerve forms a plexus—the *infra-orbital plexus*—with this nerve at its exit. From the plexus branches pass to the eyelid, the nose, and the upper lip, by the *inferior palpebral*, *lateral nasal*, and *superior labial* branches respectively. These nerves contain, after they emerge from the plexus, both motor and sensory filaments, supplying the muscles and integument of the regions to which they are distributed.

Meckel's ganglion, the spheno-palatine, or nasal ganglion, is met with in connection with the second division of the fifth. It lies in the pterygo-maxillary fossa, below the level of the superior maxillary nerve, from which it derives its sensory *roots*, two in number. The motor and sympathetic roots are contained in the Vidian nerve which enters the ganglion posteriorly. The *Vidian* nerve can be traced backwards through the Vidian foramen, and the cartilage which closes in the middle lacerated foramen ; it resolves itself into motor and sympathetic roots: (*a*) The motor is continued back beneath the Gasserian ganglion as *the great superficial petrosal* nerve, to the hiatus Fallopii, along which it runs to join the facial in the aqueductus Fallopii ; a branch from the tympanic plexus of the glosso-pharyngeal, bestowing special sense, joins the nerve in the substance of the petrous portion of the temporal. (*b*) The sympathetic branch, the *great deep petrosal*, goes to join the carotid plexus.

The branches of distribution of Meckel's ganglion are : (*a*) *Ascending* to the periosteum of the orbit. (*b*) *Descending* through the posterior palatine canals. This set exhibits three main branches : (1) A large or anterior palatine, to the roof of the mouth and the gums ; it joins the naso-palatine in front. During its descent in the canal it sends to the lower and back part of the nose the posterior inferior nasal branches. (2) The small or posterior palatine supplies the soft palate and tonsil, and the levator palati and azygos uvulæ muscles. (3) The external palatine supplies the tonsil and part of the palate. These three branches emerge through three separate foramina—anterior, posterior, and external. (*c*) *Internal* or naso-palatine branches enter the superior meatus of the nose by the naso-palatine foramen; there they are mostly distributed. One branch, however, runs down the septum of the nose as the naso-palatine nerve (Cotunnius), and gets by the anterior palatine foramen to the mouth. (*d*) *Posterior*, the pharyngeal branch, passes back through the pterygo-palatine foramen to supply the mucous membrane around the Eustachian tube.

C. The *inferior maxillary nerve* differs from other branches of the fifth in possessing a motor and sensory root. It *passes* out through the foramen ovale as two roots, but immediately the nerve enters the zygomatic fossa, the two join; the trunk of the nerve soon breaks up to form two sets of branches, the anterior and posterior.

I. The *anterior* or motor set supplies the temporal, masseteric, and external pterygoid muscles; it also sends a branch to the buccinator, mostly, however, of a sensory nature. (*a*) The deep temporal nerves are usually two in number; they pass directly outwards from the trunk of the inferior maxillary, between the base of the skull and the external pterygoid muscle, and hooking round the pterygoid ridge on the great wing of the sphenoid, ascend to the under aspect of the temporal muscle, which they supply. Frequently the buccal nerve gives off a third temporal branch. When this is present, the temporal nerves are named anterior, middle and posterior. (*b*) The masseteric nerve passes in company with the posterior deep temporal nerve, and continuing its horizontal course, crosses the sigmoid notch of the lower jaw to enter the under surface of the masseteric muscle. (*c*) The external pterygoid nerve enters the inner aspect of that muscle. (*d*) The buccal branch penetrates between the two heads of the external pterygoid, and reaches the buccal region to supply the skin and mucous membrane of the cheek. (*e*) The nerve to the internal pterygoid has developed upon it the otic ganglion.

II. The *posterior* or sensory set of branches of the inferior maxillary consist of the auriculo-temporal, the inferior dental, and the gustatory or lingual. (*a*) The *auriculo-temporal nerve* passes backwards from the main trunk under cover of the external pterygoid muscle. It has two roots between which the middle meningeal artery ascends to the foramen spinosum. Changing its direction it passes outwards behind the capsule of the jaw, and in front of the parotid gland. Finally it turns upwards over the zygoma, and accompanying the temporal artery divides into terminal branches, to the skin of the temporal region. The nerve distributes branches to the articulation of the lower jaw, to the parotid gland, to the external auditory meatus, to the membrana tympani, and auricular branches to the fore part of the ear. (*b*) The *inferior dental* nerve descends at first beneath the external pterygoid; it then lies between the lower jaw and the internal lateral ligament, and behind the lingual nerve. Accompanied by the artery it enters the inferior dental foramen on the inner side of the ramus of the lower maxilla, travels forwards in the inferior dental canal, and gives filaments to *all* the lower teeth. Opposite the second bicuspid tooth of the lower jaw the nerve divides into the incisor and mental branches. The *incisor* continues to run forwards in the lower jaw, supplying the canine and incisor teeth; the *mental* branch emerges by the mental foramen and divides into branches, going to the chin, to the lower lip, and to the mucous membrane. Before the inferior dental nerve enters the canal it gives off the *mylo-hyoid branch*, which descends in a groove on the inner aspect of the jaw, and is conducted downwards between the bone and the internal pterygoid muscle to the submaxillary region, where it runs upon the mylo-hyoid muscle to supply the anterior belly of the digastric and the mylo-hyoid muscle itself. In the canal the dental branches form a fine plexus—the *inferior dental plexus*. (*c*) The *lingual* or *gustatory nerve* appears from under cover of external pterygoid muscle in front of the inferior dental nerve. It then passes downwards and forwards between the ramus of the jaw and the internal pterygoid muscle, and gradually inclining forwards it gains the side of the tongue. There the nerve lies upon the hyo-glossus muscle and above the deep part of the submaxillary gland. Finally it crosses Wharton's duct, hooks round below it, and gaining its inner side ascends to the surface of the tongue. The branches from it pass to the filiform and fungiform papillæ of the tongue; they supply also the gums (gingival branches), the sublingual gland, and the submaxillary ganglion with sensory branches.

The chorda tympani nerve from the facial joins the gustatory nerve about half an inch below its origin, and accompanies the trunk of the nerve. The *submaxillary ganglion* is intimately associated with the gustatory nerve. The ganglion is met with in the submaxillary region lying upon the hyo-glossus muscle, with the gustatory nerve above it, and the deep part of the submaxillary gland and Wharton's duct below it. It is greyish-pink in colour and triangular in shape. It receives motor filaments from the chorda tympani and sensory filaments from the gustatory, both of which, however, seem to be dropped down from the gustatory nerve owing to the chorda tympani being associated with the gustatory; the sympathetic root is from the nervi molles on the facial artery.

The ganglion sends branches to the submaxillary gland, five or six in number; others supply the mucous membrane of the mouth, and Wharton's duct.

The *otic ganglion* is found in connection with this division. It is situated upon the nerve to the internal pterygoid muscle, and lies on the inner aspect of the inferior maxillary division of the fifth immediately it emerges from the foramen ovale. It is of an oval shape, its long axis measuring from before backwards one-sixth of an inch; it is of a greyish-pink colour. The relations are—above, foramen ovale; externally, inferior maxillary nerve; internally, tensor palati muscle; behind, the middle meningeal artery. The *motor root* is derived from the nerve to the internal pterygoid; the *sensory root* from the sensory trunk of the inferior maxillary; and its *sympathetic*, from the nerves around the middle meningeal artery.

Besides these roots the ganglion receives at its posterior part the small superficial petrosal nerve, bringing to it motor branches from the facial, and branches of special sense from the glosso-pharyngeal. The auriculo-temporal has branches passing to and from its trunk to the otic ganglion. From the ganglion proceed two muscular branches to the tensor tympani and tensor palati, whilst the nerve to the internal pterygoid finds its way through the ganglion.

VI. The ABDUCENS, or sixth nerve, *arises* from the upper part of the floor of the fourth ventricle, from a nucleus common to it and the seventh nerve. It *emerges* from the brain substance, between the anterior pyramid of the medulla, and the lower border of the pons. In its *course* forwards, it passes under cover of the posterior clinoid process, then along the outer side of the internal carotid artery, between it and the cavernous sinus, to the sphenoidal fissure; there it passes into the orbit between the two heads of the external rectus muscle, the ocular surface of which it enters. At its passage through the fissure it is the lowest of the nerves met with there.

VII. The PORTIO DURA, or facial nerve, and the PORTIO MOLLIS, or auditory nerve, together make up the seventh nerve. According to some anatomists they make the seventh and eighth cranial nerves.

A. The *portio dura arises* from the upper part of the floor of the fourth ventricle, from a nucleus in common with the sixth, and immediately superficial to the motor nucleus of the fifth nerve. The root-bundle first passes backwards and inwards towards the middle line, then upwards, and finally it bends sharply outwards to *appear* from the side of the medulla behind and above the olivary body. From the deep recess between the pons, medulla and cerebellum, the nerve *courses* forwards and outwards to the internal auditory meatus, which it enters, in company with the auditory nerve immediately below it and the auditory branch of the basilar artery upon it. At the bottom of the meatus the nerve enters the aqueduct of Fallopius, along which it passes, and from which it emerges at the stylo-mastoid foramen. It then enters the parotid gland, and forming the pes anserinus it breaks up into terminal branches, which, appearing at its anterior border, supply the face.

1. Before the facial nerve enters the temporal bone it lies upon the auditory nerve, supplying it with a group of communicating branches—the pars intermedia.

2. In the aqueduct of Fallopius the nerve passes at first outwards and slightly forwards, and then bends sharply downwards and backwards to emerge at the stylo-mastoid foramen. Situated upon the bend or genu is a marked swelling, the *intumescentia gangliofomis*, or geniculate ganglion.

The *branches* of this stage are: (*a*) The great superficial petrosal nerve passes forwards and inwards from the intumescentia. It emerges by the hiatus Fallopii, and gains the under aspect of the Gasserian ganglion; it then passes through the cartilage closing in the middle lacerated foramen, to reach the posterior aperture of the Vidian canal in the sphenoid. Before entering this canal it is joined by a sympathetic filament from the plexus around the internal carotid artery—the deep petrosal nerve—and, blended with this, it runs forwards through the Vidian canal, and gains the posterior border of Meckel's ganglion. The great superficial petrosal, before it leaves the petrous portion of the temporal, is joined by a communicating branch from the tympanic branch of the glosso-pharyngeal. (*b*) The small superficial petrosal nerve arises also from the intumescentia gangliofomis, and emerges at the anterior surface of the petrosal portion of the temporal bone immediately external to the hiatus Fallopii. The nerve then passes downwards and forwards to enter the sphenoid bone and gain the foramen ovale, where it leaves the bone by a small aperture in the posterior wall of that foramen, and descends to enter the posterior end of the otic ganglion. Just after its commencement the nerve is joined by a communicating branch from the tympanic plexus of the glosso-pharyngeal. The description of these nerves is sometimes reversed; the branch from the tympanic plexus being regarded as the main trunk, that from the facial as the communicating branch. (*c*) The external superficial petrosal passes from the ganglion, to the plexus of nerves upon the middle meningeal artery. (*d*) The nerve to the stapedius muscle is given off from the descending portion of the facial trunk. (*e*) The chorda tympani nerve arises from the facial, one-sixth of an inch above its exit from the stylo-mastoid foramen. It enters the tympanum through the iter chordæ posterius, passes forwards between the handle of the malleus and the long process of the incus, and leaves the cavity of the tympanum by the iter chordæ anterius. It finally emerges from the bone, by the canal of Huguier, to join the gustatory nerve half an inch after its commencement; with the gustatory it passes down to the submaxillary ganglion and the tongue.

3. When the facial nerve emerges from the stylo-mastoid foramen, it supplies: (*a*) A posterior auricular branch. (*b*) A branch to the posterior belly of the digastric muscle. (*c*) A branch to the stylo-hyoid muscle.

(*a*) The posterior auricular nerve turns sharply outwards and upwards, lying deeply between the ear and the mastoid process; it supplies an *auricular* branch to the retrahens aureus muscle and the muscles of the posterior surface of the ear; an *occipital* branch enters the posterior belly of the occipito-frontalis. (*b*) One of the branches to the digastric muscle perforates it to communicate with the glosso-pharyngeal. (*c*) The stylo-hyoid branch is long and slender.

4. In the parotid gland. The facial nerve enters the gland in two main trunks; the upper and larger is called the temporo-facial; the lower the cervico-facial.

In the gland these trunks freely inosculate, forming the *pes anserinus.* The nerves lie in the substance of the gland superficial to the temporo-maxillary vein and the external carotid artery.

5. In the face the *branches* are as follows:

(1) The temporo-facial set supply—(*a*) temporal branches, which ascend over the zygoma to the anterior belly of the occipito-frontalis, the attrahens aurem, the attollens aurem, the orbicularis palpebrarum, the corrugator supercilii, and the muscles on the anterior aspect of the ear. The nerves communicate with the terminal branches of the fifth in every region where they are associated. (*b*) Malar branches reach the eyelids and supply the orbicular muscle, communicating freely with the fifth. (*c*) Infra-orbital branches supply the muscles between the orbit and the mouth, reaching inwards as far as the nose. A well developed plexus—the infra-orbital—marks the inosculation of this nerve with the superior maxillary at the infra-orbital foramen.

(2) The cervico-facial nerve, the smaller of the two branches which enter the parotid gland, runs forwards below the temporo-facial nerve, and emerges at the anterior part of the parotid gland in three branches. (*a*) The buccal nerve supplies the buccinator muscle and the orbicularis oris; it communicates with the buccal branch from the inferior maxillary of the fifth. (*b*) The supra-maxillary runs along the lower jaw and passes beneath the depressor anguli oris to supply the chin and lower lip muscles, and to inosculate with the mental branch of the inferior dental. (*c*) The infra-maxillary branch crosses the angle of the jaw to reach the submaxillary region, where it supplies the platysma and inosculates with the superficial cervical nerve.

B. The PORTIO MOLLIS of the seventh, the auditory nerve, possesses two nuclei of origin, an upper and lower. The *upper*, the smaller, lies at the lateral angle of the fourth ventricle below the level of the swelling known as the tuberculum acusticum, and the crossing of the transverse striæ; the *lower* lies in the tuberculum, and under cover of the transverse striæ. These striæ are themselves part of the origin of the auditory nerve, the filaments appearing from the central ventricular groove. The nerve now *appears* as two roots upon the side of the medulla; the superior emerging from the restiform body close below the pons; the lower comes partly from the striæ of the fourth ventricle, and from the inner side of the restiform body. The nerve next *courses* outwards, having the facial nerve lying on its upper surface, and reaches the internal auditory meatus in company with the facial nerve and the auditory branch of the basilar artery. The auditory nerve then divides into two bundles: an *upper*, which runs forwards in the bone, to supply the utricle and the superior and external semicircular canals; the *lower*, the larger branch, goes chiefly to the cochlea, but also to the saccule, and the posterior semicircular canal.

VIII. The EIGHTH PAIR of cranial nerves consists of the glosso-pharyngeal, the vagus and the spinal accessory, grouped together under a common name; but perhaps the numbers, ninth, tenth and eleventh for the three nerves respectively is the better method of classification.

A. The GLOSSO-PHARYNGEAL, or ninth nerve, *arises* from the floor of the fourth ventricle in the region of the inferior fovea, immediately below the tuberculum acusticum, and above the nucleus of the vagus. The fibres *emerge* as five or six roots behind the olivary body, between those of the auditory above and the vagus below. The nerve then *courses* to the front part of the jugular foramen, where it notches the petrous portion of the temporal bone, immediately external to the groove and notch for the inferior petrosal sinus. From hence it passes to the outside of the skull, where it gains the interval between the internal jugular vein and the internal carotid artery. Descending and crossing the artery from behind forwards, it reaches the stylo-pharyngeus muscle, where, passing forwards and around that muscle, it creeps on to the posterior third of the tongue.

The *ganglia* met with on the nerve are situated at the jugular foramen; the *upper*, the *jugular* ganglion, is of small extent, and does not embrace all the nerve fibres. The very existence of this ganglion is denied by some. The *lower*, the *petrosal* ganglion, measures as much as a quarter of an inch long. It is contained in a depression in the petrous portion of the temporal bone as it leaves the jugular foramen.

From the petrosal ganglion arises the *tympanic branch*—Jacobson's nerve, as it is called. It ascends in the ridge of bone between the jugular foramen and the carotid canal, and next appears on the promontory on the inner wall of the tympanum, as the tympanic plexus.

Various branches from the plexus are to be made out, three being branches of distribution, viz.: (*a*) to the fenestra ovalis, (*b*) to the fenestra rotunda, (*c*) and to the Eustachian tube; three are branches of communication, viz.: (*a*) to the great superficial petrosal, (*b*) to the lesser superficial petrosal, (*c*) to the sympathetic on the internal carotid artery. (See page 348.)

The petrosal nerves have been already described with the facial nerve, even although the lesser superficial petrosal nerve is regarded as being primarily continued from this tympanic nerve. The branch to the sympathetic is sometimes called the *small deep petrosal nerve.*

The branches from the trunk of the glosso-pharyngeal are given off from the nerve as it passes round the stylo-pharyngeus muscle. They are the—(1) carotid, to the carotid artery; (2) muscular, to the stylo-pharyngeus; (3) pharyngeal, to the pharyngeal plexus; (4) tonsillitic, to the tonsil, around which it forms a circle, the circulus tonsillaris; (5) lingual, to the posterior third of the tongue.

The lingual branch divides into two as it reaches the tongue, and passing beneath the hyo-glossus and upon the genio-hyo-glossus muscle, it sends branches to the circumvallate papillæ and the mucous membrane over the posterior third of the tongue. A small branch is distributed to the mucous membrane on the side of the tongue as far forwards as its centre.

B. The VAGUS, pneumogastric, or tenth cranial nerve, *arises* from the floor of the fourth ventricle near the lower end. The group of cells from which it springs is situated between the hypoglossal nucleus below and internally, and the glosso-pharyngeal nucleus above and externally. It approaches the floor of the fourth ventricle between the apex of the calamus scriptorius and the posterior fovea. The nerve-roots pass through the medulla to *emerge* at its lateral aspect, lying behind the olivary body and below the superficial origin of the glosso-pharyngeal; as many as twelve fibres can be counted at its point of emergence.

The nerve *leaves* the skull by the jugular foramen, in company with the spinal accessory, and between the inferior petrosal sinus in front and the jugular vein behind. At its issue from the skull it finds itself in the interval between the internal carotid artery and the internal jugular vein. The nerve descends in the common sheath enclosing these vessels, lying on a plane posterior to and between the artery and vein. At first it accompanies the internal carotid, but afterwards the common carotid, reaching with the latter vessel to the root of the neck. There is a marked difference between the right and left vagi at the root of the neck, owing to the difference in the arrangements of the bloodvessels on the two sides. Each nerve passes down in a plane between the veins in front and the arteries behind; but the right vagus crosses the first stage of the subclavian, whilst the left descends parallel to, and antero-internal to, the trunk of the left subclavian artery in the thoracic part of its first stage.

In the *thorax* the *right* vagus nerve descends beneath the subclavian vein, and gains first, the posterior, and then the external aspect of the innominate vein. Reaching the root of the lung it gives forwards branches to the anterior pulmonary plexus, but the main trunk is continued behind the lung root to form the posterior pulmonary plexus. Gathered together below the root of the lung, the fibres form a plexus—the plexus gulæ—on the œsophagus. Finally the filaments collect to form a single trunk and gain the œsophageal opening in the diaphragm. Through the opening it reaches the posterior aspect of the stomach, to which it is distributed; it sends also large branches to the solar and hepatic plexuses of the sympathetic, as well as to the splenic and left renal plexuses.

The *left* vagus enters the thorax, as already indicated, between the arteries and veins. It gradually comes forwards anterior to the left common carotid and the left subclavian artery, parallel to which it descends. Reaching the aorta, it crosses the front of the second stage of the arch, having the left superior intercostal vein anterior to it and the phrenic nerve on its inner side. At the hollow of the aortic arch it gives off the left recurrent laryngeal nerve, which ascends behind the second stage of the aorta on its way to the larynx. The nerve gains the root of the lung, where it behaves in a similar manner to that described on the right side. Below the root the fibres are collected as on the right side, but the resultant trunk passes in front of the lower part of the œsophagus to penetrate the diaphragm at the œsophageal opening. Finally, it gains the anterior surface of the stomach, and sends branches along the lesser curvature of the stomach and the lesser omentum, to the hepatic plexus of the sympathetic at the gate of the liver.

Two *ganglia* are formed on the upper part of the nerve, viz., the ganglion of the root and the ganglion of the trunk. The ganglion *of the root*, about two lines in its widest diameter, is situated in the jugular foramen; it is connected with the facial, the petrous ganglion of the glosso-pharyngeal, the spinal accessory and the sympathetic. It gives off *Arnold's*, or the *auricular, nerve*. Arnold's nerve enters a foramen at the back and outer part of the jugular fossa, penetrates the substance of the temporal bone in which it crosses the Fallopian aqueduct, and communicates with the facial nerve; finally emerging at the auricular fissure, it is distributed to the back of the ear and auditory meatus, and there communicates with the posterior auricular of the facial. Small twigs are also given off from this ganglion to the dura mater of the skull.

The ganglion *of the trunk*, about an inch in length, is placed half an inch below the base of the skull. The spinal accessory (accessory portion) passes over the ganglion and gives some fibres to it; the hypo-glossal nerve appears to be intimately attached to it. This ganglion is connected by filaments with the hypoglossal, the sympathetic, and the first two spinal nerves. From the upper part of the ganglion the pharyngeal nerve is given off, and from the middle of the ganglion the superior laryngeal nerve.

The *branches* of the vagus are branches of communication, already mentioned, and branches of distribution. The branches of distribution, besides Arnold's nerve and the meningeal nerve coming from the ganglion of the root, are :

i. The *pharyngeal nerve* (or nerves) comes from the upper part of the ganglion of the trunk and partly from the accessory nerve ; it passes in an oblique direction downwards and inwards, either in front of, or behind, the internal carotid artery, to the middle constrictor of the pharynx. There it meets with branches, from the glosso-pharyngeal, the superior laryngeal and the superior cervical ganglion, and forms the *pharyngeal plexus.* From hence filaments are distributed to the muscles and mucous membrane of the pharynx ; one small branch accompanies the hypo-glossal to the tongue.

ii. The *superior laryngeal nerve* has its origin from the middle of the ganglion of the trunk ; it passes inwards and downwards beneath the carotid vessels, where, after communicating with the sympathetic and pharyngeal plexus, it divides into two branches : (*a*) The external passes beneath the depressors of the hyoid bone and enters the crico-thyroid muscle. This nerve gives branches to the inferior constrictor muscle and the superior cardiac sympathetic branch. (*b*) The internal branch, on reaching the space between the thyroid cartilage and hyoid bone, pierces the thyro-hyoid membrane, and divides into ascending and descending branches. The ascending, supply branches to the mucous membrane of the base of the tongue, the epiglottis, and the aryteno-epiglottidean fold. The descending, pierce the arytenoideus muscle, and supply branches to the laryngeal mucous membrane. The branches communicate with the inferior laryngeal nerve in the mucous membrane and beneath the cartilage.

iii. The *inferior laryngeal nerve* has a slightly different course on the two sides. The *right* nerve, given off just as the vagus is about to enter the thorax, winds round the first part of the subclavian artery from before backwards; then, ascending obliquely upwards behind the sheath containing the carotid artery, jugular vein and vagus nerve, it reaches the interval between the trachea and œsophagus along with the inferior thyroid artery. Finally entering the larynx beneath the lower border of the inferior constrictor, it splits up into branches to supply the intrinsic muscles of that organ with the exception of the crico-thyroid, and also distributes branches to the mucous membrane below the rima glottidis.

The *left* recurrent nerve differs from the right, in that it is given off in the upper part of the thorax as the vagus crosses the arch of the aorta, and winding round this vessel just external to the ductus arteriosus, it ascends behind the second stage of the aorta; on reaching the neck it behaves in a similar manner to the right nerve.

Branches are given off by these nerves: (α) to the cardiac plexus; (β) to the inferior cervical ganglion of the sympathetic; (γ) to the tracheal and œsophageal branches; (δ) and to the inferior constrictor.

iv. The *middle laryngeal* is very small; it arises by one or two roots from the vagus just above the larynx, and passing downwards and inwards beneath the thyroid body, it enters the larynx to end in filaments to the mucous membrane. It also gives branches to the thyroid body, the crico-thyroid muscle, and communicates with the cardiac nerves.

v. *Cardiac branches* are given off in the neck both at the upper and lower part. The *upper* nerves are small, generally two in number, and after joining the cardiac branches of the sympathetic, pass behind the carotid vessels, then in front of the first part of the subclavian artery, and are conducted by the innominate artery to the deep cardiac plexus on the right side; on the left side they are conducted by the common carotid artery to the aorta, where they end in the superficial and deep cardiac plexuses.

The *lower* cervical cardiac nerves leave the vagus just as it is about to enter the thorax; the *right* nerve runs beside the innominate artery to the deep cardiac plexus; the *left*, crosses the arch of the aorta, and also ends in the deep cardiac plexus. The *thoracic* cardiac branches are given off on the *right* side from the vagus as it lies on the trachea; being joined by some filaments from the recurrent laryngeal nerve, they end in the deep cardiac plexus. The thoracic cardiac on the *left* are derived from the recurrent laryngeal, and join the deep cardiac plexus.

vi. The *Pulmonary* branches are arranged in two sets: the anterior, small in size and two or three in number, join some filaments of the sympathetic to form the anterior pulmonary plexus, and ramify mostly on the pulmonary artery. The posterior pulmonary nerves are branches of larger size, and with filaments from the second, third, and fourth thoracic ganglia form the posterior pulmonary plexus; they are distributed along the air-tubes to the substance of the lung.

vii. *Œsophageal* branches are given off to the upper part of the œsophagus. In the posterior mediastinum the pneumogastric nerves emanate from the posterior pulmonary plexus as two cords which are directed to the œsophagus, and on the posterior surface of this tube form the œsophageal plexus (plexus gulæ). At the lower part of the posterior mediastinum each nerve is collected into a single cord, and distributed in the manner already described.

C. The SPINAL ACCESSORY NERVE (the eleventh cranial) arises from a nucleus, below the apex of the fourth ventricle, behind the central canal of the spinal cord. The accessory portion of the nerve is seen to arise from the medulla oblongata below the pneumogastric nerve; the spinal portion arises from the side of the lateral column as low down as the sixth spinal nerve, and ascends between the roots of the spinal nerves and the ligamentum denticulatum; it passes through the foramen magnum, and with the accessory part joins the pneumogastric, leaving the skull with this nerve by the jugular foramen. The *accessory* portion gives filaments to the ganglion of the root of the pneumogastric; it then passes over the surface of the ganglion of the trunk, and ends in the pneumogastric below this ganglion, as well as giving fibres to its pharyngeal and laryngeal branches.

The *spinal* portion, after leaving the jugular foramen, passes downwards and backwards across the front of the internal jugular vein, perforates the sterno-mastoid muscle and supplies it; the nerve then crosses the posterior triangle of the neck, passes beneath the trapezius muscle, and after forming a plexus with branches from the third and fourth cervical nerves, it ends in filaments to the trapezius muscle, which can be traced nearly to its lower border.

The HYPOGLOSSAL NERVE (twelfth nerve) arises from the medulla oblongata by about twelve roots in the groove between the olivary body and anterior pyramid. The roots can be traced to a nucleus in the medulla placed at first antero-laterally to the central canal at the apex, but higher up, the nucleus forms an eminence on the floor of the fourth ventricle. The filaments pass outwards above the vertebral artery, pierce the dura mater in two bundles, and leave the skull through the anterior condyloid foramen.

At the base of the skull the nerve emerges on the inner side of the pneumogastric nerve and internal carotid artery. Then descending closely connected with the second ganglion of the vagus, it comes forwards between the internal carotid artery and jugular vein. At the lower border of the digastric it curves round the occipital artery, crosses the external carotid artery, and is directed to the under surface of the tongue above the hyoid bone, being covered by the tendon of the digastric muscle, the stylo-hyoid and mylo-hyoid muscles; on the tongue it rests upon the hyo-glossus muscle. At the anterior border of the hyo-glossus it forms a plexus with branches from the gustatory or lingual nerve, and is finally distributed to the muscular substance of the tongue.

Its branches are: (*a*) Small twigs to the dura mater. (*b*) Communications with (1) the superior cervical sympathetic ganglion;

(2) the loop between the first and second cervical nerves; (3) the pneumogastric nerve. (*c*) Muscular branches to the intrinsic muscles of the tongue, the genio-hyoid, hyo-glossus, stylo-glossus, and thyro-hyoid muscles. The branch to the latter muscle is a separate twig arising near the great cornu of the hyoid bone. (*d*) The descendens noni nerve, on leaving the hypoglossal, winds round the occipital artery, and passing downwards either upon or in the sheath of the vessels, gives off a branch to the anterior belly of the omo-hyoid muscle. On the carotid sheath loops of communication from the second and the third cervical nerves join it to form the ansa hypoglossi; from this imperfect plexus branches are given off to the posterior belly of the omo-hyoid, the sterno-hyoid, and sterno-thyroid muscles; frequently it sends branches of communication to join the phrenic and cardiac nerves.

The Sympathetic Nervous System.

The sympathetic system exhibits two nervous chains arranged one on each side of the vertebral column, with offshoots to the cerebro-spinal system and to the bloodvessels all over the body. The central cord extends from the skull to the coccyx, and consists of ganglia united together by nerves.

A ganglion is a mass of nerve-cells grouped together, forming a local area of nerve force. The nerves proceeding from them are a double set of branches, and are distributed thus: two go upwards, and two go downwards, to join the next ganglia immediately above and below; two pass outwards to join the anterior primary division of each spinal nerve, and branches pass (usually inwards) to the viscera.

The connecting nerves preserve most persistently the duplicity just mentioned; one of the two exhibits a structure characteristic of the cerebro-spinal system—the *white* branch; the other, of a greyish colour, is in structure like the sympathetic nerves generally—the *grey* branch.

Hence it is seen, that the sympathetic system differs from the cerebro-spinal, inasmuch as it consists of scattered entities of nerve-force met with in the form of the extensive chains of ganglia and connecting nerves, whereas in the cerebro-spinal system, a central mass—the brain—contains the nerve-force within the limits of the cranial enclosure.

Typically, a pair of ganglia lie one on either side of each vertebra. This arrangement is seen to persist in all except the cervical, where three ganglia only are met with. These, however, are regarded as conglomerate ganglia; that is, in each a number of separate ganglia have become joined together. This is made the more likely from the fact that each ganglion has connecting filaments to more than one spinal nerve; thus, the first has connecting branches with the first four cervical, the middle ganglion, with the fifth and sixth, and the lower, with the seventh and eighth cervical nerves. Hence it may be, that instead of a pair of ganglia corresponding to each vertebra, as stated above, it would be more correct to say that each pair of spinal nerves has its corresponding pair of sympathetic ganglia.

The position of the cord on either side of the middle line of the body is such that it lies in different relations to the vertebræ at different parts. Thus in the cervical region the cords lie, one on either side, in front of the transverse processes; in the dorsal region they lie far back on the heads of the rib; in the lumbar region the cord on each side advances and lies well to the front of the vertebral column in front of the attachment of the psoas; and in the sacral region they lie internal to the anterior sacral foramina.

In ordinary dissection it is impossible to follow the separate sympathetic nerves or fine plexuses as they pass on the arteries, but it is easy to make out the ganglia, the larger visceral plexuses, and the larger nerves and plexuses on the large central vessels of the trunk.

For convenience of description it is best to arrange the sympathetic nervous system into ganglia, plexuses, and nerves.

A. The SYMPATHETIC GANGLIA are found in pairs on either side of the middle line, in contact with the vertebral column all the way from the base of the skull to the coccyx. They are named according to the regions in which they lie—cervical, dorsal, lumbar, and sacral. Each spinal nerve is considered to have a corresponding sympathetic ganglion.

I. The CERVICAL ganglia exist as three pairs.

1. The *superior ganglia*, about one inch in length, lie on either side behind the internal carotid arteries and in front of the transverse processes of the second and third cervical vertebræ, but separated from them by the rectus capitis anticus major. The branches pass: *upwards*, with the internal carotid as an external and internal division, to form the carotid and cavernous plexuses respectively at the base of the cranium; *downwards*, to the middle ganglia; *outwards*, to the first four cervical nerves; *inwards*, to form the superior cardiac nerve. Communicating branches also proceed to the cranial nerves—viz., the sixth, seventh, glosso-pharyngeal, pneumogastric, and hypoglossal, either directly from the ganglion or from the carotid or cavernous plexuses. On the anterior communicating cerebral artery, the sympathetic chains are described as meeting at the ganglion of Ribes.

2. The *middle ganglia*, much the smallest, lie on either inferior

thyroid artery, opposite the sixth cervical vertebra. The branches pass: *upwards* and *downwards*, to the superior and inferior ganglia respectively; *outwards*, to the fifth and sixth cervical nerves; *inwards*, to form the middle cardiac nerves.

3. The *inferior ganglia* lie on, or immediately above, the neck of the first rib. The branches pass: *upwards*, to the middle ganglia; *downwards*, to the first dorsal; *outwards*, to the seventh and eighth cervical; *inwards*, to form the lower cardiac nerve. When joined with the first dorsal ganglia, as they often are, they receive the name of the stellate ganglia.

II. The DORSAL ganglia consist of twelve pairs, lying in front of the heads of the ribs on either side. They lie beneath the pleura and upon the intercostal vessels. Each dorsal ganglion sends: two branches *up*, to join the ganglion above; two branches *down*, to join the ganglion below; two branches *outwards*, to join the anterior primary division of the intercostal nerves; branches pass *inwards*, from the upper six ganglia to the thoracic viscera, from the lower six to form the splanchnic nerves.

III. The LUMBAR ganglia, usually four pairs, lie on the vertebral column on either side of the abdominal aorta and along the anterior edge of the psoas muscles. The branches resemble those of the dorsal ganglia, only that below they send branches to the hypogastric plexus.

IV. The SACRAL ganglia consist of five pairs lying in front of the sacrum, and on a plane internal to the anterior sacral foramina. They resemble the dorsal and lumbar ganglia in their connections. The two gangliated cords meet below to form the *ganglion impar* in front of the coccyx.

B. The SYMPATHETIC PLEXUSES are chiefly confined to the thorax and abdomen, but various ganglia of secondary size are met with in the head and neck.

I. In the Head and Neck:

1. The *carotid plexus* is formed by the continuation upwards of the external division of branches from the superior cervical ganglion. The internal carotid artery, as it lies in the base of the cranium, has the plexus on the outer side of its second bend, as it lies in the cavernous groove. It sends communicating branches to the fifth and sixth cranial nerves, and to the greater and lesser superficial petrosal nerves. (*See* Facial Nerve.)

2. The *cavernous plexus* embraces the inner and lower sides of the internal carotid artery in the cavernous groove of the sphenoid; it communicates with the third and fourth cranial nerves, with the first division of the fifth, and with the lenticular or ophthalmic ganglion.

3. The *annulus of Vieussens* is a circlet of sympathetic nerves, surrounding the first stage of the subclavian artery.

II. The THORACIC plexuses are as follow :

1. The *cardiac plexuses:* (*a*) The *superficial* cardiac plexus lies in the hollow of the arch of the aorta, in contact with the ductus arteriosus and the upper surface of the left pulmonary artery. It is *joined* by the superior cardiac nerve from the left upper cervical ganglion, and by the lower cervical branches from the left vagus. It is *distributed* with the left coronary artery of the heart, and has associated with it the small ganglion of Wrisberg. (*b*) The *deep* cardiac plexus lies above the right pulmonary artery, on the right bronchus and the bifurcation of the trachea, and behind the first stage of the arch of the aorta. It is *joined* by the cardiac branches from all the cervical ganglia except the left upper, and by the branches of the pneumogastrics, except the lower left cervical. It is *distributed* with the right coronary artery of the heart. The coronary plexuses are the principal branches which proceed from the superficial and deep cardiac plexuses; they are found on the coronary arteries. But besides these we have the following: the deep plexus splits on the right pulmonary artery, one set of branches descend in front to join the right coronary plexus; others pass (behind) to the right auricle and to the left coronary plexus. Passing to the left, from the deep plexus, branches join the superficial cardiac, and the left coronary, plexus. Branches from both superficial and deep cardiac plexuses proceed to the lungs by the pulmonary plexuses.

2. The *pulmonary plexuses* lie one in front and the other behind the root of either lung.

They are formed chiefly by the pneumogastric nerve together with branches from the upper thoracic ganglia, and by communicating branches from the cardiac plexuses.

The *anterior* pulmonary plexuses, much the smaller, are formed of two or three filaments of the pneumogastrics at the upper border of the roots of the lungs; these are joined by the sympathetic, and the branches proceed to the lung along the bloodvessels and bronchi.

The *posterior* pulmonary plexuses are formed by the breaking up of the pneumogastric trunk into a plexus at the back of the lung, together with sympathetic nerves from the upper dorsal ganglia. Across the middle line of the body, on the bifurcation of the trachea, the pulmonary plexus of either side communicate with each other, and with the cardiac plexus.

III. The ABDOMINAL plexuses:

1. The *solar plexus* is a huge mass of nerve-tissue surrounding the cœliac axis and the superior mesenteric at their origin from the aorta; it extends as far as the supra-renal capsule on either side and the

pancreas below. It has embedded in its meshes the two *semilunar ganglia*, and several smaller unnamed ganglia ; it receives the great splanchnic nerves and branches from the pneumogastric. From this plexus are given off branches to form the diaphragmatic, gastric, hepatic, splenic, renal, supra-renal, mesenteric and spermatic plexuses.

(*a*) Upon the diaphragmatic or phrenic plexus, accompanying the inferior diaphragmatic arteries, a small ganglion is found on the right side.

(*b*) The cœliac plexus divides into—

- (α) The coronary or gastric, accompanying the coronary artery and entering the stomach therewith.
- (β) The hepatic plexus accompanies all the branches of that artery, supplying a cystic plexus also to the gall-bladder. The coronary and hepatic plexuses are joined by branches of the left vagus.
- (γ) The splenic plexus, as it enters the spleen, is joined by branches of the right vagus.

(*c*) The renal plexuses enter the kidney by as many as twenty filaments; they emanate chiefly from the semilunar ganglia, but receive filaments also from the solar, aortic, supra-renal and spermatic plexuses, and from the smallest splanchnic nerve. Renal ganglia of small size are found plentifully scattered in the plexus.

(*d*) The supra-renal plexus seems to be really the lateral continuations of the solar plexus towards the top of either supra-renal capsule. They are joined by branches from the lesser splanchnic, and possess a ganglion—the ganglion splanchnico-supra-renale.

(*e*) The superior mesenteric plexus is a huge leash of nerves proceeding from the solar plexus between the layers of the mesentery to the small intestine and colon. It is joined by the right pneumogastric nerve, and has numerous ganglia near its commencement—the ganglia meseraica.

(*f*) The aortic, or intermesenteric plexus, accompanies the aorta ; it is continued down from the solar plexus and semilunar ganglia, and receives laterally branches from the lumbar ganglia. It gives off branches to all the arteries which arise within its course, viz., the spermatic, inferior mesenteric, and lumbar offshoots to the vessels of that name. Below, the aortic plexus is continued across the common iliac arteries as distinct cords on either side to end in the hypogastric plexus.

2. The hypogastric plexus is situated between the two common iliac arteries ; it consists of a reticular network of sympathetic nerves between the peritoneum and the upper part of the sacrum. It is embedded in a mass of dense connective-tissue, and is prolonged laterally into the pelvic plexuses.

3. The pelvic plexuses are placed one on either side of the pelvis, in contact with the rectum. They are formed by branches from the hypogastric plexus, the sacral ganglia, and the third and fourth sacral nerves. Small ganglia are met with in the plexus—plexus gangliosus.

Branches proceed from the plexus to form the hæmorrhoidal, vesical, and prostatic plexuses in the male; and in the female the vaginal and uterine.

The vesical plexus is very large; it sends in the male offshoots to the vas deferens and vesicula seminalis on each side.

The prostatic plexus is very ample, forming a close network around the prostate; from it, filaments are continued forwards through the layers of the triangular ligament to join branches of the pudic, to be continued on to the penis as the small and large cavernous nerves. The small enter the crura, the large run along the dorsum of the penis before they dip into its substance.

In the female the special plexuses are: (1) the ovarian, accompanying the ovarian arteries from the aortic plexus; (2) the vaginal; and (3) the uterine from the hypogastric and pelvic plexuses. Betwixt the layers of the broad ligament a plexus is formed between the ovarian and uterine branches, in which a number of small ganglia are present.

C. The SYMPATHETIC NERVES are distributed throughout the body generally, accompanying the bloodvessels on their way to viscera or to muscles.

There are, however, a few specially named nerves which require a separate notification:

1. The *nervi molles* is the generic name given to the sympathetic filaments which surround the branches of the external carotid artery.

2. *Pharyngeal nerves* proceed from the upper cervical ganglia to the pharynx to form the pharyngeal plexus on the middle constrictor muscle, where they are joined by branches of the vagus and glosso-pharyngeal nerves.

3. The *cardiac nerves.* Branches of the superior, middle, and inferior cervical ganglia proceed to the cardiac plexuses.

(1) The upper or superficial cardiac nerve proceeds on each side from the superior cervical ganglion. Each nerve passes down the neck behind the carotid sheath and in front of the inferior thyroid artery. On reaching the chest it behaves differently on the two sides. The right nerve passes behind, or in front of, the first stage of the subclavian, descends behind the innominate artery and the aortic arch to reach the deep cardiac plexus. The left nerve descends between the left common carotid and subclavian arteries,

and crossing the aortic arch in front, ends in the superficial cardiac plexus; should it go behind the aorta it joins the deep plexus. In the neck the nerves, especially the right, have many communications with the pneumogastric and its branches, viz., the external laryngeal and the recurrent laryngeal.

(2) The middle, great or deep cardiac nerve proceeds from the middle ganglion. On the right side the nerve crosses the subclavian and travels in front of the trachea to join the deep cardiac plexus; on the left side the nerve accompanies the left superficial cardiac, but ends in the left side of the deep plexus.

(3) The inferior cardiac nerves proceed from the inferior cervical or stellate ganglia to the deep cardiac plexus. On the right side, the nerve passes beneath the subclavian artery and along the posterior part of the aortic arch; on the left side the nerve usually joins the middle cardiac. On the right side both the middle and inferior cardiac nerves communicate with the recurrent laryngeal.

4. The *splanchnic nerves:* (*a*) the great splanchnics are formed on either side by the inner branches of the lower six or more dorsal ganglia. The nerves run downwards on the lower dorsal vertebræ, pierce the crura of the diaphragm, and join the semilunar ganglia. (*b*) The lesser splanchnics from the tenth and eleventh dorsal ganglia, pass through the diaphragm, either with the great, or separately, to join the cœliac plexus. (*c*) The least splanchnics arise from the twelfth dorsal ganglia and pierce the diaphragm to end in the renal plexuses.

The Spinal Cord and its Membranes.

The spinal portion of the nervous system occupies the spinal or neural canal from the foramen magnum to the first lumbar vertebra. It does not *fill* the spinal canal, but between it and the canal boundaries, the membranes and a quantity of loose areolar tissue intervene. The boundaries of the canal are as follows: in front, the bodies of the vertebræ and the intervertebral substances; laterally, the pedicles, between which are the intervertebral foramina for the spinal nerves; posteriorly, the laminæ, with the ligamenta subflava filling up the gaps between.

Within the bony boundaries are:

1. The periosteum, differing from that met with in the cranium, inasmuch as it is separated from the dura mater by:

2. Loose areolar tissue, consisting of a delicate connective-tissue with much serous fluid in its meshes, and with an extensive system of veins—the meningo-rachidian. (*See* below.)

3. The dura mater possesses similar functions of protection in regard to the nervous structures as it does in the brain (*q. v.*).

Above it is attached around the margin of the foramen magnum; but throughout the canal it is separated from the periosteal layer by the loose areolar tissue just mentioned. Over the cord itself it is but loosely attached, so that it behaves as a sheath or *theca.* On each side two openings exist for the passage of the two roots of each spinal nerve. The membrane is continued over the nerve-roots, and becomes continuous beyond with the nerve-sheaths; it is also connected to the periosteum at the margins of the intervertebral foramina by loose areolar tissue.

4. The subdural space between the dura mater and the arachnoid contains but a very small quantity of fluid.

5. The arachnoid is in the main of the same nature as, and bears similar relations to, that met with in the brain. An imperfect septum is met with on either side, termed the *ligamentum denticulatum.* This ligament consists of tooth-like processes passing across the subdural space. It is caused by fine processes of fibrous tissue passing from the pia mater to the dura mater, and having a tooth-like sheath prolonged on it from the arachnoid. There are in all twenty-one pairs of processes; the first is attached to the margin of the foramen magnum, and the last to the first lumbar vertebra. Opposite each vertebra between these two limits a denticulate process is met with. Examine any one of these, and it will be found that it is midway between two nerves from above downwards, and in a line between the anterior and posterior roots of the nerves immediately above and below.

6. The subarachnoid space is ample, and contains the bulk of the cerebro-spinal fluid. It is traversed by the roots of the spinal nerves, the ligamenta denticulata, and processes of connective-tissue. Of these processes, one in the middle line behind—the *septum posticum* is the most distinct; but *lateral trabeculæ* of the same tissue support the posterior roots of the nerves.

7. The pia mater acts as a neurilemma; it is thicker, less vascular, but more firmly adherent to the cord than in the brain. The membrane dips into the anterior and posterior median fissures of the cord; it is gathered together into a distinct band in front, named the *linea splendens,* and also prolonged on the roots of the nerves to their sheaths. The behaviour of the membranes at the lower end of the spinal cord is as follows:

The pia mater is continued from the apex of the conus medullaris as the *filum terminale,* which descends as a glistening cord amongst the nerves of the cauda equina. It becomes blended with the arachnoid, and pierces the dura mater opposite the second sacral vertebra; from the dura mater it receives an investment, and passes to be inserted to the periosteum at the base of the coccyx.

The *veins* of the spinal cord are in four sets.

1. The meningo-rachidian veins run in the loose areolar tissue between the periosteum and dura mater. They consist of four longitudinal columns of veins occupying the four angles of the canal. They unite by frequent anastomoses, and receive the following:

2. The venæ basis vertebræ escape from the posterior part of the bodies of the vertebræ, and on either side of the anterior common ligament join the anastomosing branch between the two anterior meningo-rachidian columns of veins.

3. The dorsi-spinal veins pass from the region of the spinous processes of the vertebræ, penetrate the ligamenta subflava, and join the crossing branch between the two posterior meningo-rachidian veins.

4. The medulli-spinal veins pass from the spinal cord along the nerve-roots to join the meningo-rachidian.

Laterally the meningo-rachidian veins join the intercostals.

The SPINAL CORD, or medulla spinalis, is in all about eighteen inches long. Above, it is continued into the medulla oblongata; below, it contracts to a point, the *conus medullaris*, and is continued for some distance into the filum terminale.

The cord in its fœtal state occupies the entire length of the spinal canal; at birth, however, it reaches only to the third lumbar; whilst in the adult state it is still shorter, descending only as far as the first lumbar. Two *swellings* exist in it—viz., the cervical and lumbar. The cervical enlargement extends from the first cervical, to the second dorsal vertebra; the lumbar enlargement commences at the tenth, and ends at the twelfth dorsal vertebra.

On section in the dorsal region the cord is, like the canal, nearly circular; it is, however, in all parts a little broader than it is deep.

Naked-eye examination of the cord shows that, in contradistinction to the brain, the white matter is on the surface, and the grey matter within. Two fissures divide the cord first into two equal portions, and sub-fissures apportion either side into columns.

The *fissures.* The *anterior* median fissure is of a fair width, with a reflection of the pia mater dipping into it; in depth it reaches one-fourth of the thickness of the cord, extending as far as the white commissure. The *posterior* median fissure, a mere slit, admits a septum of the pia mater; in depth it reaches one-half of the thickness of the cord, extending as far as the grey commissure.

Laterally the fissures or depressions met with mark off the *columns.* From before backwards the following are indicated: 1. The anterior column of the cord. 2. The antero lateral groove, corresponding to the giving off of the anterior roots of the nerves. 3. The lateral column. These two columns are usually called the antero-lateral column, and the fissure mentioned as existing between them is mostly a theoretical one. 4. The postero-lateral groove is well marked. It corresponds to the giving off of the posterior roots of the spinal nerves from the cord. 5. The posterior column. 6. The groove between the posterior, and 7. The posterior median column.

The grey matter of the cord is seen, on section, to consist of symmetrical portions in either half, joined together by a grey commissure. In the centre of the grey commissure the central canal can be seen when a thin section is taken ; this canal is rudimentary in the adult, but above it expands to form the fourth ventricle.

The grey matter, looked at as a whole, presents on section :

1. Two rounded prominences, the anterior cornua, extending forwards towards, but falling short of, the antero-lateral groove ; the motor roots emerge opposite, but not immediately from, these cornua.

2. Two rather sharp prominences, the posterior cornua, extend backwards and outwards, closely approaching the postero-lateral groove. The fibres of the posterior nerve-roots are immediately connected with the posterior cornua.

The posterior cornua have a slight eminence or *caput cornu* at their extremities, immediately beneath (*i.e.*, in front of) which a constricted portion or *cervix* exists.

The crescentic appearance of either half of the grey matter is interrupted by tracts of grey matter extending longitudinally. The mass on the outer side of the crescent, sometimes called the middle cornu or intermedio-lateral tract, and the mass within the posterior cornu, the posterior vesicular column (Clarke), are met with on the outer and inner aspects of the crescent respectively.

Between the two halves of the cord the white and grey commissures are seen. The white, at the bottom of the anterior median fissure, unites the anterior columns ; the grey, at the bottom of the posterior median fissure, with the central canal in its centre, are all the structures met with in the median line.

It is beyond the scope and function of this work to trace accurately the fibres of the spinal cord ; but some knowledge is necessary to follow the connections of the various parts of the brain, etc.

A well-proved fact is that of the crossing of the nerve-fibres of both the motor and sensory roots. Although the anterior columns of the cord and the anterior pyramid of the medulla seem continuous on the surface, yet the main part of the fibres of the anterior pyramid of the medulla—the pyramidal tract—crosses at the upper limit of the spinal cord, forming the *decussation of the pyramid*, and descends in the posterior part of the lateral column. The bundle is then named the lateral, or *crossed part of the pyramidal tract*, and can be traced to the lower end of the cord. Some of the fibres of the pyramidal tract in the medulla do not cross at the accepted point of decussation, but continuing on the margin of the anterior median fissure, as the *uncrossed portion of the pyramidal tract*, become gradually smaller until it disappears at the lower end of the dorsal region. The *direct cerebellar tract* lies immediately upon the crossed pyramidal, *i.e.*, lies nearer the surface at the posterior part of the lateral column. On the margin of the posterior median fissure is the *posterior median column*, or Goll's tract, a set of connecting fibres which proceed from the posterior vesicular column of Clarke. Other fibres of the cord are: connecting fibres between opposite sides of the cord; crossing fibres of nerve-roots; and fibres proceeding between cells at different levels in the same side of the cord. Hence the spinal cord, named according to the tracing of its fibres, would be, at the level, say, of the first dorsal vertebra from before backwards: (1) The uncrossed portion of the fibres—the direct pyramidal tract (Türck). (2) A mass of white tissue involving the outer part of the anterior column and the anterior part of the lateral tract from which the anterior, or motor, roots of the spinal nerve arise. (3) The direct cerebellar tract. (4) The crossed or lateral pyramidal tract, partly concealed and partly reaching the surface behind the former. Both 3 and 4 are found at the posterior part of the lateral column immediately in front of the giving off of the posterior, or sensory, roots of the spinal nerve. (5) Behind the posterior roots a bundle of fibres continuous with the posterior nerve-roots; and (6) Goll's tract at the margin of the posterior median fissure.

Of the fibres of the medulla oblongata, those of the anterior pyramid are continued up through the pons as the anterior layer of longitudinal fibres of the pons to the crus cerebri, where they form the anterior, or under, or fasciculated fibres of the crus, to enter the corpus striatum, through which they mostly pass to reach the grey matter on the surface of the cerebrum. As they emerge from the corpus striatum they spread out, forming a fan-shaped mass, slightly bent with the convexity upwards, and named the corona radiata.

The Spinal Nerves.

The spinal nerves arise from the spinal cord by two roots. The anterior roots, the smaller and firmer, are white in appearance and motor in function; they arise between the anterior and lateral columns of the cord from the antero-lateral groove, but the points of origin are not confined to the groove.

The posterior roots, the larger and softer, are grey in appearance and sensory in function, and possess a *ganglionic enlargement* which involves its fibres. They arise from the postero-lateral groove, their fibres being continuous with the multipolar cells of the posterior cornua.

The roots join immediately beyond the ganglion to form the *trunk* of the nerve, which after a very short course—only a few lines—divides into *anterior and posterior primary divisions.* The anterior primary divisions form the nerves of the lateral and front part of the trunk and the nerves to the limbs: also the various plexuses—cervical, brachial, lumbar and sacral. The posterior primary divisions supply the muscles and skin of the back.

The nerves, as they arise from the cord, pass out on either side, to emerge at the intervertebral foramina. The cord, being shorter than the canal in which it lies, must have an effect upon the direction of the nerves on their way to the foramina. Thus the first cervical nerve ascends slightly to its exit; the second goes horizontally outwards; the third, fourth and so on, slope downwards slightly, so that at the eighth cervical they slope for a distance of one vertebra. In the dorsal region this condition obtains, until, at the twelfth dorsal vertebra, they descend for a distance of two vertebræ between the points of their origin and their exit—*i.e.*, the twelfth dorsal nerve comes off opposite the tenth dorsal vertebra.

The lumbar and sacral nerves descend from the cauda equina, *i.e.*, the leash of nerves found at the lower end of the spinal cord, at the first lumbar vertebra, having the conus medullaris in its centre; each successive nerve reaching for a distance of one vertebra lower than its immediate neighbour above.

The ganglia on the posterior roots are situated for the most part in the intervertebral foramina. But below the origin of the fifth lumbar they are situated within the spinal canal in the sacral region.

The Posterior Primary Divisions of the nerve are considered according to the regions in which they are distributed.

I. *The Cervical.*—A typical posterior primary division—say the fourth—in this region, passes from the trunk of the nerve backwards, between the posterior intertransverse muscle and the articular processes of the vertebra, to reach the interval between the complexus and the semi-spinalis muscles. It soon divides into internal and external branches. The external are very small, and end in the muscles attached to the transverse processes; the internal passes backwards to supply the muscles of the back of the neck and the skin.

The peculiarities met with are:

1. The first cervical possesses a posterior branch called the *sub-occipital;* it finds its way from between the occiput and atlas to the sub-occipital triangle, where it is distributed to the rectus capitis posticus major and minor, the superior and inferior oblique, and ends in the complexus. It takes part in the sub-occipital plexus or

plexus of Cruveilhier, situated on the complexus muscle, and composed of posterior branches from the first, second, and third cervical.

2. The posterior division of the second cervical nerve divides, as usual, into two, but the external branch is very small; the internal, the larger branch, passes round the lower border of the inferior oblique muscle, pierces the complexus muscle, and then runs forwards, to pass with the occipital artery, through the aponeurosis between the insertions of the trapezius and the sterno-mastoid muscles on the superior curved occipital line. Onwards the nerve passes to the scalp, where it supplies the skin over the posterior and postero-lateral aspects of the cranium. It supplies part of the inferior oblique muscle, the complexus muscle and the skin of the scalp over the occipital region as already stated.

3. The posterior primary divisions of the sixth, seventh, and eighth nerves never reach the skin of the back; they end in the muscles in their neighbourhood.

II. *The Dorsal.*—Each typical posterior primary division of a spinal nerve in the dorsal region, passes backwards from the trunk of the nerve between the anterior costo-transverse ligament and the articular process; it ends by dividing into two branches, an inner and outer. In the upper six dorsal nerves the internal is the larger, but in the lower six the external branch is the larger. The nerves reach the skin, and supply the muscles in the vertebral groove.

Peculiarities:

The internal branch of the second dorsal nerve is very large, and passes outwards beneath the skin as far as the spine of the scapula.

III. *The Lumbar.*—As in the dorsal, these nerves divide into internal (smaller) and external (larger) branches, supplying the skin and muscles, and reaching over the brim of the pelvis to the skin in the gluteal region.

IV. *The Sacral.*—The posterior primary divisions of the sacral nerves emerge from the sacral spinal canal by the posterior sacral foramina. The external branches of the upper three, on emerging, immediately form a plexus over the sacrum; the branches, from which enter the substance of the gluteus maximus muscle, and forming there a second plexus, are finally distributed to the skin over the sacral and neighbouring gluteal regions. The nerves below the third, including the coccygeal, are but small, and end deeply in the muscles.

The Anterior Primary Divisions of the Spinal Nerves.

The trunk, in front of the vertebral column and the limbs, is supplied by these nerves. In the cervical, brachial, lumbar and sacral regions plexuses are formed; but in the dorsal region they behave as typical nerves having no plexuses.

The anterior primary divisions of the *cervical* nerves (except the first), on their emergence from the trunk of the nerve at the intervertebral foramina, pass outwards behind the trunk of the vertebral artery, and between the two intertransverse muscles; it rests in a groove on the upper surface of the transverse process.

The peculiarities of the first and second cervical nerves are described, before the account of the plexuses is proceeded with.

The *first cervical nerve* is peculiar in many ways. It ascends to its exit from the spinal canal; its posterior root is smaller than its anterior; it comes out behind the articular processes of the atlas; its anterior division is peculiar (*q.v.*); the posterior division is larger than the anterior.

The trunk of the nerve is continued outwards underneath the vertebral artery as it lies on the atlas; changing its direction, it passes forwards internal to the rectus capitis lateralis, between which and the rectus capitis anticus minor it appears above the transverse process of the first vertebra, and in front of which it descends to form a loop with the second. It supplies muscular branches to the rectus capitis lateralis, the rectus capitis anticus—major and minor.

Filaments pass from the loop to the vagus, hypoglossal and sympathetic.

The *second cervical nerve* is also peculiar, inasmuch as it emerges behind its articular processes. All other spinal nerves emerge through the intervertebral foramina, which, of course, lie in front of the articular processes.

The Cervical Plexus.

The upper four cervical nerves form, by their anterior divisions, the cervical plexus. The nerves appear between the middle scalene and rectus capitis anticus major, and under cover of the sterno-mastoid, where they form a plexus. Each nerve (except the first) gives upwards and downwards a branch to form loops, from which the nerves arise. Each nerve is connected by a filament with the upper cervical sympathetic ganglion.

The plexus consists of two sets of branches, named the superficial and deep.

From the *superficial cervical plexus* are given off the following:

1. The small occipital nerve arises from the second and third nerves, ascends under cover of the posterior border of the sterno-mastoid until near the scalp, where it perforates the deep fascia to supply the scalp behind the ear; an auricular branch goes to the back of the ear.

2. The great auricular nerve arises from the second and third cervical nerves; it winds round the posterior border of the sterno-mastoid, and ascends on that muscle towards the lobule of the ear.

It ends in auricular, mastoid, and parotid branches, supplying the skin in the regions indicated.

3. The superficial cervical nerve turns round the posterior border of the sterno-mastoid, and, running forwards on that muscle, divides into an ascending and descending branch; the former joins with the infra-maxillary branch of the facial, the latter supplies the skin as low as the sternum. Each branch supplies offsets to the platysma.

4. The supra-clavicular nerves (three in number) arise from the third and fourth, and descend in the posterior triangle of the neck. Just above the clavicle they perforate the deep fascia and suddenly separate; they are named from before backwards the sternal, clavicular, and acromial branches. They supply the skin in the regions indicated by their names.

The *deep cervical plexus* consists of an internal and external series.

The Internal Series.—1. Connecting branches pass from the loop between the first and second nerves to the vagus, hypoglossal, and sympathetic nerves.

2. Muscular branches supplying the prevertebral muscles.

3. Two branches from the second and third nerves descend and pass forward over the carotid sheath, to join the descendens noni, to form the ansa hypoglossi. From this plexus muscular branches pass to the sterno-hyoid and sterno-thyroid muscles, and both bellies of the omo-hyoid muscle.

4. The phrenic nerve arises from the fourth cervical, with an additional branch from either the third or fifth.

The nerve descends upon the anterior scalene muscle, crosses the subclavian artery whilst lying on that muscle, and enters the chest by crossing to the inner side of the internal mammary artery. In the chest it lies in the middle mediastinum, against the side of the pericardium, and in front of the root of the lung, until it reaches the diaphragm; there it breaks up into branches which pierce the diaphragm and are distributed on its under surface; it there communicates with the sympathetic, a ganglion being formed on the right side.

The left nerve is the longer, owing to (1) the diaphragm descending lower on the left side; (2) the pericardium carrying it to the left; (3) and the fact of the nerve having to cross the aortic arch. The phrenics receive at the root of the neck communicating branches from the nerve to the subclavius and the descendens noni (best traced on the right side). Besides supplying the diaphragm, they give branches to the pericardium and pleuræ, and the right nerve distributes filaments to the superior and inferior venæ cavæ.

The *External Series* gives off chiefly muscular branches supplying the sterno-mastoid, the trapezius, the levator anguli scapulæ and the middle scalene muscles; also communicating to the spinal accessory.

The Brachial Plexus.

This plexus is formed by the anterior primary divisions of the fifth, sixth, seventh, and eighth cervical, and first dorsal, spinal nerves. The fifth and sixth unite to form a cord, which is joined by the seventh; the eighth cervical and first dorsal also join to form a cord, so that, as the plexus passes beneath the clavicle, there are only two cords. Beneath the pectoralis minor, however, the two cords divide to form three terminal sets—the outer, posterior, and inner cords of the brachial plexus.

A. *Above the Clavicle.*—The nerves, as they leave the transverse processes of the vertebræ, lie between the anterior and middle scalene muscles; the intermingling of the nerves is at once formed, and together they pass outwards and downwards upon the middle and posterior scalene muscles, and behind the third stage of the subclavian artery. The plexus is met with in the subclavian triangle, and when the arm is depressed the cords may be seen and felt, forming a ridge on the surface of the triangle. The branches given off are:

1. The nerve to the rhomboid muscles comes from the fifth cervical; it passes backwards through the substance of the middle scalene muscle and beneath the levator anguli scapulæ to the anterior surface of these muscles.

2. The nerve to the subclavius comes from the cord formed by the fifth and sixth; it runs downwards and forwards across the third stage of the subclavian artery, to reach the muscle beneath the clavicle; it has a communicating branch with the phrenic on the right side.

3. The posterior thoracic, or external respiratory nerve of Bell, comes from the fifth and sixth nerves by two roots; it descends behind all the cords of the brachial plexus, drops down into the axilla, and is found there along the inner wall lying on the serratus magnus, which it supplies with filaments until it finally ends near its lower border.

4. The supra-scapular nerve arises from the cord formed by the union of the fifth and sixth cervical; it passes outwards across the side of the neck parallel to the clavicle, until it reaches the upper border of the scapula, where it runs through the supra-scapular foramen to the supra-spinous fossa; it here passes beneath the supra-spinatus muscle, supplying it; then round the base of the spine of the scapula to the infra-spinous fossa, where it ends in the infra-spinatus muscle. It also gives branches to the shoulder-joint.

5. Small branches from the lower cervical nerves go to the scalene muscles and the longus colli.

B. As the two cords pass *beneath the clavicle*, a branch from each unites to form an arch across the axillary vessels, and from this the internal and external anterior thoracic, which supply the *pectorales major* and *minor*, are derived.

1. The internal anterior thoracic nerve comes forward between the first stage of the axillary vein and artery; it supplies and pierces the pectoralis minor to reach the major.

2. The external anterior thoracic nerve appears at the outer side of the artery, and pierces the costo-coracoid or clavi-pectoral fascia, to reach the pectoralis major.

C. *Beneath the pectoralis minor* the cords resolve themselves into their three terminal trunks—one to the outside, a second to the inside, and a third behind the axillary artery.

I. The outer cord of the brachial plexus gives off:

1. The external cutaneous, called also the musculo-cutaneous or, from the fact of its perforating the coraco-brachialis muscle, the perforans Casserii, runs outwards and downwards on the outer side of the axillary artery. It perforates the muscle named, just below the shoulder-joint; it then finds itself beneath the biceps, beneath which it passes downwards until near the elbow-joint, where it lies between the biceps and the supinator longus. It supplies three muscles: (*a*) *the biceps;* (*b*) *the coraco-brachialis;* and (*c*) *the brachialis anticus.* It becomes cutaneous about two inches below the elbow-joint, when it divides in two, an anterior and posterior branch, running along the outer side of the forearm, to end on the ball of the thumb.

2. The outer head of the median. (*See* Median Nerve.)

II. the inner cord of the brachial plexus gives off the inner head of the median, the ulnar nerve, the internal cutaneous, and the lesser internal cutaneous.

The Median Nerve arises by two heads—one from the outer, one from the inner cord of the plexus. The two heads meet upon a plane anterior and external to the third part of the axillary artery; the inner head of the median is consequently the one which crosses the axillary artery, and therefore the longer.

In the Arm.—The nerve when formed descends first on the outer side of the axillary and then the brachial arteries; it crosses the brachial artery in the middle of the arm opposite the insertion of the coraco-brachialis, and descends along the inner side of the artery as far as the bend of the elbow, where it lies one-third of an inch to the inner side of the arterial trunk. There are no branches given off from the nerve in the arm.

In the Forearm.—The median nerve enters the forearm by passing between the two heads of the pronator radii teres; it keeps still a straight or middle course down the forearm, between the superficial and deep layers of muscles, actually lying between the flexores sublimis et profundus digitorum; it crosses the ulnar artery from within outwards, about two inches below the elbow. At the wrist it lies to the outer side, but partly under cover, of the palmaris longus tendon, and passing beneath the annular ligament it reaches the palm of the hand, where it breaks up into its terminal branches.

The branches given off in the forearm are: (1) muscular to the pronator radii teres, the flexor carpi radialis, the palmaris longus, and the flexor sublimis digitorum; (2) the anterior interosseous nerve, which descends on the interosseous membrane, between the flexor profundus digitorum and the flexor longus pollicis, supplying both, and ending in the pronator quadratus; (3) a palmar cutaneous branch is given off about two inches above the wrist; it crosses the anterior annular ligament on its way to the skin of the palm.

In the Hand.—The median nerve appears on a plane deep to the superficial palmar arch, but upon the flexor tendons. It consists at first of two branches, but these resolve themselves into five, viz.: two to the thumb, one to the outer side of the index-finger, one to the adjacent sides of the index and middle, and one to the adjacent sides of the middle and ring fingers. These nerves, on their way to the fingers, supply the following muscles: the abductor pollicis, the opponeus pollicis, the outer head of the flexor brevis pollicis, and the two outer lumbricales. The digital nerves on the sides of the fingers are on a plane anterior to the digital arteries.

THE ULNAR NERVE.—This nerve seems to be the continuation of the inner cord of the plexus.

In the axilla and arm the nerve is first on the inner side of the axillary, and then the brachial artery. Half-way down the arm it leaves the brachial artery, in company with the inferior profunda artery, to pierce the fascia upon the internal supra-condyloid ridge of the humerus, and reach the back of the internal condyle. As it crosses the elbow-joint it is imbedded in a small quantity of fat. It gives off no branches in the arm.

In the Forearm.—The nerve is continued to the forearm beneath the fibrous arch which passes between the humeral and ulnar heads of the flexor carpi ulnaris. It descends in the forearm upon the flexor profundus digitorum, and for the upper half beneath the flexor carpi ulnaris. It accompanies the ulnar artery along its lower two-thirds, lying on its inner side. The branches given off are: (1) a branch to the elbow-joint; (2) muscular branches to the flexor carpi ulnaris and the inner half of the flexor profundus digitorum, given off immediately below the elbow-joint; (3) a dorsal cutaneous branch, given off two inches above the wrist, passes backwards beneath the tendon of the flexor carpi ulnaris to the back of the hand, where it becomes cutaneous, and supplies one and a half inner fingers on their dorsal aspects; (4) a small palmar cutaneous branch is given off from the nerve about two inches before it reaches the wrist; it crosses the anterior annular ligament to reach the palm.

At the wrist the ulnar nerve crosses the anterior annular ligament lying between the pisiform bone and the ulnar vessels.

In the hand the nerve consists of a superficial and deep branch. The superficial branch is continued forwards to supply the fifth and the inner half of the fourth finger; it supplies the palmaris brevis and the two inner lumbricales. The deep branch passes down with the deep branch of the ulnar artery between the flexor brevis and the abductor minimi digiti; it follows the deep branch of the artery and the deep palmar arch. The nerve supplies (*a*) the muscles of the little finger, the abductor, the flexor brevis, and the opponens minimi digiti; (*b*) the dorsal and palmar interossei muscles; and (*c*) the inner muscles of the thumb, the adductor, and half the flexor brevis pollicis.

The *internal cutaneous nerve*, a branch of the inner cord, lies at first internal to the axillary artery, but on reaching the arm it lies on a plane anterior to the brachial. It becomes cutaneous two inches above the inner condyle of the humerus, crosses the elbow in relation with the median basilic vein, and, dividing into the anterior and posterior branch, supplies the skin as far as the wrist.

The *lesser internal cutaneous nerve*, the nerve of Wrisberg, arises from the inner cord, above and internal to the internal cutaneous; it becomes cutaneous in the axilla, and supplies the arm and axilla where they touch when the arm is adducted.

III. The posterior cord of the brachial plexus gives off—in the axilla:

1. The three subscapular nerves to the subscapularis, latissimus dorsi, and teres major muscles. The long branch supplies the latissimus dorsi, the short branch supplies the subscapularis, whilst the nerve to the teres major gives a branch also to the subscapularis.

2. The circumflex nerve passes through the quadrilateral space behind the humerus, to supply the deltoid and teres minor muscles. It divides into two branches, an upper and lower. The upper branch supplies the deltoid and the skin of the back of the shoulder. The lower branch supplies the deltoid, the skin, and the teres minor; upon the branch to the teres minor is a gangliform enlargement.

3. The Musculo-Spiral Nerve seems to be the continuation of the posterior cord. It descends behind the axillary artery, and reaching the arm, leaves the brachial artery with the superior profunda artery to enter the musculo-spiral groove. After the nerve emerges on the outer side of the groove, it lies between the supinator longus and the brachialis anticus. It is half an inch external to the biceps tendon at the bend of the elbow. Opposite the neck of the radius it ends as the radial and posterior interosseous nerves.

In the arm, the nerve is divided into three stages, according to its relation to the musculo-spiral groove and triceps muscle. *Before* it enters the groove it gives off one cutaneous branch to the inside of the arm, and two muscular branches to the outer and long heads of the triceps. *In* the groove it gives off two muscular branches, one to the inner head of the triceps, the other to the anconeus. *After* it emerges from the groove, the nerve lies between the supinator longus and the brachialis anticus, where it supplies two cutaneous branches, and two muscular branches to the supinator longus and extensor carpi radialis longior. A third branch is sometimes given off to the brachialis anticus.

The cutaneous branches: (*a*) the inner supplies the skin as low as the inner condyle of the humerus; (*b*) the outer two are named upper and lower; the upper, the smaller, descends over the elbow parallel to the cephalic vein, and ends about the elbow-joint; the lower extends as far as the wrist on the posterior aspect of the forearm.

(*a*) The Radial Nerve seems to be the continuation of the musculo-spiral. It commences on a level with the outer condyle of the humerus, runs down beneath the supinator longus, and joins the radial artery in its middle third. Three inches above the wrist, however, it leaves the artery and turns backwards beneath the tendon of the supinator longus, to become cutaneous on the radial aspect of the back of the wrist; it there divides into branches which supply digital offsets to three and a half fingers on their dorsal aspect, commencing at the thumb. The nerves, however, supply the dorsal aspects of the fingers named no farther than the first phalanx, except in the case of the thumb; the median nerve beyond this supplying both front and back.

(*b*) The Posterior Interosseous Nerve is the larger of the divisions of the musculo-spiral; it commences at the bifurcation of that nerve and perforates the supinator brevis muscle to reach the back of the forearm. It there descends between the superficial and deep layers of the extensor muscles, until it sinks at the middle of the forearm, between the primi and secundi internodii pollicis to reach the interosseous membrane; whereon it descends to end in a gangliform enlargement on the back of the wrist-joint.

The branches are: (*a*) Muscular to the extensor carpi radialis brevior, the supinator brevis (these are given off before the nerve perforates the muscle), the extensor communis digitorum, the extensor minimi digiti, the extensor indicis, the extensor carpi ulnaris, the extensor ossis metacarpi pollicis, the extensores primi and secundi internodii pollicis. (*b*) Articular branches are distributed from the terminal enlargement to the carpal articulations.

The Dorsal Nerves.

The anterior primary divisions of the dorsal nerves, twelve in number, behave for the most part as typical nerves. Taking, say, the *fifth* nerve as a type, its anatomy is as follows:

The anterior primary division, four times larger than the posterior, passes outwards to the intercostal space between the fifth and sixth rib, but is close under cover of the lower border of the fifth rib. It courses outwards between the intercostal muscles, accompanying the intercostal bloodvessels, and arrives between the costal cartilages in front, where, near the edge of the sternum, it comes to the surface by piercing the pectoralis major muscles.

The branches are:

1. Muscular, to the intercostals, levatores costarum, and triangularis sterni muscles.

2. The lateral cutaneous branch, given off about half-way forwards, pierces the external intercostal muscle, and divides into anterior and posterior branches which supply the skin.

3. The terminal cutaneous branches given off on either side of the sternum are: an internal (small) and an external (large) branch. Communicating filaments, two in number, join the anterior primary division of the nerve from the thoracic ganglia of the sympathetic.

The special nerves are:

1. The first dorsal goes up to join the eighth cervical, ascending over the neck of the first rib. It drops a small branch to the first space however, before it joins the brachial plexus, which supplies the muscles in the first intercostal space but gives no cutaneous branches.

2. The lateral cutaneous branch of the second dorsal is peculiar, inasmuch as its posterior branch. under the name of the *intercosto-humeral*, crosses the axilla and supplies the skin upon the inner and posterior aspect of the arm in the upper half.

3. The last dorsal nerve is below the level of the last rib. It accompanies the first lumbar artery behind the kidney and upon the quadratus lumborum muscle; it then perforates the posterior aponeurosis of the transversalis muscle, and runs forwards between the abdominal muscles, to end as do the other abdominal intercostal nerves. The lateral cutaneous branch of this nerve runs across the

crest of the ilium, to supply the skin in the gluteal region as low down as the great trochanter.

The upper six dorsal nerves differ in some points from the lower.

In the first place, the upper six are distributed solely to the thorax —the *upper or pectoral* intercostal nerves; the lower six have their anterior ends continued to the abdomen—the *lower or abdominal* intercostal nerves. In the second place, the upper nerves are above their corresponding intercostal arteries, whilst the lower pursue a course below them. Thirdly, the lower six run along the abdominal wall, between the internal oblique and transversalis muscles, until they reach the outer edge of the rectus, through which they pass to reach the skin.

THE LUMBAR NERVES.

On leaving the intervertebral foramina these nerves emerge behind the psoas muscle, and all except the last is concerned in the formation of the lumbar plexus. A filament from the twelfth dorsal descends to join the first lumbar; a filament from the fourth lumbar descends to join the fifth to form the lumbo-sacral cord. Each nerve is joined by two sympathetic branches.

The LUMBAR PLEXUS OF NERVES is formed of branches derived from the first, second, third, and part of the fourth lumbar nerves. The plexus is under cover of the psoas muscles, and there divides into three sets: (α) one appearing to the outer side of that muscle— the ilio-hypogastric; the ilio-inguinal; the external cutaneous; and the anterior-crural; (β) a second coming through the psoas—the genito-crural; (γ) a third set passing down internal to the psoas— the obturator nerve.

I. The ILIO-HYPOGASTRIC AND ILIO-INGUINAL NERVES pass outwards beneath the kidney, pierce the lateral muscular wall of the abdomen and drop a branch each over the crest of the ilium to the skin of the gluteal region; the terminal trunks continue forwards to become cutaneous—the ilio-hypogastric immediately above the external abdominal ring, the ilio-inguinal by passing through the external abdominal ring.

II. The EXTERNAL CUTANEOUS NERVE from the second lumbar passes outwards from beneath the psoas, and, descending, crosses the iliac fossa, passes beneath Poupart's ligament to become cutaneous one inch below that ligament by perforating the fascia lata. It supplies the skin as low as the knee upon the external antero-lateral aspect of the thigh. A large cutaneous branch to the gluteal region passes backwards as soon as the nerve becomes cutaneous.

III. Th ANTERIOR CRURAL NERVE is formed of branches from the second, third, and fourth lumbar nerves. It passes down under cover of the outer edge of the psoas muscle in the abdomen, and enters the thigh beneath Poupart's ligament, between the psoas and iliacus muscles. (α) Within the abdomen it gives off branches to the psoas and iliacus muscles. (β) Whilst lying beneath Poupart's ligament, it gives a branch to the outer half of the pectineus muscle, the branch passing behind the sheath of the femoral vessels. (γ) Immediately it enters the thigh, it divides into cutaneous and muscular branches.

The *cutaneous* branches are the middle and internal cutaneous, and the internal saphenous. The *middle* cutaneous comes through the fascia lata, three inches below Poupart's ligament, as two branches, and supplies the anterior and inner aspect of the thigh; it ends below in the patellar plexus The *internal cutaneous* comes through the fascia lata as two separate branches—one one-third of the way down the inner aspect of the thigh, the other two-thirds of the way down. It supplies the skin on the inner aspect, and ends in the patellar plexus.

The *internal saphenous* nerve descends first on the outer side of the femoral artery, then enters Hunter's canal, where it lies anterior to the artery, and emerges from the canal by perforating the fascia of its roof opposite Hunter's opening. There it finds itself beneath the sartorius muscle, where it gives off a branch to perforate that muscle on its way to the patellar plexus, whilst the main trunk escapes from behind the sartorius muscle, just below the knee-joint, and pierces the deep fascia. The nerve then passes down on the inner side of the leg, to end, by a few scattered branches, in front of the ankle-joint.

The *muscular* branches supply the extensors of the knee and the flexors of the hip. Inside the pelvis, as mentioned above, the iliacus and psoas receive branches therefrom. In the thigh it supplies the following: (1) the rectus femoris; (2) the vastus externus; (3) the vastus internus; (4) the crureus; (5) the subcrureus; (6) the pectineus receives a branch to supply its outer half. The points at which these nerves enter the muscles will be understood from the accompanying plates.

IV. The Genito-Crural Nerve arises from the loop between the first and second lumbar, comes through the psoas muscle, and descends upon the sheath of the muscle until close to Poupart's ligament, where it divides into two branches: 1. The genital branch enters the internal abdominal ring and descends through the inguinal canal and external abdominal ring to supply the cremaster muscle. 2. The crural branch passes beneath Poupart's ligament, pierces the femoral sheath, and supplies the skin immediately below the centre of Poupart's ligament. Finally, it inosculates with the middle cutaneous nerve.

V. The OBTURATOR NERVE comes from the lumbar plexus (third and fourth), runs down inside the psoas, and across the side of the true pelvis to gain the obturator foramen. It passes through the foramen, in a groove above the membrane, with the vessels. The nerve then divides into two main branches, superficial and deep, being superficial and deep to the adductor brevis. (*a*) The superficial branch passes above the obturator externus, and then down the thigh between the adductor longus in front and the brevis behind. It supplies: (1) the adductor longus; (2) the gracilis; (3) adductor brevis in part; (4) pectineus in part. (*b*) The deep branch comes from the obturator foramen, through the obturator externus, and passes down the thigh between the adductor brevis in front and the magnus behind. It supplies: (1) the obturator externus; (2) the adductor magnus; (3) the adductor brevis in part. The nerve just above Hunter's opening perforates the adductor magnus to reach the popliteal artery, by which it is conducted to the back of the knee-joint. A filament is given to the hip-joint by the superficial branch.

The *accessory obturator* nerve (when present) is given off from the obturator just after its commencement; it descends parallel to the parent trunk, but goes over instead of under the horizontal ramus of the pubes, and finally joins the superficial branch of the obturator in the thigh; it gives off a branch to the inner part of the pectineus, and another to the hip-joint.

SACRAL AND COCCYGEAL NERVES.

The anterior primary divisions of the sacral nerves emerge from the vertebral foramina by the anterior sacral foramina, and of these the first, second and third, and greater part of the fourth, collect at the back of the pelvis and in front of the pyriformis muscle, to form the sacral plexus. Of these more anon; but it is necessary to describe the parts of the fourth, the fifth, and coccygeal nerves, which do not enter into the formation of the plexus.

The *fourth* sacral nerve gives a small branch to join the sacral plexus; its trunk however descends to join the fifth, and supplies muscular and visceral branches. The *muscular* branches go to the levator ani, the coccygeus, and the external sphincter. The branch to the external sphincter perforates the levator ani and runs along the inner wall of the ischio-rectal fossa to reach the muscle. The *visceral* branches supply the bladder and rectum, and communicate freely with the sympathetic nerves to supply all the pelvic viscera.

The *fifth* sacral nerve comes through the coccygeus and descends upon it to the tip of the coccyx, where it goes back through the muscle again, to the skin over the tip of the coccyx.

The *coccygeal* nerve (the sixth sacral) escapes from the spinal canal beneath the cornu of the coccyx and joins the fifth sacral.

The Sacral Plexus is formed by the lumbo-sacral cord—the result of the union of the fifth and a portion of the fourth lumbar nerves—and the first, second, third, and part of the fourth sacral nerves (anterior divisions). There is much less of a plexiform arrangement than in the brachial plexus, and the different nerves are for the most part collected into two cords: a large upper—formed by the lumbo-sacral cord, the first, second, and most of the third nerves—ends in the great sciatic nerve; the small lower, formed by part of the third and part of the fourth nerves, ends in the pudic nerve. The plexus rests on the pyriformis muscle; it is separated from the branches of the internal iliac vessels by fascia; the left plexus has the rectum in front of it.

The *branches* to muscles are: (*a*) To the pyriformis, small twigs mostly from the second nerve. (*b*) The nerve to the obturator internus muscle leaves the pelvis by the great sacro-sciatic notch, winds round the ischial spine, and, entering the pelvis again by the small sacro-sciatic notch, penetrates the inner surface of the muscle. It gives a branch to the superior gemellus muscle. (*c*) The nerve to the quadratus femoris, concealed by the great sciatic nerve, passes beneath the two gemelli and the tendon of the obturator internus to reach the anterior surface of the muscle. It gives a branch to the gemellus inferior muscle and the hip-joint. An articular branch goes direct from the plexus to the hip-joint.

The other branches are: superior and inferior gluteal nerves, small and great sciatic nerves, and the pudic nerve.

The Superior Gluteal comes from the lumbo-sacral cord; it leaves the pelvis by the great sacro-sciatic notch above the pyriformis muscle, and immediately divides into two branches, an upper which ends in the gluteus medius muscle, and a lower which runs across the gluteus minimus muscle to end in the tensor vaginæ femoris, after giving branches to the gluteus medius and minimus muscles.

The Inferior Gluteal, arising from the lumbo-sacral cord, the first and second sacral nerves, leaves the pelvis at the lower border of the pyriformis muscle, and divides into branches which enter the gluteus maximus muscle. The inferior gluteal nerve is usually described as coming from the small sciatic.

The Small Sciatic Nerve arises from the second and third sacral nerves, receiving also a branch from the inferior gluteal. Leaving the pelvis by the great sacro-sciatic notch below the pyriformis muscle, it descends beneath the gluteus maximus muscle, and upon the great sciatic nerve. Halfway down the thigh it pierces the fascia lata, and, running across the popliteal space, supplies the skin of the calf, and communicates with the external saphenous nerve.

It gives *branches*—(*a*) Gluteal cutaneous supply the skin over the lower and outer part of the gluteus maximus. (*b*) The inferior pudendal nerve (nerve of Sœmmering) turns inwards below the ischial tuberosity and over the hamstring muscles, to supply the skin on the upper and inner part of the thigh and outer part of the scrotum (or the labium in the female). It communicates with the external superficial perineal nerve. (*c*) Femoral cutaneous supply the skin on the back of the thigh.

The Pudic Nerve arises from the third and fourth sacral nerves; it leaves the pelvis between the pyriformis and coccygeus muscles, winds round the ischial spine, with, but internal to, the pudic vessels. Entering the pelvis at the small sciatic notch, it runs forwards in the outer wall of the ischio-rectal fossa, and at the back part of this fossa divides into three branches: (*a*) The *inferior hæmorrhoidal* runs inwards towards the anus, and ends by supplying branches to the skin in this part and the external sphincter. It communicates with the superficial perineal and inferior pudendal. (*b*) The *perineal* nerve runs forwards along the outer wall of the ischio-rectal fossa, and divides into superficial and deep branches. The superficial, two in number, named external and internal. The external (or posterior) runs forwards in the outer part of the perineal space to the scrotum. The internal or anterior runs forwards near the middle line, and dividing into long slender filaments is distributed to the scrotum and root of the penis. The two branches communicate freely, and also with the inferior pudendal and inferior hæmorrhoidal. In the female these nerves are distributed to the labium pudendi. The deep branches are distributed to the muscles, viz., anterior part of the external sphincter and levator ani, transversus perinei (superficial and deep), erector penis, compressor urethræ, and ejaculator urinæ. Also slender filaments are supplied to the corpus spongiosum and corpus cavernosum, some of which reach the urethra. (*c*) The *dorsal* nerve of the penis runs forwards with the pudic artery, gets between the two layers of the triangular ligament, and, after passing between the layers of the suspensory ligament, courses along the dorsum of the penis, supplying branches thereto; the nerve ends in the glans penis. When between the layers of the triangular ligament, it gives off branches to the accelerator urinæ and to the corpus cavernosum. In the female this nerve—very small—is distributed in a similar manner to the clitoris.

The Great Sciatic Nerve is the continuation of the main part of the sacral plexus. It extends from the lower border of the pyriformis to the middle of the thigh, where it divides into internal and external popliteal nerves. At first it rests upon the gemelli, obturator internus tendon and quadratus femoris muscles in the hollow between the great trochanter and ischial tuberosity, and then on adductor magnus muscle. It is covered at first by the gluteus maximus, and then by the biceps muscle. It is accompanied by branches from the sciatic artery.

It gives *branches* to the hamstring muscles and the adductor magnus muscle.

The INTERNAL POPLITEAL NERVE runs down the centre of the popliteal space close below the deep fascia, first to the outer side, then on the top, and finally on the inner side of the popliteal artery; it is the most superficial structure in the space. It gives off: (*a*) Cutaneous branch—the ramus communicans tibialis, to join the ramus communicans fibularis from the external popliteal nerve, to form the external saphenous. This nerve becomes cutaneous half-way down the leg, and runs down along the outside of the foot to the little toe. (*b*) Articular branches—two internal and an azygos, running along with the arteries of the same name. (*c*) Muscular branches, five in number—two to the gastrocnemius, one to the soleus, to the popliteus, and to the plantaris muscles. The nerve to the popliteus hooks around the lower border of the muscle to reach its anterior aspect.

The POSTERIOR TIBIAL NERVE is the direct continuation of the internal popliteal. It runs down, first internally to, then behind, and finally on the outer side of, the posterior tibial vessels to the inside of the ankle, where it lies between the posterior tibial vessels and the flexor longus pollicis. The branches given off supply: (1) the tibialis posticus; (2) the flexor longus policis; (3) the flexor longus digitorum; (4) and the plantar cutaneous reaches the sole of the foot by piercing the internal lateral ligament.

The PLANTAR NERVES, the continuations of the posterior tibial nerve, are two in number, internal and external. The nerves run in the hollow of the arteries; that is, the inner nerve is to the outer side of the internal plantar artery, whilst the outer nerve is on the inner side of the external plantar artery.

I. The *internal plantar nerve* runs along the inside of the foot, in a line parallel with the septum, between the abductor pollicis and the flexor brevis digitorum. It supplies: 1. *Two* muscles in the *first* layer, the abductor pollicis, and the flexor brevis digitorum. 2. *Two* muscles in the *second* layer, the two inner—*i.e.*, the first and second lumbricales. 3. The *two heads* of the flexor brevis pollicis in the *third* layer. 4. *Three and a half* inner toes.

II. The *external plantar nerve* runs outwards, and then forwards along a line parallel with the septum between the abductor minimi digiti and the flexor brexis digitorum. It supplies all the muscles and toes in the sole of the foot not supplied by the internal: 1. In the *first* layer, the abductor minimi digiti. 2. In the *second* layer the accessorius and the two outer (third and fourth) lumbricales. 3. In the *third* layer, the flexor brevis minimi digiti, the transversus pedis, and the adductor pollicis. 4. In the *fourth* layer, the seven interossei muscles. The first and second layers are supplied by the superficial part of the nerve; the third and fourth, by the deep part of the nerve. 5. It also gives a branch to supply the plantar aspects of *one and a half* outer toes—viz., the little toe and half the next.

The External Popliteal Nerve comes from the end of the great sciatic, passes down under cover of the inner edge of the biceps muscle, and between that muscle and the gastrocnemius; it gets finally round below the head of the fibula, to end in its terminal branches. It is said not to be within the popliteal space. *Before*, winding round the head of the fibula; it gives off: (*a*) A cutaneous branch, the ramus communicans fibularis, which runs down to join the external saphenous. (*b*) Articular branches, two external—superior and inferior; these run along with the arteries of the same name. The nerve now passes round, immediately below the head of the fibula between the peroneus longus and the bone, and there divides into anterior tibial and musculo-cutaneous.

At the point of division the recurrent articular nerve is given off, which accompanies the anterior tibial recurrent artery, giving branches to the superior tibio-fibular articulation and to the knee-joint.

1. The Anterior Tibial Nerve runs forwards beneath the extensor longus digitorum to reach the anterior tibial artery, which it accompanies throughout its length; at first the nerve is on the outer side of the artery, then on its front, but at the ankle-joint it is on the outer side again, and in that position accompanies the dorsalis pedis artery to the cleft between the first and second toes. It supplies: (1) the tibialis anticus; (2) the extensor proprius pollicis; (3) the extensor longus digitorum; (4) the peroneus tertius; (5) the extensor brevis digitorum; (6) the adjacent sides of the first and second toes. Just below the ankle-joint the nerve gives off a branch which turns outwards, and beneath the extensor brevis digitorum, and after forming a ganglionic enlargement ends in branches to this muscle and the articulations.

2. The Musculo-Cutaneous Nerve descends in the fibrous septum between the peronei and the extensor longus digitorum muscles. It supplies the peroneus longus and brevis muscles, and

gives cutaneous branches to the lower part of the leg. It perforates the fascia over the fibula in the lower third of the leg, and divides into an external and an internal branch. Both branches cross the anterior annular ligament to reach the dorsum of the foot.

The *internal* branch runs along the dorsum of the foot, and gives one branch to the inner side of the great toe, and another to the contiguous sides of the second and third toes.

The *external* branch runs outwards across the foot, and supplies the contiguous sides of the third and fourth, and fourth and fifth toes, as well as the dorsum and outer part of the foot. These nerves communicate with the internal saphenous on the inner side, and the external saphenous on the outer side of the foot.

The Alimentary Canal.

The Mouth.

The oral cavity is lined throughout by mucous membrane, studded with glands, named labial, molar, and buccal, according to their situation. Beneath the mucous membrane of the floor of the mouth lie the sublingual salivary glands. They can be felt as worm-like bodies by the tip of the tongue on either side. They open by a number of ducts—ducts of Riviniani—into the mouth. The ducts of Wharton from the submaxillary will be found opening on either side of the frænum; the duct of Stenson from the parotid opens opposite the second molar tooth of the upper jaw (*See* Salivary Glands.)

The *gums* (gingivæ) are composed of a highly vascular mucous membrane, submucous tissue and periosteum. The submucous tissue is strong and fibrous, and is tightly connected with the other layers.

The *teeth* are twenty in number in the child—milk-teeth; thirty-two in number in adults—permanent teeth. The named parts of a tooth are the crown, the neck, and the fangs.

The structures that compose a tooth are: (1) Dentine, forming the main mass of the tooth; it is composed of about twenty-eight parts of animal matter, the rest being bone salts. (2) Enamel, covering over the dentine, and forming the crown. It contains only 2 per cent. of animal matter. (3) Crusta petrosa, which resembles true bone, although not possessing Haversian canals; it lines the fangs of the teeth.

Within the tooth is a cavity containing the dental *pulp*. This consists of a fine network of connective-tissue, interspersed in which are fine bloodvessels and nerves. The dental tissues derive nourishment therefrom.

The *milk teeth*, twenty in number, five at either side of each jaw, appear at the following months. Commencing at the central incisor at one side the average times are—7, 9, 18, 12, 24 *months*. They are incisors (2), canine (1), and milk molars (2), *i.e.*, five on either side of either jaw. The *permanent* teeth, thirty-two in number, eight on either side of either jaw, appear at the following years—commencing at the central incisor, the average times are—7, 8, 11, 9, 10, 6, 12, 20 *years*. They are called—incisors (2), canine (1), premolars (2), molars (3). To write a dental formula, take the upper-jaw teeth of one side as the numerator, and the lower-jaw teeth of one side as the denominator, and we have $\frac{2}{2}-\frac{1}{1}-\frac{2}{2}-\frac{3}{3}$ in the adult human jaw.

The *incisors* have chisel-shaped crowns and long conical-shaped fangs.

The *canines* have stout conical crowns, but hollowed behind and convex in front; the fangs are long and conical.

The *bicuspids*, or premolars, have *crowns* which are convex without and within, compressed from before backwards, and possess two tubercles, of which the external is the higher and stouter; the *fang* is notched below so as almost to make a double fang.

The *molars*, or grinders, have cuboid *crowns* convex without and within; the free surfaces bear cusps—four on the molars of the upper jaw, five on the lower molars. The cusps are separated by a crucial depression; on the lower jaw the fifth cusp is placed posteriorly between the two posterior cusps, and rather to the outer side. The *fangs* of the upper molars are three in number—two external, and the third, odd, or palate fang projects inwards towards the hard palate. The lower molars have two fangs deeply notched, placed anteriorly and posteriorly; they present a gradual curve backwards; they seem more like four fangs—the anterior two and posterior two having got fused together.

The wisdom teeth, *i.e.*, the third molars, are irregular in their fangs and crowns.

The Tongue

is composed of voluntary muscular fibres, covered over with mucous membrane, and richly supplied with bloodvessels and nerves. Its fixed points are the genial tubercles on the lower jaw and the hyoid bone.

The *mucous membrane* covers the tongue, being tightly adherent to the upper surface, but more loosely to the lower. The *upper* surface is marked along its anterior two-thirds by a central groove which corresponds to the central septum of the tongue. Scattered over the anterior two-thirds are the *simple*, *filiform*, and *fungiform papillæ*. The simple are not to be distinguished by the naked eye; the filiform give the anterior two-thirds its general velvety appearance; the fungiform are seen as flattened knobs amongst the filiform. The *circumvallate*, usually eight in number, are

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arranged like the letter V at the junction of the middle and posterior thirds. The apex of the V is backwards Λ, and at its point is placed the foramen cæcum. Each circumvallate papilla consists of a circular rim, or vallum of mucous membrane with a central mushroom-like elevation and a fossa or ditch intervening. The mucous membrane behind this shows no papillæ; it is glistening and uneven, and posteriorly it is continued as three folds—a central and two lateral on to the epiglottis, forming the glosso-epiglottidean folds.

The *under* surface of the tongue shows a red, smooth mucous membrane. Centrally, a fold or frænum tying the tongue to the floor of the mouth. On either side are seen large veins—the ranine—and externally to these again, papillary fringes of tissue.

The septum of the tongue is placed centrally; it is composed of fibrous tissues with some fat at the deeper portion. It is seen on perpendicular section to increase in width from above downwards.

The muscles of the tongue are both extrinsic and intrinsic.

I. The extrinsic muscles are: 1. Genio-hyoglossus. 2. Hyoglossus. 3. Stylo-glossus. 4. Palato-glossus. 5. Pharyngeo-glossus—a bit of the superior constrictor. *Five* pairs in all.

II. The intrinsic muscles are: 1. Superficial lingualis, only one muscle. 2. Transverse lingualis—a pair. 3. Inferior lingualis—a pair. *Five* muscles in all.

The extrinsic have been already described. (*See* Muscles.) The intrinsic remain to be described.

The *superficial lingual* muscle consists of a streak of longitudinal fibres running from base to apex, beneath the dorsal mucous membrane. Owing to the septum being indistinct above, the fibres of the muscle are regarded as forming a single layer.

The *inferior lingual* muscles are found on the under surface of the tongue, between the genio-hyoglossus and the hyoglossus muscle. They are connected behind to the hyoid bone by fibrous tissue, and run forwards above the ranine arteries to the tip of the tongue.

The *transverse lingual* muscles arise from either side of the septum, and, finding their way transversely outwards through the ascending fibres of the large extrinsic muscles, are inserted into the borders and dorsum of the tongue.

The *bloodvessels* are the lingual vessels and their branches. The branches of the lingual artery are: Hyoid, dorsalis linguæ, sublingual, and ranine. Counting the lingual trunk, *five* in all.

The *nerves* are: 1. Gustatory. 2. Glosso-pharyngeal. 3. Hypoglossal. 4. Chorda tympani; and 5. Sympathetic. *Five* pairs in all.

The Salivary Glands.

In connection with the lower jaw, three pairs of glands are met with, having for their function the secretion of saliva. They are named sublingual, submaxillary, and parotid. In point of size they ought to be mentioned in the reverse order. The glands are of the compound racemose class, *i.e.*, their ducts on being followed into the glands break up in finer ducts, which ultimately dilate into alveoli or acini. On cutting into the glands they are seen to consist of nodules of yellow gland-substance, separated by a plentiful connective tissue rich in bloodvessels.

The Sublingual Gland is situated in the floor of the mouth, and can be felt by one's own tongue, or seen on the body, to form a ridge between the tongue and the lower gum, reaching from near the middle line in front, backwards to the second molar tooth.

Relations.—Above, the mucous membrane of the mouth; below, the mylo-hyoid muscle, the deep part of the submaxillary gland, Wharton's duct, and the gustatory nerve; internally is the genio-hyoglossus; externally, the lower jaw.

The ducts average about a dozen in number. Some, the *ducts of Rivini*, open directly into the floor of the mouth; others communicate with Wharton's duct; and one specially long duct—the duct of Bartholin—ends near the opening of Wharton's duct on the frenum. The vessels to the gland are derived from the submaxillary and submental branches of the facial.

The Submaxillary Gland is seen in the dissection of the submaxillary region, where it is found between the lower jaw and the digastric muscle. The gland bends round the posterior free margin of the mylo-hyoid muscle in company with the duct. The two run forwards on the upper surface of the mylo-hyoid muscle beneath the sublingual gland, and directly in contact with it. The duct—Wharton's duct—is continued onwards to open on either side of the frenum, about half an inch from the floor of the mouth.

Relations of the Gland.—When the body is in the erect position, the relations are quite changed to those seen on dissection, where the gland is approached from below. Above, the mylo-hyoid, hyo-glossus, and stylo-glossus muscles, and the facial artery; below, the cutaneous structures; externally is the lower jaw, which is grooved to receive it; internally, the anterior belly of the digastric; between it and the parotid gland is the stylo-maxillary ligament. The bloodvessels come from the facial; the deep part receives branches from the lingual.

The Parotid Gland occupies the parotid region. It is the largest of the salivary glands, and has the following relations:—It is *bounded* in front by the ramus of the jaw and the masseter muscle; above, by the zygoma and the external auditory meatus; behind and above, by the mastoid process; behind and below, by the sterno-mastoid muscle, and more deeply by the posterior belly of the digastric. It is separated from the submaxillary gland by the stylo-maxillary ligament, a process of deep cervical fascia. *Over* the gland lie the superficial structures, with the great auricular nerve. *In* the gland are found the facial nerve forming the pes anserinus, beneath the nerve is the temporo-maxillary plexus of veins, and beneath the vein the external carotid artery dividing into its terminal branches. *Beneath* the gland is the styloid process, on which the gland splits, part going forwards with the internal maxillary artery, and part backwards beneath the digastric. The duct of the parotid, *Stenson's duct*, passes across the masseter muscle, and pierces the buccinator muscle opposite the second upper molar tooth. The course of the duct is found by taking a line from the lobule of the ear forwards, to a point midway between the nose and mouth; bisect the line thus drawn, and the posterior half will be found to correspond to the line of the duct. A piece of the gland which lies on the masseter muscle, and above the level of the duct, goes by the name of the socia parotidis.

The TONSIL lies between the anterior and posterior pillars of the fauces, with the soft palate above it, and the tongue below. Externally it rests on the superior constrictor muscle of the pharynx. The arteries supplying it are branches of: 1. The ascending pharyngeal; 2. The ascending palatine; 3. The descending palatine; 4. The tonsillitic; and 5. The dorsalis linguæ.

The *nerve* supplying it is the glosso-pharyngeal, which forms a circle around it—the circulus tonsillaris. The gland possesses a number (twelve to fifteen) of flask-shaped depressions or recesses, lined by epithelium and surrounded by lymphoid tissue in large quantity.

THE PHARYNX

lies at the back of the nose and mouth, communicating with each, and with the œsophagus and larynx below. It reaches upwards to the base of the skull, and down to the commencement of the œsophagus; it measures in depth about five inches. The *muscles* forming it are — constrictors and elevators. Each muscle has been previously described. (*See* Muscles.) The *constrictors* consist of three pairs of muscles — the superior, middle, and inferior. The *elevators* are an external set, the stylo-pharyngeus, a pair of muscles; and an internal set, the salpingo-pharyngeus, connected with the mouth of the Eustachian tube. The muscles are chiefly supplied by the pharyngeal plexus of *nerves;* the pharyngeal *vessels* come from the ascending pharyngeal, and the superior and inferior thyroid. In the pharynx the following *openings* are found, seven in all—two posterior nares, the openings of the two Eustachian tubes, and the openings of the mouth, larynx, and œsophagus.

The mucous membrane of the pharynx is continuous with that of its apertures. Above the soft palate it gives passage only to air; hence it is covered by the ciliated cells characteristic of the respiratory passage proper. Below the soft palate, being for the passage of food as well as air, it partakes of the character found in the upper portion of the digestive tract, and has flattened epithelial cells. The structures of the pharynx, as seen on careful dissection from behind, are best reached by Bichat's section (that is, sawing through the cranium behind the petrous portion of the temporal, and chiselling through the basilar portion of the occiput behind the pharyngeal spine). Examined from behind, the pharynx exhibits: 1. Connective-tissue continuous with the deep cervical fascia, and named, as it ensheaths the pharynx, the post-pharyngeal aponeurosis. 2. The muscular layer formed by the constrictors. 3. The submucous tissue, or the pharyngeal aponeurosis, a stout layer of fascia becoming thicker towards the skull; the post-pharyngeal, on the other hand, getting very thin as it approaches the skull. 4. The mucous membrane. An interesting spot anatomically is the sinus of Morgagni. This is a gap between the upper curved margin of the superior constrictor and the base of the skull, which is closed in by the pharyngeal aponeurosis; through the gap go the levator palati muscle and a branch of the ascending pharyngeal artery; and on opening the sinus from behind, the mouth of the Eustachian tube is seen.

The SOFT PALATE consists of mucous membrane, submucous tissue, and a layer of muscles, with bloodvessels and nerves. It has two surfaces, anterior or inferior, and posterior or superior. The structures of which it is composed are, from behind forward: 1. Mucous membrane. 2. Submucous tissue with glands. 3. Posterior fibres of the palato-pharyngeus. 4. Levator palati. 5. Azygos uvulæ. 6. Anterior fibres of the palato-pharyngeus. 7. Tensor palati. 8. Palato-glossus. 9. Submucous tissue with glands. 10. Mucous membrane. The main mass of the palate is made up of submucous tissue with glands. The muscles have been, one and all, described in their proper places (*see* Muscles), as have the trunks of the vessels and nerves here mentioned. The *bloodvessels* supplying the palate are: the ascending palatine, the descending palatine, and the ascending pharyngeal. The *nerves* are: a branch to the tensor palati from the otic ganglion; branches of the descending palatine from Meckel's ganglion to the levator palati and the azygos uvulæ. The palato-glossus is supplied by the hypoglossal, and the palato-pharyngeus by the pharyngeal plexus of nerves.

The Œsophagus

is the muscular tube which extends from the pharynx to the stomach. It commences in the neck, opposite the sixth cervical vertebra, and, after a course of ten inches, ends opposite the tenth dorsal by piercing the diaphragm. It has a cervical and thoracic portion. The relations in the *neck* are: in front, the trachea; behind, the vertebral column; on the left, the thoracic duct; on the right and left, the common carotid arteries, and the recurrent laryngeal nerves. In the *thorax* the œsophagus has in front the trachea at the upper part, and the pericardium below; behind, the thoracic duct, the vertebral column, and the aorta below; to the right, the vena azygos major and the right lung; to the left, the aorta and the left lung. The œsophagus is not a straight tube; it has two sets of *curvatures:* the *antero-posterior*, in which it first curves forwards, then backwards, in accordance with the flexures of the vertebral column; finally it passes forwards, in front of the aorta, to reach the diaphragmatic opening; the *lateral* curvature, in which it will be found, after starting in the middle line, to curve first to the left, then back to the middle line at the fifth dorsal vertebra, then again to the left to get through the diaphragm. At the root of the neck the œsophagus protrudes a third of an inch to the left of the trachea.

The *structure* of the œsophagus is: externally a layer of fibrous tissue, beneath which is a muscular layer consisting of an external longitudinal and an internal circular set of fibres. Within these a submucous layer, and most internally a mucous membrane (covered with squamous epithelium). The muscular fibres are striated at the upper part, but non-striated below. Their action is involuntary. The *arteries* supplying the œsophagus are branches from the inferior thyroids, four or five branches from the thoracic aorta, and a branch from the gastric artery of the stomach, ascending through the œsophageal opening. The veins in the neck join the inferior thyroid; in the thorax, the vena azygos major and the intercostals. The *nerves* supplying the upper end are the inferior or recurrent laryngeals, and below the plexus gulæ formed by the pneumogastrics.

The Abdomen.

The cavity of the abdomen is bounded above by the diaphragm; below, by the levator ani; in front and at the sides, by the abdominal muscles; and behind, by the vertebral column. It is shaped like an egg, with the wide end upwards and the point below, received within the brim of the pelvis. The relations of the viscera to the wall will be given after the contents are studied.

The anterior and lateral walls of the abdomen are formed by muscles and aponeuroses. The muscles and aponeuroses have been previously described. (*See* Muscles.)

The wall of the abdomen is supplied by the lower six intercostal *nerves*, and by the ilio-hypogastric and ilio-inguinal nerves.

The *arteries* in the wall are those derived from the superior epigastric and the deep epigastric; the former comes down from the internal mammary, and the latter passes up from the deep epigastric. At the sides, branches of the intercostal arteries come forward.

Just above Poupart's ligament is the region of *inguinal hernia.* Here exists a weak spot in the abdominal wall, caused by the descent of the testicle; and through it a piece of the intestine or other abdominal viscus may protrude. The testicle lies originally in the abdomen below the kidney, but at the seventh month of fœtal life it travels down, and by the end of the eighth month reaches the bottom of the scrotum. On its way down it carries with it a process of peritoneum, called the *processus vaginalis*, which, getting separated from the general cavity, becomes at its lower part the *tunica vaginalis.* Should the processus vaginalis remain unclosed, a *congenital hydrocele* or a *congenital hernia* may take place; or, again, should it become closed only at the top, a hernia might push its way down behind the open tube, constituting an *infantile hernia.*

The testicle on its way down carries with it—first peritoneum, then sub-peritoneal fat; it also carries with it the transversalis fascia as a funnel-shaped prolongation—the infundibuliform fascia. The transversalis muscle allows it to escape beneath its lower border, but the internal oblique sends down some loops over the testicle, under the name of the cremaster muscle. The testicle now emerges from the external abdominal ring, over which is stretched the intercolumnar fascia; this it carries in front of it, and then descends to the scrotum. The coverings of an *inguinal hernia* are the same: 1. Peritoneum forming the sac. 2. Sub-peritoneal fat. 3. The infundibuliform fascia, from the transversalis fascia. 4. Cremaster muscle, from the internal oblique. 5. Inter-columnar fascia, from the external oblique. 6. Superficial fascia. 7. Skin.

The *external* abdominal ring is immediately above the pubic crest; it is triangular in shape, situated in the external oblique, and wholly aponeurotic.

The *internal* abdominal ring is found half an inch above a point midway between the symphysis pubis and the anterior superior iliac spine. It is circular, situated in the transversalis fascia, and is bounded, above and externally, by the transversalis muscle; below, by Poupart's ligament; and internally, by the deep epigastric artery. When a hernia comes down external to the deep epigastric artery, it is called oblique; when internal, direct; the difference in coverings being, that the direct usually splits the conjoined tendon.

The *abdomen* is mapped out into regions by circles and lines. To commence with, take an imaginary *circle* round the body opposite the cartilage of the *ninth rib*, and another opposite the *highest point* of the crest of the ilium. Three zones are accordingly found, the *upper* limited by the diaphragm above, and by the upper circle below; the *middle* limited by the upper and lower circles; and the *lower* by the lower circle above, and by the brim of the true pelvis below. Now draw two perpendicular *lines* from the centre of Poupart's ligament on either side up to the cartilage of the eighth rib. The abdomen is now divided into three regions, a central and two lateral; and each of these is again subdivided into three, making nine in all.

The REGIONS and their contents are:

A. On the right side.

I. The right hypochondriac region contains: 1. The main part of the right lobe of the liver. 2. The pylorus. 3. The first portion of the duodenum. 4. The gall-bladder. 5. The hepatic flexure of the colon. 6. The right supra-renal capsule. 7. The top of the right kidney.

II. The right lumbar contains: 1. The main part of the right kidney. 2. The ascending colon. 3. Part of the small intestines. 4. The head of the pancreas.

III. The right iliac contains: 1. The cæcum. 2. Small intestines.

B. On the left side.

I. The left hypochondriac region contains: 1. The spleen. 2. The cardiac end of the stomach. 3. The left supra-renal capsule. 4. Part of the left kidney. 5. The splenic flexure of the colon. 6. The tail of the pancreas.

II. The left lumbar contains: 1. The main part of the left kidney. 2. The descending colon. 3. Part of the small intestines. 4. Part of the great omentum.

III. The left iliac contains: 1. The sigmoid flexure. 2. Part of the small intestines. 3. Part of the great omentum.

C. In the middle line.

I. The epigastric region contains: 1. The main part of the stomach. 2. The left lobe of the liver. 3. The pancreas lies behind against the vertebral column. The transverse colon crosses between the epigastric and umbilical regions.

II. The umbilical region contains: 1. The small intestines in part, including the third portion of the duodenum. 2. Part of the great omentum. 3. The aorta. 4. The crura of the diaphragm.

III. The hypogastric region contains: 1. The small intestines in part. 2. Part of the great omentum. The uterus when gravid, and the bladder when distended, are also found in this region.

On opening the cavity of the abdomen the greater sac of the peritoneum is laid open and the position of the viscera seen. The structures visible are: 1. A portion of the liver. 2. The fundus of the gall-bladder. 3. The anterior surface of the stomach. 4. The great omentum. 5. The cæcum. 6. The small intestines, appearing at the edges of the omentum here and there.

The *peritoneum* is described as having two sacs, a greater and lesser, communicating through the foramen of Winslow. The peritoneum has various named parts. 1. Omenta, the name given to the reflections connected with the stomach; these are gastro-hepatic, gastro-splenic, and gastro-colic. 2. Mesenteries surround the small intestines; the meso-colon, ascending, transverse, and descending, surround the colon; the meso-sigmoid and meso-rectum. 3. Ligaments, the name given to the peritoneal reflections connected with the liver, bladder, and uterus. 4. Fold, the costo-colic fold, or fold of Jenner, separates the spleen from the left kidney, and ties up the splenic flexure of the colon.

To trace the peritoneum, the ordinary way is to commence at the umbilicus and pass upwards along the abdominal wall to the diaphragm, at the posterior part of which the peritoneum passes on to the liver, forming the upper layer of the coronary ligament of the liver. The liver is covered on its upper and anterior part, and the peritoneum now descends to the stomach, forming the anterior layer of the lesser omentum. Passing over the stomach, it descends to form the anterior layer of the great omentum, and, turning back on itself, reaches the colon and forms the under layer of the transverse meso-colon. Here it touches the vertebral column, but is again carried down upon the intestine to form the mesentery. Afterwards it descends to the pelvis, encloses the upper four inches of the rectum, covers the posterior part of the bladder, and ascends to the umbilicus. The same sac of the peritoneum can also be traced transversely, when it will be found to pass from the umbilicus outwards to the side of the lumbar region, embrace the ascending colon on the right, cross the middle line, embrace the descending colon on the left, and pass back to the umbilicus again. The colon is not completely enclosed on either the right or left side. The peritoneum comes close to, but scarcely touches, the kidneys. The *lesser* sac of the peritoneum is to be got at through the *foramen of Winslow.* This aperture is found just below the neck of the gall-bladder. The boundaries are : above, the lobulus Spigelii ; below, the first portion of the duodenum ; in front, the lesser omentum : behind, the inferior vena cava. The peritoneum in the lesser sac can be traced from the under surface of the liver downwards, forming the posterior layer of the lesser omentum, then down the back of the stomach to get between the layers of the greater sac in the great omentum. From hence it ascends over the colon, forming the upper layer of the transverse meso-colon, and, passing up over the pancreas, gets again to the under surface of the liver, where it forms the under layer of the coronary ligament, to the left it touches the spleen.

The Stomach.

The stomach is contained in the left hypochondriac and epigastric regions of the abdomen. The shape of the stomach when moderately distended is that of a curved cone, the base of the cone being to the left, the apex to the right, and directed backwards.

The stomach is one of the abdominal viscera which cross the middle line of the body, but its main mass lies to the left of that line. The left end is its higher, and the bulge (the fundus, or great *cul-de-sac*) is on a higher level than the spot where the œsophagus enters the stomach.

Towards the pyloric end there is a slight indentation on the lower wall, below which is a bulge (or small *cul-de-sac*, or antrum pylori).

The length of the axis of the stomach when moderately distended is about twelve inches, and about four inches in diameter.

The peritoneum invests the stomach closely, forming the lesser or gastro-hepatic omentum above, and the greater or gastro-colic omentum below. At the left end also is the gastro-splenic omentum.

The stomach presents for examination an anterior and posterior surface ; an upper and lower border, two extremities and two openings. The anterior surface is covered by peritoneum of the greater sac ; the posterior by peritoneum of the lesser sac. The upper border has the lesser, and the lower border the greater omentum attached. The extremities are named cardiac and pyloric on the left and right ends respectively. The pyloric end and opening are together ; but the œsophagus enters three inches from the cardiac end.

The *relations* of the stomach are : in *front*, from right to left, the liver, the wall of the abdomen in the epigastric region, and the diaphragm ; *behind*, the pancreas, the lesser peritoneal sac, the structures in the middle line, the left kidney ; to the *left*, the spleen ; to the *right*, the liver and gall-bladder ; along the lesser curvature are the lesser omentum and the gastric artery ; along the greater curvature are the gastro-epiploicæ dextra and sinistra arteries, the great omentum, and the transverse colon; but the transverse colon is separated a variable distance from the stomach.

The wall of the stomach is composed of:

1. Peritoneum.

2. The muscular layer, consisting of three sets of muscles, an external—*longitudinal*, running along the upper and lower curvatures; these fibres are continuous with the longitudinal œsophageal fibres, on the one hand, and with those of the duodenum on the other. Within the longitudinal are the *circular* fibres; they go completely round the stomach, and are continuous with the circular fibres of the duodenum. The most internal set are *oblique;* these are continuous with the circular fibres of the œsophagus, but are found only at the cardiac end.

3. The submucous layer, in which the bloodvessels and nerves are distributed.

4. The mucous membrane, covered by columnar epithelium.

In the submucous tissue are both mucous and peptic glands. The surface of the mucous membrane presents *rugæ* or folds when the stomach is empty, which however disappear when food is taken. The surface of the stomach is honeycombed in appearance when looked at with a small magnifying-glass; at the bottom of the recesses the various glands open.

The œsophageal opening is close to the diaphragm, and about three inches from the cardiac end of the stomach. It is only open when food passes. The *pyloric opening* is formed by the mucous, submucous, and circular muscular fibres of the stomach. It is usually open, but seems to have the power of acting as a valve to prevent undigested food passing through; in the dead body the opening usually measures half an inch in diameter.

The *arteries* supplying the stomach are the gastric, hepatic, and splenic. The lesser curvature is supplied by the gastric, and the pyloric branch of the hepatic; the greater curvature, by the gastro-epiploica dextra from the gastro-duodenal coming from the hepatic, and by the gastro-epiploica sinistra and vasa brevia coming from the splenic. The nerves supplying the stomach are, besides special ganglia in its substance, the pneumogastric and sympathetic.

The Small Intestine.

The small intestine commences at the pyloric opening in the stomach, and ends at the ileo-cœliac orifice in the right iliac fossa. For convenience of description it is divided into three parts—the duodenum, the jejunum, and the ileum.

The small intestines, after commencing on the right side of the body, speedily turn to the left, and have an inclination to lie to the left side of the abdomen generally. They occupy mainly the left iliac fossa and the peritoneal pouch in the pelvis between the rectum and the bladder. The whole tube narrows gradually from beginning to end. It is slung up by the mesentery in all but its duodenal portion, and in the mesentery all the vessels and nerves pass to and fro. The structure of the small intestine is much the same as that of the stomach. 1. Peritoneum ; this forms a complete layer to the jejunum and ileum, but in the duodenum it is modified, the first stage being enclosed, the second covered in front, and the third stage only touched by the peritoneum. 2. The muscular layer—longitudinal outside and circular fibres within. 3. The submucous layer. 4. The mucous layer, covered over with columnar epithelium. On the mucous membrane the following peculiarities are to be observed, partly by the naked eye and partly microscopic. Extending the *whole* length of the small intestines are found : 1. Villi. 2. Lieberkühn's follicles. 3. Solitary glands. Occupying only *parts* of the intestine are : 1. Brunner's glands in the first inch of the duodenum. 2. Peyer's patches in the lower two or three feet. 3. Valvulæ conniventes in the upper half.

The *villi* are finger glove-like projections of mucous membrane, containing bloodvessels and lymphatics found all over the small intestine, from the pylorus to the ileo-cæcal valve. They can be seen by the naked eye to give a velvety appearance to the surface of the small intestine, when the gut is opened and laid with the mucous surface upwards in water. They have great importance from their number and function in the absorption of the food ; as many as four millions have been estimated as their number by Krause. Lieberkühn's follicles, or crypts, are undistinguishable by the naked eye ; they are minute tubes in the mucous membrane.

Solitary glands, minute lymphatic bodies, are likewise undistinguishable by the naked eye.

Brunner's glands belong to the first inch of the duodenum. To see them with the naked eye, distend the duodenum with water or air, and remove from without the peritoneal and muscular coats carefully, when the tufts of the glands will be seen occupying the submucous membrane.

Peyer's patches, are groups of lymphoid tissue, situated on the free border of the gut in the lower part of the ileum. To see them, open the gut along its attached or mesenteric border, and the patches are seen plainly, especially in the young. The largest is about three inches in its longest diameter, and one inch across. They are placed with their long axes parallel to the length of gut. In number they may be from twelve to twenty.

The *valvulæ conniventes* are permanent crescentic transverse folds of the mucous and submucous tissues of the small intestine, commencing one inch beyond the pylorus, and ending gradually about half-way down the small intestines. They are most prominent where the hepatic duct enters in the second portion of the duodenum. They extend two-thirds or four-fifths of the way round the gut, and protrude as much as one-third of an inch from the surface.

The *arteries* supplying the small intestine are the pancreatico-duodenales, superior and inferior, and the vasa intestini tenuis from the superior mesenteric. The latter vessels, about twelve in number, form three arches before they reach the intestine, thus equalizing the blood-supply to all parts of the intestine. The vessels are distributed in an arborescent manner on the wall of the intestine. The nerves found in the wall of the gut are arranged in plexuses, one between the layers of the muscular fibres, called Auerbach's plexus, the other in the submucous coat, called Meissner's plexus.

The DUODENUM forms a horseshoe-shaped curve, embracing the head of the pancreas. The peritoneum closely invests the first portion, covers the anterior aspect of the second portion, and merely touches the third.

As already stated, the duodenum consists of three portions, the first or ascending, the second or descending, and the third or transverse.

1. The first stage is two inches long, and extends backwards to the right, from the pylorus to the neck of the gall-bladder. It has in *relation* with it: *above*, the foramen of Winslow and the gall-bladder; *below*, the pancreas; in *front*, the liver and abdominal wall; *behind*, the portal vein, the gastro-duodenal artery, and the ductus communis choledochus.

2. The second stage is three inches long, and extends from the neck of the gall-bladder to the right side of the third lumbar vertebra. It has in *relation* with it—in *front*, the transverse colon; *behind*, the right kidney, the right renal artery and vein, and the ductus communis choledochus; to the *right*, the ascending colon; to the *left*, the pancreas.

3. The third stage is five inches long; it extends from the right side of the third lumbar vertebra, and ascends gradually to reach the left side of the second. It has in *relation* with it—*above*, the pancreas and the superior mesenteric vessels; *below*, the small intestines; in *front*, the superior mesenteric artery and vein; *behind*, the structures in the middle line.

The *jejunum* is regarded as forming two-fifths of the length of the small intestine, and the *ileum* the remainder.

The Large Intestine.

The large intestine consists of the cæcum, the colon, the sigmoid flexure, and the rectum. In general terms, it commences in the right iliac fossa, passes upwards as the ascending colon on the right side, and forms beneath the liver a flexure—the hepatic flexure. From hence it crosses the middle line of the body as the transverse colon to below the spleen, forming a flexure—the splenic flexure. As the descending colon it is continued down the left flank, until in the left iliac fossa it again forms a flexure—the sigmoid—after which it descends into the pelvis as the rectum, to end at the anus. In length the large intestine is from five to six feet. It tapers gradually from the cæcum to the rectum. Its greatest diameter is about two and a half inches to about one inch in the sigmoid flexure. In structure the same elements are present as in the small intestine, but they are differently arranged. (1) The peritoneal coverings vary in the different regions. (*See* below.) (2) The muscular fibres are in two sets, longitudinal outside, circular within. The longitudinal fibres are mostly collected into three bands. Each band is about half an inch in width and one-twentieth of an inch in thickness. They extend from the cæcum to the rectum, where they, however, are diffused so as to cover the whole of that tube. The bands are named anterior, posterior and inner, according to their positions. The inner band becomes the lower on the transverse colon. It is owing to the position and character of these three bands that the colon is made puckered in appearance. The circular fibres are thin, but scatter all over the surface. At the rectum they form the internal sphincter muscle.

The submucous tissue presents nothing peculiar.

The mucous membrane is destitute of villi, valvulæ conniventes, etc.: only Lieberkühn's follicles and solitary lymphoid nodules are present.

The Cæcum.—The cæcum, called also the caput cæcum coli, lies in the right iliac fossa. It is that part of the intestine which lies below the opening of the small intestine into the colon. It measures about two inches and a half in depth and the same in breadth.

Relations.—The cæcum lies on the right iliacus muscle, but separated from the muscle substance by the iliac fascia and the external cutaneous nerve going to the thigh. The cæcum is covered in front, below, and at the sides by peritoneum; it has the wall of the abdomen in front, the right psoas internal to and partly behind. Opening into the cæcum at its inner and back part is the *vermiform appendix.* This tube, about four inches long, extends upwards and inwards from the cæcum in front of the psoas muscle; a reflection of peritoneum, constituting a mesentery, holds it in its place. The orifice in the cæcum is below and behind that of the ileum; it is guarded by a reflection of mucous membrane.

The *ileo-cæcal valve* is, next the pylorus, the most important trap in the intestines; it is placed to guard the opening of the ileum into the colon. The ileum enters the colon with a considerable degree of obliquity from below upwards. The slit by which it enters is nearly transverse to the axis of the colon, with a rounded end in front, but a gradually narrowing aperture as it passes backwards. Above and below this aperture the circular muscular fibres, the submucous tissue, and the mucous membrane of the gut are arranged to form valves. The upper cusp is placed horizontally; the lower more nearly vertically. The valves coalesce at the anterior and posterior edge of the opening, and behind run backwards as a frænum, still farther separating the cæcum from the ascending colon. When regurgitation from the colon is attempted, it is easy to see how the lower valve is pressed against the upper, and a complete bar is placed to any such attempt.

The *ascending colon* passes from the level of the ileo-cæcal valve upwards to the hepatic flexure on the under surface of the liver, close to the right side of the gall-bladder.

Relations.—In front and the sides it is covered by peritoneum. Anteriorly, the small intestines cover it slightly; behind are: the quadratus lumborum, the right kidney, and a quantity of areolar tissue; to the right, is the abdominal wall; to the left, the small intestines.

The *transverse colon* forms the arch of the colon, owing to its two ends being placed deeply and its central portion coming well forwards. It also arches downwards, passing from the right to the left hypochondriac region through the upper part of the umbilical. It is held in place by the transverse mesocolon.

Relations.—It is enclosed in peritoneum. In front are: the wall of the abdomen and three layers of peritoneum of the great omentum; behind is one layer of peritoneum and the third part of the duodenum; above are: the liver, the gall-bladder, the stomach and spleen; below, the small intestines.

The splenic flexure is tied up by the costo-colic or pleuro-colic fold of peritoneum, to the under surface of the diaphragm opposite the tenth rib in the left hypochondriac region.

The *descending colon* passes from the splenic flexure to the left iliac fossa, where it becomes the sigmoid flexure.

Relations.—Nearly similar to the ascending, only that there is a greater certainty of its posterior surface being uncovered by peritoneum; also it is more completely hidden from the front by the small intestines.

The *sigmoid flexure* is the narrowest part of the colon; it occupies the left iliac fossa.

Relations.—The peritoneum invests it, allowing of considerable mobility. Above is the small intestines; below, it rests on the left iliacus and psoas muscles, but separated from them by their respective fasciæ.

THE RECTUM.—The sigmoid flexure, opposite the sacro-iliac synchondrosis on the left side, ends in the rectum. The rectal tube differs from the other parts of the colon, inasmuch as its surface is smooth, its longitudinal muscular fibres being spread all over its surface in a continuous sheet. The rectum, also, unlike other tracts of the intestine, becomes larger as it descends, until just above the anus there is a well-marked *cul-de-sac.* The rectum possesses two sets of curvatures—lateral and antero-posterior. Lateral: the rectum passes at first from left to right, namely, from the ending of the sigmoid flexure to the middle line of the sacrum, then onwards in the middle line to the anus. Many specimens show the rectum passing across the median line to the right in its first stage. The antero-posterior curvatures are two: first backwards in the hollow of the sacrum, then forwards over the tip of the coccyx. In length the rectum measures eight inches.

The rectum consists of the following coats: externally, the peritoneum embraces the upper four inches; the lower four inches are covered by the rectal portion of recto-vesical fascia. Next, the muscular coat, consisting of longitudinal fibres outside, circular fibres within; the circular fibres are collected below, to form the internal sphincter muscle. Next the submucous coat and the mucous membrane. The arteries supplying the rectum are: the superior hæmorrhoidal from the inferior mesenteric; the middle hæmorrhoidal from the internal iliac, and the inferior hæmorrhoidal from the internal pudic. The veins communicate with both the portal and systemic circulation.

The peritoneum covering the rectum is arranged so that it embraces the first stage almost completely, a meso-rectum being frequently formed, so as to allow of considerable play. Lower down it covers the rectum in front and at the sides; but near the end of the second portion the upper surface only is covered. Finally, it leaves the bowel and is reflected upon the bladder. In the female it passes on to the vagina. The pouch so formed is called the pouch of Douglas, and contains the main mass of the small intestines.

The *mucous membrane* of the rectum presents many folds and creases. It is very thick and vascular, and is very loosely attached to the muscular coat. When the rectum is empty the folds just above the anus are arranged chiefly longitudinally, forming the so-called columns of the rectum. Higher up, the most marked folds are three prominent transverse folds—folds of Houston—one placed anterior (the lowest), another to the left, and the third (the highest) behind and to the right. They are found in the second stage.

The rather crude idea of dividing the rectum into three stages is, for the sake of description, still preserved here.

I. The first, or oblique stage, extends from the left sacro-iliac synchondrosis down to the middle of the third piece of the sacrum. It measures three and a half inches in length, and has: in front, small intestines; behind, the superior hæmorrhoidal vessels, the left ureter, the left internal iliac vessels, the left sacral plexus, and the left pyriform muscle; to the right, the right internal iliac vessels; and to the left, the left obliterated hypogastric artery. The peritoneum forms a nearly complete enclosure, a *meso-rectum.*

II. The second, or horizontal stage of the rectum, reaches from the middle of the sacrum, to the tip of the coccyx. It measures three inches in length, and has above, the small intestines, the fundus of the bladder, the vesiculæ seminales, the vas deferens and the prostate; below, the sacrum and coccyx, the pyriformis and coccygeus muscles; on each side the levator ani muscle. The peritoneum is in contact only with the upper part of the second stage.

III. The third, or perpendicular stage, passes from the tip of the coccyx to the anus. Its length is one and a half inches, and it has in front, the perineum; behind, the tip of the coccyx; on either side, the insertion of the levator ani muscles. At the junction of the second and third stage the prostate touches the rectum. The third stage of the rectum is destitute of peritoneum.

The anus is an almost circular orifice, where the skin and mucous membrane meet. Naturally the anus is closed by the tension of the muscles surrounding its lower end. The external sphincter, the levator ani, and coccygeus muscles have been described in their proper places, and it has been mentioned more than once, that the circular fibres of the rectum are continued below, to form a strong muscular ring round the lower part of the rectum, one inch above the anus. This ring is the *internal sphincter muscle;* its lower border comes within one inch of the anus, and from hence the muscle extends upwards for half an inch. It is a merely thickened bundle of circular fibres.

The Liver.

This enormous mass of cells, bloodvessels and ducts, weighs between fifty and sixty ounces. It measures, in the adult male, about twelve inches from right to left; seven from before backwards and three in depth. In colour it is dull red, but slightly glistening in appearance, owing to its investure of peritoneum.

It lies in the right hypochondriac, the epigastric, and, to a slight extent, in the left hypochondriac regions. It is in complete apposition with that part of the diaphragm which is above it, and follows the movements of the diaphragm during the respiratory acts. The liver is seen to be enclosed by a serous coat formed partly by the greater sac and partly by the lesser sac of the peritoneum.

It is destitute of peritoneum between the layers of the coronary ligament at a triangular spot on the posterior surface, also where the gall-bladder touches, and at the transverse fissure.

On cutting into the liver and then tearing the substance, it is seen to be composed of delicate connective-tissue which surrounds lobules —*hepatic lobules*—varying from one twenty-fourth to one-twelfth of an inch in diameter. These lobules are found microscopically to consist of cells, and it is in and around these lobules that the blood-vessels are distributed, and the bile-ducts take origin. The surface of the liver is covered beneath the peritoneum by a delicate sheath of connective-tissue, which is continuous in its under surface with the connective-tissue of the liver, and at the gate of the liver it turns in with the vessels as they enter the liver substance, under the name of Glisson's capsule. This capsule acts as a common sheath to the branches of the portal vein, hepatic artery, and hepatic ducts, binding them all together as they traverse the liver.

In outline the liver is irregularly triangular, with its apex to the left, its base on the right, and the sides along its anterior and posterior limits.

The liver presents for examination fissures, lobes, ligaments, and impressions.

Fissures.

The fissures dividing the liver lobes are: (1) The longitudinal. (2) The transverse. (3) The fissure for the gall-bladder. (4) The fissure of the inferior vena cava. The longitudinal includes two of those usually enumerated; viz., the fissures for the umbilical vein and the ductus venosus. The transverse, the fissure for the gall-bladder and that for the umbilical vein, are found on the inferior surface. The fissures for the inferior vena cava and the ductus venosus are found on the posterior surface.

1. The *longitudinal* fissure runs from the front to the back of the liver, separating the masses of the right and left lobes. It accommodates the remnant of the umbilical vein in front, and the remnant of the ductus venosus behind; hence the anterior part is spoken of as the (*a*) *umbilical fissure*, the posterior as the (*b*) *fissure for the ductus*

venosus. In *front*, it is continuous with the interlobular notch, caused by the round ligament of the liver (*i.e.*, the obliterated umbilical vein). The notch is placed about two inches to the right of the middle line of the body. Across the umbilical fissure, in many cases, a piece of liver-substance, called the *pons hepatis*, passes from the right to the left lobe.

2. The *transverse* or *portal* fissure runs from the right side of the longitudinal about its middle; it extends into the right lobe for about three inches, separating the lobulus quadratus in front from the lobulus Spigelii and caudatus behind. At the portal fissure all the structures going to and from the liver find entrance and exit. They are arranged thus : the portal vein dividing into its right and left branches is placed behind; the hepatic artery is to the left and in front, and the hepatic duct to the right and in front of the vein. Numerous lymphatic and nervous structures also pass to and fro. All are enclosed by a vesture of areolar tissue as they sink into the liver-substance; to this areolar tissue has been assigned the name of Glisson's capsule.

3. The *fissure*, *fossa*, or *impression* for the gall-bladder (the impressio vesicalis) runs at right angles to the anterior border of the liver, as far back as the transverse fissure. It lies nearly parallel to, and two inches to the right of, the fissure for the umbilical vein, *i.e.*, the front part of the longitudinal fissure.

4. The *fissure* for the inferior vena cava is situated behind the lobulus Spigelii. At this spot the inferior vena cava ploughs its way into the liver behind the Spigelian lobe, and there receives the mouths of the hepatic veins.

The Lobes of the Liver.

The lobes of the liver are simply names given to particular masses of liver-substance, portioned off by the fissures upon the under surface.

1. The *left lobe* is separated from the right by the longitudinal fissure, or to speak more exactly, the left lobe is separated by the umbilical fissure on the inferior surface, and by the fissure for the ductus venosus on the posterior surface. (Quain's Anatomy.) The left lobe forms about one-sixth of the bulk of the liver, and extends about two inches to the right of the middle line of the body.

2. The *right lobe* comprehends all the liver-substance to the right of the longitudinal fissure. It has three smaller lobes appended to its under surface; they are as follows:

3. The *lobulus quadratus* is, as its name implies, a quadrate piece of the liver-substance. It is bounded—in *front*, by the anterior border;

behind, by the transverse fissure ; to the *right*, by the fissure for the gall-bladder ; to the *left*, by the longitudinal fissure. The lobulus quadratus is frequently united to the left lobe by the *pons hepatis*—a band of liver-tissue arching over the umbilical vein.

4. The *lobulus Spigelii* is felt as a tongue-like projection on inserting the finger into the foramen of Winslow. It is situated behind the transverse fissure, to the right of the longitudinal fissure, and in front of the fissure for the inferior vena cava. To the right, this lobe is continued as the following :

5. The *lobulus caudatus* is continued from the previous lobe towards the right side, running parallel to the posterior margin of the transverse fissure.

The SURFACES of the liver are named the superior, inferior, and posterior—three in all. It is only on taking frozen sections of the viscera in position that the three can be seen. In the dissecting-room, as the liver lies on a plate, two surfaces only—a superior and inferior—are to be seen.

1. The *superior* surface, in contact with the diaphragm for the most part, is smooth and convex. The attachment of the broad ligament of the liver corresponds to, but does not indent, the position of the separation of the right and left lobes. The heart rests on the diaphragm, opposite the upper surface of the left lobe, and in sections of frozen viscera a slight indication of the fact is registered by an impression upon the upper surface of the left lobe.

2. The *inferior* surface is marked by fissures and lobes ; it comprehends the region between the anterior border of the liver and the level of the Spigelian lobe behind. It presents the following : part of the left lobe ; the umbilical fissure ; the transverse fissure ; the quadrate lobe ; the fissure for the gall-bladder (*i.e.*, the fossa or impressio vesicalis) ; the under surface of the right lobe showing, from before backwards, a depression for the hepatic flexure of the colon—impressio colica ; an impression for the kidney—the impressio renalis ; and still another, near the neck of the gall-bladder, for the bend between the first and second part of the duodenum—the impressio duodenalis.

3. The *posterior* surface is marked by a deep notch corresponding to the spot where the liver crosses the vertebral column, opposite the tenth and eleventh dorsal vertebræ ; here is seen also the fissure for the ductus venosus. To the left of the notch is a piece of the left lobe, where it touches the cardiac end of the stomach, and in front of this the tubes of His, which fit into the lesser curvature of the stomach. To the right of the notch is seen the piece of the liver-substance (about three inches in depth), which is uncovered by peritoneum ; then the lobulus Spigelii and lobulus caudatus, and the

impression for the supra-renal capsule—impressio supra-renalis—immediately behind the lobulus caudatus.

Relations of the Liver.—Above, the diaphragm, and at the pit of the stomach, the abdominal wall. *Below*, from left to right, the lesser curvature and part of the anterior wall of the stomach, the duodenum, the hepatic flexure, the right kidney (placed behind the colon). *Anteriorly*, the abdominal wall. In females the liver is always found well below the right costal cartilages; in the male the liver can be made to appear or disappear below the right costal cartilages by the movements of respiration, and by the assuming the erect or horizontal position. *Posteriorly*, the diaphragm (separating the liver from the right lung and the thoracic aorta), the supra-renal capsule, and the inferior vena cava.

The *left extremity* is tied up to the under surface of the diaphragm by the left lateral ligament, immediately in front of the œsophageal opening in the diaphragm. The *right extremity* is tied down in the right hypochondriac region by the right lateral ligament.

The *peritoneal reflections* connected with the liver are called *ligaments*, and they are arranged as the suspensory, coronary, right and left lateral, and the gastro-hepatic omentum.

The *suspensory*, broad, sickle-shaped, or falciform ligament extends from the umbilicus to the liver. Being sickle-shaped, it is best described as follows: the point of the sickle is at the umbilicus; the base at the upper surface of the liver; the convexity or back of the sickle is attached to the posterior wall of the abdomen and the under surface of the diaphragm, on the right of the middle line; the concavity, the cutting edge of the sickle, is free towards the cavity of the abdomen. The ligament is seen to deepen from its point to its base at the liver. It consists of two layers of peritoneum pulled down by the round ligament of the liver, *i.e.*, the obliterated umbilical vein, which lies enclosed between the layers along its free border.

The *coronary ligament* is the name given to the reflexions of the peritoneum, which reach the posterior part of the liver from the diaphragm above and below; the upper reflexion is continuous with the peritoneum of the greater, the lower with the peritoneum of the lesser sac.

At either end of the liver the layers coalesce to form the *right and left coronary ligaments*. The left, the longer, lies immediately in front of the œsophageal opening in the diaphragm. The right lies deeply in the right hypochondriac region.

During the passage of the blood through the liver, bile is extracted from out of the blood in the portal vein, and handed over to a special set of vessels, the *biliary capillaries*. These vessels run between the various liver-cells, and emerge at the gate of the liver as the *right and left hepatic ducts.* The two ducts after the course of an inch unite at an obtuse angle to form the *common hepatic duct,* which descends in the lesser omentum for one and a half inches, and after being joined by the duct of the gall-bladder—the *cystic duct*—is named the *ductus communis choledochus.*

The *ductus communis choledochus,* or common bile duct, results from the union of the cystic and common hepatic duct. Commencing about one and a half inches below the liver, the duct continues downwards in the lesser omentum, to the right and in front of the portal vein. Descending behind the first portion of the duodenum, it reaches the back part of the interval between the pancreas and the second or descending portion of the duodenum. There it is joined by the pancreatic duct, and then perforates the posterior part of the second portion of the duodenum half-way along. The duct passes obliquely for three-fourths of an inch in the walls of the duodenum. At its opening internally there is an elevation, a sort of papilla in the mucous membrane, which is quite smooth in the immediate vicinity. In all, the duct is from four to five inches long.

The *gall-bladder* is a cystic recess in which the bile is stored for a time. The bile has to find entrance and exit to and from the gall-bladder by the cystic duct. The gall-bladder is pear-shaped, about three inches long, and one and a half inches wide; it is capable of holding about an ounce. It lies in contact with the liver in the fissure for the gall-bladder—the impressio vesicalis; it is bound thereto by the peritoneum, which, refusing to go between it and the liver, passes below, plastering the gall-bladder to the liver wall.

The named parts are: the fundus, the body, and the neck. The fundus is forwards, reaching to, or beyond, or falling short of, the anterior border of the liver. The body gradually tapers to the neck; the neck is bent like the letter S, and is much contracted where it ends in the cystic duct.

Relations.—*Above,* the impressio vesicalis on the under surface of the right lobe of the liver, where there is a quantity of areolar tissue and the upper branch of the cystic artery. *Below,* where it is covered by peritoneum, it touches the colon near the fundus, and the duodenum near the neck. In fact, the first portion of the duodenum runs parallel with the gall-bladder, and may have to do with emptying the gall-bladder from fundus to neck, as the food passes along it. The fundus is in contact with the abdominal wall at the cartilage of the tenth rib. The neck is at the transverse fissure. To the right is the right lobe, to the left the quadrate lobe, of the liver.

The *cystic duct* runs from the neck of the gall-bladder backwards and slightly downwards to the left, to join the common hepatic duct, thereby forming the ductus communis choledochus. The duct measures one and a half inches in length; it has a peculiarly uneven mucous surface, presenting almost a spiral appearance.

The Pancreas

Is a large acinous gland situated close to the vertebral column, reaching from the right to the left side of the vertebral column. It is about eight inches long, and one inch and a half in thickness; it is of a yellowish colour.

The named parts are: the head, body, and tail, and the lesser head of the pancreas. The *head* is on the right side of the vertebral column, embraced by the duodenum. The *body* crosses the middle line opposite the first lumbar vertebra, and presents an upper, anterior and posterior border; and an inferior, anterior and posterior surface. Two aspects, anterior and posterior, however, will serve for descriptive purpose. The *tail* touches the spleen. The *lesser head* is a process beneath the head of the pancreas, and partly separated from it by the superior mesenteric vessels.

The *relations* of the pancreas are: *above*, the cœliac axis in the middle, to the right the first portion of the duodenum, to the left the splenic artery; *below*, the superior mesenteric vessels in the centre, the third portion of the duodenum to the right, and the inferior mesenteric vein to the left. In *front*, the ascending layer of the lesser sac of peritoneum and the stomach. *Behind*, the structures around the vertebral column:—they are, from right to left: the inferior vena cava, the portal vein, the right crus of the diaphragm, the aorta, the superior mesenteric artery; and on the left side, the left renal vessels, kidney, and supra-renal capsule. The *head* is in contact with the second portion of the duodenum, the common bile duct and the pancreatico-duodenal arteries (superior and inferior). The *tail* touches the spleen just below the hilus. The *arteries* supplying the pancreas are: pancreatica magna and pancreaticæ parvæ from the splenic; the superior pancreatico-duodenal from the gastro-duodenal, and the inferior pancreatico-duodenal from the superior mesenteric. The duct of the pancreas, sometimes called the canal of Wirsung, runs a little nearer the upper than the lower border, and leaves the head of the pancreas to join the ductus communis choledochus.

The Spleen.

The spleen lies in the left hypochondriac region, at the cardiac end of the stomach, in a regular cup formed by the costo-colic fold of peritoneum below. It is soft, pulpy, and purplish in colour when cut into, but possesses on its surface a serous and fibrous investure, giving it a greyish glistening appearance. The *peritoneal* covering is complete, except at the hilus and its immediate vicinity. The reflexion from the stomach, the gastro-splenic omentum, dips down, forming a pouch between the two viscera ; behind, the peritoneum leaves the spleen to reach the crus of the diaphragm. The peritoneum of the lesser sac touches the spleen below the hilus to a very small extent. The *fibrous* covering, the tunica propria, is white and elastic ; it is continuous on its deep surface with the connective-tissue and the trabeculæ of the spleen-substance. At the hilus the tunica propria is seen turning in with the vessels. The spleen *pulp* is the substance which can be squeezed or washed out of the spleen when cut into. It is a heterogeneous grumous bloody-looking mass, becoming brighter on exposure to the air. The spleen measures, in vertical length, about four and a half inches ; in breadth, three and a half inches ; and in thickness, one and a half inches ; in weight, about six ounces.

The named parts are an upper and lower end ; an anterior, external and internal surface ; and three borders. The *surfaces* are :—

The anterior surface is concave, and lies in contact with the cardiac end of the stomach, the splenic flexure, and the tail of the pancreas.

The posterior, or external surface, looks backwards and outwards ; it is in contact with the diaphragm, the peritoneum intervening.

The internal, narrow and vertical, is in contact with the left kidney and the left crus of the diaphragm.

The *borders* are : anterior, frequently notched ; internal, presenting a distinct ridge between the anterior and internal surfaces ; immediately in front of the ridge, the vessels enter at the hilus ; the posterior border is placed between the internal and posterior surfaces.

Relations.—Above, the diaphragm ; *below*, the costo-colic fold of peritoneum ; *in front*, the diaphragm and rib cartilages ; *behind*, the diaphragm ; *externally*, the diaphragm ; *internally and in front*, the stomach, the splenic flexure of the colon, and the pancreas ; *directly internal*, the left kidney.

The Kidneys

Are situated on a plane posterior to all the other viscera, and as they do not move, the peritoneum does not enclose them. The peritoneum comes close to the anterior surfaces, and in some instances touches them. Each kidney measures four inches from above downwards, two inches from side to side, and one inch in thickness. The right kidney weighs four and a half ounces ; the left four and three-quarter ounces. The named parts are : upper and lower ends ; inner and outer borders ; anterior and posterior surfaces. On the inner border is the hilus, giving entrance and exit to the various structures passing in and out of the kidney.

The kidneys lie with their upper *ends* nearer together than their lower. In some instances the kidneys unite across the middle line to form the horse-shoe shaped kidney; then, it is the lower ends that are united. The upper end of the kidney is the larger, the more rounded, and directed inwards; it has resting on it the supra-renal capsule. The lower end is smaller, more pointed and directed outwards.

The internal *border* is concave, and has the hilus placed therein with an anterior and posterior lip; the external border is convex, and rather narrow.

The *surfaces* of the kidney are anterior and posterior. The anterior is the more convex; the posterior is more flattened, and at the inner part of this surface is a portion which looks almost directly inwards towards the psoas.

The kidney is composed of the urine tubes, bloodvessels, and secreting apparatus, etc., arranged within a fibrous capsule. The *fibrous covering* completely surrounds the kidney; it is thin but firm, and connected to the kidney-substance by delicate filaments, which, when the capsule is cut and pulled apart, allows it to be easily separated from the kidney-substance. At the hilus the fibrous tissue turns inwards, with the bloodvessels and ureter, to help in the formation of the receiving apparatus found thereat.

On cutting into the kidney along the outer border from the upper to the lower end, the structure of the kidney can be made out so far as it is possible by the naked eye.

Within the hilus is found a cavity in the kidney—the *sinus*—which is lined by the piece of the fibrous capsule entering at the hilus; it contains the continuation of the ureter—the pelvis, infundibula, and calyces of the kidney. To explain these, it is best to regard the *ureter* at its upper end as dilating into what is called the *pelvis*. This again, within the hilus of the kidney, breaks up into large funnel-like tubes or *infundibula*, three or four in number. Each of these infundibula in turn breaks up into from three to six smaller cups, or *calyces*, which embrace the apices of the pyramids of the kidney.

Of the kidney-tissue proper, the outer part, or *cortical portion*, is of a light red-brown appearance, but its minute structure defies naked-eye scrutiny.

The remainder of the kidney substance shows conical masses, the *pyramids of Malpighi*. These pyramids have their bases outwards and convex; their apices are inwards, forming the papillæ, and embraced by a calyx. Between the medullary and cortical portion there is a zone between the convexities of the bases of the pyramids, where the cortical portion runs down in wedge-shaped masses; these projections are named the columns of Bertini. The apex of a papilla, when first squeezed, affords urinary fluid stained with blood, which exudes through the apertures (twenty) in the apex of the papilla, and finds its way into the calyx, then into the infundibulum, pelvis and ureter, and so to the bladder.

The *relations* of the kidneys vary a little on the two sides. The left kidney extends higher than the right; the right reaches the lower border of eleventh rib, the left the upper border. The left is on a level also with the upper border of the twelfth dorsal vertebra; the right half an inch lower.

Relations of the Right Kidney.—Above, the supra-renal capsule and liver; *below*, the crest of the ilium; in *front*, the liver, the second portion of the duodenum, the ascending, and the hepatic flexure of the colon; *behind*, the quadratus lumborum muscle, the last rib, the diaphragm, the psoas muscle, and branches of the lumbar plexus of nerves; to the *outside*, the wall of the abdomen; and to the *inside*, the vessels entering it.

Relations of the Left Kidney.—Above, the supra-renal capsule and the spleen; *below*, the iliac crest; in *front*, the descending colon, the stomach, and the tail of the pancreas; *behind*, the same as for the right; the external border is in contact below with the abdominal wall, but above with the spleen; internally, are the vessels coming and going.

The *arteries* supplying the kidneys are the right and the left renal; they arise from the aorta and pass straight out towards the hilus. Before entering, the main trunk divides into four or five branches, which enter the hilus on a plane anterior to the ureter as it enters. On tracing the vessels into the kidney, it will be found that they divide about half-way along the kidney-substance—that is, about the base of the pyramids—and from this point of division one set of branches pass outwards and another inwards. Those passing inwards run down between the various tubules of the pyramids, constituting the arteriolæ rectæ; those passing outwards give off branches which form the glomeruli or tufts contained within the Malpighian capsules.

The Ureter

Is a fibro-muscular tube, about sixteen inches long, which passes from the hilus of either kidney to the bladder. At its upper end it dilates to form a funnel-shaped tube—the *pelvis*—which is received within a recess in the kidney-substance—the *sinus*. The pelvis in part becomes continuous with the kidney capsule, and in part breaks up to form secondary funnel-shaped prolongations or *infundibuli*. These, three or four in number, are each again subdivided to form cups or *calyces*, to receive the apices of the pyramids. The ureter in its course downwards lies behind the peritoneum, and is crossed by the spermatic vessels on both sides, and the inferior mesenteric vessels on the left. Behind it rests upon the psoas muscle, descending upon it obliquely from above downwards; it then crosses over the common or external iliac vessels, being behind the sigmoid flexure on the left side and the end of the ileum on the right. Finally, the ureter gets into the recto-vesical fold of peritoneum, and turns sharply forwards below, to enter the bladder obliquely at the back part of the trigonum vesicæ.

The Bladder.

The *urinary bladder* lies in the pelvis behind the pubes and triangular ligament, and in front of the rectum. The bladder of the child, up to the age of seven, is pyriform, and protrudes above the pubes in the hypogastric region of the abdomen; in the adult also, when it is distended it will rise up above the level of the pubes. When empty, the bladder is like a collapsed tent with its floor rigid, but with its sides hanging from the apex above, in loose wrinkled folds. When being distended, the bladder becomes gradually more globular, and when over-distended the apex advances upwards and forwards, the posterior wall pushing the intestines out of its way. The empty bladder has its long aspect antero-posterior, the full bladder has its long axis almost vertical.

The named parts of the bladder are the apex, body, fundus or base, and neck. The apex is slung to the umbilicus by the urachus; the fundus rests upon the rectum, or vagina in the female; the neck is embraced by the prostate.

In connection with the bladder are *ligaments, false and true.* The true have all already been referred to. (*See* Fascia.)

The *false ligaments* are the peritoneal reflections in connection with the bladder; they are named: (1) superior; (2) lateral; and (3) posterior. The peritoneum covers the bladder only behind, above and behind, and but for a little distance upon the sides. The disturbing element to the advance of the peritoneum down the sides of the bladder is the obliterated hypogastric, or umbilical, artery, which runs as a cord from the front part of the trunk of either internal iliac artery, forwards and inwards across the lateral pelvic aspect, to the side of the bladder. Then gradually ascending towards the apex, it runs upwards with the urachus and its fellow of the opposite side, to the umbilicus.

As the obliterated vessels run forwards to the bladder, they lie on either side of the rectum, and the folds of peritoneum which they form are called the recto-vesical folds, or posterior false ligaments of the bladder. As the obliterated vessels lie on the sides of the bladder, they limit the peritoneum on the sides, so that only an inch or two of the lateral vesical wall is covered by peritoneum; the peritoneal covering is from that spot continued on to the pelvic wall, and the sheet on either side forms the false lateral ligaments of the bladder. Above, the peritoneum is continued upon the obliterated hypogastric arteries and the urachus to the umbilicus, and forms the superior false ligament of the bladder. Hence, on the sides and above, the obliterated hypogastric artery limits the peritoneum, but behind it dips down between the two arteries, along the posterior part of the bladder as far as the opening of the ureters into the bladder; it there passes backwards on to the second stage of the rectum, constituting the recto-vesical fold of peritoneum.

In the female the uterus intervenes between the bladder and rectum, and gives rise to new folds and connections. (*See* Uterus.)

The *true ligaments* are formed by the fascia of the pelvis and the urachus. The fascia of the pelvis has been previously described. (*See* Fascia.) It will be seen from that description that the pelvic fascia splits at the so-called white line into recto-vesical and obturator fascia. It is the vesical portion of the recto-vesical fascia, which advances to the bladder by way of the prostate, forming its true ligaments and fascial covering. The fascia passes first on to the prostate, and becomes continuous with its capsule; and from that the fascia advances to cover the front, sides, and lower part of the bladder—in fact, everywhere where the peritoneum is not. The fascia, on its way to the prostate, forms at the sides the *two lateral true* ligaments of the bladder; and in front the *anterior* or *pubo-prostatic* ligaments, proceed from the back of the pubes to the upper part of the prostate. The remnant of the urachus, stretching from the apex of the bladder to the umbilicus, forms the *superior true* ligament.

The *coats of the bladder* proceeding from without inwards are :—

1. The peritoneal and fascial coverings, just described.

2. The muscular fibres can be fairly well, but never satisfactorily, made out by dissecting a bladder, distended with air or water. Most externally is a layer of longitudinal fibres, collected however into two bands, placed at the front and back of the bladder. The bands can be traced from the capsule of the prostate in front, or even from the pubes (for the pubo-prostatic ligaments contain a few muscular fibres which are continued from the pubes), to the prostate and bladder. Behind, the band met with there can be followed from the prostate below, upwards along the back of the bladder. Both bundles converge to the urachus at the apex of the bladder, and are connected therewith for some distance.

The name *detrusor urinæ* is sometimes given to these bands. They open the prostatic portion of the urethra by pulling apart the upper and lower walls, and so allowing the urine to enter.

The *circular* fibres are interlaced together, forming what are called figure-of-8 loops. They are chiefly met with at the lower part of the bladder, and act no doubt as a sphincter; hence the name, *sphincter vesicæ*, given to these fibres. They compress the bladder when the detrusor has opened the urethra, and so expel the urine.

Within the circular fibres, others, along the margins of the trigone, are met with, and named submucous by Ellis.

3. Submucous coat. 4. Mucous membrane.

On opening the bladder the mucous membrane is found, pale, soft, and but loosely attached over most of the interior. Below, however, at the base of the fundus, is a patch, where the tissues are all firmly adherent, and where but little submucous tissue of the bladder exists. This patch is triangular in shape, and is bounded in front by the prostatic inlet of the urethra, and behind by the openings of the two ureters. The triangle is equilateral, one and a half inches on all its sides, and is named the *trigone*, or *trigonum vesicæ*. The openings of the ureters are oval slits directed obliquely forwards and inwards, and seated at the postero-superior angle of the trigone. At the opening into the prostate is a tongue of mucous tissue—the uvula vesicæ.

The *relations*, when the bladder is moderately distended, are: *above*, the small intestines and the great omentum; *below*, the rectum, prostate, vasa deferentia, and vesiculæ seminales; *behind*, the small intestines; in *front*, the back part of the triangular ligament and the pubes. On the sides of the bladder are found the peritoneal reflections, the obliterated hypogastric arteries, the vasa deferentia, and the bloodvessels supplying it. The *arteries* supplying the bladder are: the superior and middle vesical arteries, coming from the internal iliac along the obliterated hypogastrics; the inferior vesical, coming directly from the internal iliac. The arteries are in pairs. The *veins* open into the internal iliac. The *spinal* nerve to the bladder is derived, in common with that to the rectum, from the fourth sacral.

The Prostate.

The prostate gland embraces the neck of the bladder, encloses the first portion of the urethra, and serves as a fixed point in the mechanism for the passage of semen from the vas deferens to the urethra. It is horse-chestnut shaped, with its apex forwards at the posterior layer of the triangular ligament, and its base backwards around the neck of the bladder. The greatest breadth of the prostate is one inch and a half; its length is one inch and a quarter; and its thickness is one inch. It consists of fibrous tissue, interspersed with plain muscular fibres, elastic tissue, bloodvessels, sympathetic nerves, lymphatics and secreting glands. All these are arranged in three lobes—two lateral, and a central or third; and the whole held together by a capsule. The outer capsule is derived from the vesical portion of the recto-vesical fascia, and within it is the prostatic plexus of veins, joined in front by the dorsal vein of the penis. Within the venous plexus is the true capsule of the prostate.

The *relations* of the prostate are: in *front*, the triangular ligament; *above* and in *front*, the symphysis pubis; *above*, the pubo-prostatic ligament; *above* and *behind*, the bladder; *behind*, the bladder; *below* and *behind*, the vasa deferentia and vesiculæ seminales; *below*, the rectum; *below* and in *front*, the perineum. The lateral ligaments of the bladder, consisting of the vesical portion of the recto-vesical fascia, gain the side of the prostate obliquely from above downwards and from before backwards; hence the anterior and lower part of the prostate can be cut without injuring the lateral reflection, and thus opening the cavity of the pelvis is avoided. The arteries supplying the prostate are the inferior vesical and the middle hæmorrhoidal. The veins join the internal iliac vein behind.

The lobes of the prostate are named, lateral (two), and median, or third (one). The two lateral lobes form the main mass of the gland; they meet above in the middle line, where a slight groove indicates their union. They bulge out to form the convex sides of the pros tate, and below they end on either side at the lateral grooves, which indicate the separation between them and the third lobe. The two grooves converge in front, where the lateral lobes touch each other, for a short distance on the under surface of the prostate.

Surgically, the third lobe is the most important, as when the prostate enlarges, as it tends to do in old men, it is this lobe which pushes its way up to the floor of the bladder and prevents the exit of urine or entrance of a catheter.

The third lobe is bounded thus: *above*, the bladder end of the prostatic urethra; *below*, the rectum; *laterally*, the common ejaculatory ducts and the lateral lobes; in *front* and *below*, the sinus pocularis; *behind*, the bladder.

The prostatic portion of the urethra will be described with the urethra.

THE PENIS.

This mass of erectile tissue is arranged in three main subdivisions, covered by cutaneous structures, enclosed in fibrous tissues, and having the urethra running along its lower aspect.

The *skin* of the penis is loose, destitute of fat, free of hairs, and in front is continued from the prepuce on to the glans penis. The prepuce consists of an infolding of the skin covering the glans penis. The internal portion is moist and red, resembling a mucous membrane, and at the spot where it is continued on to the erectile tissue behind the glans, it possesses a number of glands secreting sebaceous material having a characteristic odour. They are called the glandulæ odoriferæ, or glands of Tyson. Below, the prepuce is fixed by the frenum to the under surface of the glans.

The *corpora cavernosa* are the main masses of erectile tissue. They are placed side by side, forming the dorsal and lateral aspects o the penis. Between the two above, is a groove taken advantage of by the vessels and nerves on their way forwards; between the two bodies below, the corpus spongiosum, with the urethra contained in it, finds accommodation and shelter.

Each corpus cavernosum is attached to the ramus of the ischium, just above the tuberosity, by the crus—a name given to its posterior extremity. In front each corpus cavernosum ends in a blunt point covered over by the glans penis.

A transverse section through the penis will show each corpus cavernosum to be circular in form, with a firm fibrous investment, around a quantity of erectile tissue. The fibrous investment is composed of dense layers of tissue arranged in a longitudinal and circular manner. The longitudinal fibres enclose the two corpora cavernosa in a common envelope; the circular fibres surround each body separately. Anteriorly the corpora cavernosa approach each other closely, and there the fibrous tissue separating them, permits of continuity of tissue between the two bodies; the part of the septum so broken up is named the *septum pectiniforme.*

From the inner surface of the surrounding fibres, rods or trabeculæ find their way into the cavity of the corpora cavernosa. These dividing, and again dividing and subdividing, ultimately form a network of tissue with interspaces. These spaces are occupied by venous blood, and it is this spongy condition which renders it capable of being charged with blood, and so erectile.

The *corpus spongiosum* consists of a narrow sheath of erectile tissue surrounding the urethra. Behind, towards the triangular ligament, it enlarges inferiorly to form the *bulb;* in front it has an enlargement which extends backwards and upwards to form the *glans penis.* In structure it is identical with the corpora cavernosa, but of a more delicate nature.

The *bulb of the corpus spongiosum* is placed below the urethra immediately in front of the triangular ligament; it shows a median raphé and two lateral lobes; from it erectile tissue is continued backwards to the membranous and prostatic portions of the urethra, and in front it is continuous with the mass of the corpus spongiosum.

The *glan penis* is the anterior enlargement of the corpus spongiosum, and it is almost horse-chestnut-shaped. At the apex is the urethral opening; at its base it projects beyond the corpora cavernosa, forming the *corona glandis*, behind which is the depression called the *cervix*.

The arteries to the penis are:

1. The arteries to the bulb from the internal pudics.

2. The dorsal arteries of the penis are the continuations forwards along the dorsum of the penis of the internal pudic arteries; they supply branches to the corpora cavernosa, and end in front at the glans. These two sets of vessels supply the corpus spongiosum, of which both the bulb and the glans are part.

3. The artery to each corpus cavernosum enters just above the crus, *i.e.*, one inch from the posterior attachment of the corpus cavernosum, along the centre of which it is continued forwards, supplying blood for the erectile tissues.

The nerves of the penis are derived from the internal pudic, as well as sympathetic twigs from the hypogastric plexus.

The muscles are the erectores penis and the accelerator urinæ.

The Urethra.

The urethra is the mucous channel by which the urine finds its exit from the bladder.

The female urethra will be described subsequently.

The Male Urethra is divided, for description's sake, into prostatic, membranous, bulbous, and spongy portion. On its way forwards the urethra passes through the prostate—the prostatic portion. It then pierces the posterior, and then the anterior layer of the triangular ligament; between these two layers it is called the membranous urethra. In front of the triangular ligament it is received in the bulbous and spongy portions of the urethra, and is named accordingly.

The total length of the urethra is eight and a half inches.

The structure of the urethra, on slitting it open, is seen to be that of a mucous membrane and submucous tissue, with various openings and recesses therein.

The *prostatic portion* of the urethra is commensurate in length with its passage through the prostate. It is in length one inch and a quarter; at its entrance from the bladder is about one-third of an inch wide; half-way along its length it is about half an inch; and at its anterior end about a quarter of an inch. Hence it is wider in the centre than at the end, giving it a fusiform, or spindle, shape, the wider end of the spindle being towards the bladder. On perpendicular section the prostatic urethra seems to be horse-shoe shaped, caused by the fleshy projection in its floor—the *veru montanum*. On opening the prostatic urethra from above, the floor, and the structures therein, are easily seen. Occupying the centre of the floor, and running from the uvula vesicæ behind, for a variable distance along the floor is a permanent ridge of mucous membrane, called the *veru montanum*, the *caput gallinaginis*, or the *colliculus seminalis.* On each side of the elevation is a depression, the prostatic sinus, into which the mucous (or they may be special) *glands of the prostate* open. At the anterior part of the veru montanum is a recess, into which a probe can be passed for one-third of an inch, that runs downwards and backwards, called the *sinus pocularis.* Into the sides of this sinus, but near the urethral margin, the mouth of the common ejaculatory seminal ducts open, one on either side.

The erectile tissue extends backwards into the prostatic urethra as far as the opening of the sinus pocularis.

The *membranous portion* of the urethra lies between the two layers of the triangular ligament, both of which it perforates about one inch below and behind the subpubic ligament. This is the narrowest as well as the shortest portion of the urethra; it measures one-fifth of an inch in diameter and three-quarters of an inch in length. It is curved, with its concavity upwards and forwards towards the symphysis, and its convexity downwards and backwards towards the perineum. The lower wall, although it is an arc of a greater circle than the upper, is encroached upon by the bulb below, so that it is actually shorter than the upper.

Erectile tissue is present beneath the submucous tissue of the urethra, and the compressor urethra muscle envelops it.

The *spongy portion of the urethra* extends from the membranous portion to the end at the glans. It is in length about six and a half inches. The posterior two inches is enclosed in the bulb, and is sometimes distinguished as the bulbous portion of the urethra. Here the canal is dilated to form the sinus of the bulb. Near the termination, just within the orifice of the urethra in the glans, there is a dilatation about half an inch in length, the fossa navicularis.

On vertical section of the penis, the spongy urethra looks like a transverse slit, but on the glans it appears to be vertical. The orifice of the urethra appears as a vertical slit a quarter of an inch in length, with slightly projecting lips. This is the narrowest portion of the urethra. Opening into the spongy portion are various ducts.

1. *The Ducts of the Glands of Littré.*—These are merely mucous glands, which are freely scattered throughout the urethra; they require a small magnifying-glass to see them.

2. *Lacunæ* are recesses in the mucous membrane, which open obliquely forwards, as do all urethral ducts. The largest of these,

the *lacuna magna*, is situated on the upper wall of the glandular portion; opposite it, on the lower wall, is the fossa navicularis.

3. The ducts of Cowper's glands open by two mouths placed on each side of the lower wall of the bulbous portion of the urethra.

Cowper's glands are two small glandular looking bodies, about the size of split peas, placed between the two layers of the triangular ligament, immediately below and external to the membranous portion of the urethra. They are distinguished by their fatty appearance, and by the fact that a small, but distinct twig of the artery to the bulb can be traced to them. Each duct is one inch long, it lodges in the bulb, through which it runs, to open obliquely forwards in the lower wall of the sinus.

The Testicle and the Vas Deferens.

As already described when speaking of the abdominal wall, the testicle lies below the kidney, but during the seventh and eighth month it travels down, carrying the structures of the abdominal wall in front of it, until it reaches the bottom of the scrotum. The method by which the coverings are obtained to form the layers of the scrotum having been also detailed, it is only necessary to name the tissues actually met with in the scrotum. These are—the skin, which is thin, wrinkled transversely, full of sebaceous glands and of hair-bulbs, which are placed obliquely to the surface. The centre of the scrotum is marked by raphe running from before backwards; it completely divides the scrotum into two, and corresponds deeply to a septum which totally separates one side of the scrotum from the other.

The *dartos tunic* is a thin layer of reddish tissue, consisting mainly of muscular fibres developed therein. The muscular fibres are of the plain unstriped variety, and are the cause of the transverse wrinkles caused by applying cold to the scrotal surface.

The *intercolumnar fascia* derived from the margins of the external abdominal ring.

The *cremasteric fascia*, with, developed in it, loops of muscle—the cremaster muscle from the internal oblique.

The *infundibuliform fascia* from the transversalis fascia at the margins of the internal abdominal ring.

Many of these structures are difficult, if not impossible, to make out by simply dissecting the scrotum from the surface; they must be followed downwards from the point at which they arise in the abdominal wall. Within the cutaneous coverings come the special coverings, the tunica vaginalis and tunica albuginea.

The *tunica vaginalis* testis is a piece of peritoneum which has been separated from the general peritoneum of the cavity of the abdomen.

The original tube from the peritoneum is named the *processus vaginalis*, but this begins to close before birth at two places, namely, at the internal abdominal ring and at the top of the testicle, and so the processus between these two points is obliterated. The obliterated portion is named the *funicular*, the unobliterated becomes the permanent peritoneal enclosure. The tunica vaginalis consists of two layers, a parietal and visceral, continuous with each other at the back of the testicle. The parietal portion covers the inner aspect of the coverings, the visceral the testicle and part of the epididymis.

The parietal layer extends some distance up the cord.

The *tunica albuginea* is a white dense fibrous layer enclosing the testicle, giving it shape and consistence. The outer surface is covered by the tunica vaginalis, except behind, where the vessels enter. Posteriorly the tunica albuginea sends into the testicle a fibrous septum, the corpus Highmori or mediastinum testis, extending from the upper to the lower part of the gland. From this septum numerous partitions are sent forwards through the tissue of the testicle to meet the inner surface of the tunica albuginea in front. These septa break up the cavity of the testicle into spaces or loculi, in which the seminal tubes—the tubuli semeniferi, are accommodated.

In addition to these septa, fine fibrous cords run across the testicle from side to side, maintaining its shape.

The *tissue* of the testicle is seen best by making an incision into the convex anterior border of the testicle. When that is done the brown, sticky, stringy substance of the *tubuli semeniferi* bulge out between the septal depressions. There are said to be about three hundred of these lobes in the testicle. It is possible under water to tease out a tubule for even its whole length; it is seen to be very fine, one-hundredth of an inch in breadth, and in length about two feet. Each lobe contains two or three of these tubules. Lining the septa and the inner aspect of the tunica albuginea are the bloodvessels derived from the spermatic artery. They are sometimes regarded as forming a vascular layer to the testicle, the tunica vasculosa.

At the back of the testicle lies the *epididymis*. This is a convoluted portion of the tube which conducts away the secretion of the testicle. To understand this it is necessary to know that the tubuli seminiferi find their way out of the corpus Highmori as straight tubes —vasa recta; that they then form a plexus between the inturned edges of the tunica albuginea, called the rete testes. These pass from the upper part of the testicle, forming the efferent vessels— vasa efferentia in the form of a cone—the conus vasculosus. The tubes are then bundled up together, forming the upper end of the epididymis—the globus major. Here the tubes begin to join, and before they reach the body of the epididymis, immediately below, they have joined to form one tube.

Below the body of the epididymis is the globus minor, and after that the tube leaves the lower and back part of the testicular region under the name of the vas deferens. The epididymis is, when unravelled, about twenty feet long; it is very minute, being only about one-seventieth of an inch in diameter in its widest parts. It is touched by the tunica vaginalis on its outer side only, and at the point where it overlaps the testicle is a pouch—the digital pouch.

The fœtal remains met with around the testicle are:

1. The hydatid of Morgagni, a small pyriform cyst, containing fluid and placed between the globus major and the top of the testicle. It is the remains of the hydatid of Morgagni.

2. The organ of Giraldes consists of a few convoluted remains of the Wolffian body found between the vas deferens and the epididymis.

3. The vas aberrans lies between the vas deferens and the globus minor; it is one of the ducts of the Wolffian body which have remained open.

The testicles hang in rather a peculiar fashion. The named parts are: the upper and lower ends; two surfaces, inner and outer; two borders, anterior and posterior; but the directions of these are not exactly as stated. The upper ends of the testicles look forwards and outwards, the lower ends, backwards and inwards and consequently towards each other; the inner surfaces look forwards and inwards, the outer, outwards and backwards; the anterior borders are directed downwards and forwards, and the posterior borders where the epididymes are attached, backwards and upwards.

The testicle is supplied by the spermatic arteries, and drained by the spermatic veins. The nerves are derived from the aortic, renal and hypogastric plexuses, coming with the spermatic artery, spermatic vein and vas deferens respectively.

The Vas Deferens.

The *vas deferens*, the continuation of the globus minor, runs upwards behind the body of the epididymis as a tortuous tube. Above the level of the testicle it runs straight upwards to the external abdominal ring, passes outwards and upwards along the inguinal canal, and entering the internal abdominal ring, hooks round the deep epigastric artery, and drops down to the inner side of the external iliac vein towards the pelvis. In the pelvis it passes first inwards beneath the peritoneum until it crosses the obliterated hypogastric artery to reach the side of the bladder; there it curves down along the side of the bladder, passing internal to the ureter, and coursing along the floor of the bladder internal to the vesiculus seminalis, where it ends at the back of the prostate by joining the duct of the seminal vesical to form the common ejaculatory duct. Near its termination it is again considerably dilated and tortuous.

The vas deferens feels between the finger and thumb firm and round like a piece of whip-cord; hence the name—the cord—a sad misnomer. It is accompanied as far as the internal abdominal ring by the spermatic vessels and nerves, and the various structures in the inguinal canal.

In length the vas is about two feet; in diameter about one-tenth of an inch, but the lumen of the tube itself is not more than one-fortieth of an inch. The walls are composed of dense fibrous tissue with a longitudinal and circular layer of muscular fibres lined by mucous membrane internally. A small artery, the artery to the vas deferens, accompanies it from the brim of the pelvis onwards through the inguinal canal.

The *vesiculi seminales* are two sacculated bodies composed of a single dilated tube found below the bladder, behind the prostate, and external to the vas deferens. They are enclosed in fascia and firmly bound to the bladder. When dissected out they are seen to be a single tube, dilated and sacculated with several pouches or diverticula. The tube, about five inches long, is bent on itself, so that the closed and open end of the tube lie together behind the prostate, whilst the bend is backwards; the closed end lies outside the other. The vesical at its anterior end becomes gradually narrowed, and joins the vas deferens at an acute angle to form the *common ejaculatory duct.* This duct, one inch long, finds its way forwards between the lateral and third lobe of the prostate, to open on the margins of the urethral lips of the sinus pocularis in the floor of the prostatic portion of the urethra.

Female Genital Organs.

Within the pelvis the organs met with are situated between the bladder and the rectum, pushing their way upwards for some distance beneath the peritoneum, which is here specially adapted to them. The main pelvic viscus is the uterus, with just the upper and back part of the vagina placed below it, and the ovaries and Fallopian tubes placed laterally. The peritoneal reflexions or ligaments of the uterus are as follow:

1. A large sheet of peritoneum stretching from one side of the pelvis to the other completely invests the uterus, ovaries and Fallopian tubes; it forms the broad ligaments of the uterus, one on each side. Each ligament reaches from the lateral uterine wall

to the internal wall of the pelvis; it embraces between its two layers:—the Fallopian tube at its highest point, the ovary and its round ligament bulge posteriorly, and the round ligament of the uterus finds its way outwards and forwards below the level of the Fallopian tube. Beneath the ligament the obliterated hypogastric artery, and the ureter, find their way forwards along the lateral uterine wall.

2. The recto-vaginal ligaments is the name given to the two posterior. The peritoneum, as it passes forwards from the rectum, gains the posterior part of the vagina in the middle line, covering it posteriorly for the distance of one inch; on either side of the pouch so formed—the pouch of Douglas—the peritoneum stands up into two distinct lateral folds, especially when the uterus is pulled forwards; these are the ligaments—recto-vaginal—and they contain and are occasioned by the obliterated hypogastric arteries on their way forwards to the sides of the bladder. In each ligament, besides the arterial remnants, are the ureter, the ovarian and uterine vessels and nerves on their way forwards.

3. The utero-vesical folds, or anterior ligaments, are ill-defined reflexions passing from the sides of the uterus to the bladder. In front the peritoneum does not reach the lower border of the uterus by one inch; hence the anterior and lower part of the uterus is destitute of peritoneum for that distance. The reason of the terms recto-vaginal and utero-vesical ligaments will be thus seen to be fairly correct, indicating the passage, or not, of the peritoneum to the front or back of the vagina as it leaves the uterus.

The OVARY is the organ in which the ova are hatched, and from which, at stated times, they proceed to the Fallopian tube.

The ovary is placed between the layers of the broad ligament, but bulges posteriorly so as to cause a sort of meso-ovary. It is on a level with the upper end of the uterus, placed below the Fallopian tube, and about one inch off the lateral margin of the uterus. It measures from side to side one and a half inches; in width, from before backwards, three-quarters of an inch; in thickness, from above downwards, half an inch.

The named parts of the ovary are: upper and lower ends (in the natural position); anterior and posterior borders; upper and lower surfaces. The upper (external) end is embraced by the fimbriæ of the Fallopian tube; the lower (inner) end has the round ligament of the ovary attached. This ligament, one and a half inches in length, consists of a bundle of fibrous tissue, with some muscular fibres; it proceeds from the lower (inner) end of the ovary, and between the layers of the broad ligament reaches the upper angle of the uterus. It causes a projection posteriorly (but seldom seen) on the broad ligament, and encloses a triangular space with its base outwards, apex inwards, and its sides formed by the Fallopian tube above, and the round ligament of the ovary below. The name ala vespertilionis, or bat's-wing, is given to the appearance of these two triangles placed laterally, with the uterus, or body of the bat, in the centre. Of the borders of the ovary, the posterior is free, but the anterior is tied up by the peritoneum passing from the back of the broad ligament over the ovary; it is here the vessels going to and fro the ovary enter, causing the hilus. The surfaces are both free and covered by peritoneum.

On examining the surfaces of the ovary carefully, it is seen in the adult female to be scarred, and the peritoneum over it rather more opaque than elsewhere. The opacity is caused by a different character of epithelium lining the ovary to that met with elsewhere over the peritoneal cavity; it is thicker, more columnar, and named the germ epithelium, as from it the ova emanate. A firm layer of fibrous tissue encloses the mass of the ovary, resembling in position the tunica albuginea of the testicle, and is actually called the albuginea ovarii. It is only, however, an outer condensed piece of the stroma of connective-tissue which pervades the ovary generally. On cutting into the ovary it is seen to possess bloodvessels and nerves and lymphatics, which can by careful dissection be traced from the margin to the hilus. At times small spaces are found, which, when punctured, allow a clear fluid to escape; this is the liquor folliculi, and with the aid of a microscope it is possible to make out an ovum, surrounded by a small heap of epithelial cells—the discus proligerus.

At times a reddish-yellow, star-shaped, or round mass may be seen in the ovary; this is the *corpus luteum*, a condition brought about by the escape of the ovum from its cavity—the Graafian vesicle.

Arteries.—The ovarian, from the aorta, and an anastomotic branch from the uterine to join the ovarian. The veins, when they emerge, form a plexus—the pampiniform—as in the male; they end similarly to the spermatic veins above.

The FALLOPIAN TUBE extends on each side from the region of the upper (outer) end of the ovary to the upper angle of the uterus. It is the oviduct, serving to conduct the ova from the ovary to the uterus. It is situated in the highest part of the broad ligament occupying its upper and free margin. Its walls consist of a dense layer of fibrous tissue and muscular fibres lined inside by mucous membrane; around it the peritoneum of the broad ligament is folded on its upper, anterior and posterior aspects.

The Fallopian tube measures four inches in length, and in width at its outer part about one-sixth of an inch. When examined carefully it is seen to start from the upper angle of the uterus as a round, firm, straight tube; but after proceeding outwards for about two inches it widens, becomes tortuous, and bends downwards and inwards to end in tufts or fimbriæ close to the upper (outer) end of the ovary. The outer dilated portion is named the ampulla; the inner, narrow part, the isthmus. The openings of the tube are named *ostium uterinum* and *ostium abdominale*, according as they communicate with the uterus or peritoneal cavity respectively; for it is a fact that the outer end of the tube opens by the ostium abdominale into the cavity of the peritoneum, *i.e.*, a mucous and serous tract are here continuous.

The fimbriæ are tufts or processes of the tubal tissue, arranged around the outer end of the tube and the ostium abdominale in the region of the upper (outer) end of the ovary. One fimbria, longer than the others, is attached to the ovary; all the others have free ends.

The UTERUS, or womb, lies between the layers of the broad ligament. The peritoneum, as it passes forwards from the rectum, presents a fold on either side, the recto-vaginal, and between the two the pouch of Douglas. The peritoneum passes first on to the back of the vagina, then over the top of the uterus and down the anterior surface. In front, the vagina is not touched, as the peritoneum passes straight from the uterus to the bladder, forming the utero-vesical folds. The virgin uterus is pear-shaped, with the fundus upwards; it is three inches in length, two inches wide, and one inch in thickness. All its walls are convex, both externally and internally. Its *structure* is: outside, *peritoneum*, with the limits given above; *involuntary muscular fibres*, which are best seen in the pregnant uterus to consist of three layers: an external longitudinal layer, collected as two bands on the anterior and posterior walls; an internal layer, collected in circles round the openings in the uterus; and an intermediate set, without any definite arrangement, except that some are grouped around the bloodvessels. Within the muscular layer is the *mucous membrane*, with a number of glands in its substance; there is no submucous coat. The *arteries* supplying the uterus are: the uterine from the internal iliac, and a few branches from the ovarian. The veins correspond to the arteries.

The named parts of the uterus are: body, and neck or cervix. The body forms two-thirds of the whole, and the cervix the lower one-third. They together present externally an anterior and posterior surface, lateral borders having the broad ligaments attached, a base or fundus, and below the os uteri. On opening the cavity of the uterus it will be found that the walls are all convex, and that there is a constriction between the body and cervix, called the internal os. The cavity of the *body* consequently presents three openings—above and on either side the openings of the two Fallopian tubes, and below the internal os or ostium internum; all these openings are circular. The cavity of the *cervix* presents the circular or internal os above, and the external os below. The external os is a slit rather than a foramen. It has its long axis transversely, and presents an anterior and a posterior lip; it measures five lines in its long diameter. In the virgin its lips are smooth, but in the mother the lips are notched and scarred. On the anterior and posterior walls are seen the arbores vitæ or longitudinal ridges, with lateral offshoots like the branches of a tree, hence the name arbor vitæ. Amongst the ridges a few round white swellings, glands of Naboth, are to be seen. They are looked upon as being mucous glands, the mouths of which are temporarily or permanently blocked.

The VAGINA extends from the vulva to the os uteri, which it embraces. It is placed between bladder and urethra in front, and the rectum behind; the levatores ani muscles embrace it on either side; it is touched by the peritoneum at the upper and back part for about an inch. Its walls consist of fibrous tissue outside; within this is the muscular layer, composed chiefly of longitudinal fibres; still more internally, a layer of erectile tissue, submucous tissue, and mucous membrane. On the anterior and posterior walls, just within the vulva, are found ridges, called the columns of the vagina, best seen in the virgin. The anterior wall of the vagina measures about four inches, and is attached to the anterior lip of the uterus; the posterior wall is about six inches long, and runs up behind the posterior lip to get on to the uterine wall; consequently the posterior lip of the uterus projects some little distance into the vaginal wall. The walls of the vagina are in apposition; at the inlet the vagina is longest in its vertical diameter, half way up it is the transverse, which is greatest, but at the uterine end, where it encloses the uterus, it is more globular. The lower part of the vagina is in a line with the axis of the outlet of the pelvis; at the uterine end, however, the tube is bent, so that the axis is in line with that of the uterus.

The arteries supplying it are the vaginal, vesical, and hæmorrhoidal; all branches of the internal iliac.

The *vulva* is the name given to the parts of the genital organs of the female, which can be seen on the outside, and by slightly separating the cutaneous margins.

The inlet into the vagina from without is called the *rima;* it is situated between two prominent cutaneous folds, the labia major. The outer aspect of these labia is lined by skin, the inner by mucous membrane; in front they are continued as far as the mons veneris. By separating the labia majora to a slight extent they are seen to meet in front and behind at the anterior and posterior commissures respectively. The posterior commissure has within it a transverse mucous fold, the *frenulum pudendi*, and between these two a depression, called the fossa navicularis. Behind the posterior commissure is the perinæum of the female, measuring about one inch from thence to the anus. Above the vulva is the mons veneris, a mass of fat covering over the front part of the symphysis pubes; it has crisp hairs upon its surface.

The set of structures exposed by pretty forcible eversion of the labia majora are the clitoris, the nymphæ, or labia minora, the vestibule, the orifice of the urethra, the hymen or caruncula myrtiformis.

The *clitoris* exhibits most of the structures met with in the penis, only in a minute condition.

There are rudimentary but distinctly marked corpora cavernosa surrounded at their crura by erectores clitoridis.

The corpus spongiosum is represented only by the glans clitoris, unless the glands of Kobelt can be so regarded.

The urethra is wanting in the clitoris, consequently the glans is not perforated.

The *nymphæ*, or labia minora, are pendulous folds of mucous membrane lying within the labia majora, one on either side. In front they are prolonged to form a preputial covering to the glans clitoris; extending downwards for only one inch and a half, they do not meet behind. At the anterior part, between the nymphæ, is the *vestibule*, limited in front by the clitoris, and behind by the anterior vaginal wall, and imperfectly separated therefrom by the hymen, or its remains.

The *hymen* is a fold of mucous membrane placed at the entrance to the vagina. Its condition varies; it may be absent; it may be represented simply by a minute band of tissue on the posterior wall; the membrane may be so perforated as to become cribriform; it may be a complete partition with or without a central aperture, but the most common condition is that of a semilunar fold, with its concavity forwards, and consequently with an interval above between it and the upper vaginal wall. The conditions so described are those present in the virgin. When, however, the hymen is ruptured, it contracts to form nodular enlargements which constitute the *caruncula myrtiformis.* In the vestibule, one inch behind the clitoris, is the orifice of the urethra, the *meatus urinarius.* The lips of this orifice are usually sufficiently prominent as a papillary enlargement to render it evident to touch.

The *female urethra* corresponds to the prostate and membranous portions of the male, although no prostate is present in the female.

It measures about one and a half inches in length, and is capable of distension to the size of even a finger. It perforates the triangular ligament, as in the male, and is embraced by a compressor urethra muscle. The urethra is very vascular and sensitive.

The glands of Bartholin or Duverney, the name given in the female to the homologues of Cowper's glands in the male, are placed one on each side on a level with the posterior margins of the vulva. They lie below and on either side of the entrance of the vagina. From each gland a duct runs forwards and inwards, and opens into the fossa navicularis, one on each side.

The *bulbi vestibuli* of Kobelt are two bean-shaped masses of erectile tissue found on each side within the labia minora. They have the mucous membrane within, the sphincter vaginæ without. In front, a small plexus of erectile tissue extends forwards from either bulb behind, to the clitoris in front; Kobelt named this the *pars intermedia*, being intermediate between the bulbs and the clitoris, with both of which it is continuous.

These masses are the homologues of the bulb met with in the corpus spongiosum of the male—the median raphé met with being considered to be cleft to give passage to the vagina, and the lateral parts becoming pushed asunder until they lie apart as the bulbs of Kobelt.

The Mammary Gland.

The mammary glands or breasts occupy, in the female, the upper lateral aspects of the front of the chest. Each gland is enveloped in a complete sheath derived from the superficial fascia; beneath it is a layer of deep fascia separating it from the pectoralis major muscle. The gland covers the chest from the level of the third to the seventh rib, and extends from near the lateral margin of the sternum to near the anterior fold of the axilla. The under surface of the gland is slightly concave; the anterior surface is markedly convex. The skin over it is soft, and but slightly movable over the gland-tissue. Just below the centre of the convexity of the gland, on a level with the fourth rib, is the conical projection of the nipple. The nipple consists of a mass of fine areolar tissue, embracing some fifteen ducts, on their way to open at the surface; it is wrinkled usually, but by irritation can be made to become erect. Around the nipple is a coloured area, pink or dark, according as the woman has not or has borne children; it is called the *areola*, and has around its circumference a number of large sebaceous glands, which during lactation are active and discharge.

On cutting into the mammary gland its tissue is seen to be lobular. Connective tissue, with intervening spaces filled with the 'pale reddish cream-coloured' (Quain) tissue characteristic of the secreting material, and largely interspersed with large masses of bright yellow fat, forms the mass of the gland.

Here and there a stringy fibre is to be found, which, when traced for some distance, is seen to travel in the direction of the nipple. This fibre is really an excretory duct, a *galactophorous duct*, on its way from the ultimate recess of the gland to the nipple. As it nears the areola and nipple it is seen to dilate so as to form an *ampulla* or *sinus*, and as it enters the nipple it again contracts to a minute duct. The diameter of a sinus is about a quarter of an inch during lactation, and one inch long. They serve as temporary stores or receptacles for the milk.

The arteries supplying the mammary gland are: branches of the long thoracic (the external mammary) from the axillary; branches from internal mammary and from the intercostals of the third, fourth, and fifth spaces; the vein accompanying the arteries.

The Respiratory Apparatus.

The thorax is devoted chiefly to the accommodation of the organs of respiration, the lungs. Besides, however, the gases passing to and from the lungs have to find their way through the nose, the pharynx, the larynx, the trachea, and bronchi. In the nose are distributed the olfactory and fifth nerves, serving to guard the entrance to the respiratory tract from unsuitable gases or solid materials. The nose being, however, an organ of special sense, will be described with the special senses. The larynx is really the organ of voice, and is placed in the respiratory tract to gain the means of causing its vocal cords to vibrate. The pharynx is both a food and air tract, and is described elsewhere with the alimentary tract. Hence the trachea, bronchi, and lungs are the only organs devoted to the passage of air and the functions of respiration pure and simple.

A small part of the trachea has a course in the neck; but as it is in the thorax that the respiratory organs are contained, an account of its formation and the arrangement of its contents is here given.

The Thorax.

The thorax is the conical-shaped space at the upper part of the body, enclosing the heart and great vessels, the lungs and bronchi, and various other ducts, vessels, and nerves. It is not exactly commensurate with the contents, as the upper abdominal viscera find shelter beneath its walls, and the lungs and pleura project above its upper limit at the root of the neck.

In shape it is that of a blunt cone, with its base below at the diaphragm, its apex towards the root of the neck. The walls, however, are not circular, but more ovoid, with the long axis placed transversely.

The anatomy of the thorax is arranged into a consideration, first, of its boundaries; second, the arrangement of its contents into mediastina; and lastly, the anatomy of its respiratory contents. The circulatory and nervous structures met with have been described elsewhere.

The Boundaries are :

1. Anteriorly: The sternum, the first six costal cartilages and the intercostal spaces filled up by the internal intercostal muscles and fasciæ.

2. Laterally: The ribs and intercostal spaces occupied by the external and internal intercostal muscles, vessels, nerves, and fasciæ.

3. Posteriorly: The bodies of the dorsal vertebræ; and the intervertebral substances; the anterior common ligament; the heads, necks, and angles of the ribs; and the intercostal spaces behind occupied by the external intercostal muscles, etc.

4. Inlet, or upper limit, is bounded by: The top of the sternum, cartilage of first rib, inner border of first rib, neck and head of first rib, and the first dorsal vertebra.

5. The base or inferior limit is formed by the diaphragm. (*See* Diaphragm.)

A transverse section through a frozen thorax will show the viscera in position, and it is possible to make out clearly the so-called mediastina. That is the name given to the space found between the two pleural sacs. Each pleural sac invests its own lung and the inner wall of the chest of its own side. In the middle line, however, from the sternum to the backbone, there is an area where the pleuræ do not come, and where the structures passing up and down and contained within the thorax lie: these are named the anterior, middle, and posterior mediastina. The pericardium and heart occupy the centre mediastinum, and so separate the anterior from the posterior mediastinum.

As the upper limit of these mediastina is somewhat indefinite, it is proposed (following the teaching of Struthers, Thane, and Wood) to describe a fourth or superior mediastinum, or a region called the root of the neck. This arrangement will ensure all the contents of the chest being included in the enumeration.

I. The *superior* mediastinum, or the root of the neck, comprehends the upper part of the previous three. It is bounded by a line drawn from below the first portion of the sternum (the manubrium), just where the second rib joins it, back to the fourth dorsal vertebra.

Most anteriorly in this space—*i.e.*, immediately behind the sternum—are placed:

1. An anterior *muscular* plane, consisting of the origins of the sterno-hyoid and sterno-thyroid muscles.

2. A *venous* plane, consisting of the innominate veins uniting to form the superior vena cava.

3. A *nervous* plane, consisting of the pneumogastric, phrenic, and cardiac branches of the sympathetic of the left side crossing the arch of the aorta.

4. The *arterial* plane, the transverse part of the arch of the aorta, and the great arteries given off from it—viz., the innominate, left carotid, and left subclavian.

5. The *respiratory* plane, the trachea.

6. The *food* plane, the œsophagus.

7. A posterior *muscular* plane, the longus colli muscle, as it arises from the upper dorsal vertebræ.

II. The *anterior* mediastinum reaches from the junction of the manubrium and gladiolus of the sternum to the diaphragm. Its right border is straight, but its left border below the fourth costal cartilage slopes obliquely to the left, owing to the left lung and pleura being pushed to the left by the heart. It is bounded in *front* by the gladiolus of the sternum, the costal cartilages on either side and the fasciæ covering the spaces between them; *behind*, by the pericardium; and on either *side* by the two pleuræ. Its *contents* are: the triangularis sterni muscles, the lower part of the left internal mammary artery, the remains of the thymus gland, lymphatics from the upper surface of the diaphragm, and loose areolar tissue with a few fine bloodvessels. The *rationale* of the contents is easily understood, with the exception of the left internal mammary. All the other structures mentioned are close to the middle line; but as the internal mammary arteries pass down on either side behind the costal cartilages, the pleuræ overlap the vessels, except at the lower part of the left vessel, where, owing to the left lung being pushed to the left by the heart, the artery is exposed in the mediastinum.

III. The *middle* mediastinum has in *front* the anterior, and *behind* the posterior mediastinum. On either *side* are the two pleuræ. The *contents* are: the pericardium, containing the heart and the great vessels at its base; and the two phrenic nerves.

IV. The *posterior* mediastinum is bounded in *front* by the pericardium; *behind*, by the vertebral column from the fourth to the twelfth dorsal vertebra, and the anterior common ligament; *laterally*, by the pleural sacs. The *contents* are: the œsophagus going down, the thoracic duct coming up; the aorta going down, and the vena azygos major coming up. Along with the œsophagus are the two pneumogastric nerves ; and at the lower part, on the sides of the aorta, the great splanchnic nerves.

The Pleura.

The serous investure of the lung is named the pleura. Each is a closed sac, separated by an interval in the middle of the chest from its fellow. It presents a visceral and parietal layer. The visceral (the pleura pulmonalis) covers the lung only; the parietal (the pleura costalis) lines the inner aspect of the ribs, the intercostal spaces, the upper surface of the diaphragm, the pericardium, the aorta, and forms the boundaries of the mediastina. There is only one named reflexion of the pleura ; it is placed below the root of each lung, in the area where the visceral and parietal layers meet with nothing between them : it is called the ligamentum latum pulmonis.

A section of the thorax above the root of the lung would show one circlet of pleura around the lung, and a circlet of pleura lining the wall, the two being distinct. A section through the roots of the lungs would show the continuation, front and back, of the visceral with the parietal layer, the structures at the root of the lung intervening. A section below the root of the lung would show the ligamentum latum pulmonis, as already explained.

The pleura protrudes above the superior aperture of the thorax, being about an inch and a half above the first rib, and half an inch above the clavicle. Over the apex runs the subclavian artery, and the scalene muscles protect it. Below it touches the diaphragm, and is adherent firmly thereto. It may be said to closely follow the diaphragm ; but at the spot where the diaphragm is connected with the costal cartilage there is an interval, increasing in extent below, between the pleura and diaphragm; the musculo-phrenic artery occupies this space in front. In a line with the apex of the scapula when the arm hangs, the pleura and lung reach the lower border of the twelfth rib ; in a line with the hollow of the axilla they descend to the ninth rib only ; in a line with the head of the clavicle they only reach the seventh costal cartilage. The lung and pleura descend a little lower on the left than on the right side.

The pleura may be traced vertically or horizontally. Vertically it is easily understood, but it is necessary to give the horizontal tracing more carefully. It will be found that, commencing from the back of the sternum and passing outwards, the pleura passes on the inner surface of the chest-wall, round the angles, necks, and heads of the ribs, forming the parietal layer of the pleura. It then gets on to the sides of the bodies of the vertebræ, and hence to the back of the pericardium. After leaving the pericardium, it gets on to the back part of the root of the lung, along the posterior part of the inner surface of the lung, round the posterior border, along the outer convex surface, round the sharp anterior border, then along the anterior part of the inner surface of the lung, on to the anterior part of the root of the lung, and, again touching the pericardium, passes up towards the sternum to the point at which it commenced.

The Trachea, Bronchi, and Lungs.

The trachea, or windpipe, is a tube specially adapted for the passage of gases to and from the lungs.

It commences opposite the sixth cervical vertebra, and ends opposite the cartilage between the fifth and sixth dorsal. The commencement is easily made out by feeling for the cricoid cartilage, from whence it descends in the median line for a distance of four and a half inches. In front and at the sides the tube is kept convex and firmly resistant by horse-shoe shaped cartilages; but behind, these are deficient, and there the surface is flattened and soft. The trachea increases in width from above downwards, averaging from three-quarters to one inch. The relations vary according as to whether the cervical or thoracic portion is considered.

The *cervical* portion has: in *front*, the skin, superficial fascia, deep fascia, occasionally a transverse branch uniting the anterior jugular veins, the isthmus of the thyroid gland opposite the third and fourth tracheal rings, and the fascia stretching between the two sterno-mastoid and the two sterno-thyroid muscles; *behind*, the œsophagus; on *either side*, the common carotid artery and internal jugular vein, the recurrent laryngeal nerve, a lobe of the thyroid gland, and the sterno-hyoid and sterno-thyroid muscles.

In the *thorax* the trachea has: in *front*, the arch of the aorta and the innominate artery; *behind*, the œsophagus; to the *right*, the innominate artery; to the *left*, the left common carotid, the left subclavian, and the thoracic duct.

The structure of the trachea and bronchi is as follows: 1. A fibrous layer outside, with cartilaginous arches imbedded. The cartilages are from sixteen to twenty in number; they are plano-convex, the external aspect being flat, the internal (*i.e.*, the surface towards the lumen) convex. Each forms about three-quarters of a circle; behind they end abruptly, and from the ends the muscular fibres arise. 2. Behind, where the cartilages are deficient, is a layer of transverse muscular fibres. 3. Within these, a layer of longitudinal elastic fibres, easily distinguishable by the naked eye. 4. Most internally, submucous tissue and mucous membrane covered with ciliated epithelia.

The right and left bronchus are continued from the bifurcation of the trachea to the root of the lung. The *right* bronchus diverges more suddenly than the left, and has a shorter course. It is one inch long, and enters the root of the right lung on a level with the fifth dorsal vertebra.

The relations of the right bronchus are : above, the vena azygos major; below and internally, the dark bronchial glands; behind, the fifth dorsal vertebra; in front, the right pulmonary artery and the pericardium.

The *left* bronchus is narrower and more oblique than the right. It measures two inches in length, and enters the lung opposite the sixth dorsal vertebra.

The relations of the left bronchus are : above, the arch of the aorta; below and internally, the dark bronchial glands; behind, the œsophagus and the descending aorta, and the sixth dorsal vertebra; in front, the left pulmonary artery.

The partition placed at the bottom of the trachea, where the bronchi part company, is, on account of the sudden divergence of the right bronchus, tilted slightly to the left. Hence a foreign body descending in the centre of the trachea would hit the right side of the partition and be tilted into the right bronchus.

Practically, the structure of the bronchus is the same as that of the trachea. When one traces the bronchus into the lung, it will be found to divide and subdivide, and to form by-and-by very small tubes. The bronchi first form smaller bronchi, or bronchioles; but by subdivisions the size is so reduced that capillary bronchi result. As these reach the lung-surface they suddenly dilate to form *infundibula*, on the wall of which the air-vesicles exist. These are formed by septa projecting from the wall of the recess, and causing spaces or alveoli, to allow of the air being retained for a time in contact with the bloodvessels contained in the walls. To know the structure of the lung, trace the various tissues of the trachea and bronchi into the lung, as follows :

A small bronchus presents : (1) Fibrous tissue, with cartilaginous flakes imbedded in it; (2) a complete layer of circular muscular fibres; (3) a complete layer of longitudinal elastic fibres; (4) submucous tissue; (5) mucous membrane, with ciliated epithelia. Now follow these on to the lung-substance : The fibrous tissue is continued into the lung-substance; the cartilaginous tissue ends when the diameter of the tube reaches $\frac{1}{25}$ of an inch; the muscular fibres, submucous membrane, and ciliated epithelia, end at the infundibula; but the elastic tissue is continued into the lung-substance.

The bronchial arteries and veins and pulmonary plexuses of nerves have been already noticed.

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The LUNGS occupy the main part of the thoracic cavity, and project beyond it at the top to the distance of an inch and a half. The lung is free everywhere, except at its root. The named parts of the lung are as follow: apex, base, outer convex surface, inner concave surface, round posterior border, and sharp, thin anterior border. The apex is conical, the base concave and rests on the diaphragm. The lung is divided by a fissure which extends from behind the apex downwards and forwards towards the xiphoid cartilage; the part above the fissure is called the *upper*, the part below, the *lower*, *lobe.* In the right lung a second fissure passes forward at right angles to the main fissure, and, reaching the anterior border, cuts off the third lobe of the lung. On the left side no such lobe is found, its place being taken by the heart and pericardium. Hence the right lung is a little larger than the left—the right weighing twenty ounces, the left eighteen ounces.

The *root* of either lung is found on its inner surface, midway between the apex and base, and midway between the anterior and posterior borders. It consists of the pleura, enclosing the structures found in the roots of the lungs.

The relations of the root of the *right* lung are: in front, the phrenic nerve, anterior pulmonary plexus, and the superior vena cava; behind, the posterior pulmonary plexus; above, the vena azygos major; below, the ligamentum latum pulmonis.

The relations of the root of the *left* lung are: in front, the phrenic nerve and the anterior pulmonary plexus; behind, the posterior pulmonary plexus and the descending aorta; above, the arch of the aorta; below, the ligamentum latum pulmonis.

The structures forming the roots of the lungs are: a bronchus, a division of the pulmonary artery, two pulmonary veins, a bronchial artery, a bronchial vein, branches of nerves from the anterior and posterior pulmonary plexuses, lymphatics, and some areolar tissue. The main structures vary a little in relation one to the other. On both sides from *behind forwards* the structures are—bronchus, artery, veins. Owing, however, to the left bronchus having to come low down to get beneath the aorta, the two sides differ as their structures are looked at from the front. They would then be from *above downwards:* on the right—bronchus, artery, veins; but on the left—artery, bronchus, veins.

The descent of the diaphragm increases the area within the chest-walls, and allows the air to enter and expand the lungs. The sides of the diaphragm are the only parts that move; the central aponeurotic part is retained in its place by the fibrous pericardium. Owing to the oblique attachment of the diaphragm, the direction of its descent is not straight downwards, but downwards and forwards.

Some of the viscera below the diaphragm will necessarily be affected by its descent—viz., the liver, stomach, and spleen. These viscera are under cover of the ribs, and in contact with the diaphragm, for the purpose of receiving the stimulus and pressure from the diaphragm, necessary for the performance of their functions.

In the diaphragm exist *openings* and *fissures.*

The *openings* are three in number: 1. The most anterior is the orifice for the inferior vena cava, an aponeurotic opening a little to the right of the middle line. It is *quadrilateral* in shape. 2. The orifice for the œsophagus is a muscular opening, which transmits the œsophagus, the right and left pneumogastric nerves—the left in front, the right behind—and branches of communication between the gastric and œsophageal arteries. It is *elliptical* in shape, the long axis of the ellipse extending in an antero-posterior direction. 3. The aortic orifice, an osseous and tendinous opening, having the vertebræ behind, and the crura of the diaphragm on either side. It transmits the aorta, vena azygos major, thoracic duct, and sympathetic nerves. It is *oblique* in shape.

The *fissures* or slits in the crura are for the passage of the greater, and sometimes the lesser, splanchnic nerves, and it may be the vena azygos minor in the left crus.

The Ear.

The organ of hearing is resident in the petrous portion of the temporal bone. For convenience of description it is divided into an external, middle, and internal ear. The first two are media, concerned with the transmission of sound; the last is the region where the real sense organ is.

The *external ear* presents two parts for examination, the pinna and the meatus.

The *pinna* or *auricle* is the name given to the large mass of firm but movable tissue projecting from the side of the head. In its general arrangement it is concave towards the outside, the bottom of the concavity being occupied by the meatus.

There are various undulations and depressions seen on the outer aspect of the pinna, having evidently to do with the collection of sound. Around the anterior upper margin of the pinna an incurved rim exists, the *helix.* Within this is another ridge, the *antihelix,* separated by a ditch, the *fossa of the helix* or scaphoid fossa. The upper end of the antihelix is forked and encloses a triangular fossa, or *fossa of the antihelix.* The large hollow, with the meatus or opening into the ear at its anterior aspect, is the *concha*; and it will be seen that the helix and antihelix spring from this fossa, the latter forming its upper and posterior boundary. Over the meatus, protecting it, is the prominence of the *tragus*, with its apex backwards; and just opposite it, and placed posteriorly with its apex forwards, is the *antitragus*.

The lower part of the pinna, the lobule, is soft and free from cartilage. The skin covering the pinna is tightly adherent to the inequalities of the cartilage. On the posterior (or inner) surface of the tragus there are found a bunch of stout hairs which project backwards to shield the opening into the meatus, just as the other sense organs are protected by hair, viz., the eye, the nose, even the tongue by the hair about the mouth in men, and the skin also by its (rudimentary in man) hirsute covering.

The rigidity of the ear, is given to it by a mass of yellow fibrocartilage, which presents all the inequalities just mentioned. The cartilage reaches into the meatus for the distance of half an inch. In both the pinna and meatus the cartilage is cleft. The cleft in the pinna is between the helix and tragus, where it is covered over by skin, and from this point the cleft extends inwards at the upper and anterior part of the meatus. Fibrous tissue bridges the gap, and by fibrous tissue also the pinna and the tubular portion of the meatus are fixed to the surrounding bones.

The muscles of the external ear have been already described. They are: (1) Extrinsic—the attrahens, attollens, and retrahens auriculum. (2) Intrinsic—(*a*) on the external aspect, the greater and lesser muscle of the helix, and the muscles of the tragus and antitragus; (*b*) on the internal (or posterior) aspect, the transverse and oblique muscles. (*See* MUSCLES.)

The helix presents at its fore part on the front edge of the convexity a small process—the process of the helix. From the process of the helix a bundle of fibrous tissue runs down to the root of the zygoma, constituting the anterior ligament. The posterior ligament runs from the back of the pinna opposite the concha, to the anterior aspect of the mastoid bone.

The external auditory meatus, is the name given to the canal leading from the bottom of the concha to the tympanic membrane. The canal is not straight, but inclines first forwards, then slightly backwards, and then forwards again. The cause of the bend backwards is the projection of the condyle of the lower jaw; hence, except for that projection the canal has a general direction inwards and slightly forwards. The floor of the space also rises in the centre about the junction of the cartilaginous and osseous portions. From hence the floor slopes downwards, both internally and externally. The canal at its inlet is ovoid, with its long axis from above downwards; at the inner end near the membrana tympani it is ovoid, with its long axis from before backwards. In the centre the canal is narrowest, and most nearly circular.

The diameter of the tube is on an average a little over a quarter of an inch, and its length along the centre of the tube, one and a quarter inches; the upper wall is slightly shorter than the lower.

The outer half inch of the meatus is formed of cartilage continued from the pinna as already explained. The inner three-quarters of an inch is formed of bone. The skin, continued into the meatus from the concha, lines the whole tube, reaching even to the bottom, where it forms the outer layer of the membrana tympani. The part over the cartilage is thick, and contains sebaceous glands and hair-follicles. Glands resembling sweat-glands are met with in the same region; they, however, in this region secrete cerumen, or wax, and are called accordingly ceruminous glands.

The bloodvessels of the external ear and meatus are:

(1) The posterior auricular artery supplies the inner aspect of the auricle, and sends branches around the rim of the cartilage as well as through it to supply the outer aspect. The same artery sends branches also along the meatus. (2) The anterior auricular artery from the temporal. (3) The internal maxillary also supplies branches to the meatus.

The *veins* accompany the arteries.

The *nerves* are:

(1) The great auricular, from the superficial cervical plexus. (2) The posterior auricular, from the facial. (3) The auricular branch of the pneumogastric. (4) Temporal branches of the facial nerve. (5) Auricular from the auriculo-temporal, from the third division of the fifth. (6) The small occipital from the superficial cervical plexus.

The Tympanum.

The tympanum, drum, or middle ear, is a small cavity in the substance of the temporal bone. In it a chain of bones, supported by ligaments, and acted on by muscles, stretches from the outer wall at the membrana tympani to the inner wall. The breadth of the space is about one-sixth of an inch, and its greatest diameter, lying in an antero-posterior direction, is about one-third of an inch.

The boundaries are: The *roof* is formed by a plate of bone constituting part of the anterior surface of the petrous portion of the temporal; the *floor* by a piece of bone between the tympanum and jugular fossa: the *outer* wall is formed by the membrana tympani; the *inner* wall by a piece of bone bounding the labyrinth externally: *in front* is the opening of the Eustachian tube; and *behind* the openings of the air-cells in the mastoid process.

The membrana tympani is a glistening, glassy-like membrane, which separates the external from the middle ear. It is in thickness $\frac{1}{250}$ of an inch, and in its greatest diameter, which extends from above and behind, to the anterior and lower part, ·37 of an inch.

It is covered outside by the cutaneous structures continued from the meatus, and within by the mucous membrane of the tympanum, continuous through the Eustachian tube with the pharynx. The tissue of which it is composed between these two is found microscopically to be a delicate fibrous structure. The membrana tympani is set obliquely in the meatus; in fact, it forms with the floor of that tube an angle of 55°.

The membrane is connected to the bony ring, which is complete except at the anterior and upper part, where a notch exists—the notch of Rivinius. Here a flaccid connective-tissue—the membrana flaccida is situated, which closes the gap and so completes the separation of the meatus and drum of the ear. When looked at with an auriscope the membrane is seen to be depressed in its centre towards the cavity of the tympanum. This is the *umbo*, and to its inner aspect the long process of the malleus is attached. Hence the surface of the membrane is not level, but when seen from the outside it is depressed in the centre, around which it is convex, and then it dips inwards again at its outer margin.

The *inner wall* of the tympanum presents the following:

1. The fenestra ovalis, an aperture situated near the upper wall, communicating with the vestibule internally. The aperture corresponds to the base of the stapes, and is almost kidney-shaped, the convex border being upwards, and the hilus below; the long axis of the aperture is in a direction from before backwards.

2. Below the aperture is a projection, the promontory, caused by the bulge of the first coil of the cochlea.

3. Below and behind the promontory is a funnel-shaped depression leading to the fenestra rotunda. A thin membrane placed in this aperture separates the tympanic cavity from the scala tympani. This is the secondary membrane of the tympanum.

4. Above the fenestra ovalis, right at the upper wall, the bulge met with indicates the presence of the aqueduct of Fallopius.

5. Behind the fenestra ovalis is the pyramid, a small conical eminence with a minute opening in its apex.

The *openings* in the tympanum are the Eustachian tube, the canal of the tensor tympani muscle, the openings for the entrance and exit of the chorda tympani nerve, the mastoid cells and the Glasserian fissure.

(*a*) The *Eustachian tube* is an osseo-cartilaginous tube communicating with the pharynx below and the tympanum above. In all it is one and a half inches in length; it is directed forwards and inwards from the tympanum with a slight inclination downwards (Quain). The part next the pharynx is cartilaginous, and forms one inch of the entire length; it opens into the pharynx by a dilated trumpet-shaped opening on a level with the inferior turbinated bone. The cartilage of which it is composed is incomplete below and externally; here a fibrous bundle bridges the slit, and completes the circumference of the canal. The muscles connected with the Eustachian tube are the salpingo-pharyngeus around its mouth; the tensor palati, the levator palati, and the tensor tympani. The osseous part of the tube is only about half an inch long. It lies between the angle of union of the squamous with the petrous portion of the temporal bone. Above the tube is a piece of bone, the processus cochleariformis, which separates it from the canal for the tensor tympani muscle. (*b*) The opening of the tensor tympani canal is immediately above that of the Eustachian tube. (*c*) The chorda tympani openings are: one posteriorly, just below the pyramid, the *iter chordæ posterius;* one anteriorly, close below the Glasserian fissure, the *iter chordæ anterius.* (*d*) The mastoid cells open upon the posterior wall of the tympanum by one large and by a number of more minute openings. (*e*) The Glasserian fissure extends along the anterior wall from the anterior point of attachment of the membrana tympani. Through it passes the processus gracilis of the malleus, a ligament, the chorda tympani nerve, and an artery—the tympanic. (*f*) Besides these are the fenestra ovalis, the fenestra rotundum, and the hole in the pyramid already described.

The Bones of the tympanum are the malleus, incus, and stapes. They form an articulated chain of bones connecting the outer and inner walls of the tympanum.

The *malleus* is named on account of its supposed likeness to a hammer. It is situated immediately within the membrana tympani. It presents for examination a head, neck, and processes.

The *head* of the bone is above, presenting a round apex to the roof of the tympanum; on its posterior and inner side is the articulation for the incus.

The *neck* is simply the constricted portion below the head.

The *processes* are the handle, the short and the long process.

The *handle*, or manubrium, seems to be the continuation of the bone downwards. It forms an angle with the head, the apex of the angle being outwards; it is flattened from before backwards, until just at the point below, where it is flattened from without inwards. It is received between the layers of the membrana tympani, and corresponds at its end to the depression of the umbo. At the junction of the head and handle, the *lesser* process projects outwards, abutting as a small conical eminence against the upper and back part of the membrana tympani, to which it is attached by muscles. The *long* process, the processus gracilis of the malleus, is a long delicate ligamentous rod, which enters the Glasserian fissure in front, and to the sides of which it is attached by fibrous tissue.

The *incus*, or anvil, so named from its shape, is the central bone in the chain of ossicles. It presents a body and processes for examination. The *body* has a cupped, or saddle-shaped, surface for articulation with the back part of the head of the malleus. Running backwards from the body is the *shorter* conical process; it is fixed by ligaments to near the openings of the mastoid cells. The *long* process seems to be the continuation of the incus downwards in nearly a vertical direction; just at its lower end it is bent inwards rather suddenly. On its end is the processus orbicularis, or os orbiculare, a flattened nob, covered by cartilage and articulating with the stapes.

The *stapes* is the most internal bone in the chain of ossicles. It has received its name from its rather close resemblance to a stirrup. It presents for examination a head, a base, and two crura.

The *head* is placed most externally, and articulates on its external aspect with the lower end, the processus orbicularis, of the incus. The *base*, corresponding to the stirrup-bar, has the fenestra ovalis internally. This part has something of a kidney-shaped outline, with the hilus below. (*See* Fenestra Ovalis.) It is fixed by ligaments to the margins of the fenestra, and usually adheres after the removal of the other ossicles.

The *crura* spring from below the head (the neck) and pass, one to the anterior, the other to the posterior, part of the outer surface of the base. The anterior crus is the shorter, the posterior the more bent.

The gap enclosed between the crura and base is filled in by a thin piece of mucous membrane.

The *articular* surfaces between each bone and its neighbour is formed of cartilage, synovial membrane, and a capsular ligament.

The LIGAMENTS of the tympanum require very special dissections and a rather powerful hand-magnifying glass for their investigation. (*a*) The anterior ligament of the malleus runs beween the neck of the malleus and the Glasserian fissure parallel to the processus gracilis. This ligament was thought, until a few years ago, to be a muscle, and was dignified with the name—laxator tympani. (*b*) An accessory anterior ligament connects the anterior tympanic wall with the neck of the malleus. (*c*) The external ligament of the malleus runs from the margin of the notch of Rivinius backwards to the root of the short process of the malleus. (*d*) The superior ligament of the malleus passes between the roof of the tympanum and the head of the malleus, slinging the bone in its place. (*e*) The inferior ligament of the malleus runs backwards from near the lower end of the handle below the level of the long process of the incus, to the back part of the tympanum. (*f*) The ligament of the incus ties the short crus to the posterior wall near the mastoid cells.

The MUSCLES of the tympanum are the tensor tympani and the stapedius.

The *tensor tympani* muscle lies in the canal already spoken of, lying above the level of the Eustachian tube, and separated therefrom by the processus cochleariformis. The muscle *arises* at the base of the cranium from the Eustachian tube and the piece of the great wing of the sphenoid adjacent, and from the sides of the canal in which it is conducted to the tympanum. Over the lower margin of the canal, the muscle, when it reaches the tympanum, bends at almost a right angle, and passes outwards across the cavity of the tympanum to be inserted into the upper and inner aspect of the handle of the malleus. A dense sheath embraces the muscle in its way across the tympanic cavity.

The *stapedius* muscle is lodged in the cavity of the pyramid, from the apex of which it emerges as a fine tendon to be inserted into the back part of the head (or neck) of the stapes.

The actions of these muscles are readily understood from a consideration of their position. The tensor tympani must evidently act by pulling inwards the handle of the malleus, and so increase the tension of the membrana tympani to which it is attached. The stapedius will evidently tilt the stapes, thus raising its anterior part from out of the fenestra ovalis.

The *arteries* of the tympanum: (1) The tympanic branch of the internal-maxillary coming through the Glasserian fissure. (2) The stylo-mastoid from the posterior auricular. (3) The internal carotid gives some branches as it lies in the carotid canal. (4) The petrosal branch from the middle meningeal, which enters the petrous portion of the temporal bone through the hiatus Fallopii.

The *veins* of the tympanum communicate inside the cranium with the superior petrosal sinus; outside the cranium with the temporo-maxillary vein.

The *nerves* in the tympanum are: (1) On the inner wall, grooving the promontory, is the tympanic plexus. (*See* Glosso-pharyngeal Nerve.) (2) The chorda tympani from the facial, entering and leaving the tympanum by separate apertures (as has been described, *see* Tympanum), to pass in the tympanum between the handle of the malleus and the long process of the incus. (*See* Facial Nerve.) (3) The tensor tympani muscle is supplied by the otic ganglion. (4) The stapedius by the facial.

The Internal Ear.

The internal ear, or labyrinth, can only be followed by the naked eye to a very slight extent. The cochlea, the vestibule, and the semicircular canals of which it is composed can be easily recognised. Special preparations have to be made to even gain a notion of the osseous part. The membranous part of the labyrinth will not be dealt with in this work at all.

The VESTIBULE is an ovoidal space, with its long axis placed nearly antero-posteriorly. In length it is about one-eighth of an inch; in breadth, *i.e.*, from without inwards, about one-sixth.

Boundaries: Externally, a piece of bone between it and the tympanum, perforated by the fenestra ovalis. *Internally*, a perforated area, the fovea hemispherica, for the passage of nerves from the auditory; behind the fovea is a ridge, the crista vestibuli; and behind the crista, the vestibular opening of the aqueduct of the vestibule. *In front*, an opening leads to the scala vestibuli of the cochlea. *Behind* are the five openings of the semicircular canals. *In the roof* is the fovea hemi-elliptica, also transmitting filaments of the auditory nerve.

The vestibule contains two membranous sacs, the utricle and the saccule, united by the saccus endolymphaticus.

The SEMICIRCULAR CANALS are three tubes, forming about two-thirds of a circle. The tubes are named superior, posterior, and external, according to the position they occupy. The superior canal projects upwards towards the floor of the skull, and forms the elevation met with on the anterior aspect of the petrous portion of the temporal bone.

The superior and posterior canals lie nearly vertical, whilst the external is horizontal.

The posterior is the longest of the three canals; the external the shortest.

All the canals at one of their ends have a dilatation or *ampulla;* and the non-ampullated ends of the superior and posterior canals unite together before they reach the vestibule, thus making a common opening, and reducing the foramina at the posterior wall of the vestibule to five. The canals have a diameter of one-twentieth of an inch, but at the ampulla one-tenth of an inch.

The COCHLEA, when exposed, appears as a conical-shaped body, lying with its long axis horizontally, placed in the substance of the petrous portion of the temporal. Its apex is forwards, and slightly outwards and downwards; its base is backwards, and towards the vestibule and the internal auditory meatus.

From base to apex it is a quarter of an inch in length, and across the base it measures the same.

The condition of the cochlea is that of a spiral tube wound round a central pillar—the modiolus.

The *spiral tube* makes two and a half turns round the modiolus. It is in length two and a half inches, and in breadth one-tenth of an inch. It is coiled from left to right in the right ear, and from right to left in the left ear, when looked at from behind. The first turn of the tube is much the largest, the others falling almost wholly within its embrace; it bulges into the tympanum, forming the promontory.

The *modiolus* is the central pillar around which the tube winds; it tapers to a point in front, just below the highest point of the cochlea, but the bone there again slightly expands, forming the cupola. Up the centre of the modiolus, the auditory vessels and nerve pass on their way from the internal auditory meatus to the distribution of the nerve.

Projecting from the side of the modiolus, and reaching half-way across the cavity of the spiral osseous canal just described, is a thin flange of bone. This is the spiral lamina of bone which, with a membrane—the basilar membrane—serves to divide the spiral canal into two distinct chambers, the scala tympani and the scala vestibuli.

The *scala tympani* is the posterior of the two canals, as the cochlea lies in the head, but which in diagrams seems to be the lower. It commences at the fenestra rotunda below, and above communicates with the scala vestibuli through the helicotrema, a spot where the hamulus or hook-like end of lamina spiralis is not connected to the modiolus. From the lower end of the scala tympani a foramen runs outwards and backwards to open at the aqueductus cochlea in the petrous portion of the temporal bone. Through the aqueduct runs a vein and a canal, connecting the scala tympani with the sub-arachnoid fluid. The scala vestibuli lies in front of, or according to diagrams above, the scala tympani, as already explained. Below, it opens into the vestibule, and above it communicates with the scala tympani through the helicotrema.

The Orbit.

The orbit is a conical-shaped space situated on either side of the nose, below the anterior aspect of the cranium.

The resemblance to a cone is not exact, as the surfaces are flattened partially, so that the sides meet at angles. The *apex* of the orbit is backwards at the optic foramen; the base forwards at the face. The optic foramen is situated in the lesser wing of the sphenoid, and is directed forwards and slightly outwards; through this foramen the optic nerve and ophthalmic artery gain the orbit from the cranium; their relations being such that the artery is external to, and below the level of, the nerve.

The *base* of the cone, *i.e.*, the facial extremity of the orbit, is formed by the frontal, malar, and superior maxillary bones; the exact bones met with, commencing from within and passing outwards, are: the internal angular process of the frontal, the supra-orbital arch of the frontal having the supra-orbital notch or foramen situated at the junction of the inner and middle third, the external angular process of the frontal, the perpendicular portion of the malar, the horizontal portion of the malar, the body of the superior maxilla, and the nasal process of the superior maxilla. The *roof* of the orbit is formed by the orbital aspect of the horizontal plate of the frontal, and behind by the under surface of the lesser wing of the sphenoid.

The *floor* is formed by the upper surface of the superior maxilla, a portion of the malar bone at the front and outer part, and the orbital process of the palate at the inner and back part. The *outer* wall is formed by the orbital plate of the malar, and by the orbital surface of the great wing of the sphenoid. The *inner* wall exhibits the lachrymal bone in front, the os planum of the ethmoid in the centre, and a bit of the body of the sphenoid behind.

The *angles* present are four.

1. The *superior internal* is formed between the frontal above, and the lachrymal and ethmoid below. It shows two foramina, the anterior and posterior ethmoidal. Through the anterior goes the anterior ethmoidal artery and the nasal twig of the fifth; through the posterior goes the posterior ethmoidal vessels.

2. The *superior external* angle is formed in front by the meeting of the frontal and malar bones, but behind these lies the sphenoidal fissure, a triangular opening with its apex forwards and its base backwards at the sphenoid; its upper border formed by the great wing, and its lower border by the lesser wing, of the sphenoid. Through the fissure various nerves find their way into the orbit, and the ophthalmic vein finds its way back to the cavernous sinus.

The structures entering are arranged according to their relation to the two heads of the external rectus muscle. Passing above the two heads, from within outwards, are the fourth, frontal and lachrymal nerves. Passing between the two heads, in order from above, are the upper division of the third nerve, the nasal twig of the fifth, the lower division of the third, and lowest of all is the sixth nerve. The ophthalmic vein also leaves the orbit between the two heads of the external rectus, being most inferior in position.

3. The *inferior external* angle is formed in front at the junction of the horizontal with the vertical part of the malar bone; behind is the spheno-maxillary fissure. This fissure is bounded externally by the great wing of the sphenoid, internally by the superior maxilla; through the fissure only a few branches of the fifth nerve and some bloodvessels pass.

4. The *inferior internal* angle is bounded: anteriorly by the lachrymal and ethmoid, and behind by the superior maxilla and palate. At its anterior part is the groove on the lachrymal bone, and the nasal duct leading from the orbit to the nose. Other salient points in the orbit are: the impression for the pulley of the superior oblique under cover of the internal angular process of the frontal bone; the cavity for the lachrymal gland under cover of the external angular process of the frontal. On the floor is the infra-orbital groove leading towards the infra-orbital canal and foramen, for the accommodation of the vessels and nerves of that name.

The Eyelids.

The eyelids are part of the protective apparatus around the eye; the others are the eyebrow and the hairs—the cilia—on the edge of the eyelids.

The basis of each eyelid is the so-called tarsal cartilage contained within it. The 'cartilage' is really dense fibrous tissue, which, however, behaves as cartilage in giving a solid structure to the lids. The upper cartilage is semilunar, the lower a longitudinal streak. Each is fixed internally and externally by the internal and external tarsal ligaments. The *internal tarsal ligaments* are derived from the tendo-oculi. This round cord of fibrous tissue is attached to the nasal process of the superior maxilla, and at its outer end is divided into two ligaments, the superior, and inferior, internal tarsal ligaments. The tendo-oculi (*see* Orbicularis Palpebrarum Muscle) is about three lines long; it has the orbicularis palpebrarum attached above and below it.

The external tarsal ligaments are merely loose fibrous continuations from the surface of the malar bone to the outer parts of the tarsal cartilages.

The next important special structure met with in the eyelid is the *palpebral ligament.* This is merely a fibrous prolongation from the margins of the orbit to sling the cartilages in their places.

The structures met with in the eyelid from front to back are: The skin, a fine, delicate layer; subcutaneous areolar tissue destitute of fat-cells; the orbicularis palpebrarum (which see); the palpebral ligament; the aponeurosis of insertion of the levator palpebræ; the vascular layer; the tarsal cartilage; the involuntary muscle of the lids; the Meibomian follicles, and mucous membrane.

In the lower lid there is no muscle corresponding to the levator palpebræ. The edge of the eyelids is rather sharply cut, and from before backwards exhibits: (*a*) the cilia, or eyelashes; those on the upper eyelid are bent, with their concavity upwards; those on the lower have their convexities upwards. They are regarded as being in two rows. The bulbs of the cilia separate a bundle of the fibres of the orbicularis from the main mass; it is called the *ciliary bundle;* around the cilia are the openings of sebaceous and sweat glands. (*b*) Behind these the Meibomian glands have their orifices. These glands—twenty to thirty in number in each eyelid—lie within the tarsal cartilages, and immediately in contact with the mucous membrane. They are long sebaceous glands, with saccular appendages on their walls, and their minute orifices can be seen with the naked eye on the margin of the lids.

The eyelids meet internally and externally at the inner and the outer canthi or angles, respectively. The inner canthus is rounded, the outer acute. On each lid, one-sixth of an inch from the inner canthus, is an elevation, the *papilla* lachrymalis. Just behind the apex of the papilla is an opening, the *punctum* leading to a minute canal, the *canaliculus*, and hence to the lachrymal *sac.* Within the inner canthus is a reddish elevation of what seems to be mucous membrane, but which is in reality skin, covered by hair. This is the *caruncula lachrymalis*, immediately external to which is the *plica-semilunaris.* The latter is the homologue of the third eyelid—the membrana nictitans—met with in many of the bird tribe.

The LACHRYMAL APPARATUS consists of the lachrymal gland, lachrymal ducts, puncta, canaliculi, lachrymal sac, and nasal duct.

The *lachrymal gland* lies under cover of the external angular process of the frontal bone. It is almond-shaped, about three-quarters of an inch long, lying with its long axis crosswise to the orbit. Above, it is lashed to the frontal bone by a quantity of fibrous tissue; below, it is concave, and rests on the external and superior recti muscles. A piece of the gland under cover of the eyelid, and so capable of compression by the orbicularis, is detached from the main mass by a quantity of fibrous tissue: it is called the inferior lachrymal gland. The lachrymal artery and nerve enter the gland at its posterior border.

From the gland, twelve (or thereabouts) lachrymal ducts convey the lachrymal secretion to the outer and upper part of the conjunctival reflexion, which they pierce. The secretion partly finds its way to the inner side of the eye by the motions of the eyelids, and partly is lost by evaporation. Arrived near the inner canthus, it finds its way through the puncta placed in the papillæ of the upper and lower lid. (*See* Eyelid.) From hence, the lachrymal canals (the canaliculi) carry the fluid to the lachrymal sac. Both tubes are bent after they have proceeded a short distance, and dilated where bent; they pass horizontally inwards to open separately, the one into the upper, the other into the lower, part of the outer side of the sac.

The *lachrymal sac* is a membranous bag placed in the groove of the lachrymal bone. It is closed above, and has the two openings of the canaliculi on the outer wall; below it is continued into the nasal duct. The relations are: in front, the tendo-oculi and the orbicularis palpebrarum; behind, the tensor-tarsi muscle at its origin from the flat part of the lachrymal bone; internally, the groove of the lachrymal bone; and externally and above it is covered by the tensor-tarsi muscle on its way forwards to be inserted into the back part of the puncta.

The *nasal duct*, seven lines in length, leads from the lachrymal sac downwards, slightly backwards and slightly outwards, to the opening of the duct in the inferior meatus of the nose. The bones forming the nasal duct internally are: the lachrymal bone above, and the inferior turbinated below; the superior maxilla forms its outer boundary all the way along. The bones are covered by a dense fibrous tissue and a mucous membrane, which at its opening into the meatus is prolonged into a kind of valve—valve of Hasner.

The Eye.

Situated within the bony orbit, resting on fat, and surrounded by muscles, is the eyeball. Around it are tissues, placed so as to allow of its movements on neighbouring structures—viz., the conjunctiva in front, and the capsule of Tenon behind. The various structures have also distinct functions—the sclerotic a protective, the choroid a nutritive, and the retina a visual. In the centre are the various media—the cornea, aqueous humour, lens, and vitreous humour.

The eye seems to consist of the coaptation of two segments or spheres: the anterior, the smaller, formed by the cornea; the posterior, formed by the sclerotic. The eyeball measures in its transverse diameter one inch, and in its vertical and antero-posterior diameters, each nine-tenths of an inch.

The *conjunctiva* is the mucous membrane covering over the front of the eye. It consists of an *ocular* portion, where it is reflected over the eyeball, and a *palpebral*, where it lines the inner surface of the lids. Over the front of the cornea it is clear and transparent, and is incorporated with its tissue. Opening upon it at the outer angle of the orbit are the lachrymal ducts, and near the inner canthus it is continued into the two puncta lachrymalia.

The *capsule of Tenon* is a lymphatic sheath covering the eyeball behind where the conjunctiva touches it. In front it is traversed by the tendons of the ocular muscles; and behind, at the entrance of the ciliary vessels and nerves, it blends with the sclerotic.

The SCLEROTIC COAT, with the cornea, determines the shape and size of the eye. The cornea forms the anterior one-sixth, the sclerotic the posterior five-sixths, of the globe of the eye.

The sclerotic coat consists of bundles of dense fibrous tissue interspersed with elastic tissue, the whole combining to form a close network, continuous in front with the tissue of the cornea.

The outer surface of the sclerotic is smooth and white, and covered by the capsule of Tenon. The inner surface, seen on snipping the coat open with scissors, is of a brown colour, and flocculent from the presence of shreds of a connective tissue, met with between the sclerotic and choroid—the *membrana fusca.* Traversing the inner surface of the sclerotic are the ciliary vessels and nerves, on their way forwards to the iris.

The sclerotic coat is connected with the following structures, from before backwards: In front, the conjunctiva overlaps it; the recti muscles are next inserted into it—the superior rectus four lines, the external three lines, the inferior three lines, and the internal two lines from the corneal margin; half-way back the venæ vorticosæ, in four branches, perforate the sclerotic coat to join the ophthalmic vein; just behind the meridian of the eyeball the superior and inferior oblique muscles are attached; the long ciliary vessels and nerves perforate the sclerotic behind its centre; the short ciliary vessels and nerves perforate around the optic nerve; and most posteriorly of all, the optic nerve enters the eyeball by piercing the sclerotic coat at the *lamina cribrosa.*

The Cornea.

The cornea preserves the shape, protects the central portions of the eyeball, and allows of the entrance of light. It forms about one-sixth of the circumference of the eyeball. It is in thickness about one-thirtieth of an inch, in diameter about half an inch, and in shape nearly circular. It is curved with its convexity forwards, and its concavity bounds the anterior or aqueous chamber of the eyeball. Around its margin it is continuous with the tissue of the sclerotic, which advances over the anterior surface to some extent, rendering the posterior concave surface more extensive than the anterior. It is this overlapment which has given rise to the misleading statement, that the cornea is inserted into the sclerotic, like a watch-glass into its frame; but a watch-glass and its frame are not the same in structure, whereas the cornea and sclerotic are continuous in structure.

The knowledge of the cornea to be ascertained by naked-eye examination is very meagre. After death a delicate layer, a sort of skin, can be raised from the anterior surface; this can be traced to the sides, where it is seen to be continuous with the conjunctiva. The main mass, or *substantia propria* of the cornea is a tough tissue continuous with the sclerotic at the sides. Behind this a distinct lamellar layer of tissue can be raised and peeled off; this is the elastic membrane of Descemet or Demours.

The Choroidal Coat.

The *choroid* is the vascular coat of the eye, and lies within the sclerotic. It is continuous in front with the iris, and behind it is perforated by the optic nerve. At the spot where it is continuous with the iris it forms a circlet of thickened projections named the ciliary processes. These project on the inner aspect, and are best seen when the choroid is detached and viewed from behind.

The appearance of the choroid is that of a jet-black covering; but although pigment does exist in the choroidal cells, the colour apparently given to it, is due to the pigmentary cells of the retinal layer found within the choroid.

The various structures met with in connection with the choroid in order from without inwards are: the *membrana fusca*, a delicate reticulum of fibrous tissue between the sclerotic and choroid; the *ciliary vessels and nerves*, passing forwards to the iris, etc.; the plexuses of veins, the *vasa vorticosa;* the *choroidal tissue proper*, consisting of fine fibrous tissue, with branched connective-tissue corpuscles containing pigment, and the *membrana supra-choroidea* covering it externally; the *tunica Ruyschiana*, a fine microscopic plexus of bloodvessels forming the inner layer of the choroid; and the membrane of Bruch, a delicate connective tissue forming the most internal limit to the choroidal structures.

The *ciliary processes*, when viewed from behind, after the choroid has been stripped off, or still better when a vertical section of the eyeball has been made, are seen to consist of a white fringe-like circlet of tissue between the choroid and the iris. They look white, because the pigment-cells have become adherent to the suspensory ligament of the lens, with which the processes are connected deeply. In number these processes are about seventy; and it can be made out that they are not all the same size, some measuring as much as one-tenth of an inch, others only one-fortieth of an inch. The large processes predominating form in fact about two-thirds of the whole. In a carefully injected eye these processes are seen to be very vascular; they are, in fact, delicate plexuses of minute blood-vessels.

The *iris* acts as a sensitive, contractile, and coloured shade or blind to the retina within. It is suspended in the aqueous chamber; its outer or circumferential part is attached to the cornea by the ligamentum pectinatum iridis, and to the front part of the choroid by the ciliary processes. In breadth it measures half an inch across. In its centre is the pupil, varying in size—from one-twentieth to one-third of an inch—according to the extent of its contraction or dilatation. The iris consists of a *delicate reticulum of fibrous tissue*, covered over, anteriorly by a *layer of cells* continuous with that from the back of the cornea, and posteriorly by layers of pigment-cells—*the uvea*. In the fibrous tissue are found muscles, vessels, nerves, and lymphatics. The *muscles* are of two sorts, circular and radiating. The *circular* fibres are arranged round the pupil, forming the *sphincter pupillaris;* the *radiating* fibres pass from the margin towards the pupil, forming the *dilatator pupillaris.* The *vessels* are derived from the ciliary, and form two circles: the one around the outer part of the iris, and the other near the pupil. They are called the *circulus iridis major* and *circulus iridis minor.* The *nerve* supplying the dilatator is the sympathetic through the ciliary nerves; the nerve supplying the sphincter is the third, also through the ciliary nerves; all of these nerves proceed from the lenticular ganglion.

The white rim of tissue seen at the junction of the choroid and iris, and obscuring the ciliary processes, is the ciliary muscle.

The *ciliary muscle* arises at the junction of the cornea and sclerotic, and is inserted into the junction of the iris and choroid, obscuring the continuation of the two. As already mentioned, the junction between the iris and choroid is effected by the ciliary processes, and the ciliary muscle comes to be inserted into them. These processes are in turn blended on their inner surfaces with the *suspensory ligament* of the lens; and thus the muscle comes to act on the capsule and the lens itself, by increasing or diminishing its convexity and density.

It is found microscopically that there are two sets of fibres to the ciliary muscle; a radiating set, the outer, named the meridional and radiating fibres; a circular set, the inner or deeper, named the circular ciliary muscle.

The Retina.

The *retina* is situated within the choroid coat, and upon the vitreous humour. It exists as a soft mass of tissue of a pinkish-white colour, and showing minute bloodvessels in its substance. The retina is easily separated from its connection, except behind, where it is continuous with the entrance of the optic nerve. It is confined mostly to the posterior half of the eyeball, but it is seen to extend forwards to within a short distance of the margin of the lens. Here the retina ends by an indented border, the *ora serrata ;* but from hence, as a delicate non-visual membrane, it is continued forwards to the ciliary processes, as the *pars ciliaris retinæ.*

The inner aspect of the retina shows: (1) *The macula lutea*—the yellow spot of Sömmerring, about one-twentieth of an inch in diameter. This occupies a point in a line drawn through the axis of the eye, one-tenth of an inch to the outer side of the entrance of the optic nerve. (2) In the centre of the yellow spot is the *fovea centralis.* (3) The *porus opticus* is the name given to the round disc at the spot where the optic nerve enters the back of the eye. The disc is slightly elevated, forming the *colliculus nervi optici*, and from the centre of the elevation the central retinal vessels pass to and fro. The disc when seen in a healthy living eye by the ophthalmoscope, has a light grey tint with a faint pinkish tinge.

The arteria centralis retinæ is the name given to the bloodvessel which enters the optic disc. It arises from the ophthalmic artery, or one of its branches, pierces the outer side of the optic nerve about half an inch behind the eyeball, and between the fibres of the nerve enters at the centre of the optic disc. At the fundus of the eye the central artery divides into two branches, one going upwards, the other downwards. Each branch subdivides again and again, and finally the branches become lost to view by ending in capillaries. The veins accompany the artery, although the trunks are separated on the disc. All the bloodvessels avoid the spot of most acute vision, the macula lutea.

The *aqueous chamber* is the name given to the region immediately behind the cornea. It is bounded in front by the cornea, and behind by the lens and its capsule. The iris floats in the thin fluid with which the chamber is filled and divides it into a space in front and behind. The division is incomplete, but as the iris at the circumference of the pupil rests on the lens, an attempt at division is made. The part in front of the iris is called the anterior chamber of the aqueous humour, and the part behind, apparently triangular on section, the posterior chamber of the aqueous humour. The humour, or fluid, is a watery liquid containing chiefly chloride of sodium.

The *vitreous humour* forms the main mass of the contents of the eyeball. It is a transparent, soft, gelatinous substance; it is enclosed in the hyaloid membrane, over which the retina is expanded. Through the centre of the vitreous humour in a frozen eye, a canal one-twelfth of an inch in diameter, running from the optic disc to the back of the lens, can be made out. This canal—the canal of Stilling—represents the place where an artery traversed the vitreous humour in the fœtus.

The *hyaloid membrane* is the thin delicate membrane which surrounds the vitreous humour. Upon its outer aspect the retina is spread; hence the light must traverse the hyaloid membrane on its way to the retina. Towards the anterior part the hyaloid membrane becomes more dense and firm, and passes on to the front of the lens as the *zonula of Zinn*, or the suspensory ligament of the lens. As it passes the margin of the lens to get to the front, fine fibres proceed from the under surface of the suspensory ligament of the lens, to reach the sides of the posterior aspect of this body, becoming continuous with its capsule. The suspensory ligament has upon its outer or anterior surface the ciliary processes, and when these processes are pulled off the suspensory ligament they are seen to leave the pigment on the ligament, and thus imprint an exact impression of the processes upon it.

On the inner (posterior) aspect of the suspensory ligament is the space called the *canal of Petit*, which surrounds the margin of the lens. This can be blown up by inserting the end of a blow-pipe beneath the membrane at the margin of the lens (when the lens and vitreous humour are removed together), and blowing pretty strongly. The area immediately around the lens becomes distended by particles of air, and a sacculated canal is demonstrated.

The LENS lies behind the iris, and in front of the vitreous humour. It is surrounded marginally by the suspensory ligament of the lens, and enclosed completely in a transparent capsule. The surfaces are convex, each being of the curvature characteristic of the ellipse. The convexity of the posterior surface is much the greater. In breadth the lens measures one-third of an inch; in thickness—that is, from before backwards—one-fifth of an inch. When the lens is pinched between the finger and thumb the outer part is found to be the softer, breaking down readily, but the central portion is firmer, constituting, for want of a better name, the nucleus. When the lens has lain in water for some time after removal, three faint white lines passing from the focal points—the poles in front and behind—can be readily seen. When the lens is held up to the light, it is seen that these radiating lines of the two surfaces do not cover one another, but that the lines of one surface fit the intervals of the other. These lines correspond to septal planes, towards which the lens-fibres are directed.

The lens varies in its convexity from youth to old age. The fœtal lens is nearly spherical; the adult lens has ellipsoid surfaces, the posterior being the more prominent; in the lens of an old person both surfaces are seen to be flattened. Variations also occur in colour and transparency, etc.; the lens of the fœtus is of a reddish colour, and is slightly opaque; the lens of an adult is colourless and transparent; the lens of an old person becomes amber coloured and slightly opaque.

The lens of the fœtus is soft; that of the adult more firm; whilst the lens of an old person's eye becomes quite tough.

The Larynx.

The organ of voice is situated at the upper end of the windpipe, so as to receive the influence of the air going to and from the lungs upon the vocal cords; it is placed high up, and as close to the mouth as possible, so that the voice may not be lost before it gains the lips. The larynx communicates above with the pharynx, and below with the trachea; it is placed below the hyoid bone and between the carotid arteries of the two sides.

In the description of the larynx the following parts have to be noted: the cartilages, the ligaments, the muscles, and the mucous membrane and its peculiarities.

The CARTILAGES of the larynx are the thyroid, cricoid, two arytenoid, the cartilages of Santorini and Wrisberg.

The *thyroid* cartilage, so called from its shield-like shape, is composed of two lateral alæ, which meet in front, but are widely apart behind. The union in front is V-shaped, with the point forwards. In the male this prominence, felt immediately below the skin, is named the pomum Adami.

The upper border of each ala is curved, the lower straight; the posterior border is free, round, and stout, and gives attachment to the stylo-pharyngeus and palato-pharyngeus muscles. The borders at their union are prolonged on either side into the superior and inferior cornua; the superior cornua are two slender tapering projections, which slope slightly towards each other; the inferior are strong and short, and present on the inner part of their tips a facet for articulation with the cricoid cartilage.

The outer surface of each ala presents an oblique line running from behind forwards, and above downwards. To the line the sterno-thyroid muscle is inserted, and from it the thyro-hyoid arises; behind the oblique line the inferior constrictor arises, and along the lower border of the cartilage the crico-thyroid muscle is attached.

The inner surface of each ala is slightly concave. At the inner surface of the recess between the two alæ in front, the epiglottis, the true and false vocal cords, and the thyro-arytenoidei muscles are attached.

The *cricoid* cartilage is the only example of a complete ring of cartilage in the body. It can be felt through the skin in the middle line, below the lower border of the thyroid cartilage, a small interval, occupied by the crico-thyroid membrane, intervening.

The external surface is rather rough for the attachment of muscles; it gives origin on either side the middle line to: in front, the crico-thyroid muscles, and behind these the inferior constrictors of the pharynx. At the junction of either lateral and posterior aspect, the facet for articulation with the inferior cornu of the thyroid cartilage is seen. Posteriorly is a ridge in the middle line, giving attachment to some fibres of the œsophagus, and on either side of the ridge a shallow depression gives origin to the crico-arytenoideus posticus muscle. The inner aspect of the cricoid cartilage is rounded and smooth, and covered by mucous membrane.

The upper border is horizontal for the anterior half of the circumference, giving attachment in front and at the sides to the crico-thyroid membrane, and at either side, external to the membrane, the crico-arytenoideus lateralis arises. In the posterior half of the ring the upper border rises to an eminence, so that the depth of the cartilage behind is nearly one inch, as compared with the depth in front, which is only one-sixth of an inch. Upon the side of the rise are seen two ovoid facets for articulation with the arytenoid cartilages.

The lower border of the cricoid is cut horizontally; to it the fibrous tissue of the trachea is attached.

The *arytenoid* cartilages are two pyramidal-shaped pieces of hyaline cartilage, about half an inch in height. The apices of the pyramids are upwards, and the bases rest on the sides of the slope of the eminence at the posterior part of the cricoid cartilage.

Each pyramid presents an apex, a base, three borders, three angles, and three surfaces.

The *surfaces* are: anterior, posterior, and internal. The anterior has the thyro-arytenoideus muscle attached to it; the posterior surface has the arytenoideus muscle upon it; but the internal is covered with mucous membrane. The *angles* are: the anterior, posterior, and external. The anterior angle is sharp and prominent; it is named the vocal process, from the fact of its giving attachment to the true vocal cords. The external angle, the muscular process, gives attachment to the lateral and posterior crico-arytenoid muscles. The posterior angle is mythical; in fact, the cricoid cartilage seems as though it had been there rounded off to a considerable extent.

The *cartilages of Santorini*, or *cornicula laryngis*, lie in the aryteno-epiglottidean fold of mucous membrane, close to the apices of the arytenoid cartilages, to which they are sometimes attached. They are small nodules of hyaline cartilage.

The *cartilages of Wrisberg*, or *cuneiform cartilages*, lie also in the aryteno-epiglottidean fold of mucous membrane in front of the cornicula on each side. They are composed of a soft conical mass of yellow elastic fibro-cartilage.

The *epiglottis* is a leaf-like flap of yellow fibro-cartilage, placed at the entrance of the larynx from the pharynx. The free edge of the leaf is upwards; its stalk is downwards, and is attached to the posterior surface of the thyroid cartilage in the middle line by a ligament, the thyro-epiglottidean.

To the hyoid bone, the epiglottis, by its anterior aspect, is also fixed by the hyo-epiglottidean ligament, to the back of the body of the hyoid bone. The *anterior*, or lingual surface, is attached to the tongue by three folds of mucous membrane—a central and two lateral, the glosso-epiglottidean. The *margin* of the epiglottis has two folds of mucous membrane running downwards and backwards to the arytenoid cartilages—the aryteno-epiglottidean folds. The *posterior* surface of the epiglottis is free and convexo-concave from above downwards. Numerous pits are to be seen on the epiglottis when the mucous membrane is stripped off. They accommodate the mucous glands.

The Ligaments of the Larynx.

1. The *thyro-hyoid* membrane, is a sheet of fibrous tissue which extends from the upper border of the thyroid cartilage, to the upper border of the posterior aspect (the inferior surface) of the hyoid bone. Between the body of the bone and the membrane in the middle line is a well-developed bursa. The main mass of the membrane is spoken of as the *middle* thyro-hyoid membrane, whereas the two rounded pieces of the membrane behind, between the upper cornua of the thyroid cartilage and the nodular terminations of the greater cornua of the hyoid bone posteriorly, are named the lateral thyro-hyoid ligaments. In the latter, small cartilaginous nodules are at times met with—the cartilago triticea.

2. The *crico-thyroid* membrane is an elastic sheet of tissue attached in the middle line between the thyroid and cricoid cartilages. At

the sides it is attached to the cricoid cartilage below (within the crico-arytenoideus muscle), but above it is continuous with the true vocal cords.

3. The superior and inferior *thyro-arytenoid ligaments* on each side form the false and true vocal cords respectively. They each proceed from the recess on the posterior aspect of the middle of the thyroid cartilage in front, the false immediately above the true, the true opposite a point half-way between the upper and lower borders of the thyroid in the middle line. Both ligaments pass backwards to the arytenoid cartilages, where they are attached, the upper to the anterior surfaces, the lower to the anterior angles of the arytenoid cartilages. The upper cords are fibrous in structure, the lower elastic.

4. The *crico-tracheal ligament* connects the lower border of the cricoid cartilage to the first tracheal cartilage below.

The *crico-thyroid articulations* are formed by the articular surfaces on the inner aspect of the thyroid cartilage and the outer aspect of the cricoid; the parts are held together by a capsular ligament, with synovial membrane between them.

The *crico-arytenoid* articulations are situated between the bases of the arytenoid cartilages and the ovoid facets, on the sides of the slope of the upper border of the cricoid cartilage. They are held together by a capsular ligament, and lubricated by a synovial membrane.

The *muscles* of the larynx have been described in the chapter on Muscles, and the action of each muscle fully gone into.

The *arteries* are derived from the superior and inferior laryngeal arteries, branches of the superior and inferior thyroids. The veins leave the larynx by the laryngeal veins, and these in turn join the thyroid veins.

The *nerves* are the superior and inferior laryngeal, branches of the pneumo-gastric. The superior pierces the thyro-hyoid membrane with the bloodvessels, and supplies the mucous membrane and the arytenoid muscle. Before the superior laryngeal nerve enters the larynx it gives off the external laryngeal to the crico-thyroid muscle.

The inferior laryngeal nerve enters the larynx on each side immediately behind the inferior cornua of the thyroid cartilage and above the crico-thyroid articulation. It supplies all the muscles of the larynx except the crico-thyroid. The arytenoideus receives branches from both the laryngeal nerves. The nerves meet by inosculating branches, beneath the alæ of the thyroid cartilage and beneath the mucous membrane of the laryngeal aspect of the pharynx.

The Interior of the Larynx.

The mucous membrane of the larynx is highly sensitive, and acts as a trap to prevent solid particles gaining access to the lungs. Above, the inlet into the larynx is triangular, with its apex backwards and its base forwards. It is bounded in front by the epiglottis, behind by the arytenoid cartilages, and at the sides by the aryteno-epiglottidean folds of mucous membrane. Half-way down the interior of the larynx, the folds of mucous membrane covering the true and false vocal cords are seen. Their structure and attachment have been already explained.

The *superior* or *false vocal cords*, are rounded folds of mucous membrane extending from the front to the back of the interior of the larynx on either side. They are slightly arched, with the concavity downwards, and are wider apart than are the true vocal cords below them.

The *inferior* or *true vocal cords* have all to do with the production of voice. They are continuous below with the upper border of the crico-thyroid membrane, and elastic in structure, as previously stated. Examined laryngoscopically, they are seen as yellowish-white bands closer together than are the false cords above them. They exhibit between them an interval of the shape of a V, with the apex forwards at the thyroid cartilage, and the base behind at the mucous fold covering the arytenoideus muscle, between the arytenoid cartilage. The interval is named the 'rima glottidis'; it measures from before backwards one inch less a line (one-twelfth of an inch); the anterior seven lines being enclosed between the vocal cords themselves, and the posterior four lines between the arytenoid cartilages. The spot at which it is possible to widen the rima glottidis to the greatest extent is at the ending of the cord at the anterior angle or vocal process of the arytenoid: here the breadth of the gap may be increased to as much as half an inch in the adult male.

Between the upper and lower vocal cords there is seen a recess, which curls upwards on the outer side of the superior vocal cords. This is the ventricle of the larynx, of which there is one on either side. From the upper part of the ventricle a pouch leads upwards for half an inch, reaching as high as the upper border of the thyroid cartilage; it is bounded externally by the thyroid cartilage, and internally by the false vocal cords and the mucous membrane covering it. The apex is rounded, the body conical, and the base presents an opening, whereby it allows the secretion from its glands to reach the ventricle and the true vocal cord.

The sac is enclosed in an investment of fibrous tissue and muscular fibres—the compressor sacculi laryngis of Hilton. (*See* Muscles of the Larynx.)

The Nose.

As the organ of smell, as an essential element in the sense of taste, as a passage for air, and as an essential accessory to the voice, this organ is all-important. The power of expression granted to it is but limited. The nose consists of two lateral cavities—nasal fossæ, opening separately in front and behind, being partitioned off from each other by the perpendicular plate—the *septum nasi.*

The openings in front, the *anterior nares,* are formed in the midst of cartilages which form the anterior part of the nose. In the dried skull the inlet into the nose is cordiform, with the apex upwards, and bounded by the nasal bones above, and the superior maxilla on either side and below. The cartilaginous septum being gone, the opening appears undivided.

The CARTILAGES of the nose give shape and support to it, in front of the bones; they consist of two lateral cartilages, upper and lower, and the cartilage of the septum.

The *lateral* cartilages: 1. The *superior* consists of two triangular pieces of fibro-cartilage, lying immediately below the nasal bones. Each cartilage is sharply bent on itself as it reaches the middle line of the nose, presenting an outer flange on the outer wall of the nostril, and a median portion which dips down to join the upper edge of the cartilage of the septum. The posterior margin of the outer flange is connected to the superior maxilla by fibrous tissue; the lower border touches the inferior lateral cartilages.

2. The *lower* cartilages are plates of fibro-cartilage curved so as to give outline to the tip of the nose. The curve takes place near the middle line at the tip of the nose, so that part of the cartilage forms the outer wall, and part the septum. The outer portion is connected to the superior maxilla by fibrous tissues; the inner portion passes backwards, occupying the anterior part of the septum; its lower end turns outwards, maintaining the shape of the nostril and keeping it open.

The cartilage of the septum of the nose occupies the anterior and lower part of the septum nasi. It is almost quadrilateral in shape. The anterior border is attached above to the crest formed by the nasal bones, and below it is fixed to the upper and lower lateral cartilages; the posterior border is fixed to the vomer, the superior border to the perpendicular plate of the ethmoid, and the lower border to the crest formed by the junction of the vomer and the superior maxillæ.

The *outlet* of the nose into the pharynx is quadrilateral, but divided into two by the vomer. Each aperture behind measures one inch from above downwards, and half an inch from side to side; it is bounded above by the sphenoid; below by the palate; internally by the vomer; and externally by the internal pterygoid plate.

Each nasal fossa possesses roof, floor, and an outer and an inner wall.

The *roof* is formed from before backwards by the nasal cartilages, the nasal bones, the frontal bone, the cribriform plate of the ethmoid, the body of the sphenoid, and the sphenoidal turbinated bone.

The *floor* is formed by the palate processes of the superior maxilla and palate bones.

The *outer* wall is formed by six bones. Three reach from roof to floor—the superior maxilla with its nasal process, the palate, and the internal pterygoid plate; three reach part of the way along the outer wall—the nasal, the lachrymal, and the ethmoid.

The *inner* wall, or septum, is formed from above downwards by the perpendicular plate of the ethmoid, the crest formed by the junction of nasal bones, the nasal spine of frontal, the vomer, the triangular cartilage, and the crest formed by the junction of the palatine processes of the superior maxillary and palate bones.

On the outer walls of the nose are seen three *turbinated bones.* The lower is a separate bone, and reaches all the length of the nose; the middle and upper bones are processes of the ethmoid bone, and reach, the former two-thirds, the latter one-third of the distance, along the posterior part of the nose. They divide the outer wall into three MEATUSES—the superior, middle, and inferior. Each meatus is below its corresponding turbinated bone.

Into the *lower* meatus the nasal duct opens; into the *middle* the infundibulum, and the antrum of Highmore; into the *upper*, the ethmoidal cells, sphenoidal cells, and naso-palatine foramen. The infundibulum transmits air and mucous from the frontal sinuses and anterior ethmoidal cells.

The nose is lined throughout by the Schneiderian membrane, which consists of the mucous and submucous tissues firmly blended with the periosteum.

The *nerves* found in the nose are: In the upper part the *olfactory* nerve, found distributed wherever the ethmoid bone presents a surface to the nose. The other nerves are found chiefly at the four angles: at the anterior superior angle is found the *nasal* twig from the fifth; at the anterior inferior angle, branches from the anterior *dental;* posteriorly and inferiorly, branches from the *descending palatine;* posteriorly and superiorly, *naso-palatine* nerves. The last-mentioned group sends one branch down the side of the septum towards the anterior palatine foramen, called the nerve of Cotunnius.

The *bloodvessels* of the nose enter the foramina with the nerves. They are chiefly supplied from the internal maxillary; and one, the artery to the septum, comes from the superior coronary in the upper lip.

THE THYROID GLAND.

The thyroid gland, or body, exists as a lateral mass around the lower part of the larynx. Although applied to, it has no immediate functional or structural connection with, the organ of voice. The gland consists of two lobes, one on each side, united by a band of gland-substance which crosses the middle line, the isthmus. Each lobe is pyramidal, with its apex upwards; it lies with its long axis inclined from below upwards, and before backwards, and also from within outwards, so that the apex is on a plane posterior and external to the base. The *apex* reaches as high as the middle of the thyroid cartilage, the base as low as a level with the fifth tracheal cartilage. The isthmus unites the *lower ends* of the thyroid gland; it passes across the trachea opposite the third and fourth cartilages. The *inner* aspect of each lobe is concave, the outer convex. The inner surface is in contact with the larynx and trachea, the pharynx and œsophagus on the left side. The *outer* surface is covered by the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles. *Posteriorly*, the sheath of the carotid vessels is touched by the outer border of the gland, and the deep cervical fascia completes the boundary. On cutting into the gland it is found to be firm and granular, and on squeezing the cut surface a thick fluid, tinged yellow, escapes; around the gland is a membranous capsule, the deep surface of which is connected with the areolar tissue of the interior. The vesicles of which it is composed are for the most part microscopic, but it is possible, on tearing out the tissue, to make an isolation of small vesicles, which are big enough, singly, to be seen by the naked eye.

The arteries of the thyroid body are the right and left, superior and inferior thyroids. The superior thyroid comes from the external carotid, the inferior from the thyroid axis. They enter the upper and lower parts of the gland, and form large and numerous anastomosing arches. A third pair of vessels, the thyroidea-ima, is found at times entering the lower part of the thyroid body from the innominate.

The veins are the superior, inferior, and middle thyroid veins, described more than once previously. The superior and middle join the internal jugular; the inferior join either innominate.

The nerves are derived from the middle and inferior cervical ganglia and also from the pneumogastric nerve.

The Thymus Gland.

The thymus gland is met with in its fully-grown condition in children of about twenty-two months of age. After that time it gradually disappears, until by the time puberty is reached, it exists only as a mass of areolar tissue. It occupies the root of the neck above the transverse portion of the aorta, and in front of the great vessels arising therefrom, and reaches up on either side of the neck beneath the sterno-hyoid and sterno-thyroid muscles as high as the thyroid gland. It presents, usually, two lateral lobes, which either touch each other along the middle line, or possess between them a third or intermediate lobe.

The gland, when cut into, is seen to consist of a soft, pulpy substance of a grey colour, with a pink haze over it. It possesses a thin capsule, continuous on its under surface with the connective-tissue of the gland. The connective-tissue breaks up the gland-substance into large lobules, and each lobule in turn consists of a medullary and cortical portion. The centre of each lobule exhibits a central cleft, which, however, may be a post-mortem change.

The arteries are derived from the internal mammary, the superior and inferior thyroids, and minute branches from the subclavian and common carotid arteries arising directly from the main trunks. The veins open into either innominate.

The Suprarenal Bodies.

A small ductless gland is found resting on the top of either kidney. Each gland, capsule or body is triangular in shape, with a slightly pointed apex above, and its base resting on the upper end of the kidney; it is flattened from before backwards, hence its surfaces are anterior and posterior, and its borders internal and external. The body measures usually one and a half inches in depth, one and a quarter inches in breadth, and one-third of an inch in thickness.

The *relations* are: above, on the right side the liver, on the left the spleen; below, the kidney; behind, the corresponding crus of the diaphragm; on the inner side, each gland is intimately connected with the solar plexus and semilunar ganglion.

The body is of a yellow colour, and on section is seen to consist of two parts, a cortical and medullary portion; the former is intersected by processes from the surrounding capsule; the latter is softer, darker, and possesses a fine plexiform network of connective tissue. Cells of a columnar form fill the spaces throughout the body. The *arteries* come from the inferior phrenic, aorta and renal. The *vein* on the left side joins the renal, but on the right the inferior vena cava.

INDEX.

THE END.

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CORRIGENDA AND ADDENDA.

Page 3, 10th line from bottom, *read* 'superior longitudinal' for 'lateral.'

Page 7, at lines 17 and 18 from bottom, *read* 'tabular' for 'tubular.'

Page 35, 18th line from bottom, *read* 'ischium' for 'pubes.'

Page 52, 6th line from bottom, transpose 'flexion' and 'extension.'

Page 149, 17th line from top, *read* 'longus' for 'communis.'

Page 251, *Add* at end of section on Spermatic Artery 'The Inferior Mesenteric Artery arises above the bifurcation of the aorta from its left antero-lateral aspect. It passes beneath the peritoneum and across the left psoas and ureter to distribute the following branches: (1) Colica sinistra; (2) Sigmoid; and (3) Superior hæmorrhoidal.'