OUTLINES OF

VETERINARY ANATOMY.

PART I.

THE ANTERIOR AND POSTERIOR LIMBS.

BY

rlando
O. CHARNOCK BRADLEY,

MEMBER OF THE ROYAL COLLEGE OF VETERINARY SURGEONS; PROFESSOR OF ANATOMY IN THE NEW VETERINARY COLLEGE, EDINBURGH.

LONDON:

BAILLIÈRE, TINDALL & COX,

20 & 21, KING WILLIAM STREET, STRAND.

1896.

PREFACE.

In the following pages I have endeavoured to present the most important facts of Veterinary Anatomy in as condensed a form as possible, consistent with lucidity. It has long been felt that such a book was wanted by students preparing for their examinations, and if the present volume is of assistance to such, its mission will have been fulfilled. No pretensions are made to originality (other than of treatment) or completeness, and it is intended that this little work shall be used in conjunction with the larger standard text-books.

In a first edition it is almost inevitable that errors should occur, and I dare not hope that this will be an exception to the rule; I therefore crave the indulgence of my readers, and shall feel very grateful to them if they will point out any mistakes, technical or otherwise.

I have to express my indebtedness to those professional and literary friends who have assisted me by their suggestions and encouragement; and also to the textbooks, such as *Chauveau*, *Strangeways*, *Ellenberger*, etc., to which reference has been repeatedly made.

O. C. B.

NEW VETERINARY COLLEGE,
EDINBURGH,
April, 1896.

CONTENTS.

THE ANTERIOR LIMB OF THE HORSE.

THE POSTERIOR LIMB OF THE HORSE.

TABLE OF DIAGRAMS.

VETERINARY ANATOMY.

THE ANTERIOR LIMB OF THE HORSE.

THE **Anterior** limb of the horse is divided into the following **regions**:

I. The **Shoulder**—skeleton formed by the *Scapula*.
II. The **Brachium**, or Arm—skeleton formed by the *Humerus*.
III. The **Antibrachium**, or Fore-arm — skeleton formed by the *Radius* and *Ulna*.
IV. The **Manus**, or Hand—consisting of:
  1. *Carpus*, formed by eight bones:
     Scaphoid, lunar, cuneiform, trapezium, pisiform, trapezoid, magnum, and unciform.
  2. *Metacarpus*, formed by five bones:
     One large metacarpal, or cannon; two small metacarpals, or splints; two sesamoids.
  3. *Digit*, subdivided into three phalanges:
     (*a*) Proximal phalanx—os suffraginis.
     (*b*) Median phalanx—os coronæ.
     (*c*) Distal phalanx—os pedis and os naviculare.

BONES.

SCAPULA (SHOULDER-BLADE).

Class.—Flat bone, triangular in shape.

Situation.—Antero-lateral aspect of thoracic cavity.

Direction.—Downwards and forwards. It presents *two surfaces, three borders,* and *three angles.*

Surfaces.

External, or Dorsum.—Has a *spine,* most marked at *tubercle,* dividing it into two unequal parts: (1) *Antea-spinatus* (supra-spinous) *fossa* (the lesser), and (2) *postea-spinatus* (infra-spinous) *fossa* (the greater).

Internal, or Venter.—Forms *subscapular fossa,* and has two rough triangular spaces superiorly for muscular attachment.

Borders.

Superior.—Nearly straight. Irregular for attachment of *cartilage of prolongation.*

Anterior.—Sharp and thin. Superior two-thirds convex; inferior third concave.

Posterior.—Thick, slightly concave.

Angles.

Anterior or Cervical.—Thin.

Posterior or Dorsal.—Tuberous.

Inferior or Humeral.—Expanded and separated by a *neck* or *cervix.* Presents:

1. *Glenoid cavity,* for articulation with head of humerus.
2. *Coracoid process,* situated anteriorly, and divided into a *base* and *summit,* or beak, curved inwards.

Nutrient Foramen.—In inferior third of postea-spinatus fossa.

It **articulates** with humerus, inferiorly.

Development.—From three centres:

1. For greater part of the bone.
2. For coracoid process.
3. In centre of glenoid cavity.

Reference to Side.—Place the spine outwards, the glenoid cavity downwards, and the coracoid process anteriorly.

HUMERUS.

Class.—Long bone.

Situation.—Between scapula and radius and ulna.

Direction.—Downwards and backwards. It possesses a *shaft* and *two* (proximal and distal) *extremities.*

I. **Shaft.**—Twisted in appearance.

Surfaces.

Anterior.—Wider above than below. Has muscular imprints at its middle and inferior portions.

Posterior.—Convex and smooth.

External.—Excavated by *musculo-spiral groove,* or furrow of torsion, which passes from above to below, and from behind to before, and is bounded anteriorly by the *deltoid ridge. External tuberosity* (or tubercle) is at upper third of ridge, and bends backwards.

Internal.—Rounded, and not well marked from anterior and posterior surfaces. It has the *internal tuberosity* (or tubercle) about its middle.

II. Extremities.

Proximal.—

Head.—Convex and smooth; much larger than glenoid cavity of scapula.

Cervix.—Just below the head.

Depression containing foramina just in front of head.

External Trochanter (trochiter or tuberosity).—Has a *summit* anteriorly and a *convexity* posteriorly.

Internal Trochanter (trochin or tuberosity).—Has *anterior*, *posterior*, and *inferior* portions.

Bicipital Groove. — Situated anteriorly. For passage of tendon of origin of flexor brachii. Bounded on each side by the external and internal trochanters. Presents two concavities, separated by median ridge.

Distal.—

Articular Surface.—Broader in front than behind, and divided by groove into:

Internal condyle, and

External condyle, or *trochlea*.

Posteriorly are two ridges:

Epicondyle, internally.

Epitrochlea, externally, smaller than epicondyle.

Olecranon fossa divides the two ridges and receives the olecranon process of ulna.

Anteriorly.—*Coronoid fossa*, to receive the coronoid process of radius.

Externally.—Depression for attachment of the external lateral ligament.

Internally.—Small tuberosity for internal lateral ligament.

Nutrient Foramen.—In inferior third of internal surface.

It **articulates** with three bones:

Scapula, superiorly.

Radius and ulna, inferiorly.

Development.—From six centres:

1. For shaft.

2 and 3. For the proximal and distal extremities.

4. For external trochanter.

5 and 6. For condyles at inferior extremity.

Reference to Side.—Place the head superiorly, the bicipital groove anteriorly, and the deltoid ridge externally.

RADIUS.

Class.—Long bone.

Situation.—Vertically between humerus and upper row of carpal bones.

It possesses a *shaft* and *two extremities.*

I. **Shaft.**—Flattened from before to behind.

Surfaces.

Anterior.—Convex and smooth.

Posterior.—Slightly concave from above to below.

1. Externally: a narrow triangular roughened surface, with apex downwards, reaching to lower fourth.
2. Shallow transverse groove, which helps to form *radio-ulnar arch.*

3. A vertically elongated eminence of insertion, near internal border and towards lower third.

Borders.

External and Internal.—Rounded and thick.

II. Extremities.

Proximal.—The larger of the two; has:

1. **Articular surface,** elongated from side to side, and moulded on the articular surface on distal extremity of humerus.
2. **Rough ridge** round articular surface, for attachment of capsular ligament.
3. **External tuberosity** at external extremity of articular surface, well marked.
4. **Bicipital (internal) tuberosity,** antero-internally to articular surface, for insertion of flexor brachii.
5. **Coronoid process,** a small conical eminence placed anteriorly.
6. **Two small diarthrodial facets** posteriorly for articulation with ulna.
7. **Roughened surface,** terminating inferiorly at radio-ulnar arch, for articulation with ulna.

Distal.—

1. **Articular surface,** elongated from side to side, and divided into three parts: (*a*) *External,* oval and convex, for articulation with cuneiform and trapezium; (*b*) *middle,* concavo-convex, for lunar; (*c*) *internal,* the largest, concavo-convex, for scaphoid.

2. **Two tuberosities**: (*a*) *External*, has a vertical fissure; (*b*) *internal*, well marked.
3. **Three grooves** anteriorly for passage of tendons, two being vertical, one oblique.
4. **Ridge** round articular surface for attachment of capsular ligament.

Nutrient Foramen.—In radio-ulnar arch.

It **articulates** with six bones:

Humerus, superiorly.

Ulna, posteriorly.

Cuneiform, trapezium, lunar, and scaphoid, inferiorly.

Development.—From four centres:

1. For shaft.

2 and 3. For the two extremities.

4. For external tuberosity at distal extremity.

Reference to Side.—Place the articular surface for humerus superiorly, and the surface for ulna postero-externally.

ULNA.

Class.—Elongated or interrupted bone.

Situation.—Postero-externally to radius.

Direction.—Vertical. Has a *body* and *two extremities.*

I. Body.—Triangular.

Surfaces.

External.—Smooth and nearly plane.

Internal.—Smooth and slightly hollowed.

Anterior.—

1. *Two diarthrodial facets* superiorly.
2. Rough surface.
3. Shallow transverse groove for formation of radio-ulnar arch.
4. Rough triangular surface, with apex below.

Borders.

External and Internal.—Sharp.

Posterior.—Concave, rounded, and thicker.

II. **Extremities.**

Superior.—Forms the *olecranon process :*

1. **External surface,** slightly convex.
2. **Internal surface,** concave.
3. **Anterior border,** thin superiorly, and shows a prominent part, the *beak of the olecranon,* and a smooth concavity for articulation with humerus.
4. **Posterior border,** concave and smooth.
5. **Summit,** terminates olecranon superiorly.

Inferior.—Sharp and pointed, and situated about the lower fourth of radius.

It **articulates** with two bones :

Humerus, supero-anteriorly.

Radius, anteriorly.

Development.—From two centres :

1. For body.
2. For superior extremity.

Reference to Side. — Place the olecranon process superiorly, concave surface internally, and the facets for radius anteriorly.

CARPUS.

Composed of seven or eight bones.

A. Upper Row.—Scaphoid, lunar, cuneiform, trapezium.*

B. Lower Row. — Pisiform* (sometimes absent), trapezoid, magnum, unciform.

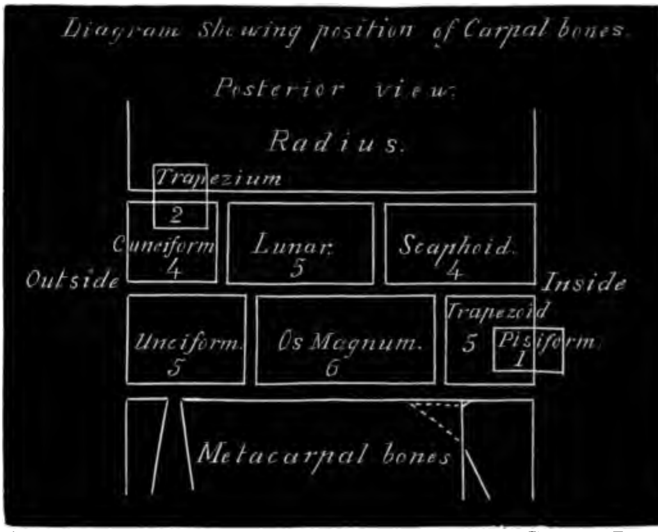

FIG. 1.—DIAGRAM SHOWING POSITION OF CARPAL BONES (POSTERIOR VIEW).

The figures denote the number of articulations of each bone.

The following formula may be used to indicate the number of bones:

$$\frac{4}{3 \text{ or } 4} = 7 \text{ or } 8 \text{ bones.}$$

* The trapezium is sometimes called the pisiform. In that case the pisiform is known as the trapezium.

A. THE UPPER OR ANTIBRACHIAL ROW.

THE SCAPHOID.

Class.—Irregular.

Situation.—The most internal bone of upper row. Has *six surfaces.*

Surfaces.

Anterior and Internal.—Are continuous, convex, and rough.

Posterior.—Rough and irregular.

External.—Rough, excavated, and has three projecting facets for lunar.

Superior.—Smooth, concavo-convex for radius.

Inferior.—Smooth, and divided into anterior convex part for os magnum, and posterior concave part for trapezoid.

It **articulates** with four bones:

Radius, superiorly.
Lunar, externally.
Magnum and trapezoid, inferiorly.

Development.—From one centre.

Reference to Side. — Concavo-convex surface superiorly. The three facets are for articulation with lunar.

THE LUNAR, OS LUNARE, OR OS SEMILUNARE.

Class.—Irregular.

Situation.—Middle bone of upper row. Is wedge-shaped.

Possesses *four surfaces*, a *base*, and an *apex.*

Surfaces.

Superior.—Articular, triangular, and concave posteriorly.

Inferior.—Articular. Has a concavo-convex portion for magnum, and a small oblong portion for unciform.

Internal.—Excavated, and has three projecting facets for scaphoid.

External.—Excavated, and has two projecting facets for cuneiform.

Base.—Rough, placed anteriorly.

Apex.—Rough and tuberous, placed posteriorly.

It **articulates** with five bones:

Radius, superiorly.
Scaphoid, internally.
Cuneiform, externally.
Magnum and unciform, inferiorly.

Development.—From one centre.

Reference to Side.—Place the concavo-convex facet superiorly, the apex posteriorly. Two small facets go externally for cuneiform.

CUNEIFORM.

Class.—Irregular.

Situation.—The external bone in the upper row of carpal bones.

Has *five surfaces.*

Surfaces.

Superior.—Concave for radius.

Inferior.—Concave for unciform.

External.—Convex, rough for ligamentous attachment.

Internal.—Two facets for lunar.

Posterior.—Sloping. Concave facet for trapezium.

It **articulates** with four bones:

Lunar, internally.
Radius, superiorly.
Unciform, inferiorly.
Trapezium, posteriorly.

Development.—From one centre.

Reference to Side.—Place the two facets for lunar internally, the concave facet for radius superiorly, and the concave facet for trapezium posteriorly.

TRAPEZIUM OR PISIFORM (SOMETIMES CALLED THE SUPERCARPAL BONE).

Class.—Irregular.

Situation.—Supero-posteriorly to cuneiform.

Has *two surfaces* and a *circumference.*

Surfaces.

External.—Rough, convex, and has groove for tendon of flexor metacarpi externus.

Internal.—Rough, concave.

Circumference.

Superior.—Rough for muscular and ligamentous attachment.

Anterior.—Two facets:

1. Upper, concave for radius.
2. Lower, convex for cuneiform.

Posterior and Inferior.—Rough.

It **articulates** with two bones :

Radius, supero-anteriorly.

Cuneiform, infero-anteriorly.

Development.—From one centre.

Reference to Side.—Place the concave facet superiorly and anteriorly, and the convex roughened surface externally.

B. LOWER OR METACARPAL ROW.

PISIFORM OR TRAPEZIUM.

Rounded, about the size of a pea. Not always present.

It **articulates** with trapezoid, behind which it is placed.

TRAPEZOID.

Class.—Irregular.

Situation.—The most internal bone in the lower row.

Has *six surfaces.*

Surfaces.

Superior.—Smooth, and convex for scaphoid.

Inferior.—Smooth. Has two facets :

1. Large, for inner small metacarpal bone.
2. Small, for large metacarpal bone.

External.—Excavated, and has two or three facets for os magnum.

Internal.—Rough, convex.

Anterior (apex).—Roughened.

Posterior (base).—Roughened. May have small facet for pisiform.

It **articulates** with five bones :

Scaphoid, superiorly.

Os magnum, externally.

Large and inner small metacarpals, inferiorly.
Pisiform (if present), posteriorly.

Development.—From one centre.

Reference to Side.—Place convex smooth surface superiorly, the two or three facets for magnum externally, and the base posteriorly.

Os Magnum.

Class.—Irregular.

Situation.—The median bone in the lower row.

Has *six surfaces.*

Surfaces.

Superior.—Divided into two facets :

1. Inner, concave for scaphoid.
2. Outer, concavo-convex for lunar.

Inferior.—Flat, and has two facets :

1. Large and flat, occupying nearly the whole surface, for large metacarpal.
2. Small, oblong and bevelled, for inner small metacarpal.

Internal.—Excavated, and has two or three facets for trapezoid.

External.—Excavated, and has two facets for unciform.

Anterior (base).—Roughened and convex.

Posterior (apex).—Roughened, narrow and rounded.

It **articulates** with six bones :
Scaphoid and lunar, superiorly.
Trapezoid, internally.
Unciform, externally.
Large and inner small metacarpals, inferiorly.

Development.—From one centre.

Reference to Side.—Place the small oblong bevelled facet inferiorly and internally, and the broad roughened surface (base) anteriorly.

Unciform.

Class.—Irregular.

Situation.—The most external bone of the lower row.

Has *six surfaces.*

Surfaces.

Superior.—Smooth, convex, and sloping downwards and backwards.

Inferior.—Smooth and flat, and has two facets:

1. Inner, large, for large metacarpal.
2. Outer, for outer small metacarpal.

Internal.—Excavated, and has two facets for os magnum.

External.—Convex and rough.

Anterior (base).—Slightly convex and rough.

Posterior (apex).—Rough, forms prominent process.

It **articulates** with five bones:

Lunar and cuneiform, superiorly.
Os magnum, internally.
Large and outer small metacarpals, inferiorly.

Development.—From one centre.

Reference to Side.—Place the convex articular surface superiorly, the two facets for magnum internally, with the hook-shaped process (apex) posteriorly.

METACARPUS.

Large Metacarpal Bone (Cannon Bone).

Class.—Long bone.

Situation.—Between carpus and phalanges.

Direction.—Vertical.

Has a *shaft* and *two extremities.*

I. Shaft.

Surfaces.

Anterior.—Smooth, and convex from side to side.

Posterior.—Flat. On each side is a narrow rough surface, extending from upper extremity to about the middle, for articulation with small metacarpals.

Borders.

Internal and External.—Thick, rounded and smooth.

II. Extremities.

Superior.—Presents:

1. Superiorly, three continuous facets for lower row of carpus. The external is bevelled.
2. Anteriorly and internally, an eminence for muscular attachment.
3. Posteriorly and on each side, two small facets for small metacarpals.

Inferior.—Two *condyles* (inner one slightly the larger), divided by median articular ridge. Above the condyles, on each side, is a depression for ligamentous attachment.

Nutrient Foramen.—On posterior surface, at the junction of upper and middle thirds.

It **articulates** with eight bones:

Trapezoid, os magnum and unciform, superiorly.
Two small metacarpals, postero-laterally.
Os suffraginis and two sesamoids, inferiorly.

Development.—From two centres:

1. For shaft and proximal extremity.
2. For distal extremity.

Reference to Side.—Place the flattened facets for carpal bones superiorly, the convex surface anteriorly, and the eminence for muscular attachment internally.

Two Small Metacarpals (Splint Bones).

Class.—Interrupted.
Situation.—Postero-laterally to large metacarpal.
Direction.—Vertical.
Have a *body* and *two extremities.*

I. Body.

1. Three **surfaces**:
   (*a*) *Anterior*, rough, for articulation with large metacarpal.
   (*b*) *External*, smooth and slightly rounded.
   (*c*) *Internal*, smooth and flat.
2. Three **borders**, dividing the surfaces.

II. Extremities.

Proximal (head).—

Superiorly.—Two facets for carpal bones.
Anteriorly.—Two facets for large metacarpal.

Inferior.—Small nodule, or 'button,' placed about lower fourth of large metacarpal.

They **articulate** with:

Trapezoid and magnum (internal one).

Unciform and magnum (external one).

Large metacarpal (both).

Development.—From one centre each. Sometimes the ' button ' ossifies separately.

Differences between the Two Bones.

Inner.	*Outer.*
The larger and longer.	The smaller and shorter.
Two facets at proximal extremity.	One facet at proximal extremity.
Sometimes only one facet for large metacarpal.	Always two facets for large metacarpal.

THE TWO SESAMOIDS.

Class.—Irregular.

Situation.—Posteriorly at distal extremity of large metacarpal.

Each has *three surfaces*, a *base*, and an *apex*.

Surfaces.

Anterior.—Smooth, convex transversely and concave vertically.

Posterior.—Smooth, convex. The surfaces of the two bones form a groove for tendons.

External.—Has roughenings for ligamentous attachment.

Base.—Placed inferiorly.

Apex.—Placed superiorly.

They **articulate** with the large metacarpal.

Development.—From one centre.

DIGIT.

Os Suffraginis, Proximal or Metacarpal Phalanx (Large Pastern Bone).

Class.—Long bone.

Situation.—Between large metacarpal and os coronæ.

Direction.—Downwards and forwards.

Has a *shaft* and *two extremities.*

I. Shaft.

Surfaces.

Anterior.—Smooth and convex from side to side.

Posterior.—Flattened, with triangular roughened base upward.

Borders.

Internal and External.—Thick and rounded.

II. Extremities.

Proximal.—The larger; presents:

1. Two *glenoid cavities,* separated by median articular groove.
2. Postero-laterally, two *eminences* for ligamentous attachment.

Distal.—

1. Two *condyles,* separated by median groove.
2. Laterally, a roughened *depression* for ligamentous attachment.

It **articulates** with two bones:

Large metacarpal, superiorly.

Os coronæ, inferiorly.

Development.—From three centres:

1. For shaft.

2 and 3. For the extremities.

Reference to Side.—Place the bone with its posterior surface flat on the table; the external condyle does not touch.

Os Coronæ, Median Phalanx (Small Pastern Bone).

Class.—Short bone.
Situation.—Between os suffraginis and os pedis.
Direction.—Downwards and forwards.
Has *six surfaces.*

Surfaces.

Superior.—Two glenoid cavities, divided by median ridge.

Inferior.—Two condyles, divided by median groove.

Anterior.—Rough, convex or flat.

Posterior.—Slightly excavated. Has superiorly a transversely elongated surface for passage of a tendon.

It **articulates** with three bones:
Os suffraginis, superiorly.
Os pedis and navicular bone, inferiorly.

Development.—From two centres:
1. For superior extremity.
2. For remainder of bone.

Os Pedis, Distal Phalanx (Coffin Bone).

Class.—Irregular.
Situation.—Below os coronæ and within the hoof.
Has *three surfaces, three borders,* and *two lateral angles.*

Surfaces.

Anterior.—Convex from side to side; shows numerous vascular openings; also:

1. *Preplantar groove,* or fissure, which commences between *retrossal* and *basilar* processes, runs horizontally, and terminates anteriorly in one of the large foramina.
2. The *patilobe eminence,* between the above groove and inferior border.

Superior.—Articular, and composed of two *glenoid cavities* and a median ridge.

Inferior or Solar.—Concave, and divided into two parts by the *semilunar crest* or *ridge*:

1. The *anterior* part, or *sole,* is finely perforated.
2. The *posterior* part, or *tendinous* surface, has:
   (*a*) A median triangular roughened depression for the tendon of the flexor pedis perforans.
   (*b*) Two *plantar fissures,* or *grooves,* running from the roots of the *basilar processes,* and terminating in the *plantar foramina.*

Borders.

Superior.—Curved, with convexity forwards. Presents:

1. The *pyramidal process,* or eminence, centrally placed.
2. Two *depressions* for ligamentous attachment.

Inferior.—Thin, convex, semilunar, and irregular, with a notch at its most anterior part.

Posterior.—Slightly concave, and has a transversely elongated facet for navicular bone.

Lateral Angles.

The two posterior projections are divided into two parts by the *preplantar fissure* or *notch:*

1. The *basilar process*, placed superiorly; and
2. The *retrossal process*, placed inferiorly.

The angles support the *lateral cartilages.*

The **semilunar sinus** is found in the substance of the bone, the plantar foramina leading to it.

It **articulates** with two bones:

Os coronæ, superiorly.

Navicular bone, posteriorly.

Development.—From two centres:

1. For articular surface.
2. For remainder of the bone.

The Navicular Bone.

Class.—Irregular.

Situation.—Inferiorly and posteriorly to os coronæ, and posteriorly to os pedis.

Has *two surfaces*, *two borders*, and *two extremities.*

Surfaces.

Superior.—Articular and smooth; has two *glenoid cavities* and a median ridge.

Inferior.—Smooth, and has two concavities with a median projection, covered by fibro-cartilage, for the passage of a tendon.

Borders.

Anterior.—Divided into two portions:

1. Superior, articular for os pedis.
2. Inferior, an elongated excavation for ligamentous attachment.

Posterior.—Rough and triangular, and gives attachment to a ligament.

The Extremities are pointed, and afford ligamentous attachment.

It **articulates** with two bones :

The os coronæ and os pedis.

Development.—From one centre.

ARTICULATIONS.

I. SCAPULO-HUMERAL (or Shoulder-joint).

Class.—Enarthrosis.

Formed by the glenoid cavity of the scapula and the head of the humerus.

Ligaments.—

1. *Capsular*, surrounding the two articular surfaces, and disposed as all capsular ligaments are.
2. Certain muscles acting as ligaments, viz., antea and postea spinati, postea-spinatus minor, subscapularis, and flexor brachii.

Synovial Membrane.—One lining the internal face of the capsule.

Movements.—Flexion, extension, adduction, abduction, rotation, and circumduction.

II. HUMERO-RADIO-ULNAR (or Elbow-joint).

Class.—Ginglymus.

Formed by the articular condyles of the humerus, the articular surface on the superior extremity of the radius, and the sigmoid notch of the ulna.

Ligaments.—

1. *Capsular*, surrounds the articular surfaces. The flexor brachii (tendon of insertion) is attached to it in front, and the anconeus behind.
2. *External lateral*, from a small depression on the external part of the distal extremity of the humerus (some fibres coming from the posterior ridge of the musculo-spiral groove) to the supero-external tuberosity of the radius.
3. *Internal lateral*, much longer, but less strong, than the preceding. From a small eminence above the internal condyle of the humerus to the inner border of the radius.

Synovial Membrane.—Possesses three diverticula:

1. In the olecranon fossa.
2. Lining the tendon of the flexor metacarpi externus; and
3. At the origin of the flexors of the digit.

Movements.—Flexion and extension.

III. RADIO-ULNAR.

Class.—Diarthrosis and synarthrosis.

Formed by the anterior surface of the ulna (with its two diarthrodial facets), and the roughened surface and two diarthrodial facets on the posterior face of the radius.

Ligaments.—

1. *Interosseous*, pass between the adjacent bony surfaces, and become ossified in the adult.

2. *Arciform,* or superior radiating, attached to the inner and outer borders of the ulna and contiguous parts of the radius, above the radio-ulnar arch.
3. *Inferior radiating,* similar to above, but much smaller, and below the radio-ulnar arch.

Synovial Membrane.—A prolongation from the elbow for the diarthrosis.

Movements.—Very slight in the young, and practically absent in the adult.

IV. THE CARPUS (OR KNEE-JOINT).

This is a complex ginglymoid and arthrodial articulation, formed by the radius, all the bones of the carpus, and the three metacarpal bones.

The **Ligaments** are divided into *special* and *common:*

1. The **Special** ligaments are divided into five groups:

(*a*) *Superior carpal,* uniting the bones of the upper row. Three anterior and three interosseous;

The *anterior* are flat bands attached to the anterior faces of the bones.

The *interosseous* pass between the adjacent faces of the bones. The most external one is scarcely interosseous, but is placed beneath the posterior common ligament.

(*b*) *Inferior carpal,* uniting the bones of the lower row. Two anterior and two interosseous.

These are arranged in a manner similar to those of the superior carpal group.

(c) *Radio-carpal*, three in number, and uniting the radius to the bones of the upper row:

An *oblique* one, passing from the radius to the scaphoid.

A small and slender ligament under the oblique, passing from the radius to the lunar.

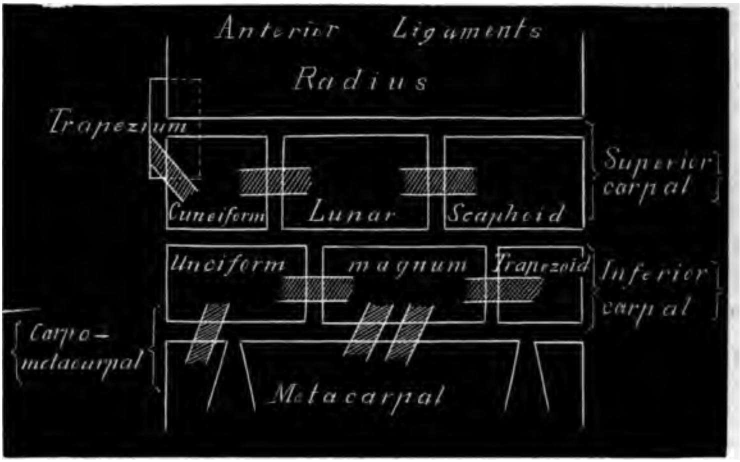

FIG. 2.—THE ANTERIOR CARPAL LIGAMENTS.

A *superior trapezial*, uniting the trapezium to the outer border of the distal extremity of the radius.

(d) *Intercarpal*, also three in number. These unite the two rows of bones.

One joining the scaphoid to the magnum and trapezoid.

A second, joining the cuneiform and magnum,

And a third, known as the *inferior trapezial*, passing from the trapezium to the cuneiform and head of the external small metacarpal bone.

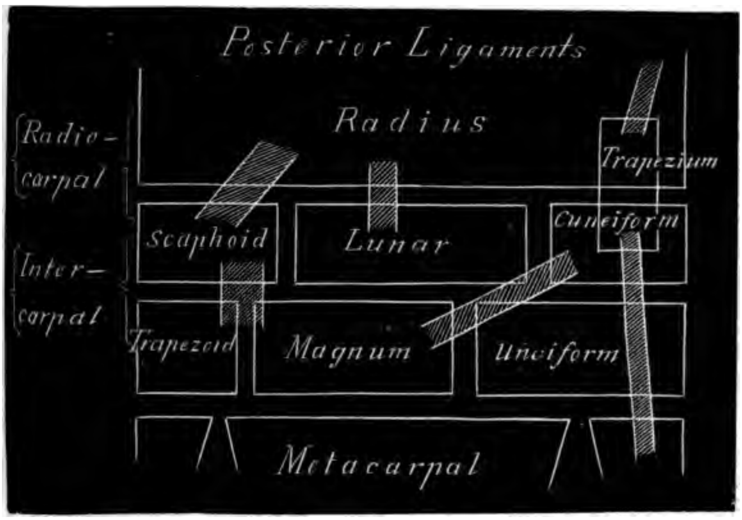

FIG. 8.—THE POSTERIOR CARPAL LIGAMENTS.

(*e*) *Carpo-metacarpal*, six in number, viz., two anterior, two posterior, and two interosseous.

One *anterior*, consisting of two bundles of fibres, joins the magnum to the head of the large metacarpal bone.

The other *anterior* unites the unciform and head of the external small metacarpal.

The *posterior* join the magnum and trapezoid to the heads of the large and inner small metacarpals.

The *interosseous* unite the three bones of the lower row to the three metacarpals.

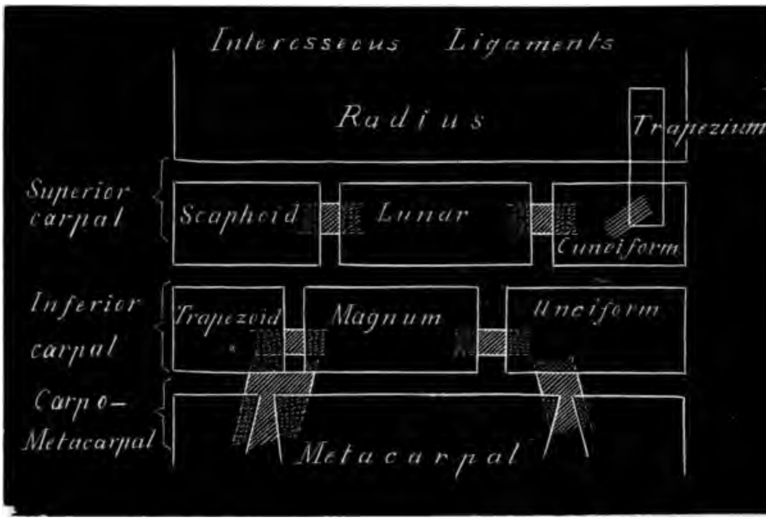

FIG. 4.—THE INTEROSSEOUS CARPAL LIGAMENTS.

2. The **Common** ligaments are four in number: two laterals, an anterior and a posterior.

(*a*) The *internal lateral* is attached to the inner part of the distal extremity of the radius, and consists of two bundles of fibres; the superficial of which is attached to the magnum and large metacarpal, and the deep to the scaphoid, trapezoid, and inner small metacarpal.

(*b*) The *external lateral* passes from the external part of the distal end of the radius, and consists of two bundles, the more superficial of which is attached to the external small metacarpal, and the deeper one to the cuneiform, unciform and external small metacarpal.

(*c*) The *anterior common* or *capsular* is a quadrilateral membranous expansion, covering the anterior face of the carpus and being attached to the distal end of the radius, the bones of the carpus and their anterior ligaments, and the heads of the metacarpals.

(*d*) The *posterior common* or *capsular* is disposed in a similar manner to the anterior common, on the posterior face of the carpus. It is much stronger than the anterior, and has been described as the strongest ligament in the body.

The **Synovial Membranes** are four or five in number: (1) Radio-carpal; (2) intercarpal; (3) carpo-metacarpal; (4) between the trapezium and cuneiform bones; and sometimes (5) between the pisiform and trapezoid.

Movements.—Flexion and extension in the radio-carpal and intercarpal portions; gliding movement takes place between the individual bones, and there is also some slight lateral movement.

V. INTERMETACARPAL ARTICULATION.

Class.—Diarthrosis and synarthrosis.

Formed by the adjacent surfaces of the large and small metacarpal bones.

Ligament.—Interosseous, which becomes ossified in old animals.

Movements.—Almost none.

VI. METACARPO-PHALANGEAL (OR FETLOCK-JOINT).

Class.—Ginglymus.

Formed by the distal extremity of the large metacarpal, the proximal extremity of the os suffraginis, and the anterior faces of the two small sesamoids.

Ligaments. — (1) *Accessory,* or sesamoidean; (2) *proper.*

1. **Accessory.**
   - (*a*) *Superior sesamoidean,* or suspensory. Attached superiorly to the heads of the large metacarpal bone and the lower row of the carpus. It passes down the groove formed by the three metacarpals, bifurcates some little distance above the sesamoids, each portion becoming attached to the summit of a sesamoid and then passing downwards and forwards to gain the front of the digit and join the extensor pedis tendon.
   - (*b*) *Inferior sesamoidean,* divided into three parts: (1) an external Y-shaped, (2) a middle V-shaped, and (3) a deep X-shaped. This ligament arises superiorly from the base of the sesamoids—the external portion passing

to the glenoid cartilage of the os coronæ; the middle portion to the ridges on the posterior surface of the os suffraginis, and the deep portion to the supero-posterior part of the os suffraginis.

(*c*) The *external* and *internal lateral sesamoidean* pass from the lateral faces of the sesamoids to the tubercles on each side of the head of the os suffraginis.

(*d*) The *inter-sesamoidean* unites the two sesamoids and is covered by fibro-cartilage, thus forming a smooth groove for the flexor tendons to play over.

2. **Proper.**

(*a*) *Capsular*, arranged in the usual way.

(*b*) *External* and *internal lateral*, passing from the lateral aspects of the distal end of the large metacarpal to the supero-lateral parts of the os suffraginis.

Synovial Membrane.—This is prolonged upwards between the two branches of the superior sesamoidean ligament.

Movements.—Flexion and extension, and slight lateral movement when the joint is flexed.

VII. PROXIMAL INTERPHALANGEAL (OR PASTERN-JOINT).

Class.—Ginglymus.

Formed by the distal end of the os suffraginis and the proximal end of the os coronæ.

Ligaments.—

(1) *Capsular*, connected with the tendon of the extensor pedis.

(2) *External* and *internal lateral*, attached to the distal extremity of the os suffraginis and the proximal extremity of the os coronæ, and continued downwards and backwards to form the postero-lateral ligaments of the next joint.

(3) Two *posterior*, arising from three points on the borders of the os suffraginis, and becoming attached to the glenoid cartilage of the os coronæ, one on each side of the external portion of the inferior sesamoidean ligament.

Synovial Membrane.—This lines the posterior surface of the extensor pedis tendon, and is continued upwards between the glenoid cartilage and the os suffraginis.

Movements.—Flexion and extension and some slight lateral movement when the joint is flexed.

VIII. DISTAL INTERPHALANGEAL (OR COFFIN-JOINT).

Class.—Ginglymus.

Formed by the articular surface on the distal end of the os coronæ, the os pedis and navicular bone.

Ligaments.—

(1) *Capsular*, attached around the articular margin of the three bones, and connected with the tendons of the extensor pedis and flexor pedis perforans.

(2) Two *antero-lateral,* from the lateral faces of the os coronæ to the small depressions on each side of the pyramidal process of the os pedis.

(3) Two *postero-lateral,* continuation of the laterals of the preceding joint; they are attached to the superior margin of the navicular bone. These unite to form

(4) The *superior navicular.*

(5) The *inferior* or *interosseous* passes from the anterior margin of the navicular bone to the semilunar ridge of the os pedis.

(6) The two *lateral naviculars* unite the extremities of the navicular bone and the lateral cartilages and alæ of the os pedis.

The **Synovial Membrane** forms a prolongation upwards behind the os coronæ.

Movements.—Flexion and extension.

MUSCLES.

The muscles are divided into the following primary groups:

A. **Shoulder** or scapular region.
B. **Brachium** or arm region.
C. **Antibrachium** or fore-arm region.
D. **Manus** or hand or metacarpal region.

A. SHOULDER OR SCAPULAR REGION.

Consists of two groups: (1) External and (2) internal scapular.

I. External Scapular Group.

Comprises four muscles:

1. **Teres Externus.**

Synonyms.—Teres minor, long abductor of the arm.

Situation.—Immediately beneath the scapular aponeurosis, and along the posterior border of the postea-spinatus.

Origin.—Consists of two portions, one from the posterior angle of the scapula, and the other, more aponeurotic, from the scapular spine.

Insertion. — The external tuberosity of the humerus.

Relations.—Externally, the scapular aponeurosis. Internally, the postea-spinatus, postea-spinatus minor, and caput magnum and medium.

Actions.—Flexes and slightly rotates the shoulder-joint and abducts the arm.

Blood-supply.—Posterior circumflex.

Nerve-supply.—Circumflex.

2. **Antea-spinatus.**

Synonyms.—Superspinatus, superacromio-trochiterus.

Situation.—In the antea-spinatus fossa.

Origin.—Cartilage of prolongation, antea-spinatus fossa and anterior surface of scapular spine.

Insertion.—The internal and external trochanters of the humerus.

Relations.—Externally, the scapular aponeurosis; internally, the scapula and subscapularis; anteriorly, pectoralis parvus; posteriorly, scapular spine and postea-spinatus.

Action.—Extends the shoulder-joint and acts passively as a ligament.

Blood-supply. — Prescapular, subscapular, and posterior circumflex.

Nerve-supply.—Prescapular.

3. **Postea-spinatus.**

Synonyms.—Subspinatus, subacromio-trochiterus.

Situation.—In the postea-spinatus fossa.

Origin.—The postea-spinatus fossa, the cartilage of prolongation, and the posterior surface of the scapular spine.

Insertion.—By two tendons, one to the convexity of the external trochanter of the humerus, the other to a ridge below, having a synovial membrane between itself and the convexity.

Relations.—Externally, the teres externus and scapular fascia; internally, the scapula, cartilage of prolongation and postea-spinatus minor.

Actions.—Abducts and rotates the humerus.

Blood-supply.—Prescapular and subscapular.

Nerve-supply.—Prescapular.

4. **Postea-spinatus Minor.**

Synonyms.—Scapulo-humeralis minor, short abductor of the arm.

Situation.—Beneath the teres externus and postero-inferior to the postea-spinatus.

Origin.—The posterior costa of the scapula and small tubercle on the external margin of the glenoid cavity.

Insertion.—Behind the deltoid ridge.

Relations.—Externally, teres externus and postea-spinatus; internally, the large and medium heads of the triceps extensor brachii, and the capsular ligament of the shoulder-joint.

Actions.—Abducts and rotates the humerus.

Blood-supply.—Subscapular.

Nerve-supply.—Prescapular.

II. Internal Scapular Group.

Consists of three muscles:

1. **Subscapularis.**

Synonym.—Subscapulo-trochineus.

Situation.—In the subscapular fossa, is triangular, with its base divided into three portions, and placed superiorly.

Origin.—From the entire subscapular fossa.

Insertion.—To the internal trochanter of the humerus, its tendon possessing a small synovial membrane.

Relations.—Externally, the scapula and shoulder-joint; internally, the serratus magnus; anteriorly, the antea-spinatus and sub-scapular bloodvessels and nerves.

Actions.—Adducts and slightly rotates the arm.

Blood-supply.—Subscapular and prescapular.

Nerve-supply.—Subscapular.

2. **Teres Internus.**

Synonyms.—Teres major, subscapulo-humeralis.

Situation.—Posterior to the subscapularis, and along the posterior border of the scapula.

Origin.—Posterior angle and border of the scapula.

Insertion. — The internal tuberosity of the humerus, its tendon blending with that of the latissimus dorsi.

Relations.—Externally, the aponeurosis of the latissimus dorsi and of the scapulo-ulnaris; internally, serratus magnus; anteriorly, subscapularis.

Actions.—Adducts and rotates the humerus, and flexes the shoulder when it acts along with the teres externus.

Blood-supply.—Subscapular.

Nerve-supply.—Brachial plexus.

3. **Scapulo-humeralis Gracilis.**

Synonyms.—Scapulo-humeralis posticus, grèle.

A small, insignificant cylindrical bundle of muscular fibres, found between the large head of the triceps and the capsular ligament of the shoulder-joint. It arises just above the glenoid cavity, and terminates below the head of the humerus. It is said to render tense the capsular ligament of the shoulder-joint during flexion, and so prevent injury to this structure. It is regarded as peculiar to solipeds.

Nerve-supply.—Circumflex.

B. BRACHIUM OR ARM REGION.

Divided into two groups: (1) Anterior brachial group; (2) posterior brachial group.

I. Anterior Brachial Group.

Consists of three muscles:

1. **Flexor Brachii.**

Synonyms.—Biceps (a misnomer), coraco-radialis.

Situation, etc.—In front of the humerus, long and cylindrical, possesses fibro-cartilage in its tendon of origin, and has a tendinous intersection passing from end to end.

Origin.—Base of the coracoid process of the scapula; its tendon of origin passes over and is moulded upon the bicipital groove, and between them is a synovial membrane.

Insertion.—The bicipital tuberosity of the radius, capsular ligament of the elbow-joint, and beneath the internal lateral ligament of this joint. At the commencement of the tendon of insertion a strong slip is given off and spread over the anterior face of the extensor metacarpi magnus.

Relations.—Anteriorly, fascia and levator humeri; posteriorly, humerus and humeralis obliquus. Its origin is related with the bifid insertion of the antea-spinatus.

Actions.—Flexes the fore-arm, extends the arm, and renders tense the antibrachial fascia. Its tendinous cord acts as a passive support to the shoulder-joint, and allows the animal to rest while standing.

Blood-supply. — Coraco-radial branch of the humeral and anterior circumflex.

Nerve-supply.—Median.

2. **Coraco-humeralis.**

Synonyms.—Coraco-brachialis, omo-brachialis.

Situation, etc.—On the inner surface of the humerus; long and fusiform.

Origin.—Beak of the coracoid process of the scapula.

Insertion. — By fleshy attachments above and below the internal tuberosity of the humerus.

Relations. — Externally, humerus, humeralis obliquus and shoulder-joint; internally, pectoralis magnus; anteriorly, flexor brachii; posteriorly, teres internus and latissimus dorsi.

Actions.—Adducts, rotates and extends the arm.

Blood-supply.—Anterior circumflex.

Nerve-supply.—Median.

3. **Humeralis Obliquus.**

Synonyms.—Humero-cubitalis obliquus, humero-radialis, brachialis anticus.

Situation, etc.—In the musculo-spiral groove. It forms an almost complete circuit of the humerus.

Origin.—Posterior surface of humerus below the head.

Insertion.—Internal surface of the head of the radius, some fibres passing to the ulna and becoming blended with the arciform ligament.

Relations.—Externally, large and medium heads of triceps; internally, humerus; anteriorly, flexor brachii.

Action.—Flexes the elbow-joint.

Blood-supply.—Deep humeral.

Nerve-supply.—Musculo-cutaneous.

II. Posterior Brachial Group.

Contains five muscles.

1. Scapulo-ulnaris.

Synonyms. — Scapulo-olecranius longus, long extensor of the fore-arm.

Situation.—Closely applied to the inner face of the caput magnum of the triceps.

Origin.—Posterior border of the scapula.

Insertion.—Inner face of the olecranon process of the ulna and antibrachial aponeurosis.

Relations.—Externally, caput magnum; internally, pectoralis magnus, teres internus and latissimus dorsi.

Action.—Extends the fore-arm, flexes the arm, and renders tense the antibrachial aponeurosis.

Blood-supply.—Subscapular and ulnar.

Nerve-supply.—Radial.

The following three muscles are frequently described as forming one, and for this reason are known as the *caput magnum, medium* and *parvum* of the *triceps extensor brachii*. The above names will be here retained.

2. Caput Magnum.

Synonyms. — Scapulo-olecranius major, large extensor of the fore-arm.

Situation, etc.—Triangular in shape, and fitted into the angle formed by the scapula and humerus.

Origin. — Posterior angle and border of the scapula.

Insertion.—The summit of the olecranon, to the inner side, as it passes over the bone; it is provided with a synovial bursa.

Relations.—Externally, teres externus, panniculus and aponeurosis; internally, latissimus dorsi, teres internus and scapulo-ulnaris.

Action.—Flexes the arm and extends the fore-arm.

Blood-supply.—Deep humeral and posterior circumflex.

Nerve-supply.—Radial.

3. **Caput Medium.**

Synonyms. — Humero-olecranius externus, short extensor of the fore-arm.

Situation.—Inferior to the magnum.

Origin. — A ridge running from the external tuberosity to near the head of the humerus.

Insertion.—Posterior part of the summit of the olecranon. Some of its fibres join the magnum.

Relations.—Externally, teres externus; internally, caput parvum, humeralis obliquus and extensor metacarpi magnus; superiorly, caput magnum.

Action.—Extends the fore-arm.

Blood-supply.—Deep humeral, posterior circumflex and ulnar.

Nerve-supply.—Radial.

4. **Caput Parvum.**

Synonyms.—Humero-olecranius internus, middle extensor of the fore-arm.

Situation. — Small and triangular, along the inferior border of the magnum.

Origin.—Below and posterior to the internal tuberosity of the humerus.

Insertion.—By two tendons to the summit of the olecranon; one is attached more posteriorly than the other, and possesses a synovial bursa.

Relations.—Externally, the humerus, humeralis obliquus and caput medium; internally, the insertions of the coraco-humeralis, latissimus dorsi and teres internus, and the scapulo-ulnaris; superiorly, caput magnum.

Action.—Extends the fore-arm.

Blood-supply.—Ulnar.

Nerve-supply.—Radial.

5. **Anconeus.**

Synonyms.—Humero-olecranius minor, small extensor of the fore-arm.

Situation.—Behind and above the elbow-joint.

Origin.—From the epitrochlea and epicondyle, particularly the former.

Insertion.—Anterior and external aspects of the olecranon. It is also attached to the capsule of the joint.

Relations.—Supero-posteriorly, caput magnum; antero-inferiorly, the capsular ligament of the elbow-joint.

Action.—Makes tense the capsular ligament during extension.

Blood-supply.—Deep humeral.

Nerve-supply.—Radial.

C. ANTIBRACHIUM OR FORE-ARM REGION.

The muscles are arranged in two groups: (1) Anterior antibrachial or extensor group; (2) posterior antibrachial or flexor group.

I. Anterior Antibrachial Group.

Includes four extensor muscles:

1. **Extensor Metacarpi Magnus.**

Synonyms.—Epicondylo-premetacarpeus, anterior extensor of the metacarpus.

Situation, etc.—Pyramidal in shape, anterior to the radius.

Origin.—Epitrochlea, and capsule of elbow-joint. It receives a tendinous slip from the flexor brachii.

Insertion.—To the tuberosity placed antero-internally at the proximal extremity of the large metacarpal bone.

Relations.—Externally, extensor pedis; internally, humeralis obliquus and flexor brachii; anteriorly, antibrachial aponeurosis and extensor metacarpi obliquus; posteriorly, the radius.

Action.—Extends the metacarpus.

Blood-supply.—Deep humeral and anterior radial.

Nerve-supply.—Radial.

2. **Extensor Metacarpi Obliquus.**

Synonyms. — Cubito-premetacarpeus, radio-premetacarpeus, oblique extensor of the metacarpus.

Situation, etc.—Runs obliquely across the anterior face of the lower extremity of the radius.

Origin.—External border of the radius.

Insertion.—Head of inner small metacarpal bone.

Relations.—Anteriorly, antibrachial aponeurosis and extensor pedis; posteriorly, radius and extensor metacarpi magnus.

Action.—Extends and rotates the metacarpus.

Blood-supply.—Anterior radial.

Nerve-supply.—Radial.

3. **Extensor Pedis.**

Synonyms.—Epicondylo-prephalangeus, humero-prephalangeus, anterior extensor of the phalanges.

Situation.—External to the extensor metacarpi magnus.

Origin.—Epitrochlea, anterior face of the distal extremity of the humerus, external ligament of the elbow-joint, and external part of the head of the radius.

Insertion.—After passing through a groove at the distal extremity of the radius, being attached to the capsule of the fetlock-joint, and being joined by the two slips from the superior sesamoidean ligament, it is inserted to the pyramidal process of the os pedis.

Relations.—Antero-externally, aponeurosis; posteriorly, extensor suffraginis, carpus, metacarpus, and digit; internally, extensor metacarpi magnus.

Action.—Extends the phalanges and assists in extending the metacarpus.

Blood-supply.—Anterior radial.

Nerve-supply.—Radial.

As parts of the extensor pedis are usually described two small muscles—*Phillip's* and *Thiernesse's.*

Phillip's muscle is very thin, and arises from the external lateral ligament of the elbow-joint; it is closely applied to the fleshy portion of the extensor pedis. Its tendon finally joins that of the extensor suffraginis below the carpus.

Thiernesse's muscle is very small, and placed along the inner face of the extensor pedis. It arises from the external arciform ligament, and its tendon joins that of the extensor pedis just above the carpus.

4. **Extensor Suffraginis.**

Synonyms. — Cubito- or radialis-prephalangeus, lateral extensor of the phalanges.

Situation, etc.—Semipenniform, between the extensor pedis and flexor metacarpi externus.

Origin.—External lateral ligament of the elbow-joint, external part of the head of the radius, and external border of the radius and ulna.

Insertion.—The head of the os suffraginis. At a little distance below the carpus, the tendon is joined by two structures, one the tendon of Phillip's muscle, the other a band of fibrous tissue (check ligament) from the inferior border of the trapezium.

Relations.—Anteriorly, the extensor pedis; posteriorly, flexor metacarpi externus and flexor pedis perforans and perforatus.

Action.—Extends the digit and assists in extending the metacarpus.

Blood-supply.—Interosseous.

Nerve-supply.—Radial.

II. Posterior Antibrachial Group.

Contains five flexors :

1. **Flexor Metacarpi Externus.**

Synonyms. — Epicondylo-supercarpeus, humero-supercarpeus externus, external flexor of the metacarpus.

Situation.—Between the extensor suffraginis and flexor metacarpi medius.

Origin.—Epitrochlea of the humerus.

Insertion.—By two tendons, one to the upper part of the trapezium, the other to the head of the external small metacarpal bone.

Relations.—Externally, the antibrachial aponeurosis; internally, flexor pedis perforans and perforatus and flexor metacarpi medius; anteriorly, the extensor suffraginis.

Action.—Flexes the metacarpus.

Blood-supply.—Posterior radial and ulnar.

Nerve-supply.—Radial.

2. **Flexor Metacarpi Medius.**

Synonyms.—Epitrochlea supercarpeus, humero-metacarpeus internus, oblique flexor of the metacarpus.

Situation.—At the postero-internal part of the fore-arm.

Origin.—Epicondyle and posterior face of the olecranon.

Insertion.—With a tendon of the externus to the superior part of the trapezium.

Relations.—Externally, the antibrachial aponeurosis; internally, the flexor pedis perforans and perforatus; anteriorly, the internus; posteriorly, the externus.

Action.—Flexes the metacarpus.

Blood-supply.—Posterior radial and ulnar.

Nerve-supply.—Ulnar.

3. **Flexor Metacarpi Internus.**

Synonyms.—Epitrochlea metacarpeus, humero-metacarpeus internus.

Situation.—In the internal and posterior part of the fore-arm.

Origin.—Base of the epicondyle together with the medius.

Insertion.—Head of the inner small metacarpal bone. The tendon passes through a synovial sheath behind the carpus.

Relations.—Superficially, the antibrachial aponeurosis; internally, flexor pedis perforans and perforatus, as well as the posterior radial bloodvessels and median nerve; anteriorly, the radius.

Action.—Flexes the metacarpus.

Blood-supply.—Posterior radial.

Nerve-supply.—Median.

4. **Flexor Pedis Perforatus.**

Synonyms. — Epitrochlo-phalangeus, humero-coronarius or humero-phalangeus, flexor sublimis.

Situation.—Beneath the metacarpal flexors. Its muscular part is thin, its tendon is long, and receives the *superior carpal* or *check ligament* before it enters the *carpal sheath;* this ligament is attached to the lower part of the posterior surface of the radius.

Origin.—Epicondyle.

Insertion.—Its tendon bifurcates and forms a ring for the passage of the perforans tendon, and is attached to each side of the os coronæ.

Relations.—

Muscular Portion.—Anteriorly, the perforans; posteriorly, the flexor metacarpi externus and medius.

Tendinous Portion.—Anteriorly, the perforans tendon; posteriorly, the carpal and metacarpo-phalangeal sheaths.

Action.—Flexes the pastern, fetlock, and carpal joints.

Blood-supply.—Posterior radial.

Nerve-supply.—Ulnar.

5. **Flexor Pedis Perforans.**

Synonyms.—Cubito-phalangeus, humero-radio-phalangeus, flexor profundus.

Situation.—Beneath the perforatus, and against the posterior face of the radius. Its muscular portion is divided in three parts, viz., humeral, ulnar, and radial.

Origin.—

1. *Humeral*—in common with the perforatus from the epicondyle.
2. *Ulnar* (*ulnaris accessorius*)—from the

posterior border of the olecranon. Its tendon joins that of the chief portion near the carpus.

3. *Radial* (*radialis accessorius*)—from the back of the radius. Its tendon also joins the main tendon at the carpus.

Insertion.—The common tendon, after passing through the carpal sheath, is joined by the *inferior carpal* or *check ligament*, which is a continuation of the posterior ligament of the carpus. Before becoming attached to the semilunar ridge of the os pedis, the tendon becomes expanded, forming the **plantar aponeurosis.**

Relations.—

Muscular Portion.—Anteriorly, the radius; posteriorly, the perforatus.

Tendinous Portion.—Anteriorly, the posterior carpal ligament, the inferior check ligament, the superior sesamoidean ligament, the sesamoidean groove, the inferior sesamoidean ligament, and the navicular bone; posteriorly, the perforatus tendon, and the plantar cushion.

Action.—Flexes the phalanges and metacarpus.

Blood-supply.—Posterior radial.

Nerve-supply.—Ulnar and median.

The *check ligament* allows of rest while in a standing position.

D. METACARPAL REGION.

The region of the metacarpus includes two pairs of rudimentary muscles:

1. The **Lumbrici**, which arise on each side of the perforans tendon a little above the sesamoidean ring of the perforatus, and become lost in the fibrous tissue of the 'ergot.'
2. The **Interossei Metacarpei** (or anterior lumbrici), are placed between the small metacarpal bones and the superior sesamoidean ligament.

ARTERIES.

BRACHIAL ARTERY. (*See* THORAX.)

I. Collateral Branches.

1. **Prescapular**, or Superscapular.—Arises near the tendon of subscapularis, and passes upwards between the antea-spinatus and subscapularis.

It supplies the antea- and postea-spinati muscles, the tendon of origin of the flexor brachii and the shoulder-joint.

2. **Subscapular**, or Inferior Scapular. — Arises between the subscapularis and teres internus.

Course.—Passes upwards and backwards, and terminates near the posterior angle of the scapula.

Branches.—

(*a*) To the *latissimus dorsi.*

(*b*) *Posterior circumflex* or scapulo-humeral, which passes under the large head of the triceps and the postea-spinatus, and gains the outer surface of the shoulder.

(*c*) *Anterior muscular.*

(*d*) *Posterior muscular.*

(*e*) *Nutrient scapular.*

II. Terminal Branch.

HUMERAL ARTERY.

Course.—From the point of origin of the subscapular artery to the lower end of the humerus.

I. Collateral Branches.

1. **Prehumeral**, or Anterior Circumflex.

Course.—Passes forward between the two portions of the coraco-humeralis, and gains the anterior surface of the humerus.

It supplies the flexor brachii, coraco-humeralis, shoulder-joint and levator humeri.

2. **Deep Humeral.**

Course.—Arises near the internal humeral tuberosity; soon divides into two branches.

It supplies the large and medium heads of triceps, humeralis obliquus, the anconeus and extensor metacarpi magnus.

3. **Ulnar**, or Cubital.

Course.—Arises near the nutrient foramen of the humerus, passes beneath the scapulo-ulnaris, and between the middle and external flexors of the metacarpus.

It forms the **superior carpal arch** by anastomosing with the recurrent radial.

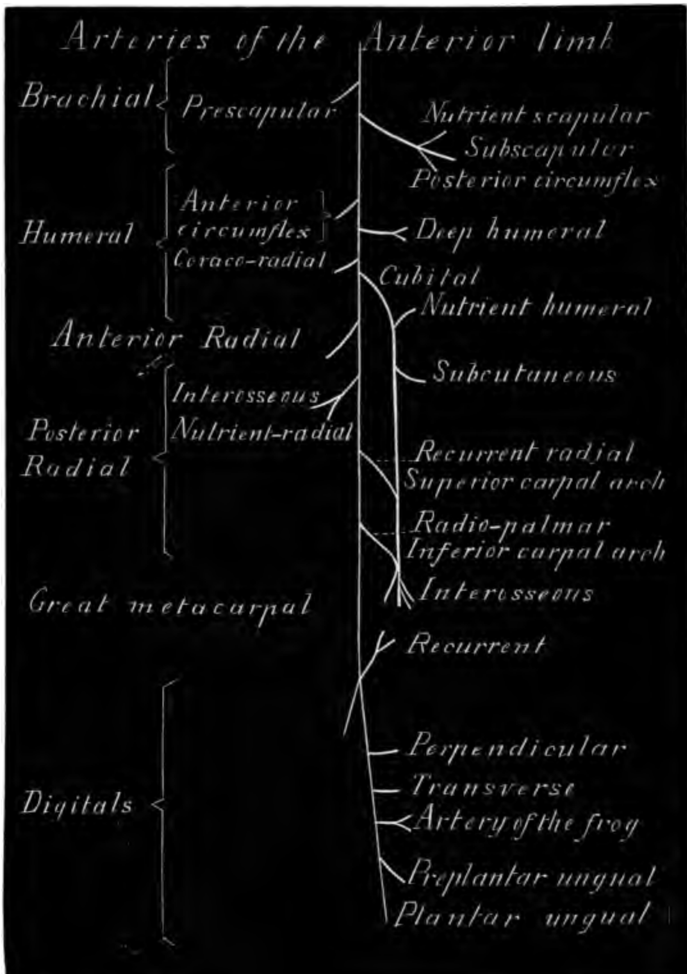

FIG. 5.—DIAGRAM OF THE ARTERIES OF THE ANTERIOR LIMB.

Branches.—

(*a*) *Nutrient artery* of the *humerus*.

(*b*) *Articular* branches.

(*c*) *Muscular* twigs.

(*d*) *Subcutaneous* branches.

It supplies the medium head of triceps, scapulo-ulnaris, flexor metacarpi externus and medius.

4. **Coraco-radial.** — Supplies the flexor brachii, dividing into ascending and descending branches.

II. Terminal Branches.

1. **Anterior Radial.**

Course.—Arises above the humeral condyle, passes beneath the flexors of the fore-arm, and afterwards between the extensor pedis and the radius; it terminates at the carpus, and anastomoses with the interosseous branch of the posterior radial.

It supplies the extensor muscles situated in front of the fore-arm and the capsule of the carpus.

2. **POSTERIOR RADIAL.**

Course.—Usually considered to be the continuation of the humeral artery. Passes internal to the elbow-joint and behind the tendon of insertion of the flexor brachii, afterwards beneath the flexor metacarpi internus. It terminates at the distal end of the radius by two branches.

I. Collateral Branches.

1. **Articular,** to elbow-joint.

2. **Muscular,** to posterior antibrachial region.

3. **Interosseous.**

Course. — Arises near radio-ulnar arch, which it traverses, then passes along the radio-ulnar groove underneath the extensor suffraginis. At the carpus it divides into numerous branches, and joins the anterior radial.

Branches.—

(*a*) *Articular*, to elbow.

(*b*) *Muscular*, to the extensors of the metacarpus and digit.

(*c*) *Nutrient radial.*

4. Recurrent Radial.

Course.—Arises above the carpus, passes obliquely outwards and downwards to anastomose with the cubital, and so form the **superior carpal arch.**

II. Terminal Branches.

1. **Radio-palmar**, or Common Trunk of the Interosseous Metacarpal Arteries.

Course.—Arises just above the carpus, and passes downwards and to the inside of its posterior surface, being external to the posterior annular ligament. On a level with the head of the inner metacarpal bone it passes outwards and anastomoses with a branch from the superior carpal arch, and so forms the **inferior carpal arch**, which has the following branches:

(*a*) *Two anterior interosseous*, which pass down the grooves formed by the large and small metacarpal bones.

(*b*) *Two posterior interosseous*, which pass down each side of the superior sesamoidean ligament, and terminate by anastomosing with the large metacarpal artery.

2. **LARGE METACARPAL ARTERY, or Collateral Artery of the Cannon.**

Course.—Arises just above the carpus, passes under the posterior annular ligament, and descends internal to the flexor tendons, terminating above the sesamoid bones in the two digital arteries.

I. Collateral Branches.

1. **Muscular.**
2. **Synovial, tendinous and cutaneous.**
3. **A recurrent** artery, given off near its termination, which passes upwards between the metacarpal bone and the superior sesamoidean ligament, and divides into:
   (*a*) *Internal lateral,*
   (*b*) *External lateral,*

these passing up the inner and outer borders of the ligament.

II. Terminal Branches.

THE TWO DIGITAL ARTERIES (Internal and External), or Collateral Arteries of the Digits.

Course.—They commence just above the sesamoid bones between the flexor tendons and the superior sesamoidean ligament, gain the lateral faces of the fetlock-joint, and descend—on the outer and inner aspects of the digits—to the alæ of the os pedis, under which they terminate in two branches.

I. Collateral Branches.

1. **Perpendicular Artery.**

Course.—Arises about the middle of the os suffraginis, passes obliquely downwards and forwards, and unites with its fellow, above the coronary band, to form the **superficial coronary arch.**

2. Transverse Artery.

Course.—Arises underneath the lateral cartilage, passes forwards under the extensor tendon, and unites with its fellow to form the **deep coronary arch.**

3. Artery of the Plantar Cushion, or **Frog.**

Course.—Arises about the upper margin of the lateral cartilage, passes downwards and backwards, and enters the plantar cushion, dividing into anterior and posterior branches.

II. Terminal Branches.

1. Preplantar Ungual Artery.

Course.—Arises inside the ala of the os pedis, traverses the preplantar foramen (or notch), runs along the preplantar groove, and terminates near the 'toe' in numerous branches which pierce the os pedis.

Branches.—

(*a*) *Deep retrograde*, given off before the artery passes through the foramen and supplying the posterior part of the plantar cushion.

(*b*) *Second retrograde*, given off immediately after the passage of the artery through the foramen, and supplying the lateral cartilage.

(*c*) Numerous *ascending* and *descending laminal* branches, which anastomose with the coronary arch and circumflex artery respectively.

2. Plantar Ungual Artery.

Course.—Passes along the plantar groove, pierces the plantar foramen, and so gains the semilunar sinus in the interior of the os pedis; here it inosculates with its fellow, forming the **circulus arteriosus** or **semilunar anastomosis.**

Branches.—

(*a*) *Ascending* or *laminals*, which supply the sensitive laminæ.

(*b*) *Descending* or *inferior communicating*, which leave the bone by the foramina above its edge, and unite to form the **circumflex artery.**

Branches of the circumflex artery.—

(*a*) *Ascending*, to sensitive laminæ.

(*β*) *Descending* or *solar*, to the velvety tissue of the sole; these unite to form the **inferior circumflex artery.**

VEINS.

THE VEINS OF THE FOOT.

These are arranged in two sets of plexuses: (1) *Internal, intra-osseous*, or deep; (2) *external, extra-osseous*, or superficial.

I. The Intra-osseous Plexus.

Is satellite to the circulus arteriosus, and pours its blood into the deep lateral coronary plexus.

II. The Extra-osseous Plexuses.

1. The **Solar**, situated in the plantar reticulum; pours its blood into the **Circumflex Vein** (a satellite of the artery); this vein opens into the coronary plexus.

2. The **Podophyllous** or **Laminal**, situated in the podophyllous reticulum; its blood passes into the circumflex vein and coronary plexus.

3. The **Coronary**, situated on a level with the distal interphalangeal articulation, and connected with the lateral cartilages. It is divided into a *central* or *anterior* and two *lateral* portions.

(*a*) The *central* is connected with the coronary cushion, and receives branches from the laminal veins.

(*b*) The *laterals* consist of two layers of vessels: (*a*) a superficial plexus placed on the external surface of the lateral cartilage; (*β*) a deep plexus placed on the internal surface of the lateral cartilage, and formed by veins from the podophyllous, solar and intra-osseous plexuses.

The veins from the coronary plexuses, together with the **Vein of the Frog**, form—

THE DIGITAL VEINS.

These accompany the digital arteries, and unite above the fetlock beneath the flexor tendons; the result of the union is an arch from which spring the three metacarpal veins.

THE METACARPAL VEINS.

These are three in number, viz.: *Internal* and *external metacarpals*, or collaterals of the cannon; and *deep metacarpal*, or interosseous collateral of the cannon.

1. **Internal Metacarpal Vein.**
   Course, etc.—Passes upwards along with the large metacarpal artery and external metacarpal nerve. Above the knee it forms the root of the **Internal Subcutaneous Vein,** and anastomoses with the other two metacarpal veins.
2. **External Metacarpal Vein.**
   Course.—Runs up the outer border of the flexor tendons; at the knee it anastomoses with the internal vein, and so forms the roots of the **Ulnar** and **Posterior Radial Veins.**
3. **Deep Metacarpal Vein.**
   Course.—Placed between the large metacarpal bone and the superior sesamoidean ligament; on a level with the head of the metacarpal bone it divides into several branches, which unite with the internal and external veins and help to form the posterior radial vein.

VEINS OF THE FORE-ARM.

I. Superficial.

1. **Internal Subcutaneous,** a continuation of the internal metacarpal; ascends the internal surface of the fore-arm in an oblique direction (upwards and forwards). It terminates in two branches:

(*a*) The *Basilic Vein,* which crosses the pectoralis transversus and opens into the **Humera Vein.**

(*b*) The *Cephalic Vein,* which crosses the flexor brachii, gains the space formed by the levator humeri and pectoralis anticus, and opens into the jugular vein.

2. **External Subcutaneous**, passes up the anterior face of the fore-arm, and opens either into the internal subcutaneous or, more frequently, into the cephalic vein.

II. **Deep.**

1. **Anterior Radial Vein.**
2. **Posterior Radial Vein.**
3. **Ulnar Vein.**

These are satellites of the arteries of the same name, and unite to form—

THE HUMERAL VEIN,

which is a satellite of the humeral artery, and receives corresponding branches. It receives, however, two veins, which have no corresponding arteries, viz.:

1. The **Basilic**, already mentioned.
2. The **Subcutaneous Thoracic**, or Spur Vein, which, though really belonging to the thorax, is usually described here. It commences near the flank in the panniculus carnosus, passes along the superior border of the pectoralis magnus, then beneath the muscles of the posterior brachial region, and finally opens either into the humeral or, more rarely, into the brachial vein.

The humeral vein about the shoulder-joint becomes—

THE BRACHIAL VEIN.

This vein accompanies the artery, enters the thorax, and, with its fellow and the jugular confluent, forms the **Anterior Vena Cava.**

LYMPHATICS.

The **Brachial Glands** are arranged in two groups:

1. On the inner surface of the inferior extremity of the humerus. This group receives the vessels from the foot and fore-arm, and sends nine or ten branches to—

2. A group near the tendons of insertion of the teres internus and latissimus dorsi. The efferent vessels from the second group pass to the **prepectoral** glands, following in their course the brachial bloodvessels.

NERVES.

The **Brachial Plexus** supplies the anterior limb with nerves.

(For a full description of this plexus and the nerves it supplies to the thorax, etc., see the Thorax, Part II.)

Branches (to the Fore-limb).

1. **Circumflex Nerve.**

   Course, etc.—Formed by the 7th and 8th cervical, passes downwards and backwards between the subscapularis and teres internus; winds round the posterior aspect of the shoulder-joint.

   It supplies the teres internus, teres externus, postea-spinatus minor, and levator humeri.

2. **Nerve of the Teres Internus.**

   Course, etc.—Formed by the 7th and 8th cervical, passes downwards and backwards, being related with the subscapularis, and terminates in the teres internus.

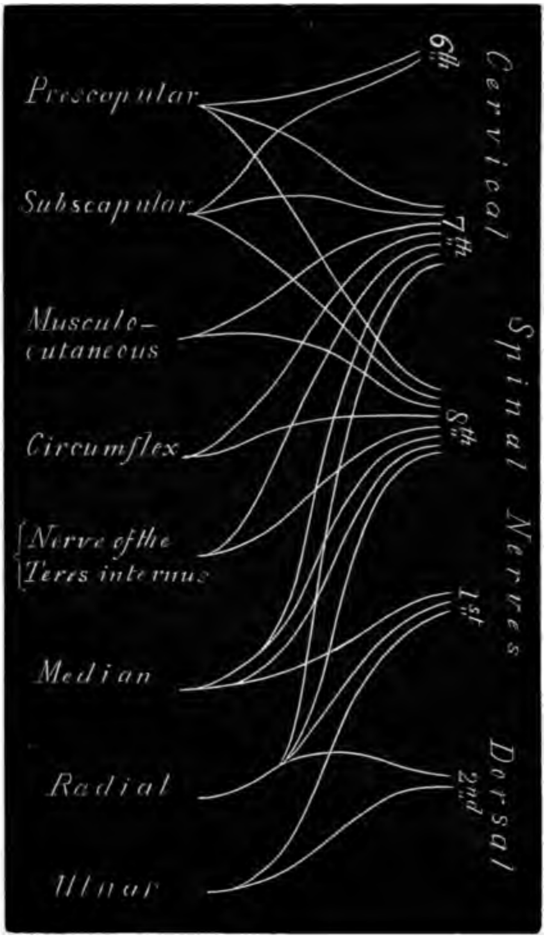

FIG. 6.—DIAGRAM SHOWING THE ORIGIN OF THOSE BRANCHES OF THE BRACHIAL PLEXUS WHICH SUPPLY THE ANTERIOR LIMB.

3. **Subscapular Nerve.**

Course, etc.—Formed by the 6th, 7th, and 8th cervical, passes downwards to the subscapularis. This nerve is usually double.

4. **Prescapular or Superscapular Nerve.**

Course, etc.—Formed by the 6th, 7th, and 8th cervical, gains the interval between the subscapularis and antea-spinatus, passes to the external surface of the scapula, and terminates in the postea-spinatus.

It supplies the antea- and postea-spinati, etc.

5. **Musculo-cutaneous or Anterior Brachial Nerve.**

Course, etc.—Formed by the 7th and 8th cervical, gains the inner aspect of the shoulder-joint, forms a loop round the brachial artery by means of a branch which joins the median nerve, passes between the two tendons of insertion of the coraco-humeralis, and terminates in the flexor brachii.

It supplies the coraco-humeralis, flexor brachii, and the skin.

6. **Radial Nerve.**

Course, etc. — The most voluminous of the branches of the brachial plexus. Formed chiefly by the 1st dorsal, passes obliquely downwards and backwards, being related to the subscapularis and teres internus muscles and the humeral artery. It insinuates itself between the humeralis obliquus and the large head of the triceps, winds round to the front of the elbow, and passes under the extensors down the anterior surface of the radius, terminating in the extensor metacarpi obliquus.

It supplies the triceps, scapulo-ulnaris, elbow-joint, and the extensors of the metacarpus and foot, as well as the skin of the region.

7. **Ulnar or Cubital Nerve.**

Course, etc.—Formed by the 1st and 2nd dorsals, passes downwards and backwards, gains the humeral artery and accompanies it for a short distance, *i.e.*, to the origin of the deep humeral artery, courses between the small head of the triceps and scapulo-ulnaris, to the inner aspect of the elbow-joint, then along the posterior border of the flexor metacarpi medius, and terminates at the carpus by two branches.

Branches.

(*a*) To the *pectoralis transversus* and the skin of the fore-arm.

(*b*) To the *flexor muscles* of the fore-arm, except the flexor metacarpi internus and externus.

(*c*) *Cutaneous*, which passes between the tendons of insertion of the flexor metacarpi externus and medius, and is distributed to the skin of the fore-arm, carpus and external metacarpal region.

(*d*) A branch which, when joined by a branch from the median, forms the *external metacarpal* nerve.

8. **Median Nerve.**

Course, etc.—Formed by the 7th and 8th cervical and 1st dorsal. Runs downwards to the humeral artery, where it forms a loop by uniting with a branch from the musculo-cutaneous; it accompanies the humeral and posterior radial arteries, and terminates above the carpus by two branches.

Branches.

(*a*) A *branch* of the *thoracic nerves.*
(*b*) *Musculo-cutaneous,* given off about the middle of the humerus, and distributed to the muscles and skin in front of the fore-arm.
(*c*) Branches to the *flexor metacarpi internus* and *flexor pedis perforans* and *perforatus.*
(*d*) An *anastomotic* branch to the external metacarpal nerve, which, above the carpus, passes obliquely outwards and downwards.
(*e*) *Internal metacarpal* or *plantar nerve.*

METACARPAL OR PLANTAR NERVES (**External and Internal**).

Course.—Origin as given above. They run down the lateral surfaces of the flexor tendons along with the veins. The internal is also related to the large metacarpal artery, lying posterior to it. About the middle of the metacarpus an *oblique branch* passes from the internal to the external. Each terminates at the fetlock as the three digital nerves.

DIGITAL NERVES (**Anterior, Middle, and Posterior**).

1. **Anterior.**—Is distributed to the skin in front of the digit, and to the coronary cushion.

2. **Middle.** — Supplies the coronary cushion and

podophyllous tissue. This usually anastomoses with the other two nerves, particularly with the anterior.

3. **Posterior.**—The most voluminous and important of the three nerves. Accompanies the digital artery to the wing of the os pedis, proceeds along with the preplantar ungual artery to the podophyllous tissue and the bone.

Branches.

(*a*) To the *flexor tendons.*
(*b*) To the *plantar cushion* (a satellite of the artery).
(*c*) To the *lateral cartilage.*
(*d*) Branches *satellites* of the *plantar ungual artery.*

THE EPIDERMAL APPENDAGES.

The Hair.

In the posterior region of the carpus, metacarpus and digit the hair is of greater length than in the other parts of the limb; this is particularly the case with some breeds of horses; the greatest length is attained behind the metacarpo-phalangeal articulation, where a tuft of hair known as the **fetlock** is found.

The **Chestnuts** are horny productions, oval or rounded in outline, found in the anterior limb on the inner face of the lower extremity of the fore-arm, and in the posterior limb on its inner face, just below the tarsus. Sometimes they are merely plate-like growths, in other cases short rods. The chestnuts are composed of epithelial cells, arranged in a tube-like manner;

they are absent in the posterior limbs of the ass, and are only very small in the mule.

The **Ergots** are fibrous and horny projections situated behind the metacarpo-phalangeal articulation, and in the midst of the fetlock. They consist of a deep fibrous thickening and a superimposed excessive development of epithelium.

THE FOOT OF THE HORSE.

THE foot of the horse consists of the horny box (the **hoof**) and its contents, situated at the distal extremity of the limb.

It has a skeleton, or basis, composed of bones, ligaments, tendons, lateral cartilages, and plantar cushion.

I. The Skeleton, etc.

The **Bones** are the os pedis, os naviculare, and the inferior portion of the os coronæ; these have received detailed description elsewhere.

The **Ligaments** are those connected with the coffin-joint.

The **Tendons** are the terminations of those of the extensor pedis and flexor pedis perforans.

The **Lateral Cartilages** and the **Plantar Cushion**, from their intimate connection with the os pedis, have received the name of—

The Complementary Apparatus of the Os Pedis.

The **Lateral Cartilages**, two in number, are bent plates of mixed cartilage (mostly hyaline) placed above the wings of the os pedis, and inclining backwards and inwards. They present *two faces* and *four borders*:

The *external face* is smooth and convex, and has a part of the keratogenous membrane attached to its lower portion. It is pierced by numerous foramina, which allow of the passage of veins.

The *internal face* is concave, and postero-inferiorly is connected with the plantar cushion.

The *superior border* is thin and usually convex, and presents notches for the passage of blood-vessels and nerves.

The *inferior border* is attached to the alæ of the os pedis, and posteriorly to the plantar cushion.

The *anterior border* is oblique, sloping from above downwards, and from before backwards. The cartilage is connected by this border with the antero-lateral ligaments of the coffin-joint.

The *posterior border* is also oblique, being parallel to the anterior.

The **Plantar Cushion** is a wedge-shaped mass of fibrous tissue (containing some little adipose tissue), placed between the horny frog and the perforans tendon, and bounded laterally by the lateral cartilages.

It presents *two faces*, *two borders*, a *base*, and an *apex*:

The *superior face* is connected with the sheath of the perforans tendon, being covered by the *proper tissue of the plantar cushion*, a fibrous expansion continued upwards to the fetlock-joint.

The *inferior face* presents anteriorly a central ridge, which divides posteriorly, bounding a central depression, each portion terminating posteriorly as a *bulb* of the plantar cushion. This face is covered by that part of the keratogenous membrane which secretes the horny frog.

The *borders*, which are somewhat triangular, being widest posteriorly, are connected with the lateral cartilages.

The *base* looks backwards and upwards, and presents the two *bulbs of the plantar cushion;* it is also covered by keratogenous membrane.

The *summit*, or anterior extremity, is connected with the os pedis in front of the semilunar ridge.

Clothing the above basis is—

II. The Keratogenous Membrane.

This is a very vascular and nervous fibrous expansion, a continuation and a modification of the corium of the skin; it is intimately connected on the one hand with the horny hoof, and on the other with the structures mentioned above. It may be divided into four portions:

1. **The Coronary Cushion.**—A bulging projection surrounding the coronet, and possessing *two borders, two extremities*, and a *surface:*

The *superior border* is limited by the perioplic ring.

The *inferior border* is separated from the sensitive laminæ by a white line.

The *extremities* are narrow, and inflected at the region of the heels to become blended with the velvety tissue.

The *surface* is convex, and studded with numerous projections, or **papillæ**, which are inserted into the upper extremities of the horn tubes of the wall.

2. **The Perioplic Ring** is placed above the coronary cushion, from which it is divided by a slight groove. Its papillæ are smaller than those of the coronary cushion.

3. **The Podophyllous Tissue** (or Sensitive Laminæ) is that part of the keratogenous membrane situated on the anterior face of the os pedis and the lower parts of the lateral cartilages.

Its *surface* is covered by the fleshy or sensitive laminæ, each of which we may consider to be a modified papilla. There are some five or six hundred of these structures running downwards from the coronary cushion to the toe. Each lamina has its free margin denticulated, and its surfaces covered by fifty or sixty **secondary laminæ** (or **lamellæ**), which form an acute angle with the primary ones. The inferior extremity of a lamina is marked by the presence of five or six rather large papillæ.

The podophyllous tissue is inflected at the heels along the lower surface of the foot, the laminæ of this part being connected with the bars of the hoof.

The **podophyllous reticulum** is the name applied to the deeper layers of the tissue, which are opened up by the numerous veins constituting the laminal plexus.

4. The **Velvety Tissue** (or Sensitive Sole).—This portion covers the under surface of the os pedis and plantar cushion.

Its *surface* is studded with numerous small papillæ (from which it derives its name), the shortest of which are in the middle depression of the plantar cushion.

The **plantar reticulum** is similar to the podophyllous reticulum in its disposition, etc.

III. The Hoof.

This horny structure may be divided into three parts: Wall, sole, and frog.

1. **The Wall** (or Crust).—This can be seen when the foot is in its natural position upon the ground, and consists of a thick, somewhat crescentic plate of horn curved upon itself, and having the extremities of the crescent inflected to form the bars.

The wall may be divided into the **outside** and **inside toe**, on each side of the middle line; the **quarters**; the **heels**, constituting the posterior part of the wall and the **bars**, inflections between the sole and frog.

The wall presents for consideration *two surfaces*, *two borders*, and *two extremities:*

The *external surface* is smooth, convex from side to side, straight from above to below, and covered by a varnish-like horn, the **periople.**

The *internal surface* is concave, and covered with the **horny laminæ** (or **keraphyllous tissue**); these fit into the spaces between the sensitive laminæ.

The *superior border* is thin, this being due to the presence of an excavation, the **cutigeral groove,** which lodges the coronary cushion, and which is marked throughout its entire surface by minute openings, the mouths of the horn tubes.

The *inferior border* comes in contact with the ground in the natural state, or with the shoe in a shod animal. It is related internally to the circumference of the sole.

The *extremities* form the **bars,** the upper surfaces of which blend with the frog and sole, the lower forming a slight ridge between these structures.

2. **The Sole** is the roughly crescentic, thick, horny plate placed internal to the inferior border of the wall. It presents *two surfaces* and *two borders :*

The *external surface* looks downwards, and is concave; normally it shows semi-detached flakes of horn.

The *internal surface* is in contact with the velvety tissue, and is convex. Its extent is covered with small openings resembling those of the cutigeral groove.

The *anterior border* (the larger) is convex, and united to the inferior border of the wall by a layer of soft horn, **the white line.**

The *posterior border* is a deep V-shaped notch, which receives the point of the frog and the bars.

3. **The Frog.**—This is a somewhat pyramidal-shaped mass of elastic horn, and presents *four faces,* a *base,* and an *apex :*

The *inferior face* presents a middle depression, or **median lacuna**, which separates two lateral ridges which are convergent anteriorly, and terminate posteriorly at the heels of the frog.

The *lateral faces* are divided from the bars by the **lateral lacunæ**, or **commissures of the frog**.

The *superior face* is moulded on the lower face of the plantar cushion, and presents a middle eminence—the **frog-stay**—and two lateral depressions. The whole surface shows fine openings analogous to those of the sole and cutigeral groove.

The *base* (posterior extremity) presents two rounded eminences, known as the **bulbs** or **glomes of the frog**.

The *summit* (anterior extremity) is in contact with the sole.

Structure of the Hoof.

The horn of the hoof is composed of epithelial cells arranged in a tubular manner, the tubes being cemented together by other epithelial cells.

In microscopic section the horn is seen to be composed of:

1. Tubular substance.
2. Intratubular substance.
3. Intertubular substance.

1. **The Horn Tubes** are all arranged in the same direction, viz., with their long axes directed from above to below; those of the wall are straight, but those of the frog are slightly wavy. The upper extremity receives a papilla from the keratogenous

membrane. A **tube** is found to consist of concentric layers of elongated epithelial cells, the long axes of the cells being parallel to the long axis of the tube.

2. The **Intratubular Substance** may be considered to be the débris of epithelial cells cast off from the tip of the papilla. It is more or less opaque, and arranged in an irregular moniliform manner.

3. The **Intertubular Substance** consists essentially of epithelial cells, arranged with their long axes either at right angles to, or forming a more or less acute angle with, the long axis of the tube, the exact direction depending upon the distance of the cell from the tube. Pigment corpuscles are said to exist in this substance.

Production of the Hoof.

The periople is formed by the perioplic ring, the wall by the coronary cushion, and the frog and sole from the velvety tissue. The white line uniting the sole and wall is formed by the terminal papillæ of the sensitive laminæ.

The **Vascular** and the **Nervous Supply** of the foot have been given in their proper places.

ANTERIOR LIMB OF THE OX, SHEEP, PIG AND DOG.

(*In every instance the horse is taken as a type, and usually only variations from that type will be mentioned.*)

BONES.

Scapula.

Ruminants.—The bone is more triangular; the spine is nearer the anterior border, and terminates inferiorly in an **acromion process**; the antea-spinatus fossa is to the postea-spinatus fossa as 1 : 3; the coracoid process is small.

Pig.—The anterior and superior borders are convex; the spine is nearer the centre, and has a large tubercle, which is curved backwards; the **acromion process** is represented by a small projection; the coracoid process is small.

Dog.—The cartilage of prolongation is absent; the spine is near the centre, and terminates in a well-developed acromion process; the anterior angle is indistinct, the anterior and superior borders being blended and convex; the coracoid process is small, and helps to form the glenoid cavity. (The dog possesses a rudimentary **clavicle** embedded in muscles.)

Humerus.

Ruminants.—The musculo-spiral groove is not so deep; the bicipital groove is single, and the external trochanter arches over it; the internal trochanter and the external and internal tuberosities are small; the epitrochlea and epicondyle are more nearly of the same size; the olecranon and coronoid fossæ are deep, and the nutrient foramen is in the posterior surface.

Pig.—The musculo-spiral groove is shallower, but the bone is twisted in an *f*-like manner; the bicipital groove is single, and the external trochanter arches over it; the internal trochanter and external tuberosity are small; the internal tuberosity is represented by a roughened surface; the articular head possesses a better marked neck.

Dog.—The bone is relatively long and curved in an *f*-shaped manner; the head is provided with a distinct neck; the bicipital groove is single, and pushed internally by the external trochanter; the internal trochanter is very small; the olecranon and coronoid fossæ are in communication by means of a foramen.

(In the cat there is a **supra-condyloid foramen** above the inner condyle, but the olecranon and coronoid fossæ are not joined.)

Radius.

Ruminants.—Shorter and smoother; its distal end is cut off obliquely from without to within.

Pig.—Short and thick.

Dog.—Relatively long; its distal extremity is larger than its proximal; the coronoid process is large; there is a convex facet below the head posteriorly and inclined to the inner side, and a concave facet on the outer side of the distal extremity; these are for articulation with the ulna.

Ulna.

Ruminants.—Extends the whole length of the radius, and articulates with the cuneiform bone; the olecranon process is compressed laterally; there are two radio-ulnar arches, joined by a groove which runs between the two bones externally.

Pig.—Larger than the radius; it articulates by its distal end with the cuneiform and trapezium; the olecranon process is large and tuberous.

Dog.—Well developed and long; below the sigmoid notch there is a concave facet, looking outwards and for articulation with the radius; distally there is a convex facet for the radius and facets for the cuneiform and trapezium.

Carpus.

Ruminants.—Formula: $\frac{4}{2}=6$ bones. The trapezoid and pisiform are absent; the trapezium is tuberous, and articulates with the cuneiform only; the cuneiform articulates with both radius and ulna.

Pig.—Formula: $\frac{4}{4}=8$ bones. The trapezium articulates with the ulna and cuneiform; the cuneiform articulates with the radius and ulna; the unciform articulates with the two outer metacarpal bones, the magnum with the inner larger metacarpal, and the trapezoid with the two inner metacarpals.

Dog.—Formula: $\frac{3}{4}=7$ bones. The scaphoid and lunar are united, and the single bone thus formed articulates with the radius; the cuneiform articulates with the radius and ulna, and the trapezium with the ulna. In the lower row, the unciform articulates with the fourth and fifth metacarpals, the magnum with the third and fourth, the trapezoid with the second, and the pisiform with the first and second metacarpals.

Metacarpus.

Ruminants.—This region contains two bones, a **large** and an **external small** bone.

The **Large Metacarpal** has only two facets at its proximal extremity for articulation with the bones of the lower row of the carpus; its distal end presents a double articulatory surface, each portion resembling that of the horse, and separated from the other by a deep groove; the anterior and posterior surfaces of the shaft show longitudinal furrows, which correspond to a septum dividing the medullary canal.

The **Small Metacarpal** bone is very rudimentary, being little more than a nodule of bone.

There are four **Sesamoid** bones, each articulating with the large metacarpal and the os suffraginis.

Pig.—There are four bones, the two central ones being large and of nearly equal size; the outer and inner bones are smaller. Each metacarpal has two **Sesamoids.**

Dog.—There are five metacarpal bones: the innermost is short and rudimentary, and has a trochlea distally; the two central ones are longest and best developed. All the metacarpals articulate with each other at their proximal ends. There are two **Sesamoids** to each metacarpal bone.

Digits.

Ruminants.—In all there are four digits, but two are represented by nodules of bone situated at the back of the fetlock. The other two have three phalanges each.

First Phalanx resembles the os suffraginis of the horse, but is laterally compressed.

Second Phalanx resembles that of the horse, but is more cubical, and possesses a small medullary canal.

Third Phalanx almost exactly resembles half of the os pedis of the horse.

Each digit has a **Navicular** bone, which is quadrilateral in outline.

Pig.—There are four complete digits, each consisting of three phalanges and a navicular bone. The two central digits are larger than the two lateral ones.

Dog.—There are five digits. The innermost possesses only two phalanges, and does not touch the ground in walking. The third phalanx has a hollow to receive the root of the claw. The navicular bone is absent, its place being taken by a projection of bone from the inferior surface of the third phalanx.

ARTICULATIONS.

Shoulder-joint.

Pig and Dog.—The synovial membrane is prolonged into the bicipital groove. The glenoid cavity is deepened by a rim of cartilage.

Elbow-joint.

Ruminants.—The internal lateral ligament is shorter than the external.

Pig.—Interosseous ligaments unite the radius and ulna firmly together.

Dog.—The radius and ulna are movable on each other. An **orbicular ligament** surrounds the head of the radius, and is attached to the external lateral ligament. Rotatory movements take place between the two bones ; when the palmar surface of the manus is placed downwards (as is usually the case), the condition is known as **pronation** ; when the palm is turned inwards, **supination** is the result.

Carpus.

Differences occur due to the differences in the number of bones.

Intermetacarpal Joint.

Ruminants.—There is only one articulation.

Pig.—The four metacarpals articulate with each other by diarthrodial facets, and are joined together by interosseous fibres and prolongations from the anterior and posterior carpal ligaments.

Dog.—There is an arrangement similar to that in the pig, but movement between the bones is freer.

Fetlock-joint.

Ruminants.—This is a double joint. There are three **inter-sesamoidean** ligaments uniting the four bones. The **inferior sesamoidean** ligament consists of four small bands for each digit. The **superior interdigital** ligament is crucial, and joins the first phalanges. **Lateral sesamoidean** ligaments unite the outer sesamoids to the first phalanges. The **superior sesamoidean** ligament is distributed in a very noteworthy manner; commencing as in the horse, it divides inferiorly into eight branches. Two branches proceed to the perforatus tendon, and assist it in forming a ring for the perforans tendon. Four branches are attached to the sesamoids; those belonging to the outer sesamoids are continued forwards to the front of the digits, and join the extensor proprii tendons. The two last branches pass through the interarticular notch of the metacarpal bone, become united to each other, then pass obliquely downwards and forwards between the first phalanges, again separate, and unite with the extensor proprius tendon of each digit.

Pig and Dog.—There are ligaments attached to each joint which somewhat resemble those of the ruminant. The superior sesamoidean ligament is replaced by muscles. The inferior sesamoidean ligament consists of two crucial bundles. There is a small bony nodule found in the anterior capsular ligament, which acts as a sesamoid for a tendon of the common extensor of the digits.

Pastern Joint.

Ruminants.—The glenoid cartilage is attached to the first phalanx by two bands only, and is connected with the perforatus tendon.

Coffin-joint.

Ruminants.—There is an **inferior interdigital** ligament uniting the naviculars and inner faces of the third phalanges.

Dog.—An elastic ligament stretches from the lower end of the second to the third phalanx, just above the root of the claw; it acts as a retractor of the claw (this is more powerful in the cat than in the dog).

MUSCLES.

Shoulder.

Dog.—The **Acromio-humeralis**—considered to be part of the teres externus, in front of which it is placed—passes from the acromion to the humerus.

The **Antea-spinatus** is voluminous, and has only one tendon of insertion, which is attached to the external trochanter.

The **Postea-spinatus** also has only one tendon of insertion.

The **Coraco-humeralis** is short and single, being inserted above the teres internus.

Arm.

Pig and Dog.—The **Flexor Brachii** is attached both to the bicipital tuberosity and the inner side of the ulna.

The **Humeralis Obliquus** has also an insertion to the ulna just below that of the preceding muscle.

The **Scapulo-ulnaris** arises from the latissimus dorsi.

The **Caput Medium** and **Anconeus** are both large.

Fore-arm.

Ruminants.—The **Extensor Metacarpi Magnus** is similar to that of the horse.

The **Extensor Metacarpi Obliquus** is attached to the inner side of the head of the large metacarpal bone.

The **Extensor Pedis** is represented by two muscles: (1) The **Extensor Communis Digitorum**, the tendon of which bifurcates at the fetlock, each portion being inserted to the pyramidal process of the third phalanx of a digit; and (2) the **Extensor Proprius Internus**, which is placed internally to the preceding; its tendon, after receiving slips from the superior sesamoidean ligament, is attached to the anterior face of the second and the external face of the third phalanx.

The **Extensor Suffraginis**, which is thicker than in the horse, becomes the **Extensor Proprius Externus**, and is disposed in a manner similar to the internus.

The three muscles are all extensors, but in addition the proprii are expansors, and the communis is an approximator of the digits.

The **Flexor Pedis Perforatus** is double, but the two tendons unite about the middle of the metacarpus and again divide, each portion going to its own digit and receiving a slip from the suspensory ligament to assist in forming the ring for the passage of the perforans tendon. The check ligament is attached to the tendon of this muscle.

The **Flexor Pedis Perforans** does not receive the check ligament, and divides about the fetlock into two tendons, one for each digit. Its insertion is blended with the plantar cushion and inferior interdigital ligament.

Pig.—The **Extensor Metacarpi Magnus** is inserted to the head of the inner large metacarpal bone, and the **Extensor Metacarpi Obliquus** to the head of the inner small metacarpal bone.

The **Extensor Communis Digitorum** terminates in four tendons, one for each digit.

The **Extensor Proprius Internus** has a double tendon passing to the two inner digits.

The **Extensor Proprius Externus** also has a double tendon, which is attached to the two outer digits.

The **Flexor Pedis Perforatus** is double throughout, and is inserted to the mesian phalanges of the two large digits.

The **Flexor Pedis Perforans** terminates in four tendons, one for each digit.

Dog.—The **Extensor Metacarpi Magnus** has two tendons, attached to the second and third metacarpal bones.

The **Extensor Metacarpi Obliquus** is inserted to the head of the first metacarpal bone, and blends with the posterior carpal ligament.

The **Extensor Communis Digitorum** has four tendons of insertion, one for each of the principal digits.

The **Extensor Proprius** has three tendons, which are inserted to the anterior surfaces of the three outer digits.

The **Flexor Pedis Perforatus** has four tendons of insertion, which are attached to the mesian phalanges of the four chief digits.

The **Flexor Pedis Perforans** terminates in five tendons, one for each digit. Its ulnar and radial portions are large, and it contributes a small tendon to the carpal sheath.

The following muscles are not represented in the other domesticated animals:

1. **Extensor Pollicis et Indicis.**
   Origin.—External surface of radius.
   Insertion.—To the first and second digits.
2. **Supinator Longus** (rudimentary).
   Origin.—The ridge of the musculo-spiral groove of the humerus.
   Insertion.—Inner face of the distal end of the radius. This muscle is a very slight supinator.
3. **Supinator Brevis.**
   Origin.—External condyle of the humerus and external ligament of the elbow-joint.
   Insertion.—Anterior surface and internal border of the radius.
4. **Pronator Teres.**
   Origin.—Epicondyle of the humerus.
   Insertion.—Inner border of the radius.
5. **Pronator Quadratus.**
   Origin.—The radius, from near the elbow-joint to the carpus.
   Insertion.—The ulna, through nearly the same extent of surface.

The pronators oppose the supinators by turning the palmar surface of the manus downwards.

Metacarpus.

Ruminants.—There are no separate muscles in this region, but the superior sesamoidean ligament contains numerous muscular fibres.

Pig.—The superior sesamoidean ligament is replaced by four **Interosseous Metacarpal** muscles, which arise from the posterior faces of the heads of the metacarpal bones, and from the posterior carpal and intermetacarpal ligaments; their tendons gain the front of the region and join the proprii tendons. A single **Lumbricus** muscle passes from the internal tendon of the perforans to the proprius tendon of the internal digit. A separate muscle arises from the carpo-metacarpal ligament, and joins the extensor proprius tendon of the outermost digit.

Dog.—This region in the dog is plentifully supplied with muscles, most of which have no representatives in the other domesticated animals:

1. **Adductor Brevis Pollicis.**
   Origin.—Posterior carpal ligament.
   Insertion.—Metacarpal bone and proximal phalanx of the pollex.
   It adducts and flexes the pollex.
2. **Opponens Pollicis.**
   Origin and Insertion.—Very like the preceding.
   It merely adducts the pollex.
3. **Flexor Brevis Pollicis.**
   Origin.—Posterior carpal ligament.
   Insertion.—Inner side of proximal phalanx of the pollex.
   It flexes the pollex.
4. **Adductor Indicis.**
   Origin.—Posterior carpal ligament.
   Insertion.—Upper and inner face of the proximal phalanx of the index.
5. **Abductor Minimi Digiti.**
   Origin.—The trapezium.
   Insertion.—Upper part of the proximal phalanx of the fifth digit.

6. **Adductor Minimi Digiti** (Opponens).
Origin.—Posterior carpal ligament.
Insertion.—Upper extremity of the proximal phalanx of the fifth digit.

7. **Flexor Minimi Digiti.**
Origin.—Inferior trapezial ligament.
Insertion.—To the tendon of the abductor.

8. **Palmaris Brevis.**—A rounded, almost hemispherical, mass placed below the carpus, and connected with the skin and the aponeurosis of the preceding muscles.

9. **Lumbrici.**—Are placed between the four principal tendons of the perforans, arising from them; they join the extensor tendons of the three external digits.

10. **Interossei Metacarpei.**—These are four in number, and are situated in front of the flexor tendons.
Origin.—Posterior and lateral surfaces of the four principal metacarpal bones, and from the posterior carpal and intermetacarpal ligaments.
Insertion.—The extensor tendons.

ARTERIES.

Ruminants.—The **Prescapular** artery is absent.

The *Scapulo-humeral* branch of the subscapular supplies most of the muscles in the posterior brachial region.

The **Humeral** artery is small.

The **Radio-palmar** branch of the posterior radial is given off high up the fore-arm, and forms at the carpus three **posterior** and one **dorsal interosseous** arteries.

The **Posterior Interosseous** arteries are variable.

The **Dorsal** artery gains the anterior aspect of the limb, and anastomoses with the anterior radial and the **large metacarpal** artery. It occupies the groove on the anterior face of the metacarpal bone.

The **Great Metacarpal** artery gives off a branch which passes between the two portions of the distal extremity of the metacarpal bone, and ascends in the groove on the front of that bone. It forms three digital arteries, a **middle** and **two lateral.**

The **Middle Digital** artery gains the posterior face of the perforatus tendon; at the lower extremity of the proximal phalanges it bifurcates, forming the two **Ungual** arteries, which enter the plantar foramina of the distal phalanges, being distributed in the same manner as the plantar ungual in the horse.

The **Lateral Digital** arteries (internal and external) pass down the outer face of the digits. The external artery is formed by the great metacarpal and external interosseous arteries; the internal by the metacarpal alone.

Pig.—The **Brachial** artery in this animal is distributed in a similar manner to that of the ruminant.

The **Subscapular** is distributed in much the same manner as the deep humeral of the horse.

Dog.—The **Humeral** artery terminates as the posterior radial and ulnar arteries. Its collateral branches resemble those of the horse. The **Anterior Radial** artery is very small.

The **Ulnar** artery, after a short course, gives off an *interosseous* branch which gains the deep face of the pronator quadratus, and about the lower third of the fore-arm divides into the **anterior** and **posterior interosseous** arteries.

The **Anterior Interosseous** artery gains the anterior face of the carpus, where it forms a plexus, and supplies the anterior face of the digits.

The **Posterior Interosseous** artery, at about the level of the trapezium, divides into two branches, a superficial and a deep. The *superficial* branch, along with the ulnar and radio-palmar arteries, forms the **superficial palmar arch**; the *deep* branch, with the radio-palmar, forms the **deep palmar arch**, from which are formed **eight interosseous metacarpal arteries,** *four posterior* or *palmar*, which unite with the collaterals of the digits, and *four anterior* or *dorsal*, which, passing through the inter-metacarpal spaces, anastomose with the anterior interosseous artery, and terminate by joining the collaterals of the digits.

The **Radial** artery, passing along the inner face of the perforatus muscle, unites with a branch of the posterior interosseous artery to form the **superficial palmar arch,** from which four branches spring, the four **palmar** or **collateral arteries** of the digits, which have the following distribution: The *internal* supplies the pollex; the *second*, the index; the *third*, the medius and annulus; and the *external*, or *fourth*, the minimus.

VEINS.

Ruminants.—There are *four digital veins:* an *anterior*, a *posterior*, and *two laterals.*

1. The **Anterior Digital** vein is placed in front of the digits and metacarpus, terminating in the subcutaneous vein.

2. The **Posterior Digital** vein accompanies the collateral artery of the metacarpus, and terminates in a posterior radial vein.

3. The **Internal Digital** vein passes along the inner border of the superior sesamoidean ligament, and bifurcates about the carpus, one branch going to the internal subcutaneous vein, the other to a posterior radial.

4. The **External Digital** vein is found along the outer border of the ligament, and it joins the internal vein below the carpus.

NERVES.

Ruminants.—The **Radial** nerve supplies branches to the extensors of the fore-arm, and to the extensors in the anterior antibrachial region. It also forms a **cutaneous** branch, which divides, one portion terminating at the carpus, the other forming the two **dorsal collaterals of the digits.**

The **Ulnar** nerve forms the **external plantar** nerve without receiving a branch from the median.

The **Median** nerve forms the **internal plantar** nerve, which divides into three branches. The *first* joins the external plantar nerve about the distal end of the metacarpal bone; the *second* forms the **internal collateral of the external digit** and the **external collateral of the internal digit**; while the *third* forms the **internal collateral of the internal digit.**

Pig.—The **Median** nerve supplies the interosseous palmar muscles, and then divides into four branches, which form the **collaterals of the digits.**

The **Ulnar** nerve, near the trapezium, divides into two branches, one of which supplies the external digit; the other forms the **dorsal collaterals** of the two external digits.

Dog.—The **Radial** nerve, by means of a cutaneous branch, supplies the *collateral dorsal* nerves of the digits.

The **Median** nerve is blended with the ulnar to near the elbow-joint. Below the carpus it supplies *collateral nerves* to all the digits except the fourth and external part of the third; in addition it provides a branch which, along with a branch from the ulnar, forms the **superficial palmar arch.**

The **Ulnar** nerve provides *dorsal* and *palmar* branches. The *dorsal* forms the **external dorsal collateral** of the fourth digit. The *palmar*, dividing into eight branches, supplies all the digits except the internal border of the index.

THE FOOT.

Ruminants.—The **Hoof** is double, each part corresponding in general arrangement to the hoof of the horse; the horny frog is rudimentary. Each part of the hoof is called a **Claw.**

The rudimentary digits are provided with small horny caps, found behind the fetlock-joint.

Pig.—The **Hoofs** are four in number for each limb, and resemble in essential respects those of the ruminant.

Dog.—This animal is provided with **Claws**, or **Nails**, at the ends of the digits; each claw consists of a curved projection of horn protecting the supero-anterior face of the phalanx only. The claws of the cat are retractile.

The skin on the posterior faces of the digits is much thickened, forming the **Pads**—five in number—four of which are small and placed under the four principal digits, the fifth being large and situated behind the preceding.

THE POSTERIOR LIMB OF THE HORSE.

THE **Posterior** limb of the horse is divided into the following **regions**:

I. The **Croup**, or Hip—skeleton formed by the *Os Innominatum.*

II. The **Thigh**—skeleton formed by the *Femur.*

III. The **Leg**—skeleton formed by the *Tibia* and *Fibula.*

IV. The **Pes**, or Foot—consisting of:

1. *Tarsus,* formed by six bones:
   Astragalus, calcaneum, cuboid, cuneiform magnum, cuneiform medium, cuneiform parvum.

2. *Metatarsus* 3. *Digit*	Similar to corresponding regions in the anterior limb.

BONES.

The **Os Innominatum** is formed by three bones: (1) The *Ilium,* the largest and most anterior; (2) the *Ischium,* the most posterior; and (3) the *Pubis,* the smallest.

1. THE ILIUM.

Class.—Flat bone, triangular in shape.

Situation. — It forms the anterior part of the os innominatum, and is directed downwards, backwards, and outwards.

It presents *two surfaces, three borders,* and *three angles.*

Surfaces.

(*a*) **External** (Dorsal or Gluteal).—Superiorly it is concave, and inferiorly convex, and possesses ridges for muscular attachment.

(*b*) **Internal** (Venter or Iliac).—This is divided into two portions :

a. External, smooth for muscular attachment.

β. Internal, roughened and partially occupied by the *auricular facet* for articulation with the sacrum.

Borders.

(*a*) **Anterior** (Crest of the Ilium).—Convex above, concave below, and roughened for muscular attachment.

(*b*) **External.**—Thick and concave.

(*c*) **Internal.**—Thin and concave, and terminating posteriorly in the *superior ischiatic* (or sciatic) *spine.*

Angles.

(*a*) **Internal or Posterior Iliac Spine.**—Roughened and curved upwards and ba kwards. It is sometimes called the *angle of the croup.*

(*b*) **External or Anterior Iliac Spine.**—Consists of four tuberosities arranged in two pairs—superior and inferior—joined by a thick plate of bone. This is known as the *angle of the haunch.*

(*c*) **Posterior.**—Thick and triangular, and presents:

(*a*) A concave articular facet.

(β) Portion of *superior ischiatic spine.*

(γ) Externally, two depressions for the attachment of the rectus femoris muscle.

(δ) Antero-internally, the *ilio-pectineal eminence.*

Nutrient Foramen.—On the internal surface, at about the union of its middle and lower thirds.

It **articulates** with four bones:

Sacrum internally, and femur, ischium and pubis posteriorly.

2. THE ISCHIUM.

Class. — Flat bone, irregularly quadrilateral in shape.

Situation.—It is placed behind the ilium, forming the posterior part of the os innominatum.

It presents *two surfaces, four borders,* and *four angles.*

Surfaces.

(*a*) **Superior.**—Smooth and slightly concave.

(*b*) **Inferior.**—Almost flat, and roughened for muscular attachment.

Borders.

(*a*) **Anterior.**—Concave, and bounds the obturator foramen posteriorly.

(*b*) **Posterior.**—Thick and roughened; it is inclined inwards and forwards, forming, with the corresponding border of the other ischium, the *ischial arch.*

(*c*) **Internal.**—Joins the opposite bone at the *ischial symphysis.*

(*d*) **External.**—Thick and smooth; forms a boundary of the lesser sciatic notch; anteriorly it helps to form the superior ischiatic spine.

Angles.

(*a*) **Antero-internal.**—Sometimes called the *ramus;* joins the pubis.

(*b*) **Antero-external.**—Assists in the formation of the acetabulum.

(*c*) **Postero-internal.**—Applied to the corresponding angle of the other ischium.

(*d*) **Postero-external.**—Thickened and rough, forming the *tuber ischii,* from the under part of which the *inferior ischiatic spine* runs forwards.

It **articulates** with four bones:

The femur, ilium and pubis anteriorly, and its fellow of the opposite side internally.

3. THE PUBIS.

Class.—Irregularly triangular.

Situation.—Anterior to the ischium.

It presents *two surfaces, three borders,* and *three angles.*

Surfaces.

(*a*) **Superior.**—Smooth and concave, supporting the urinary bladder.

(*b*) **Inferior.**—Very slightly convex. It is crossed by the *pubio-femoral groove*, which lodges the pubio-femoral ligament.

Borders.

(*a*) **Anterior.**—Forms, with the corresponding border of the other pubis, the *brim of the pelvis.*

(*b*) **Internal.**—Joins the other pubis at the *pubic symphysis.*

(*c*) **External.**—Concave, and bounds the obturator foramen.

Angles.

(*a*) **Antero-internal.**—Meets the other pubis.
(*b*) **Antero-external.**—Helps to form the acetabulum.
(*c*) **Posterior.**—United to the ischium.

It **articulates** with three bones:
The ilium and ischium externally and posteriorly, and its fellow internally.

The **Acetabulum**, or cotyloid cavity, is formed by the union of the three bones, and is a deep articular cavity for the reception of the head of the femur. It is surrounded by a *rim*, or *brim*, which is incomplete internally. The incomplete portion is the *cotyloid notch.* A triangular portion of the cavity is non-articular, and roughened for ligamentous attachment; this is the *fundus acetabuli*, and is formed by the pubis.

The **Obturator Foramen**, foramen ovale, or thyroid foramen, is a large oval or rounded opening on the floor of the pelvis, and circumscribed by the three segments of the os innominatum.

Development of Os Innominatum.—From six centres:

1. For the ilium.
2. For the ischium.
3. For the pubis.
4. In the acetabulum. At the junction of the three bones.
5. For the iliac crest.
6. For the tuber ischii.

Reference to Side.—Place the ilium anteriorly, the acetabulum externally, and the posterior iliac spine superiorly.

THE PELVIS.

Is formed by the two *ossa innominata*, the *sacrum*, *one or two coccygeal vertebræ*, and the *sacro-sciatic ligaments*. It is the most posterior of the three great body cavities, and has an anterior opening—the *inlet*, communicating with the abdomen—and a posterior opening—or *outlet of the pelvis*. The *inlet* is circumscribed by the base of the sacrum, the ilio-pectineal lines, and the anterior borders of the pubes. The *outlet* is limited above by the anterior coccygeal vertebræ, laterally by the sacro-sciatic ligaments (posterior borders), and inferiorly by the posterior borders of the ischia.

Characteristics of the Female Pelvis.

The transverse measurement between the acetabula and the ischial tuberosities is greater than in the male.

The obturator foramen is rounder and larger.

The ischial arch is more distinctly concave (in the male it is somewhat triangular).

The floor (formed by the superior surfaces of the ischia and pubes) is flatter than in the male.

THE FEMUR.

Class.—The largest long bone in the body.

Situation.—It extends downwards and forwards from the acetabulum.

It possesses a *shaft* and *two extremities.*

I. The Shaft.

Surfaces.

(*a*) **Anterior.**—Smooth, and convex from side to side, and shows a few imprints of muscular attachments.

(*b*) **Posterior.**—Somewhat triangular, being widest superiorly, and possessing supero-externally a roughening for the triceps abductor, supero-internally an oblique ridge for the ischio-femoralis, and in its middle third a roughening for the attachment of the adductor brevis and adductor longus.

(*c*) **External.**—Presents superiorly the *trochanter minor*, and inferiorly the *supra-condyloid fossa.*

(*d*) **Internal.**—Presents, in its upper third, the *trochanter internus*, and inferiorly the *supra-condyloid crest.*

II. Extremities.

Proximal.—

This presents the *head* internally, the *trochanter major* externally.

The **Head** is smooth, convex and articular, with the exception of a notch for the attachment of the round and pubio-femoral ligaments.

The **Cervix**, or Neck, limits the head inferiorly.

The **Trochanter Major**, placed externally to the head, is divided into a *summit* (the highest part), a *convexity* (anterior to the summit), and a *crest* (below the convexity).

The **Trochanteric Ridge** joins the trochanters, major and minor.

The **Trochanteric** (or Digital) **Fossa** is placed internal to the trochanteric ridge.

Distal.—

Presents *two condyles* and a *trochlea.*

The **Condyles** articulate with the tibia, and are smooth and convex.

The **Intercondyloid Fossa** or **Groove** divides the condyles.

The **Trochlea** is a pulley-shaped surface for articulation with the patella. It consists of two lips (the inner being much the larger) and a middle groove.

Internal to the inner condyle is a pit for the internal lateral ligament of the stifle-joint.

External to the external condyle are two depressions—the upper for the external lateral ligament, and lower for the origin of the popliteus.

Nutrient Foramen.—About the middle of the internal surface.

It **articulates** with four bones:

The ischium and ilium superiorly, the patella antero-inferiorly, and the tibia inferiorly.

Development.—From four centres:

1. For the shaft.

2 and 3. For the extremities.

4. For the trochanter major.

Reference to Side.—Place the trochanter major superiorly and externally, and the trochlea anteriorly.

THE PATELLA.

Class.—It is irregularly pyramidal in shape, and is sometimes described as a short bone.

Situation.—It is placed in front of the trochlea of the femur.

It presents *three surfaces.*

Surfaces.

(*a*) **Anterior.**—Convex and rough.

(*b*) **Posterior.**—Smooth and articular, consisting of a middle ridge and two depressions, the internal of which is the larger.

(*c*) **Superior.**—Somewhat concave from before to behind, and roughened for muscular attachment.

It **articulates** with the femur.

Development.—From one centre.

THE TIBIA.

Class.—A long bone.

Situation.—Placed below the femur, and directed downwards and backwards.

It possesses a *shaft* and *two extremities.*

I. The Shaft.

Surfaces.

(*a*) **External.**—Smooth, concave above and convex below.

(*b*) **Internal.**—Slightly convex from side to side;

it shows a roughening for muscular attachment superiorly; otherwise it is smooth and subcutaneous, being covered by very strong periosteum.

(*c*) **Posterior.**—Flattened from side to side. Superiorly there is a smooth triangular space covered by the popliteus; the middle of the surface is marked by ridges running obliquely downwards and inwards, for the origin of the flexor pedis perforans.

Borders.

(*a*) **Anterior.** — Forms the *tibial crest* superiorly; inferiorly it is rounded and smooth.

(*b*) **External.**—Concave, and divided from the fibula by the *tibio-fibular arch.*

(*c*) **Internal.**—Thick, and carries a tubercle superiorly for the attachment of the popliteus.

II. **Extremities.**

Proximal.—

Much larger than the distal, and presents two *articular facets*—for the condyles of the femur —divided by the *tibial spine,* which is excavated externally for the attachment of one of the crucial ligaments.

Anteriorly is the **Anterior Tuberosity,** which is concave externally and convex internally, and continuous with the tibial crest; it is excavated for the attachment of the middle straight patellar ligament.

The **External and Internal Tuberosities** are placed laterally, the external one carrying the articular facet for the fibula.

Distal.—

Elongated from side to side; presents two articular grooves—which run backwards and inwards—divided by an articular ridge.

Laterally are the two **Malleoli**, the internal being the larger, and the external being grooved for the passage of the peroneus tendon.

Nutrient Foramen.—In the upper third of the posterior surface.

It **articulates** with three bones:

The femur and fibula superiorly, and the astragalus inferiorly.

Development.—From five centres:

1. For the shaft.
2 and 3. For the extremities.
4. For the anterior tuberosity.
5. For the external malleolus.

Reference to Side.—Place the spine superiorly, the crest anteriorly, and the articular surface for the fibula externally.

THE FIBULA.

Class.—An interrupted long bone.

Situation.—Along the external border of the tibia.

It possesses a *head* and a *lower portion*.

I. The **Head**, or superior extremity, is flattened laterally, and shows two surfaces—the inner being roughened for articulation with the tibia, the outer also roughened for the attachment of the external lateral ligament of the stifle-joint.

II. The **Lower Portion** gradually tapers away, terminating about the lower third of the tibia; it is connected with the external malleolus by a ligamentous cord.

It **articulates** with the tibia only.

Development.—From two centres:

1. For the head.
2. For the lower part.

The external malleolus of the tibia may be regarded as the distal extremity of the fibula.

THE TARSUS.

Is composed of six bones.

A. Upper Row.—Astragalus and calcaneum.

B. Lower Row.—Cuboid, cuneiform magnum, cuneiform medium, and cuneiform parvum.

The number of bones may be indicated by the following formula:

$$\frac{2}{4} = 6 \text{ bones.}$$

A. THE UPPER OR TIBIAL ROW.

THE ASTRAGALUS.

Class.—An irregular or short bone.

Situation.—Immediately below the tibia.

It presents *six surfaces.*

Surfaces.

Anterior and Superior.—Blended, and forming the trochlea, which consists of two ridges and a dividing groove, running upwards, backwards and inwards, and for articulation with the tibia.

Inferior.—Convex from before to behind, and presenting a large facet for the cuneiform magnum, and a small bevelled one for the cuboid.

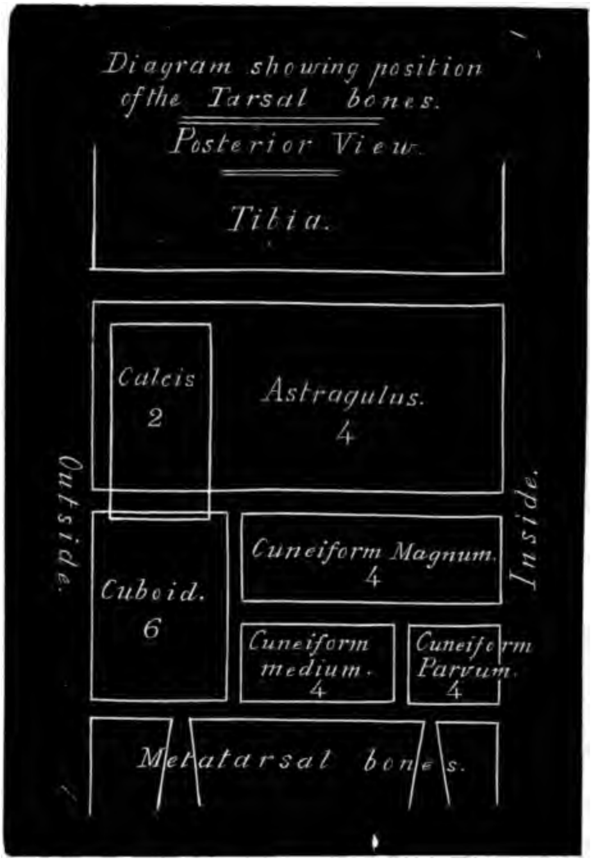

FIG. 7.—DIAGRAM SHOWING POSITION OF THE TARSAL BONES (POSTERIOR VIEW).

The figures denote the number of articulations of each bone.

Posterior.—Irregular, and possesses four facets for articulation with the calcaneum.

Internal.—Roughened and tuberous.

External. — Roughened, and excavated for ligamentous attachment.

It **articulates** with four bones:

The tibia superiorly, the calcaneum posteriorly, and the cuboid and cuneiform magnum inferiorly.

Development.—From one centre.

Reference to Side.—Place the pulley-shaped surface supero-anteriorly, and the tuberosity internally.

THE CALCANEUM, OR OS CALCIS.

Class.—Irregular.

Situation.—It forms the 'point of the hock.'

It possesses a *body* and a *tuberosity.*

I. The Body.

Anteriorly, carries three or four facets for articulation with the astragalus.

Inferiorly, possesses a concave facet for articulation with the cuboid.

II. The Tuberosity.

The Tuberosity, or tuber calcis, springs from the superior part of the body, and presents *two surfaces, two borders,* and a *summit.*

Surfaces.

(*a*) **External.**—Smooth, and almost flat.

(*b*) **Internal.**—Concave, and helps to form the tarsal groove for the passage of the tendon of the flexor pedis perforans.

Borders.

(*a*) **Anterior.**—Concave and rounded.

(*b*) **Posterior.**—Thick, straight, and covered by the calcaneo-cuboid ligament.

The **Summit**, or superior extremity, is expanded, and presents an anterior smooth convexity, a middle depression for the attachment of the gastrocnemius tendon, and a posterior smooth convexity, over which the perforatus tendon passes.

It **articulates** with two bones :

The astragalus antero-inferiorly, and the cuboid inferiorly.

Development.—From two centres :

1. For the summit of the tuberosity.
2. For the rest of the bone.

Reference to Side.—Place the tuberosity posteriorly, superiorly and externally.

B. THE LOWER OR CUBOIDAL ROW.

THE CUBOID.

Class.—An irregular or short bone.

Situation.—It is the external bone of the lower row.

It presents *six surfaces.*

Surfaces.

Superior.—Smooth, and convex for articulation with the calcaneum and astragalus.

Inferior.—Possesses two pairs of facets, anterior and posterior ; the two most external facets are for articulation with the external small metatarsal bone, the two internal ones for the large metatarsal.

Internal.—Presents four facets, two for articulation with the cuneiform magnum, and two for the medium.

Anterior, Posterior, and External.—Non-articular, and roughened for ligamentous attachment.

It **articulates** with six bones:

The astragalus and calcaneum superiorly, the cuneiform magnum and medium internally, and the large and external small metacarpals inferiorly.

Development.—From one centre.

Reference to Side.—Place the largest smooth facet superiorly, the four facets for the cuneiforms internally. The anterior face is wider and smoother than the posterior.

The Cuneiform Magnum (also known as the Scaphoid).

Class.—Irregular.

Situation.—It is one of the internal bones of the lower row.

It possesses *two surfaces* and *four borders*.

Surfaces.

(*a*) **Superior.**—Concave, and articular for astragalus. A roughened depression passes from about the centre to the outer border.

(*b*) **Inferior.**—Slightly convex, and possesses two facets for articulation with the cuneiform medium, and a small convex facet postero-internally for the cuneiform parvum.

Borders.

(*a*) and (*b*) **Anterior and Internal.** — Blended and roughened.

(*c*) **Posterior.**—Irregular.

(*d*) **External.**—Concave, and possesses two facets for articulation with the cuboid.

It **articulates** with four bones:

The astragalus superiorly, the cuboid externally, and the cuneiform medium and parvum inferiorly.

Development.—From one centre.

Reference to Side.—Place the concave facet superiorly, the two facets for the cuboid externally, and remember that the anterior and internal borders are blended and non-articular.

The Cuneiform Medium.

Class.—It is an irregular, flattened bone.

Situation.—Immediately below the cuneiform magnum, and internal to the cuboid.

It possesses *two surfaces* and *three borders.*

Surfaces.

(*a*) **Superior.**—Slightly concave, and carries two facets.

(*b*) **Inferior.**—Almost flat; it presents a non-articular depression, which passes towards the external border.

Borders.

(*a*) **Anterior.**—Rough, convex and non-articular.

(*b*) **External.**—Carries two facets for articulation with the cuboid.

(*c*) **Internal.**—Carries one facet for cuneiform parvum.

It **articulates** with four bones:

The cuneiform magnum superiorly, the cuboid externally, the cuneiform parvum internally, and the large metatarsal inferiorly.

Development.—From one centre.

Reference to Side.—Place the base of the triangle anteriorly, the flatter surface inferiorly, and the border with *two* facets externally.

The Cuneiform Parvum.

Class.—An irregular bone.

Situation.—It is the most internal bone of the lower row. It is also the smallest tarsal bone.

It possesses *four surfaces* and *two extremities.*

Surfaces.

(*a*) **Superior.**—Concave for articulation with cuneiform magnum.

(*b*) **Inferior.**—Possesses two facets—one for articulation with inner small metatarsal bone, the other for the inner small and large metatarsals.

(*c*) **Internal.**—Rough and convex.

(*d*) **External.**—Possesses one facet for the cuneiform medium.

Extremities.

(*a*) **Anterior** (or apex).—Sharp.

(*b*) **Posterior** (or base).—Is represented by a projection.

It **articulates** with four bones:

The cuneiform magnum superiorly, the cuneiform medium externally, and the large and inner small metatarsals inferiorly.

Development.—From two centres.

Reference to Side.—Place the cup-shaped facet for the cuneiform magnum superiorly, the single facet for the cuneiform medium externally, and the projecting plate of bone posteriorly.

The Metatarsal Bones.

The **Large Metatarsal Bone** resembles the large metacarpal in its essential features, only differing from this bone in the following respects:

1. It is longer.
2. Its shaft is squarer on section.
3. It possesses three unequal facets superiorly—a small inner one for the cuneiform parvum, a middle large one for the cuneiform medium, and an outer for the cuboid.
4. On the external surface an oblique groove is to be seen, passing downwards and backwards.
5. The distal extremity is larger, both from side to side and from before to behind.

The **Small Metatarsal Bones** differ from the small metacarpals in the following respects:

1. They are longer and larger.
2. They have larger heads.
3. The external is the larger.
4. The external carries two facets for the cuboid, and the internal two for the cuneiform parvum and one for the cuneiform medium.

THE DIGIT.

The following differences are found to exist between the **Posterior Digits** and those of the anterior limb:

The **Os Suffraginis** is longer, its proximal end is wider, and its distal end narrower (the whole bone is more triangular).

The **Os Coronæ** is longer, but narrower from side to side.

The **Os Pedis** is more pointed at the toe, and has its solar surface more concave.

The **Navicular Bone** is shorter and narrower.

ARTICULATIONS.

I. SACRO-ILIAC ARTICULATION.

Class.—Amphiarthrosis.

Formed by the pelvic bones, the sacrum and first one or two coccygeal vertebræ (the articulatory surfaces are really only the auricular facet of the ilium and the corresponding facet on the sacral transverse processes).

Ligaments.—

1. *Inferior sacro-iliac*, surrounding the articulatory surfaces, somewhat as a capsule.
2. *Superior sacro-iliac*, passes from the sacral spines to the posterior iliac spine.
3. *Lateral sacro-iliac*, from the posterior spine and

border of the ilium to the transverse processes of the sacrum. It is triangular in shape.

4. *Sacro-sciatic*, passes from the extremities of the sacral transverse processes to the first two or three coccygeal vertebræ to the superior ishiatic spine and tuber ischii. It forms two notches: (*a*) The *greater sciatic notch*, above the iliac shaft, which affords passage to the gluteal bloodvessels and nerves; and (*b*) the *lesser sciatic notch*, above the ischiatic shaft, giving passage to the common tendon of the pyriformis and obturator internus muscles.
5. *Sacral*, bands of tissue passing between the sacral spines and transverse processes.

Synovial Membrane.—A small one is found lining the inferior sacro-iliac ligament.

Movement.—Very slight.

II. ISCHIO-PUBIC SYMPHYSIS.

Class.—Synarthrosis.

Formed by the adjacent margins of the two ischia and the two pubes.

Ligaments.—Strands of transverse fibres are found in the young, but these ossify in adult life.

The *obturator ligament* is a membranous structure almost completely closing the obturator foramen, a small opening being left anteriorly for the passage of the obturator bloodvessels and nerves.

III. COXO-FEMORAL (OR HIP-JOINT).

Class.—Enarthrosis.

Formed by the acetabulum and the head of the femur.

Ligaments.—

1. *Capsular*, attached to the rim of the acetabulum and the articular margin of the head of the femur.
2. *Cotyloid*, a rim of fibro-cartilage surrounding and deepening the acetabulum; it is interrupted at the cotyloid notch.
3. *Transverse*, completes the circumference of the acetabulum by extending across the cotyloid notch. It binds down the pubio-femoral ligament.
4. *Round* (ligamentum teres), passing from the fundus acetabuli to the notch on the head of the femur.
5. *Pubio-femoral*, arises from the notch on the head of the femur, passes through the cotyloid notch, along the pubio-femoral groove, crosses its fellow in the middle line, and finally becomes lost in the abdominal aponeurosis of the opposite side of the body.

Synovial Membrane.—This lines the capsular ligament, and contacts the round and pubio-femoral ligaments.

Movements. — Flexion, extension, adduction, abduction, rotation, and circumduction.

IV. THE STIFLE-JOINT.

The stifle-joint consists of two distinct articulations.

A. The Femoro-patellar.

Class.—Arthrosis.

Formed by the trochlea of the femur and the posterior surface of the patella.

Ligaments.—

1. *Capsular*, attached to the articular margins, and is loose, to allow of extensive flexion of the stifle-joint.
2. *Internal lateral*
3. *External lateral*

   These pass from the condyles of the femur to the lateral margins of the patella.

4. *External straight*
5. *Middle straight*
6. *Internal straight*

   Pass from the lower margin of the patella (the internal being attached to a piece of fibro-cartilage) to the anterior tibial tuberosity, the middle occupying the excavation on that tuberosity.

Synovial Membrane.—This lines the capsular ligament, and communicates with the synovial membranes of the tibio-femoral articulation.

Movements.—Gliding.

B. The Tibio-femoral.

Class.—Ginglymoid.

Formed by the condyles of the femur and the articular surfaces on the head of the tibia.

Ligaments.—Two *semilunar cartilages* or *menisci* are interposed between the articular surfaces; they possess two surfaces and two borders. The superior surface is concave, the inferior is flattened. The external border is convex and thick; the inner is concave and thin, and embraces the tibial spine. These menisci are held in position by means of *five coronary ligaments;* the *internal* meniscus has *two* ligaments, one attached in front of, and the other behind, the tibial spine; the *external* meniscus has *three* ligaments, one anterior, attached in front of the tibial spine, one supero-posterior, inserted in the intercondyloid notch, and the third infero-posterior, attached below the articular head of the tibia.

1. *Anterior crucial* (or interosseous), passing from the tibial spine to the internal surface of the external condyle.
2. *Posterior crucial,* passing from the external surface of the internal condyle (intercondyloid notch) to a small tubercle below and behind the internal articular surface of the tibia.
3. *External lateral,* arises from the external condyle and passes to the head of the fibula. A synovial bursa is placed where it passes over the head of the tibia.
4. *Internal lateral,* passes from the internal condyle to the internal tibial tuberosity. It is longer than, but not so strong as the external.
5. *Capsular* (or posterior), is a membranous expansion placed behind the joint and attached to the femur, menisci, lateral ligaments and tibia.

Synovial Membranes.—These are two in number, one for each condyle and corresponding part of the tibial surface. They are separated by the crucial ligaments.

Movements.—Flexion, extension, and some rotation.

V. TIBIO-FIBULAR ARTICULATION.

Class.—Diarthrosis.

Formed by the heads of the fibula and tibia.

Ligaments.—

1. *Capsular*, binding the two bones together superiorly.
2. *Interosseous*, usually divided into a superior and an inferior portion.
3. *A round ligamentous cord* unites the distal extremity of the fibula to the external malleolus.

Movement does not take place to any appreciable extent.

VI. THE TARSUS (OR HOCK-JOINT).

This is a complex ginglymoid and arthrodial joint, formed by the tibia, all the bones of the tarsus, and the three metatarsal bones.

The **Ligaments** are divided into *special* and *common* :

1. The **Special** ligaments are divided into three groups :

(*a*) *Superior tarsal*, uniting the astragalus and calcaneum. One superior, two lateral, and one interosseous :

The *superior* passes from just above the trochlea of the astragalus to the adjacent part of the calcaneum.

The *laterals* are covered by the common lateral ligaments.

The *interosseous* occupies the excavations between the facets of the two bones.

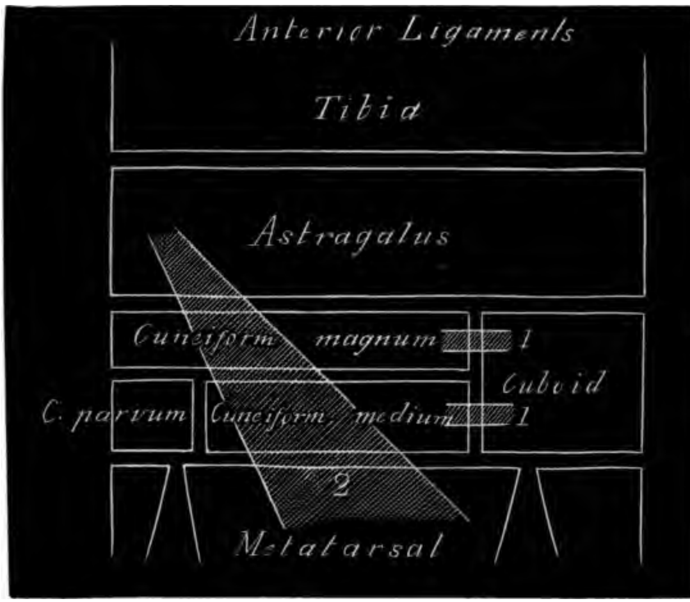

FIG. 8.—THE ANTERIOR TARSAL LIGAMENTS.

1. Anterior ligaments of the inferior tarsal group. 2. Oblique or astragalo-metatarsal ligament.

(*b*) *Inferior tarsal*, uniting the bones of the lower row. Two anterior and three interosseous:

The *anterior* unite the cuboid to the cuneiform magnum and medium.

The *interosseous* are placed between the bones, two corresponding to the anterior, and the third joining the three cuneiform bones together.

(*c*) *Intertarsal*, uniting all the bones to each other and the metatarsals :

Calcaneo-cuboid, passes down the posterior

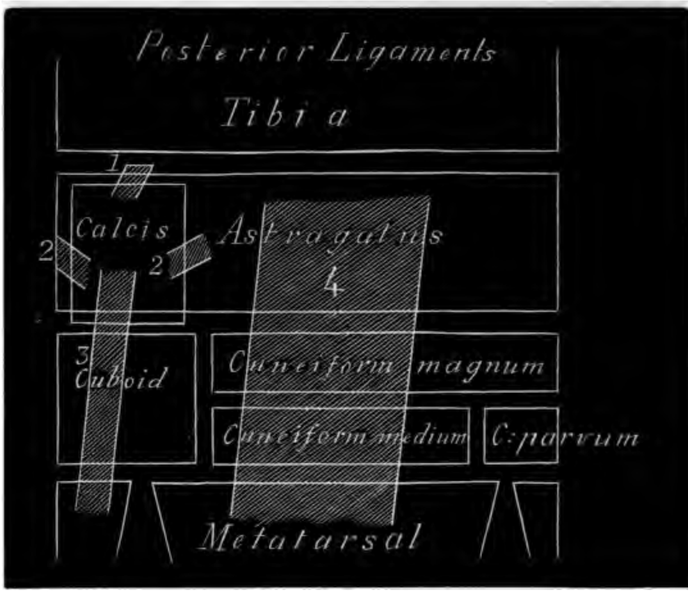

FIG. 9.—THE POSTERIOR TARSAL LIGAMENTS.

1. Superior ligament of the superior tarsal group. 2. Lateral ligaments of the superior tarsal group. 3. Calcaneo-cuboid. 4. Tarso-metatarsal (this is really attached to the posterior faces of all the tarsal bones, and the heads of the three metatarsals).

border of the calcaneum, to become attached to the cuboid and the head of the external small metatarsal bone.

Astragalo-metatarsal (or oblique), springs from the inner surface of the astragalus, its fibres diverging and becoming attached to the cuneiform magnum and medium and the large metatarsal bone.

Great interosseous, unites the calcaneum,

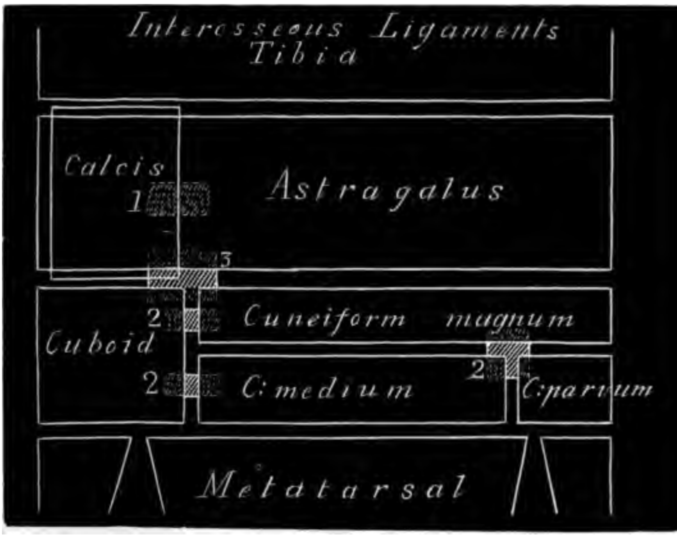

FIG. 10.—THE INTEROSSEOUS TARSAL LIGAMENTS.

1. Interosseous ligament of the superior tarsal group. 2. Interosseous ligaments of the inferior tarsal group. 3. Great interosseous ligament.

astragalus, cuneiform magnum, and cuboid.

Tarso-metatarsal, situated in the tarsal groove, and attached to the posterior faces of all the bones and the three metatarsal bones.

2. The **Common** ligaments are four in number: two laterals, an anterior, and a posterior.

(*a*) *Internal lateral,* is attached to the internal malleolus of the tibia, and consists of three bundles of fibres—a superficial, passing on to the astragalus, the three cuneiforms, and the large and inner small metatarsals; a middle, connected with the astragalus and calcaneum; and a deep, passing to the astragalus.

(*b*) *External Lateral.*—This is attached to the external malleolus of the tibia, and consists of two bundles of fibres—a superficial, attached to the astragalus, calcaneum, cuboid, and the large and external small metatarsals; and a deep, passing on to the astragalus and calcaneum.

(*c*) *Anterior.*—This is membranous, and attached to the tibia, astragalus, cuneiform magnum and medium, the astragalo-metatarsal ligament, the lateral ligaments, and the heads of the metatarsal bones.

(*d*) *Posterior.*—This encloses the tibio-astragalus joint ('true hock-joint') posteriorly.

Synovial Membranes.—These are three in number: (1) For the tibia and astragalus (the 'true hock-joint'); (2) between the rows of bones (intertarsal); (3) between the lower row and the metatarsal bones (tarsometatarsal).

Movements. — Flexion and extension take place between the tibia and astragalus, and gliding movements between the individual tarsal bones.

The articulations below the tarsus are the same as those below the carpus.

MUSCLES.

The muscles are divided into the following primary groups:

A. **Croup**, hip or gluteal region.
B. **Thigh** or femoral region.
C. **Leg** or tibial region.
D. **Pes**, foot or metatarsal region.

A. CROUP OR GLUTEAL REGION.

Contains three muscles:

1. **Gluteus Externus.**

Synonyms.—Ilio-trochanterius medius, superficial gluteus.

Situation.—Immediately beneath the gluteal aponeurosis, composed of fleshy and aponeurotic portions; triangular in shape.

Origin.—

1. Anterior iliac spine and second and third sacral spines.
2. Gluteal aponeurosis.
3. Ischial tuberosity.
4. Sacro-sciatic ligament.

Insertion.—Trochanter minor of the femur.

Relations.—Externally, gluteal aponeurosis; internally, gluteus maximus; anteriorly, tensor vaginæ femoris; posteriorly, triceps abductor femoris.

Action.—Abducts the thigh.

Blood-supply.—Gluteal.

Nerve-supply.—Gluteal.

2. **Gluteus Maximus.**

Synonyms. — Ilio-trochanterius magnus, middle gluteus.

Situation, etc.—Immediately beneath the externus, and upon the external face of the ilium and sacro-sciatic ligament. It is a very voluminous muscle.

Origin.—Gluteal aponeurosis, dorsum, shaft and spines of the ilium, the sacro-sciatic ligament, lateral borders of the sacrum, and the aponeurosis of the longissimus dorsi.

Insertion. — (1) The summit of the trochanter major of the femur, and (2) a ridge below its convexity. There is a synovial membrane between the second tendon and the bone.

Relations.—Externally, gluteal aponeurosis and gluteus externus; internally, the ilium, sacro-sciatic ligament, and gluteus internus; anteriorly, longissimus dorsi and tensor vaginæ femoris; posteriorly, triceps abductor femoris.

Action.—Extends and abducts the thigh or moves the pelvis on the femur, as in rearing. The action depends upon whether the pelvis or femur is fixed.

Blood-supply.—Gluteal and ilio-lumbar.

Nerve-supply.—Gluteal.

3. **Gluteus Internus.**

Synonyms. — Ilio-trochanterius parvus, deep gluteus.

Situation, etc.—Under the medius and immediately above the hip-joint; is small, thick, and quadrilateral.

Origin.—Shaft of the ilium and superior iliac spine. It is also attached to the capsule of the hip-joint.

Insertion.—Internal to the convexity of the trochanter major of the femur.

Relations.—Externally, gluteus maximus; internally, the hip-joint; anteriorly, rectus femoris; posteriorly, gemellus anticus.

Actions.—Abducts the thigh, and tenses the capsular ligament of the hip-joint during flexion.

Blood-supply.—Gluteal.

Nerve-supply.—Gluteal.

B. THIGH OR FEMORAL REGION.

Divided into three groups: (1) Anterior femoral or crural; (2) posterior femoral or crural; (3) internal femoral or crural.

I. Anterior Femoral Group.

1. Tensor Vaginæ Femoris.

Synonyms.—Tensor fasciæ latæ, ilio-aponeuroticus.

Situation, etc.—Immediately underneath the skin and in front of the glutei. It is thin and triangular.

Origin.—Anterior iliac spine.

Insertion.—By aponeurosis to the patella, etc.

Relations.—Externally, the skin; internally, vastus externus, rectus femoris and iliacus;

anteriorly, lymphatic glands (precrural); posteriorly, gluteus externus and maximus.

Actions.—Flexes the femur and tenses the fascia.

Blood-supply.— Iliaco-femoral, ilio-lumbar and circumflex ilii.

Nerve-supply.—Gluteal and anterior crural.

2. **Crural Quadriceps** (consisting of four parts).

(*a*) *Rectus Femoris.*

Synonyms.—Ilio-rotuleus, anterior straight muscle of the thigh.

Situation, etc.—Immediately anterior to the femur. It is thick and fusiform.

Origin.—By two tendons, from depressions above the cotyloid cavity.

Insertion.—Superior face of the patella.

Relations.—Anteriorly, the tensor vaginæ femoris; posteriorly, externally and internally, the other parts of the quadriceps.

Actions.—Flexes the thigh and extends the leg.

Blood-supply. — Iliaco-femoral and superficial femoral.

Nerve-supply.—Anterior crural.

(*b*) *Vastus Externus.*

Synonym.—Femoro-rotuleus externus.

Situation, etc.—External to the rectus femoris. It is thick and flattened from side to side.

Origin.—External and (partially) anterior surfaces of the femur.

Insertion.—Superior face of the patella. It rarely joins the rectus femoris.

Relations.—Externally, tensor vaginæ femoris and gluteus externus; internally, rectus femoris, vastus internus and crureus; posteriorly, femur and triceps abductor femoris.

Action.—Extends the leg.

Blood-supply.—Iliaco-femoral.

Nerve-supply.—Anterior crural.

(*c*) *Vastus Internus.*

Synonym.—Femoro-rotuleus internus.

Situation.—Internal to the rectus femoris.

Origin.—Internal and (partially) anterior surface of the femur.

Insertion.—Superior surface of the patella.

Relations.—Externally, vastus externus and rectus femoris; internally, adductor longus, pectineus, iliacus, and sartorius.

Action.—Extends the leg.

Blood-supply.—Superficial femoral.

Nerve-supply.—Anterior crural.

(*d*) *Crureus.*

Synonym.—Femoro-rotuleus medius.

Situation.—Beneath other parts of quadriceps.

Origin.—Lower part of the anterior face of the femur.

Insertion.—Superior face of the patella. It is also attached to the patellar capsular ligament.

Relations.—Externally, vastus externus; internally, vastus internus; anteriorly, rectus femoris; posteriorly, the femur.

Actions.—Extends the leg, and probably renders tense the capsular ligament.

Blood-supply. — Iliaco-femoral and superficial femoral.

Nerve-supply.—Anterior crural.

3. Rectus Parvus.

Synonyms. — Ilio-femoralis gracilis, anterior gracilis.

Situation, etc.—Anterior to the hip-joint. It is small, thin, and cylindrical.

Origin.—Ilium just above the cotyloid cavity.

Insertion.—Supero-anterior part of the femur by aponeurosis.

Relations.—Anteriorly, rectus femoris; posteriorly, capsular ligament of the hip-joint.

II. Posterior Femoral Group.

Comprises three muscles:

1. Triceps Abductor Femoris.

Synonyms.—Ischio-tibialis externus, long vastus.

Situation, etc.—Behind the thigh. This is a very large muscle, consisting of two portions, an anterior and a posterior, of which the former is much the longer.

Origin :

Anterior portion. — Spines of the sacrum, sacro-sciatic ligament, coccygeal aponeurosis and the ischial tuberosity.

Posterior portion.—Inferior ischiatic spine and ischial tuberosity.

Insertion.—The tibial crest and fascia, and the antero-external part of the patella.

Relations.—Externally, the gluteal fascia; internally, gluteus externus, sciatic nerves, the adductors and biceps rotator tibialis.

Actions :

Anterior portion.—Abducts and extends the thigh.

Posterior portion.—Flexes the leg and tenses the tibial aponeurosis.

Blood-supply. — Obturator, deep femoral and femoro-popliteal.

Nerve-supply.—Gluteal and great sciatic.

2. **Biceps Rotator Tibialis.**

Synonyms.—Ischio-tibialis, medius or posticus, semitendinosus.

Situation.—Posterior and internal to the triceps. It is long and thick, and bifid at its origin.

Origin.—(1) Spines of the sacrum and the sacro-sciatic ligament; (2) ischial tuberosity.

Insertion.—Crest of the tibia and tibial fascia.

Relations.—Externally, gluteal aponeurosis and triceps; anteriorly, sciatic nerves; internally, adductor magnus.

Action.—Extends the thigh, flexes and rotates the leg, tenses the tibial aponeurosis, and assists in rearing.

Blood-supply. — Obturator, deep femoral, and femoro-popliteal.

Nerve-supply.—Gluteal and sciatic.

3. **Adductor Magnus.**

Synonyms.—Ischio-tibialis internus, semimembranosus.

Situation, etc.—Internal to the biceps. It has a thick anterior and a thin posterior border.

Origin.—Coccygeal aponeurosis, ischial tuberosity, and inferior surface of the ischium.

Insertion.—A small roughened eminence internal to the internal condyle of the femur.

Relations.—Externally, the biceps, the triceps, and sciatic nerves; internally, skin and penis; anteriorly, adductor longus.

Action.—Adducts and extends the thigh, and assists in rearing.

Blood-supply.—Obturator, ischiatic and femoro-popliteal, and deep femoral.

Nerve-supply.—Obturator.

III. Internal Femoral Group.

The muscles of this group are nine in number, and are disposed in three layers.

1. **Sartorius.**

Synonym.—Sublumbo-tibialis.

Situation, etc.—In the abdominal cavity and inner part of the thigh. It is thin and elongated.

Origin.—Iliac aponeurosis (near the tendon of the psoas parvus) and pelvic brim.

Insertion.—Internal straight patellar ligament, in common with the gracilis.

Relations.—Anteriorly, crural aponeurosis and Poupart's ligament; posteriorly, gracilis, pectineus, vastus internus, and femoral artery and vein; internally, psoas magnus and iliacus.

Action.—Adducts the leg and flexes the thigh.

Blood-supply.—Saphena and femoral.

Nerve-supply.—Internal saphenic.

2. **Gracilis.**

Synonyms.—Subpubio-tibialis, short adductor of the leg.

Situation, etc.—On the internal surface of the thigh, immediately under the skin. It is quadrilateral in shape.

Origin.—The ischio-pubic symphysis.

Insertion.—Internal straight patellar ligament (along with the sartorius) and inner face of the head of the tibia. It helps to form the tibial aponeurosis.

Relations.—Externally, the crural aponeurosis and saphenic vessels and nerves; internally, the pectineus and adductors; anteriorly, the sartorius; posteriorly, the biceps rotator tibialis.

Action.—Adducts the limb and tenses the tibial aponeurosis.

Blood-supply.—Saphena and femoral.

Nerve-supply.—Obturator.

3. **Pectineus.**

Synonym.—Superpubio-femoralis.

Situation.—Beneath the gracilis.

Origin.—The inferior surface of the pubis and the pubio-femoral ligament.

Insertion.—Below the internal trochanter of the femur.

Relations. — Antero-externally, the iliacus and psoas magnus, vastus internus, femoral vessels, and sartorius; internally, the gracilis; superiorly, the obturator externus.

Action.—Adducts, flexes, and rotates the femur.

Blood-supply.—Femoral and deep femoral.

Nerve-supply.—Obturator.

4. **Adductor Brevis.**

Synonyms.—Subpubio-femoralis, small adductor of the thigh.

Situation.—Beneath the gracilis and behind the pectineus.

Origin.—Inferior surface of the pubis.

Insertion.—About the middle of the posterior surface of the femur, along with one of the tendons of the adductor longus.

Relations.—Anteriorly, the pectineus; posteriorly, the adductor longus; internally, the obturator externus; externally, the gracilis.

Action.—Adducts, flexes and rotates the femur.

Blood-supply.—Deep femoral.

Nerve-supply.—Obturator.

5. **Adductor Longus.**

Synonyms.—Posterior pubio-femoralis, great adductor of the thigh.

Situation.—Underneath the gracilis, and in front of the adductor magnus (semi-membranosus).

Origin.—Inferior surface of the ischium.

Insertion.—By two tendons: (*a*) Along with the brevis; (*b*) to the internal femoral condyle with the magnus.

Relations.—Anteriorly, the adductor brevis, obturator externus; posteriorly, the adductor magnus; internally, the ischio-femoralis and sciatic nerve; externally, the gracilis.

Action.—Adducts, extends and rotates the femur.

Blood-supply. — Deep femoral and superficial femoral.

Nerve-supply.—Obturator.

6. **Ischio-femoralis.**

Synonyms.—Quadratus femoris, square crural.

Situation.—Between the adductors and the abductors of the thigh.

Origin.—Inferior surface of the ischium.

Insertion.—Posterior surface of the femur, below the trochanter internus.

Relations.—Anteriorly, the femur and obturator externus; posteriorly, the adductor longus; internally, the posterior gemellus and sciatic nerve; externally, the adductor longus.

Action.—Adducts and extends the femur.

Blood-supply.—Deep femoral and obturator.

Nerve-supply.—Sciatic.

7. **Obturator Externus.**

Synonym.—Subpubio-trochanterius externus.

Situation.—Immediately below the obturator ligament.

Origin.—Inferior faces of the ischium and pubis and the obturator ligament.

Insertion.—The trochanteric fossa.

Relations.—Superiorly, the obturator ligament and capsular ligament of the hip-joint; inferiorly, the pectineus, adductor brevis and longus, and ischio-femoralis.

Action.—Adducts and rotates the femur.

Blood-supply.—Obturator and deep femoral.

Nerve-supply.—Obturator.

8. **Obturator Internus.**

Synonym.—Subpubio trochanterius internus.

Situation.—On the floor of the pelvis.

Origin.—The superior face of the ischium and pubis.

Insertion.—The trochanteric fossa. Its tendon joins that of the pyriforis in the lesser sciatic notch.

Relations.—Superiorly, the pelvic aponeurosis and sciatic nerve; inferiorly, the ischium, pubis, obturator ligament, and obturator externus.

Action.—Rotates (and possibly abducts) the femur.

Blood-supply.—Obturator.

Nerve-supply.—Sciatic.

9. **Pyriformis** (sometimes considered as a portion of the preceding muscle).

Synonym.—Sacro-trochanterius.

Situations.—Internal to the pelvic walls. It is semi-penniform in shape.

Origin.—Anterior part of the sacrum and internal surface of the shaft of the ilium.

Insertion.—Its tendon is joined to that of the obturator internus.

Relations.—Internally, the peritoneum and pelvic aponeurosis; externally, the ilium and sacro-sciatic ligament.

Action.—Rotates the femur.

Blood-supply.—Internal pudic.

Nerve-supply.—Sciatic.

10. **Gemelli** (Anterior and Posterior).

Synonyms.—Ischio-trochanterius, gemini.

Situation.—On each side of the common tendon of the pyriformis and obturator internus.

Origin.—The shaft of the ischium, one in front of and the other behind the common tendon.

Insertion.—The trochanteric fossa.

Relations.—Anteriorly, the capsule of the hip-joint and the obturator externus; posteriorly, the sciatic nerve.

Action.—Rotates the femur.

Blood-supply.—Obturator.

Nerve-supply.—Sciatic.

C. LEG OR TIBIAL REGION.

The muscles of this region are divided into two groups: (1) Anterior tibial; (2) Posterior tibial.

I. Anterior Tibial Group.

1. Extensor Pedis.

Synonyms.—Femoro-prephalangeus, anterior extensor of the phalanges.

Situation.—On the antero-external face of the tibia.

Origin.—In common with the tendon of origin of the flexor metatarsi, from a small depression between the trochlea and external condyle of the femur.

Insertion.—The pyramidal process of the os pedis; it is also attached to the capsule of the fetlock-joint, and the anterior faces of the proximal and median phalanges.

Relations.—Anteriorly, the tibial aponeurosis; posteriorly, the peroneus; internally, the flexor metatarsi. Its tendon is related to the anterior face of the tibia, metatarsus, and two first phalanges and the capsules of the tarsal and fetlock joints.

Action.—Extends the digit and flexes the metatarsus.

Blood-supply.—Anterior tibial.

Nerve-supply.—Anterior tibial.

2. **Peroneus.**

Synonyms.—Peroneo-prephalangeus, lateral extensor of the phalanges.

Situation.—Internal to the extensor pedis.

Origin.—External lateral ligament of the stifle-joint, the entire external surface of the fibula, and the intermuscular septum dividing it from the perforans.

Insertion.—Its tendon joins that of the extensor pedis about the upper third of the metatarsus.

Relations.—Anteriorly, the extensor pedis; posteriorly, the flexor pedis perforans; externally, the tibial aponeurosis. Its tendon contracts the tibia, external lateral ligament of the tarsal-joint, and the metatarsal bone.

Action.—Assists the extensor pedis.

Blood-supply.—Peroneal.

Nerve-supply.—Musculo-cutaneous.

3. **Flexor Metatarsi.**

Synonym.—Tibio-premetatarseus.

Situation.—Beneath the extensor pedis. It consists of two portions — a tendinous and a fleshy:

(*a*) The *tendinous* portion:

Attachments.—It springs from a depression between the trochlea and external femoral condyle, and terminates by two tendons—one being attached to the large metatarsal bone, the other (a smaller one) to the cuboid. Its two portions form a ring, through which the tendon of the fleshy part passes.

Action.—It mechanically flexes the hock when the stifle-joint is flexed.

(*b*) The *fleshy* portion:

Origin.—Head of the tibia and the tendinous portion.

Insertion.—Its tendon bifurcates, one part being attached to the large metatarsal bone, the other to the small cuneiform bone.

Action.—Flexes the tarsus.

Relations.—

(*a*) *The Tendinous Portion.*—Anteriorly, the extensor pedis; posteriorly, the fleshy portion and anterior ligament of the tarsus.

(*b*) *The Fleshy Portion.*—Anteriorly, the extensor pedis and the tendinous portion; posteriorly, the tibia and anterior tibial artery.

Blood-supply.—Anterior tibial.

Nerve-supply.—Anterior tibial.

II. Posterior Tibial Group.

1. Gastrocnemius.

Synonyms.—Bifemoro-calcaneus, gemelli of the tibia.

Situation.—Behind the tibia, being in part subcutaneous.

Origin.—(*a*) The roughened margin of the supra-condyloid fossa; (*b*) the supra-condyloid crest.

Insertion.—Behind the summit of the tuber calcis. A synovial bursa is placed between the tendon and the anterior part of the summit of the tuber.

Relations.—Anteriorly, the flexor pedis perforatus, popliteus, vastus externus, and the popliteal vessels and nerves; posteriorly, the triceps, abductor femoris, and tibial aponeurosis; internally, the biceps rotator tibialis. Its tendon is covered by that of the perforatus, the two being together known as the *Tendo-Achillis.*

Action.—Extends the tarsus.

Blood-supply.—Popliteal and femoro-popliteal.

Nerve-supply.—Internal popliteal.

2. **Plantaris.**

Synonyms.—Soleus, peroneo-calcaneus.

Situation.—Along the outer face of the gastrocnemius.

Origin.—Head of the fibula.

Insertion.—Summit of the calcaneum.

Action.—May possibly assist the preceding (?).

3. **Flexor Pedis Perforatus.**

Synonyms. — Gastrocnemius internus, femoro-phalangeus.

Situation.—Almost completely surrounded by the gastrocnemius. It is a tendinous cord with some few muscular bundles.

Origin.—Supra-condyloid fossa.

Insertion.—Its tendon passes to the inner face and afterwards to the posterior face of the gastrocnemius tendon, gains the summit of the tuber calcis, to which it is attached by lateral slips, passes over the tuber (there is a synovial bursa here) and descends the posterior metatarsal region to terminate, as did the corresponding tendon in the anterior limb.

Relations.—Anteriorly, the popliteus, tibia, perforans and flexor accessorius; posteriorly, the gastrocnemius.

Action. — Flexes the pastern and fetlock joints, and assists in extending the tarsus. Its chief function is to act mechanically and prevent flexion of the tarsus when the animal is standing.

Blood-supply.—Femoro-popliteal.

Nerve-supply.—Internal popliteal.

4. **Popliteus.**

Synonym.—Femoro-tibialis obliquus.

Situation.—Immediately below and behind the stifle-joint.

Origin.—From the inferior depression outside the external femoral condyle.

Insertion.—The supero-posterior triangular surface of the tibia.

Relations.—Anteriorly, the posterior capsule of the stifle-joint, the popliteal vessels and the tibia; posteriorly, the flexor pedis perforatus and gastrocnemius; internally, the biceps rotator tibialis and tibial aponeurosis; externally, the flexor pedis perforans and accessorius.

Action.—Flexes and rotates the tibia.

Blood-supply.—Popliteal.

Nerve-supply.—Internal popliteal.

5. **Flexor Pedis Perforans.**

Synonyms.—Tibio-phalangeus.

Situation.—Its muscular portion is applied to the posterior face of the tibia. Its tendon is very similar to the corresponding structure in the anterior limb.

Origin.—(*a*) The posterior face of the tibia; (*b*) the external tibial tuberosity; (*c*) the fibula; (*d*) the interosseous tibio-fibular ligament.

Insertion.—Its tendon passes through the *tarsal sheath*, receives a *check ligament* (similar to that of the anterior limb) and is finally attached to the semilunar ridge of the os pedis.

Relations.—Anteriorly, the tibia; posteriorly, the perforatus and gastrocnemius; internally, the flexor accessorius; externally, the peroneus.

Action.—Flexes the phalanges and assists in extension of the metatarsus.

Blood-supply.—Posterior tibial.

Nerve-supply.—Internal popliteal.

6. **Flexor Pedis Accessorius.**

Synonyms.—Peroneo-phalangeus, oblique flexor of the phalanges.

Situation.—Between the perforans and popliteus.

Origin.—External tibial tuberosity.

Insertion.—Its tendon joins that of the perforans about the upper third of the metatarsus.

Relations.—Anteriorly, the perforans and popliteus; posteriorly, the gastrocnemius and perforatus. Its tendon is covered by the tibial aponeurosis, and passes through a sheath on the inner face of the tarsus.

Action.—Assists the perforans.

Blood-supply.—Posterior tibial.

Nerve-supply.—Internal popliteal.

D. METATARSAL REGION.

1. **Extensor Pedis Brevis.**

Synonyms.—Tarso-prephalangeus, exterior pedis accessorius.

Situation.—Below and in front of the tarsus.

Origin.—Anterior and inferior part of astragalus.

Insertion.—It joins the tendon of the extensor pedis.

Relations.—Anteriorly, the extensor tendon; posteriorly, the anterior tibial artery.

Action.—It may possibly assist the extensors.

There are *two lumbrisi* and *two interosseous* muscles in this region, which correspond to those in the anterior limb.

ARTERIES.

The posterior limb is supplied with blood by the *internal and external iliac* arteries, which result from the quadrifurcation of the posterior aorta at about the level of the last lumbar vertebra.

INTERNAL ILIAC ARTERY.

Course.—It passes from the level of the last lumbar vertebra downwards and backwards to near the insertion of the psoas parvus muscle.

I. Collateral Branches.

1. **Umbilical.**—This is usually, but not always, a fibrous cord in the adult, and it extends to the fundus of the bladder.

2. **Internal Pudic**, or Artery of the Bulb.

Course.—Commences near the origin of the internal iliac, passes backwards and downwards along the side of the bladder, curves over the ischial arch, and terminates in the bulb of the penis.

Branches.—

(*a*) Small twigs to the pyriformis muscle.

(*b*) *Vesico-prostatic:* this supplies the prostate gland, vesiculæ seminales, termination of the vas deferens, and the bladder.

(*c*) Small twigs to the pelvic portion of the urethra, Cowper's glands, anus, and perineum.

The above description applies to the male. **In the female** it terminates as rectal, vulval, vaginal and bulbous arteries.

The **Vaginal Artery** represents the vesico-prostatic, and supplies the vagina, posterior part of the uterus, and the bladder.

3. **Lateral Sacral**, or Sub-sacral.

Course.—Arises just behind the sacro-iliac articulation, passes backwards under the inferior sacral

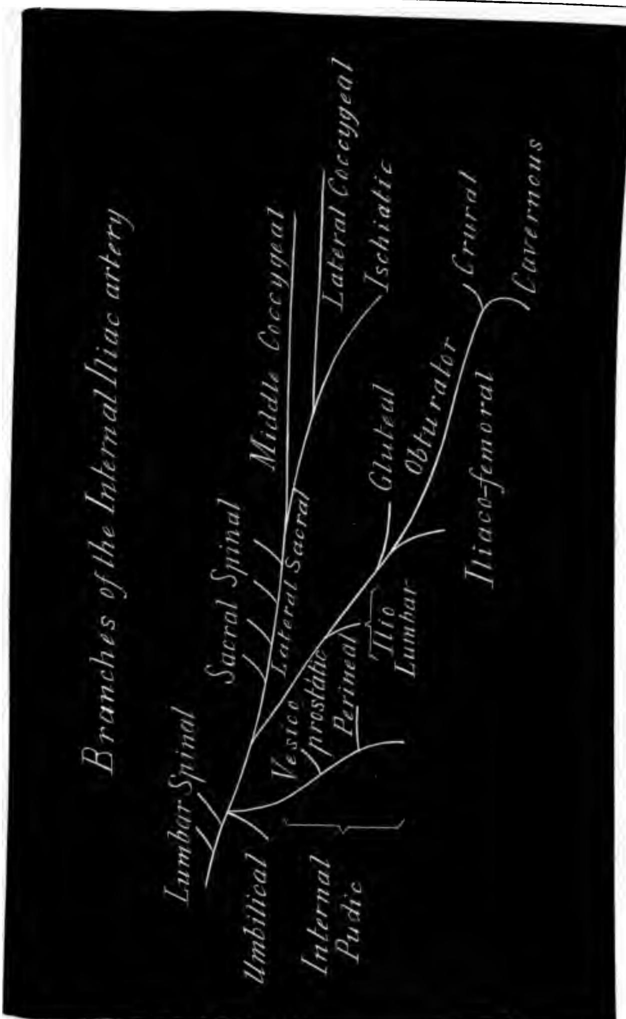

FIG. 11.—DIAGRAM OF THE BRANCHES OF THE INTERNAL ILIAC ARTERY.

foramina, and terminates in two branches at the posterior extremity of the sacrum.

I. *Collateral Branches.*—

Sacro-spinal, four in number; these enter the spinal canal through the inferior sacral foramina: they supply the spinal cord.

II. *Terminal Branches.*—

(*a*) *Ischiatic*, passes round the sacro-sciatic ligament, and terminates in the posterior femoral region, anastomosing with the obturator, deep femoral, and femoro-popliteal arteries.

(*b*) *Lateral coccygeal*, passes between the coccygeal vertebræ and the depressor coccygis; it supplies the muscles and skin of the tail.

(*c*) *Middle coccygeal*, variable, but most commonly formed by the left lateral sacral artery.

4. **Ilio-lumbar**, or Ilio-muscular.

Course.—Arises at a right angle, passes between the iliacus and the ilium just behind the sacro-iliac articulation. It supplies the joint, the sublumbar muscles, the gluteus maximus, and the tensor vaginæ femoris.

5. **Gluteal.**—Very voluminous; it passes through the greater sciatic notch, and supplies the gluteal muscles.

II. Terminal Branches.

1. **Obturator.**—May arise in common with the iliaco-femoral.

Course.—Passes backwards and downwards between the peritoneum and ilium, underneath the obturator internus, through the obturator foramen, and terminates in *cavernous* and *crural* arteries.

Cavernous Artery.—This supplies the crura of the penis, and contributes the *posterior dorsal artery of the penis*, which passes forward to anastomose with the anterior dorsal artery.

2. **Iliaco-femoral.**—Very large in the horse.

Course.—Passes external to the tendon of the psoas parvus, between the ilium and iliacus, and enters the crural muscles between the rectus femoris and vastus externus. It supplies the crural muscles (from the outside), the gluteals, and the tensor vaginæ femoris.

EXTERNAL ILIAC ARTERY.

Course.—Arising at the level of the last lumbar vertebra, it passes in an oblique or curved manner downwards and outwards, and, near its termination, slightly forwards. At the ilio-pectineal line it terminates as the *femoral.*

I. Collateral Branch.

Circumflex Ilii.—This sometimes arises from the aorta.

Course.—It passes outwards towards the anterior iliac spine, crossing the iliacus and psoas magnus; it terminates in two branches:

(*a*) *Anterior*, supplies the internal oblique and transverse abdominal muscles.

(*b*) *Posterior*, passes between the iliacus and internal oblique abdominal muscles, along the tensor vaginæ femoris, and terminates in the skin, etc., in front of the thigh.

II. Terminal Branch.

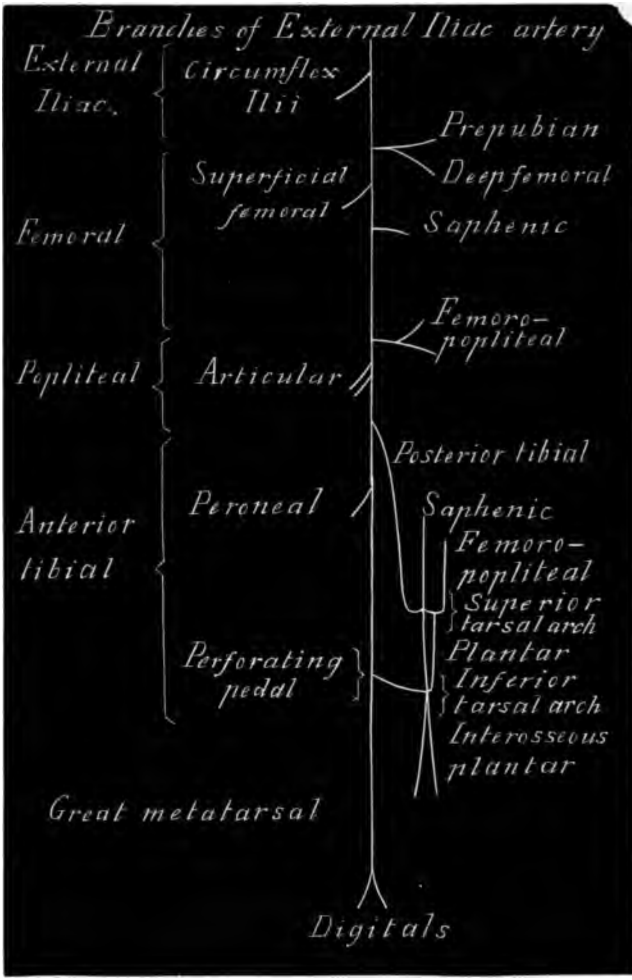

FIG. 12.—DIAGRAM OF THE BRANCHES OF THE EXTERNAL ILIAC ARTERY.

FEMORAL ARTERY.

Course.—It commences at the pelvic brim, passes into the *femoral space* formed by the iliacus, pectineus and sartorius, traverses the ring formed by the adductor longus and the femur, and terminates, as the popliteal, between the two heads of the gastrocnemius.

I. Collateral Branches.

1. **Prepubian Artery.**

Course.—Arises at the commencement of the femoral (in common with the deep femoral), traverses the crural ring, and terminates in the *posterior abdominal* and *external pudic* arteries.

(*a*) *Posterior abdominal* (or epigastric), passes forwards between the transverse and internal abdominal muscles. It supplies the abdominal walls, and anastomoses with the anterior abdominal and circumflex ilii arteries.

(*b*) *External pudic*, descends the inguinal canal and terminates as the *subcutaneous abdominal* and *anterior dorsal artery of the penis.*

(*a*) *Subcutaneous abdominal*, runs subcutaneously forwards, supplies numerous cutaneous branches and anastomoses with its fellow in front of the umbilicus.

(*β*) *Anterior dorsal*, divides into *anterior*—which passes forward—and *posterior* portions; the latter anastomoses with the posterior dorsal artery.

In the **female**, the external pudic artery divides into subcutaneous abdominal and **mammary** branches, the latter supplying the mammary gland, replacing the dorsal artery, and terminating in the skin of the inner face of the thigh and the perineum.

2. **Deep Femoral**, or Arteria Profunda Femoris.—Arises in common with the prepubian, passes between the iliacus and pectineus, then between the pectineus and obturator externus, gains the posterior face of the femur, and terminates in the muscles in the posterior and internal femoral regions; it supplies the hip-joint, and anastomoses with the ischiatic and obturator arteries.

3. **Superficial Femoral**, or Arteria Superficialis Femoris.—Arises a little below and opposite the preceding, passes between the adductor longus and the iliacus and psoas magnus, gains the space between the vastus internus and rectus femoris, and terminates in the anterior crural muscles.

4. **Innominate**, or Small Muscular.—These are small and numerous. One supplies the stifle-joint, and another forms the **nutrient artery of the femur**.

5. **Saphena.**

Course.—Arises at an acute angle from near the middle of the course of the femoral, passes between the adductor longus and brevis, and becomes subcutaneous; it terminates above the calcaneum by anastomosing with the femoro-popliteal and posterior tibial arteries.

II. **Terminal Branch.**

POPLITEAL ARTERY.

Course.—Continues the femoral from the heads of the gastrocnemius, passes behind the stifle-joint and underneath the popliteus muscle, terminating as the *anterior and posterior tibial* arteries.

I. Collateral Branches.

1. **Femoro-popliteal.**—This arises between the two heads of the gastrocnemius, passes between the biceps rotator tibialis and adductor magnus; it terminates in cutaneous branches at the back of the thigh. It contributes ascending and descending branches, which anastomose with the ischiatic, obturator, and deep femoral arteries.

2. **Articular**, to the stifle-joint.

3. **Muscular**, to the gastrocnemius and flexor perforatus. One of these branches descends along the perforatus, and terminates by anastomosing with a recurrent branch of the posterior tibial artery above the tarsus.

II. Terminal Branches.

1. **Posterior Tibial.**

Course.—Superiorly it is deep-seated behind the tibia, and beneath the popliteus and flexor perforans, but lower down it gradually becomes more superficial; about the summit of the tuber calcis it describes an S-shaped curve, and terminates as the two plantar arteries.

I. *Collateral Branches.*—

1. *Muscular*, to the posterior tibial muscles.
2. *Nutrient tibial.*

3. *Articular* to the tarsus.
4. *Recurrent*—two in number—which anastomose with the saphena and popliteal arteries.

II. *Terminal Branches.*—

Plantar, Internal and External.—These pass down each side of the flexor perforans tendon, and anastomose with the perforating pedal artery on a level with the head of the metatarsal bones; from the arch resulting from this anastomosis four arteries arise: (*a*) Two *superficial* and small, which pass down to the fetlock; and (*b*) two deep or *interosseous plantar arteries*, internal and external—the external being very small. These arteries pass down the outer and inner borders of the superior sesamoidean ligament, and anastomose with the great metatarsal artery, thus forming the sesamoidean arch. The internal interosseous artery is sometimes considered to be the continuation of the perforating pedal.

2. **ANTERIOR TIBIAL.**—Much larger than the posterior tibial, and may be considered as the continuation of the popliteal.

Course.—It pierces the tibio-fibular arch, gains the anterior face of the tibia and the deep face of the flexor metatarsi; on reaching the tarsus it changes its name, and becomes the pedal artery.

I. Collateral Branch.

It contributes a *peroneal* branch, which supplies the peroneus.

II. Terminal Branch.

Pedal Artery.—This crosses the anterior face of the tarsus somewhat obliquely, and divides into two branches:

1. *Perforating Pedal* (or Arteria Pedis Perforans). —This passes through the canal formed by the cuboid and the cuneiform magnum and medium, and terminates behind the tarsus by anastomosing with the plantar arteries.
2. *Great Metatarsal* (or Collateral Artery of the Cannon).—This runs down the groove formed by the large and outer small metatarsal bone, passes under the lower extremity of the small metatarsal, gains the posterior face of the large metatarsal, and terminates by anastomosing with the interosseous plantar arteries to form the sesamoidean arch, from which arise the *digital arteries*, which have a distribution similar to those of the anterior limb.

VEINS.

THE **Veins of the Foot** and the **Digital Veins** are disposed in the same manner as those of the anterior limb.

From the sesamoidean arch three **Metatarsal Veins** spring, viz., *internal*, *external*, and *deep*.

1. **Internal Metatarsal Vein.**

Course.—Accompanies the plantar nerve along the margin of the flexor tendons. Below the tarsus it passes slightly forward, and joins the tibial vein by means of a transverse branch. It finally forms the anterior root of the **Internal Saphenic Vein.**

2. **External Metatarsal Vein.**

Course.—Similar to the internal, but along the outer border of the flexor tendons. It communicates with the deep vein just below the tarsus, and terminates above the joint as the posterior root of the **Internal Saphenic Vein.**

3. **Deep Metatarsal Vein.**

Course.—Between the superior sesamoidean ligament and the bone. It receives the beforementioned branch from the external, passes between the cuboid and cuneiforms accompanying the perforating pedal artery, and forms the chief origin of the **Anterior Tibial Vein.**

VEINS OF THE LEG.

I. Superficial.

1. **Internal Saphenic Vein.**—Arises by two roots: (*a*) *Anterior,* from the internal metatarsal vein; (*b*) *posterior,* from the external. These pass up the inner face of the leg, and unite before reaching the region of the thigh. The vein so formed passes between the sartorius and the gracilis, and joins the

femoral. This vein is variable, and may open into the external pudic.

2. **External Saphenic Vein.**—Commences near the calcaneum, and communicates with the internal saphenic and posterior tibial veins. It accompanies the external saphenic nerve along the gastrocnemius tendon and posterior to the muscle, finally opening into the popliteal vein.

II. Deep.

1. **Anterior Tibial Vein.**—May be considered a direct continuation of the deep metatarsal vein.

2. **Posterior Tibial Vein.**—Commences near the calcaneum in branches from the internal and external saphenic veins.

The two tibial veins unite to form—

THE POPLITEAL VEIN,

which is a satellite of the artery. Its **Femoro-popliteal** branch joins the external saphenic vein.

The popliteal forms the root of—

THE FEMORAL VEIN,

a satellite of the artery, receiving branches similar to those given off by the artery with the addition of the internal saphenic.

The femoral becomes—

THE EXTERNAL ILIAC VEIN

at the brim of the pelvis. This vein accompanies the artery, and receives a branch, the **Circumflex Ilii.**

THE INTERNAL ILIAC VEIN,

a satellite of the artery, and receiving branches corresponding to those of the artery, joins the **External** to form—

THE COMMON ILIAC VEIN,

which with the corresponding vein from the other limb forms the root of the **Posterior Vena Cava.**

LYMPHATICS.

1. **Precrural Glands,** situated along the inner face of the anterior border of the tensor vaginæ femoris and the course of the circumflex ilii artery.

   Afferent vessels come from the inner and anterior parts of the thigh.

   Efferent vessels—four in number—pass to the

2. **Iliac Glands,** which form a group of five or six, in the triangle formed by the circumflex ilii artery.

   Afferents proceed from the precrural glands, and from the deep lymphatics of the abdominal parietes.

   Efferents—from four to six in number—pass to the sub-lumbar glands.

3. **Popliteal Glands**—of which there are from three to five—are placed near to the femoro-popliteal artery.

   Afferents come from the region of the tarsus, and from the postero-inferior gluteal region.

   Efferents join the deep inguinal glands.

4. **Superficial Inguinal Glands**, situated anterior to the inguinal ring, and to the side of the sheath; they are about twelve in number.

Afferent vessels come from the internal part of the thigh, the sheath and scrotum, and from the inferior wall of the abdomen.

Efferent vessels—five or six in number—proceed to the

5. **Deep Inguinal Glands**, which are placed beneath the crural aponeurosis in the femoral space, and are related to the femoral bloodvessels.

Afferents may be traced as far as the fetlock; they are superficial, and accompany the internal saphenic vein.

Efferents pass to the

6. **Sublumbar Glands**, which consist of three groups, near the aortic quadrifurcation.

Afferents—the lymphatics of the pelvis, the efferents from the deep inguinal and iliac glands, and lymphatics from the spermatic cord, rectum and great colon.

Efferents pass to the receptaculum chyli.

NERVES.

The **Lumbo-sacral Plexus** supplies the posterior limb. It is formed by the last two lumbar and the first three sacral nerves, and consists of two portions: (1) An *anterior* or *lumbar*, and (2) a *posterior* or *sacral*, the internal iliac artery being between them.

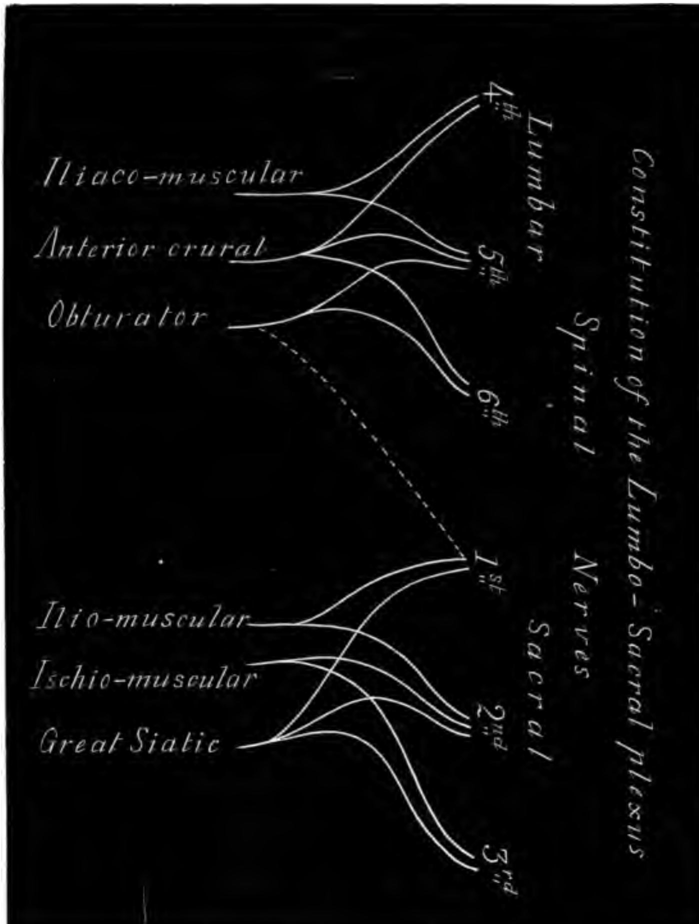

FIG. 13.—DIAGRAM OF THE CONSTITUTION OF THE LUMBO-SACRAL PLEXUS.

I. The Anterior Portion

is placed beneath the psoas parvus, and supplies the following branches:

1. **Iliaco-muscular Nerves.**—Small and unimportant; pass, with the artery, across the iliacus.

2. **Anterior Crural or Femoral Nerve.**

Course, etc.—This is the largest branch of the anterior portion of the plexus. Passes downwards between the psoas magnus and parvus, underneath the sartorius, and terminates in the quadriceps cruralis.

Branches.

(*a*) **Internal Saphenic Nerve.**

Course, etc.—Passes between the sartorius and gracilis, becomes subcutaneous, and follows the internal saphenic vein to the hock.

(*b*) **Accessory Branch of the Internal Saphenic Nerve.**

Course, etc.—This accompanies the internal saphenic artery and vein.

3. **Obturator Nerve.**

Course, etc.—Placed at its commencement underneath the peritoneum to the inside of the iliac arteries, it follows the obturator artery, passing through the obturator foramen, and terminating in the obturator externus, pectineus, adductors, and gracilis.

II. The Posterior Portion

breaks up into the following branches:

1. **Anterior Gluteal or Ilio-muscular Nerves.**—Four

or five in number, and formed principally from the first two sacral nerves.

Course, etc.—They leave the pelvis through the greater sciatic notch, one branch going to the gluteus maximus; a second passes over the shaft of the ilium, and becomes lost in the tensor vaginæ femoris; and a third is terminated in the gluteus internus.

2. **Posterior Gluteal or Ischio-muscular Nerves.**—Usually two in number, superior and inferior.

(*a*) *Superior.*

Course.—Leaves the pelvis by the greater sciatic notch, passes downwards and backwards between the sacro-sciatic ligament and the gluteus maximus, and terminates in the triceps abductor femoris; *en route*, it supplies branches to the gluteus maximus and externus.

(*b*) *Inferior.*

Course.—Placed beneath the *superior* nerve, it terminates in the biceps rotator tibialis and the skin of the posterior femoral region.

3. **Great Sciatic or Great Femoro-popliteal Nerve.**

Course, etc.—Emerges from the pelvis by the greater sciatic notch in company with the gluteal bloodvessels and nerves. It runs downwards between the sacro-sciatic ligament and the gluteus maximus, passes behind the hip-joint, descends in the sheath formed by the adductor magnus and biceps rotator tibialis; insinuates itself between the two heads of the gastrocnemius, and then proceeds along the posterior surface of the tendon of the flexor pedis perforatus; near the calcaneum it terminates as the *external* and *internal plantar* or metatarsal nerves.

A. Collateral Branches.

(*a*) **External Sciatic, Popliteal, or Small Femoro-popliteal Nerve.**

Course, etc.—Is given off on a level with the gemelli muscles; passes forwards and downwards between the gastrocnemius and adductor magnus. Behind the lateral ligament of the stifle-joint it terminates in two branches.

(*a*) *Musculo-cutaneous* nerve, passes down the antero-external part of the leg, becomes subcutaneous, and supplies the skin of the anterior metatarsal region. It may be traced to the fetlock, and sometimes beyond.

(β) *Anterior tibial* nerve, gains the deep face of the anterior tibial muscles, supplies the extensor pedis and flexor metatarsi, and finally terminates near the fetlock.

(γ) *Peroneal cutaneous* nerve. This is principally cutaneous.

(*b*) **Deep Pelvi-crural Nerves.**

Course, etc.—These pass with the parent trunk behind the hip-joint, and are distributed to the obturator internus, gemelli, and ischio-femoralis.

(*c*) **Posterior Crural Nerve.**

Course, etc.—Arises near the gemelli muscles and supplies the posterior femoral muscles.

11

(*d*) **External Saphenic Nerve.**

Course, etc.—Leaves the sciatic at from four to six inches before that nerve passes between the two heads of the gastrocnemius. It proceeds downwards on the outer face of the gastrocnemius, and is finally distributed to the outer side of the metatarsus, and even to the digit.

(*e*) **Branch to the Posterior Tibial Muscles.**

Course, etc.—A short thick trunk given off as the sciatic passes between the two heads of the gastrocnemius.

B. **Terminal Branches.**

External and Internal Plantar or Metatarsal Nerves.

Course, etc.—Commence above the tarsus, and pass through the tarsal groove. At the head of the large metatarsal bone the external is placed between the perforans tendon and the small metatarsal bone. They terminate as the *digital nerves*, which are arranged in the same manner as those of the anterior limb.

POSTERIOR LIMB OF THE OX, SHEEP, PIG AND DOG.

BONES.

Os Innominatum.

Ruminants.—The ilium has a ridge on its gluteal surface extending from the anterior iliac spine to the superior ischiatic spine. The anterior iliac spine is composed of three tuberosities. The ilio-pectineal eminence is large. The ischium is large. The superior ischiatic spine is large. The tuber ischii is formed by three eminences, the lower one corresponding to the inferior ischiatic spine. The pubis is large, and incompletely ossified to its fellow. The pubio-femoral groove is indistinct. The obturator foramen is large. The acetabulum is deep, and the cotyloid notch constricted. The floor of the pelvis is very concave, and the union of the two ossa innominata is marked by a well-developed tuberosity placed below.

In the small ruminants the long axes of the ilium and ischium are nearly in the same straight line.

Pig.—The long axes of the ilium and ischium are nearly in the same straight line. The ilium has a ridge on its gluteal surface joining the superior ischiatic spine and iliac crest. The iliac crest is convex. The superior ischiatic spine is prominent, and carries transverse muscular ridges on its outer surface. The two ossa innominata generally remain separate.

Dog.—The ilium has a concave gluteal surface, a convex crest, and no marked posterior angle. The superior ischiatic spine has a blunt border. The tuber ischii is single. The ischial arch is not extensive. The two ossa innominata unite late in life.

Femur.

Ruminants.—The bone is not so massive. The trochanter minor is absent. The trochanter major is undivided. The trochanteric ridge passes obliquely across the back of the bone, joining the trochanters major and internus, the latter being higher than in the horse. The head is smaller, and provided with a better marked neck. The supracondyloid fossa is shallow. The condyles and trochlea are rather smaller than in the horse.

Pig.—The trochanter minor is absent, and the trochanter major undivided; the summit of the latter is on a level with, or lower than, the articular head. The neck is much contracted. The supracondyloid fossa can scarcely be said to exist. The lips of the trochlea are nearly of the same size.

Dog.—The bone is very long. The head is provided with a well-marked neck, and is higher than the summit of the undivided trochanter major. The trochanter minor is absent. The posterior surface of the shaft carries a double ridge (linea aspera), which is connected above with the two trochanters, and below with the supracondyloid crest and a roughened tuberosity representing the supracondyloid fossa. A facet is seen above and behind each condyle, this being for articulation with the **fabella** (a sesamoid bone connected with the head of the gastrocnemius).

Patella.

Ruminants.—Much narrower than in the horse.

Pig.—Still narrower, and more elongated.

Dog.—Still more elongated from above to below.

Tibia.

Ruminants.—Shorter, and with fewer muscular ridges on its posterior surface. The anterior tuberosity has no excavation for the patellar ligament. The external tuberosity carries no articular facet for the fibula. There are three antero-posterior grooves distally. The external malleolus is detached, and forms the **Malleolar Bone** which articulates with the tibia, astragalus, and calcaneum, and is connected, by means of a long ligamentous cord, with the fibula.

Pig.—The posterior face is almost free from ridges. The external malleolus is detached, and forms the distal extremity of the fibula.

Dog.—A very long bone, with an unexcavated anterior tuberosity, a well-marked crest, a small spine, a detached external malleolus, and two antero-posterior distal grooves.

Fibula.

Ruminants.—Very rudimentary, and anchylosed to the head of the tibia.

Pig.—Extends the whole length of the tibia, its shaft being compressed laterally.

Dog.—As long as the tibia, and very slender; it articulates distally with the tibia and astragalus.

Tarsus.

Ruminants.—Formula: $\frac{2}{3} = 5$ bones, the cuboid and cuneiform being represented by a single **cubo-cuneiform** bone. The astragalus possesses three pulley-shaped surfaces—a superior for the tibia, an inferior for the cubo-cuneiform bone, and a posterior for the calcaneum. The tuberosity of the calcaneum is elongated, and grooved at the summit for the flexor pedis perforatus tendon. The cuneiform parvum is smaller than in the horse.

Pig.—Formula: $\frac{2}{5} = 7$ bones. The astragalus and calcaneum are very similar to those of the ruminants. The cuneiform parvum is represented by two bones, so that there are three cuneiforms (ecto-, meso-, and endo-) articulating with the metatarsus.

Dog.—Formula: $\frac{2}{5} = 7$ bones. The astragalus carries a **head** inferiorly, which articulates with a cup-shaped depression on the cuneiform magnum. The summit of the tuber calcis possesses a groove. As in the pig, there are three cuneiform bones next to the metatarsus.

Metatarsus.

Ruminants.—There are two bones—a large and an inner small—resembling the metacarpals. The large metatarsal differs from the large metacarpal in being longer, having a squarer shaft, and possessing three articular surfaces superiorly.

Pig.—The bones of this region resemble in all essential respects those of the metacarpus.

Dog.—There are five metatarsal bones, four well-developed and resembling the metacarpals, and one (the innermost) rudimentary.

Digits.

These in all animals resemble those of the anterior limb; the dog, however, possesses a rudimentary fifth digit, which may be represented by a single nodule of bone, or (at its maximum development) by three small phalanges.

ARTICULATIONS.

Hip-joint.

The pubio-femoral ligament is absent in all the domestic animals not belonging to the equine species; as a consequence, lateral movement is freer.

Stifle-joint.

Small Ruminants and Pig.—There is only one straight patellar ligament, and one synovial membrane.

Dog.—There is only one straight patellar ligament; the menisci are connected in front of the tibial spine, and there is only one synovial membrane, which is continued to the fabellæ.

Tibio-fibular Articulation.

Ruminants.—This can scarcely be said to exist, as anchylosis takes place.

Pig.—There is an amphiarthrosis at the proximal extremity, and a diarthrosis distally, with an interosseous ligament between.

Dog.—Similar to the pig, but with a diarthrosis at both extremities.

Tarsus.

There are a variety of minor differences; the arrangement of the articular surfaces gives freer movement in the ruminants, pig and dog than in the horse.

MUSCLES.

Croup.

Ruminants.—The **Gluteus Externus** and **Triceps Abductor Femoris** are blended. The **Gluteus Maximus** is smaller, and the **Gluteus Internus** larger, than in the horse.

Pig.—Much the same as in the ruminants.

Dog.—The **Gluteus Externus** is very voluminous, but the **Gluteus Maximus** is very small.

Thigh.

Ruminants.—The **Tensor Vaginæ Femoris** is more extensive, and blended inferiorly with the triceps abductor femoris.

The **Rectus Parvus** is absent.

The **Triceps Abductor Femoris** is connected with the gluteus externus and tensor vaginæ femoris.

The **Biceps Rotator Tibialis** has no attachment to the sacrum.

The **Adductor Magnus** is divided inferiorly, one portion being attached to the femur, the other to the head of the tibia.

The **Pyriformis** is absent.

The **Obturator Internus** tendon traverses the obturator foramen, and joins that of the obturator externus.

Pig.—Very similar to the ruminants.

Dog.—The **Rectus Femoris** has only one tendon of origin.

The **Triceps Abductor Femoris** is undivided.

The **Sartorius** has its origin from the inner face of the anterior iliac spine, and its muscular portion extends down to the tibia.

The **Gracilis** is thin, and limited in extent.

The **Adductor Longus** is large and undivided.

Leg.

Ruminants.—The **Extensor Pedis** and the tendinous portion of the flexor metatarsi are represented by three muscles:

1. A **flexor of the Metatarsus**, which is inserted to the head of the metatarsal bone and the cuneiforms.

2. **Extensor Communis Digitorum.**

3. **Extensor Proprius Internus.**

The two latter are disposed as in the anterior limb.

The **Tibialis Anticus** represents the fleshy portion of the flexor metatarsi of the horse, its tendon passing through the ring formed by the flexor of the metatarsus above mentioned, and becoming attached to the cuneiforms and the metatarsal bone.

The **Peroneus** is replaced by the **Extensor Proprius Externus,** which is disposed as in the anterior limb.

The **Peroneus Longus Lateralis** (unrepresented in the horse) arises from the external face of the head of the tibia, and, after a devious course, is attached to the metatarsal bone and cuneiform parvum.

The **Flexor Pedis Perforatus** has a much better marked fleshy portion than in the horse; its tendon, and also that of the **perforans,** are disposed as in the anterior limb.

Pig.—The **Extensor Communis Digitorum** has four tendons of insertion, one being destined for each digit.

The **Extensor Proprii**—internus and externus—have each two tendons, one for the large and one for the small digit.

The **Tibialis Anticus** is inserted to the cuneiform parvum.

The **Peroneus Longus Lateralis** is attached to the head of the internal metatarsal bone.

The **Flexor Pedis Perforatus** terminates in two tendons, one for each principal digit.

The **Flexor Perforans** has four tendons, one for each digit.

Dog.—In the anterior tibial region there are four muscles:

1. **Tibialis Anticus.**

   Origin.—The anterior tuberosity and crest of the tibia. It receives a slip from the fibula.

   Insertion.—The internal metatarsal bone.

2. **Extensor Communis Digitorum.**

   Origin.—Between the trochlea and external condyle of the femur.

   Insertion.—It has four tendons arranged as in the anterior limb.

3. **Peroneus Longus.**—Placed between the preceding and the peroneus brevis.

Origin.—Head of the tibia.

Insertion.—(*a*) First metatarsal; (*b*) metatarsal bone of the hallux.

Action.—Abducts, and perhaps flexes, the limb.

4. **Peroneus Brevis.**—Divided into two portions, superior and inferior.

(*a*) **Superior.**

Origin.—Upper third of the anterior border of the fibula.

Insertion.—Its tendon joins the common extensor tendon of the external digit.

Action.—It is the extensor proprius of the external digit.

(*b*) **Inferior.**

Origin.—External face and anterior border of the fibula.

Insertion.—The external metatarsal bone.

Action.—Abducts the foot.

In the posterior tibial region –

The **Plantaris** is absent.

The fleshy portion of the **Flexor Pedis Perforatus** is thick, and blended superiorly with the gastrocnemius; its tendon is divided into four strands.

The **Flexor Perforans** has also four tendons.

The **Tibialis Posticus** is a thin muscle placed between the flexor perforans and accessorius; its origin is from the tibia and fibula, its tendon being lost in the posterior ligament of the tarsus.

Metatarsus.

Ruminants.—The **Extensor Pedis Brevis** is attached to the common extensor and proprius internus tendons.

Pig.—The **Extensor Pedis Brevis** is attached to the common extensor tendons.

There are four **Interossei** muscles, as in the anterior limb.

Dog.—The muscles of this region are:

1. **Extensor Pedis Brevis**, which consists of three bundles of fibres, terminating in the three outer tendons of the common extensor.

2. An **accessory** to the perforans, arising from the outer face of the tarsus.

3. Rudimentary muscles of the hallux.

4. **Abductor Minimi Digiti**, which passes from the posterior tarsal ligament to the first phalanx of the small digit.

5. Four **Interossei Muscles**, as in the anterior limb.

6. **Lumbrici**, as in the anterior limb.

ARTERIES.

I. Internal Iliac Artery.

Ruminants.—The **Middle Sacral** artery is large, and forms the true termination of the aorta; it supplies the coccygeal arteries.

A common trunk supplies the **Umbilical** and **Uterine** arteries.

The **Iliaco-femoral** and **Obturator** are both absent in the small ruminants; the latter is, however, represented in the large ruminants by a very small twig. The deep femoral takes the place of these arteries.

The **Lateral Sacral** is either absent or very small; the **Ischiatic** is given off directly from the internal iliac.

Pig.—The **Internal Iliac**, after supplying **umbilical** and **gluteal** branches, is continued by the **Internal Pudic**, which contributes (1) a **hæmorrhoidal** artery (to the rectum and the adjoining organs), (2) some gluteal twigs, and (3) a branch representing the ischiatic; and terminates as the **cavernous** and **dorsal** arteries of the penis.

Dog.—The **Internal Iliacs** arise from a common trunk some little distance behind the external iliacs; this common trunk supplies the **umbilical** arteries.

Each iliac forms two branches:

1. **Internal Pudic**, which terminates as the **cavernous** and **dorsal** arteries of the penis, after giving off **vesical, hæmorrhoidal** and **uterine** branches.

2. A representative of the **Gluteal**, leaving the pelvis by the greater sciatic notch, and forming spinal and gluteal branches.

II. External Iliac Artery.

Ruminants.—The only noteworthy deviations from the type are found in the tibial arteries.

1. **Posterior Tibial.**—This is much larger than in the horse.

The **Internal Plantar** is very much larger than the external.

Both **Plantars** anastomose with the perforating pedal, and form two or three **superficial** and two **deep metatarsal arteries.**

2. **Anterior Tibial.**—This terminates as the **perforating pedal** and **great metatarsal.**

The **Great Metatarsal** passes down the groove on the anterior face of the metatarsal bone, and gives off a **perforating** branch, which pierces the foramen at the distal extremity of the metatarsal bone, gains the back of the bone, and anastomoses with the metatarsal branches of the posterior tibial artery, and forms the **external lateral digital artery.** The great metatarsal terminates as the **common digital**, which, near the distal extremities of the proximal phalanges, divides into the two **unguals**, one for each digit.

The **Internal Lateral Digital** if formed by the great metatarsal.

Pig.—The general arrangement resembles that in the ruminants.

Dog.—The **Circumflex Ilii** is given off from the aorta directly.

In the female the **External Pudic** supplies a **mammary** branch, which anastomoses with a mammary branch of the internal thoracic artery.

The **Posterior Tibial** is very small, but the **Saphena** is large, and terminates in small **plantar** arteries.

The **Anterior Tibial** contributes a **tarsal** branch, and, entering the third intermetatarsal space, forms an arch beneath the flexor tendons; three **digital** arteries spring from this arch, and are distributed as are those of the anterior limb.

VEINS.

Ruminants.—There are **three Digital veins**, an anterior and two laterals; from these three veins five **metatarsals** are formed: (*a*) two *deep anterior*, which pass up in company with the great metatarsal artery; (*b*) a *superficial anterior*, which forms the anterior root of the external saphenic vein, and also joins the anterior tibial vein; (*c*) two *posterior*—internal and external—the internal terminating in the internal saphenic and posterior tibial veins, the external forming a root of the external saphenic.

NERVES.

Ruminants.—The **Musculo-cutaneous** branch of the popliteal nerve is large, and forms the **dorsal collaterals** of the digits.

The **Anterior Tibial** nerve sends a branch along the anterior face of the metatarsal bone, which, passing between the condyles at the lower extremity, terminates as the **deep collaterals** of the digits.

The **Metatarsal** nerves do not possess an anastomotic branch.

Pig.—The **Musculo-cutaneous** at the tarsus forms three branches, the **dorsal collaterals** of the digits.

The **Anterior Tibial** anastomoses with the plantar nerves.

The **External Plantar** is large, and supplies the external and part of the internal digits.

The **Internal Plantar** is small, and supplies the inner digits.

Dog.—The **Lumbo-sacral** plexus is formed by four lumbar and two sacral nerves.

The **Musculo-cutaneous** terminates in three branches, which form the **dorsal collaterals** of the digits.

The **External Plantar** supplies all the digits except part of the fourth.

APPENDIX.

CLASSIFICATION OF BONES.

THE **Bones** are usually divided into four classes :

1. **Long Bones.**—These are found in the limbs, of which they form the chief constituents. They possess a *shaft*, or diaphysis, and two *extremities*, or epiphyses. The shaft is hollow, forming the medullary canal.

Examples.—The femur, humerus, etc.

(*a*) *Interrupted Bones* are those which have not attained their full development.

Examples.—The ulna and splint bones.

(*b*) *Elongated Bones* resemble long bones, but have no medullary canal. The ribs may be said to belong to this class.

2. **Short Bones** are cubical or oblong, and are represented by the os coronæ and the carpal and tarsal bones.

3. **Flat Bones** are developed in two directions (width and length) at the expense of the third (depth).

Examples.—The scapula and parietal bone.

4. **Irregular Bones** are often of very complex outline; the best examples are found in the median plane of the body, such as the vertebræ.

CLASSIFICATION OF SURFACE-MARKINGS OF BONES.

The surface-markings of bones are either *eminences* or *depressions :*

I. **Eminences.**—These are either articular or non-articular.

1. **Articular Eminences.**
   (*a*) *Head* (Caput, Capitulum, or Capitellum).—This is a rounded eminence, almost always limited by a constriction or neck (*cervix*).
   (*b*) *Condyle.*—This resembles a head to some extent, but its outline is usually more or less oval, and it has no neck.
2. **Non-articular Eminences.**
   (*a*) *Apophysis.*—This is a generic term applied to all non-articular processes.
   (*b*) *Trochanter, Tuberosity, and Tubercle.* — These terms are applied to roughened eminences, and are used to indicate their relative sizes, the trochanter being the largest.
   (*c*) *Spine.*—A spine is usually a thin, sharp, and sometimes pointed eminence.
   (*d*) *Ridge, Line, Crest, etc.*—These terms are sufficiently self-explanatory.

II. **Depressions.**—We may also divide these into articular and non-articular.

1. **Articular Depressions.**
   (*a*) *Glenoid Cavity.* — Usually a shallow articular surface.
   (*b*) *Cotyloid Cavity.*—This is a deeper depression than the preceding.
2. **Non-articular Depressions.**
   (*a*) *Fossa.*—A fossa is a more or less extensive excavation formed by one or more bones.
   (*b*) *Sinus and Antrum.*—These terms are applied to cavities found in the interior of bones.
   (*c*) *Foramen.*—A short opening formed by one or more bones is usually known as a foramen.
   (*d*) *Canal and Meatus.*—We may consider these to be foramina which are continued for some distance into the bone or bones.
   (*e*) *Notch, Fissure, Groove, Furrow, etc.*—These terms are self-explanatory.

CLASSIFICATION OF ARTICULATIONS.

Joints are divided into Diarthroses, Synarthroses, and Amphiarthroses.

I. **Diarthrosis**, or Discontinuous Articulation.—Movement in this class is usually free.

1. **Enarthrosis** (ball-and-socket joint).—A head fits into a glenoid or a cotyloid cavity.
   Example.—Shoulder and hip joints.
2. **Ginglymus** (hinge joint).—Movement is confined to one plane.
   Example.—Elbow-joint.
3. **Diarthrosis Rotatorius.**—One bone forms a pivot, around which the other rotates.
   Example.—Atlo-axoid joint.
4. **Arthrosis.**—The articular surfaces are plane or undulating, and the movement is of a gliding character.
   Example. — Between the individual bones of the carpus and tarsus.
5. **Condylarthrosis.**—This is sometimes described as differing from enarthrosis in the movement not being quite so free.

II. **Synarthrosis**, or Continuous Articulation.—In this class the bones in the adult are united by osseous matter, and movement is consequently nil.

1. **Sutura.**—Sutures have been divided into true and false.
   (*a*) *Vera* (True).—Here projections from one bone fit into depressions in the other. According to the character of these projections, suturæ veræ are divided into: *Sutura dentata* (with tooth-like projections), *serrata* (saw-like), and *limbosa* (dentation and bevelling combined).
   (*b*) *Notha* (False).—In this class the projections are either absent or small. The sub-classes of sutura notha are: *Sutura harmonia* (the two bones have almost smooth edges) and *squamosa* (the bones overlap).

2. **Schindylesis.**—This should be considered as a variety of suture. A projection from one bone fits into a notch in another. An example is seen where the sphenoid projects into the incisura sphenoidalis of the frontal.
3. **Synchondrosis.**—A cartilaginous layer unites the two bones; this cartilage ossifies in the adult (synostosis).

   Example.—Between the basi-occiput and basi-sphenoid.
4. **Gomphosis.**—One bone fits into a depression formed by another.

   Good examples are not forthcoming.
5. **Symphysis.**—The union in this case is through fibro-cartilage and fibrous tissue.

   Example.—The pubic and ischial symphyses.

III. **Amphiarthrosis**, or Mixed.—In this class fibrous tissue and fibro-cartilage are the connecting structures. This class is not always mentioned, its members being sometimes placed under synarthroses.

Example.—The joint between the ilium and sacrum.

CLASSIFICATION OF MOVEMENTS IN JOINTS.

Flexion.—This term is used to indicate a lessening of the angle formed by two bones.

Extension is the opposite of flexion, the angle being increased.

Abduction indicates the movement from the median plane of the body.

Adduction is the opposite of abduction, the movement being towards the median plane.

The term **angular movement** is frequently applied to the above movements.

Circumduction.—In this movement one extremity of a bone describes a circle or ellipse, the other extremity being fixed.

Rotation.—A bone moves about its own axis.

Gliding.—This movement is best seen in the carpus and tarsus, where the surfaces of adjacent bones glide over each other.

TABLE OF BONES, MUSCULAR ATTACHMENTS, ETC., OF THE HORSE.

ANTERIOR LIMB.

Bone.	Centres of Ossification.	Articulates with	Muscles.	
			Arising from	Inserted to
Scapula.	3.	Humerus.	Antea-spinatus. Postea-spinatus. Postea-spinatus minor. Teres externus. Subscapularis. Scapulo-ulnaris. Caput magnum. Scapulo-humeralis posticus Teres internus. Flexor brachii. Coraco-humeralis.	Trapezius. Levator humeri. Rhomboidei. Serratus magnus (from the trunk and neck). Pectoralis parvus (from the trunk).
Humerus.	6.	Scapula. Radius. Ulna.	Humeralis obliquus. Caput medium. ,, parvum. Anconeus. Extensor metacarpi magnus. Extensor pedis. Flexor metacarpi internus. Flexor metacarpi medius. Flexor metacarpi externus. Flexor pedis perforatus. Flexor pedis perforans.	Panniculus. Antea-spinatus. Postea-spinatus. Postea-spinatus minor. Subscapularis. Scapulo-humeralis posticus. Pectoralis magnus. Pectoralis anticus. Teres externus. ,, internus. Coraco-humeralis. Latissimus dorsi. Levator humeri.

Bone.	Centres of Ossification.	Articulates with	Muscles.	
			Arising from	Inserted to
Radius.	4.	Humerus. Ulna. Scaphoid. Lunar. Cuneiform. Trapezium.	Extensor metacarpi obliquus. Extensor pedis. ,, suffraginis. Radialis accessorius.	Flexor brachii. Humeralis obliquus.
Ulna.	2.	Radius. Humerus.	Flexor metacarpi medius. Ulnaris accessorius. Extensor suffraginis. Humeralis obliquus.	Scapulo-ulnaris. Caput magnum. Caput medium. ,, parvum. Anconeus.
Scaphoid.	1.	Radius. Lunar. Magnum. Trapezoid.		
Lunar.	1.	Radius Cuneiform. Unciform. Magnum. Scaphoid.		
Cuneiform.	1.	Radius. Trapezium. Unciform. Lunar.		
Trapezium.	1.	Radius. Cuneiform.		Flexor metacarpi externus. Flexor metacarpi medius.
Pisiform.	1.	Trapezoid.		
Trapezoid.	1.	Pisiform. Scaphoid. Magnum. Two metacarpals.		

Bone.	Centres of Ossification.	Articulates with	Muscles. Arising from	Muscles. Inserted to
Magnum.	1.	Scaphoid. Lunar. Unciform. Two metacarpals. Trapezoid.		
Unciform.	1.	Lunar. Cuneiform. Two metacarpals. Magnum.		
Large metacarpal.	2.	Trapezoid. Magnum. Unciform. Two small metacarpals. Two sesamoids. Os suffraginis.		Extensor metacarpi magnus.
External small metacarpal.	1.	Unciform. Large metacarpal.		Flexor metacarpi externus.
Internal small metacarpal.	1.	Trapezoid. Magnum. Large metacarpal.		Extensor metacarpi obliquus. Flexor metacarpi internus.
Sesamoids.	1.	Large metacarpal.		
Os suffraginis.	3.	Large metacarpal. Os coronæ.		Extensor pedis. Extensor suffraginis.
Os coronæ.	3.	Os suffraginis. Os pedis. Os naviculare.		Flexor pedis perforatus. Extensor pedis.
Os pedis.	2.	Os coronæ. Os naviculare.		Extensor pedis. Flexor pedis perforans.
Navicular bone.	1.	Os pedis.		

POSTERIOR LIMB.

Bone.	Centres of Ossification.	Articulates with	Muscles. Arising from	Muscles. Inserted to
Ilium.	2.	Sacrum. Ischium. Pubis. Femur.	Longissimus dorsi. Iliacus. Quadratus lumborum. Compressor coccygis. Abdominales(3). Glutei (3). Tensor vaginæ femoris. Rectus femoris. ,, parvus. Pyriformis.	Psoas parvus.
Ischium.	2.	Ilium. Pubis. Femur. Its fellow.	Gluteus internus. Triceps abductor. Biceps rotator. Triceps adductor. Gracilis. Obturators (2). Gemelli (2). Ischio-femoralis.	
Pubis.	2.	Ilium. Ischium. Its fellow.	Adductor brevis. Pectineus. Sartorius. Obturators (2).	Abdominales (4).

Bone.	Centres of Ossification.	Articulates with	Muscles.	
			Arising from	Inserted to
Femur.	4.	Ilium. Ischium. Patella. Tibia.	Vasti (2). Crureus. Gastrocnemius. Flexor pedis perforatus. Extensor pedis. Flexor metatarsi. Popliteus.	Psoas magnus. Iliacus. Glutei (3). Obturators (2). Pyriformis. Gemelli (2). Tensor vaginæ femoris. Rectus parvus. Pectineus. Triceps adductor. Triceps abductor. Ischio-femoralis.
Patella.	1.	Femur.		Rectus femoris. Vasti (2). Crureus. Tensor vaginæ femoris. Triceps abductor.
Tibia.	5.	Femur. Fibula. Astragalus.	Flexor metatarsi. Plantaris. Flexor perforans. Flexor accessorius.	Sartorius. Gracilis. Triceps abductor. Biceps rotator. Popliteus.
Fibula.	2.	Tibia.	Peroneus. Flexor perforans.	
Astragalus.	1.	Tibia. Calcaneum. Cuboid. Cuneiform magnum.	Plantaris.	
Calcaneum.	1.	Astragalus. Cuboid.		Gastrocnemius.

Bone.	Centres of Ossification.	Articulates with	Muscles.	
			Arising from	Inserted to
Cuboid.	1.	Calcaneum. Astragalus. Cuneiform magnum. Cuneiform medium. Two metatarsals.		Flexor metatarsi.
Cuneiform magnum	1.	Astragalus. Cuneiform medium. Cuneiform parvum. Cuboid.		
Cuneiform medium.	1.	Cuneiform magnum. Cuneiform parvum. Cuboid. Large metatarsal.		
Cuneiform parvum.	2.	Cuneiform magnum. Cuneiform medium. Two metatarsals.		Flexor metatarsi.
Large metatarsal.	2.	Cuboid. Cuneiform medium. Cuneiform parvum. Two small metacarpals. Os suffraginis. Two sesamoids.		Flexor metatarsi.

Bone.	Centres of Ossification.	Articulates with	Muscles.	
			Arising from	Inserted to
External small metatarsal.	1.	Cuboid. Large metatarsal.		
Internal small metatarsal.	1.	Cuneiform parvum. Large metatarsal.		

The rest of the bones have articulations and muscular attachments similar to those of the anterior limb, except that there is no extensor suffraginis.

INDEX.

END OF PART I.

Baillière Tindall and Cox, King William Street, Strand.

OUTLINES OF

VETERINARY ANATOMY.

PART II.

THE TRUNK.

BY

O. CHARNOCK BRADLEY,

MEMBER OF THE ROYAL COLLEGE OF VETERINARY SURGEONS; PROFESSOR OF ANATOMY IN THE NEW VETERINARY COLLEGE, EDINBURGH.

LONDON:

BAILLIÈRE, TINDALL & COX,

20 & 21, KING WILLIAM STREET, STRAND.

PREFATORY NOTE.

I AM indebted to Mr. R. S. Rowlands for the figures (9 to 21 inclusive) illustrating the comparative section of this part. The actual organs of the ox, sheep, pig and dog do not commonly find their way into the dissecting-rooms, and it is hoped that the figures will assist in fixing the relative shapes on the mind of the student.

O. C. B.

NEW VETERINARY COLLEGE,
EDINBURGH,
June, 1896.

CONTENTS.

THE TRUNK OF THE HORSE.

TABLE OF DIAGRAMS.

VETERINARY ANATOMY.

THE TRUNK OF THE HORSE.

THE **Trunk** has a *skeleton* formed by :

Eighteen **Dorsal Vertebræ**, with their appended **Ribs** and the **Sternum.**

Six **Lumbar Vertebræ.**

The **Sacrum** and **Pelvis.**

The **Coccygeal Vertebræ** (variable in number).

It possesses three cavities :

1. The **Thorax**, containing the heart and principal bloodvessels, lungs, etc.
2. The **Abdomen**, containing the greater part of the alimentary tract and its accessory glands, etc.
3. The **Pelvis**, containing the posterior extremity of the alimentary tract and parts of the urino-genital system.

BONES.

DORSAL VERTEBRÆ (18).

(For a description of a typical vertebra, see *Head and Neck*, Part III.)

General Characteristics.—They are all *true* vertebræ. The *body* is small and short, with an anterior extremity less convex, and a posterior less concave, than in the cervical region.

Capitular facets (anterior and posterior) are found on the centra for articulation with the half of the head of a rib.

The *inferior spine* is rudimentary.

The *intervertebral notches* are small.

The *transverse processes* are small, single and tuberous, and carry facets (*tubercular facets*) for articulation with the tubercles of the ribs.

The *superior spine* is long, and represented by a rod of bone, flattened from side to side, tuberous at the summit, and possessing a sharp anterior and a thick excavated posterior edge.

The *oblique processes* are small, with almost flat, horizontal facets.

The *neural arch* is compressed from above to below.

A dorsal vertebra usually possesses twelve *articular facets*—three anterior, three posterior, and three on each side.

Special Characteristics—*Superior Spine.*—Is short and pointed in the 1st, longest in the 4th, and diminishes in length from this point. The summit is tuberous to about the 10th; after this it is compressed from side to side. The direction is backwards to the 15th, the 16th being almost (or quite) vertical; the 17th and 18th directed forwards.

Capitular Facets.—These decrease in depth from the 1st to the last, and in the last three or four vertebræ are continuous with the tubercular facets. The 18th vertebra has no posterior capitular facet.

Transverse Processes.—Diminish in size from the 1st to near the last, but exhibit a gradually increasing division into two portions.

Oblique Processes.—Up to the 10th there is a rapid diminution in size, the members of each pair also becoming more closely approximated. The last seven or eight processes tend to become concave (anterior) and convex (posterior).

LUMBAR VERTEBRÆ (6).

General Characteristics.—They are all *true* vertebræ.

The *body* is longer than that of a dorsal, but shorter than that of a cervical, vertebra.

The *inferior spine* is rudimentary, being represented by an antero-posterior ridge.

The *intervertebral notches* are unequal in depth, the posterior being the deeper and larger.

The *transverse processes* are very well developed, consisting of projections of bone flattened from above to below, and slightly depressed towards their free extremities.

The *superior spines* are broad, strong, flattened from side to side, slightly inclined forwards, and about the same height as that of the last dorsal.

Oblique Processes.—The anterior have concave articular surfaces, which look inwards; the posterior convex, and looking outwards. Each process has a small eminence placed external to its articular facet.

The *neural ring* approaches the circular in outline, and is relatively large.

Special Characteristics—*Transverse Processes.*—The 3rd is usually the longest and straightest; the 1st and 2nd are directed backwards, and the 4th, 5th and 6th forwards. The 4th carries an articular facet (intertransverse) on its posterior border; the 5th and 6th on both borders.

Superior and Inferior Spines.—These decrease from the 1st to the last.

Articular Surfaces.—The 1st, 2nd and 3rd have the usual six articular surfaces; the 4th has eight, and the 5th and 6th have ten.

THE SACRUM.

This consists of five sacral vertebræ, which are *false*, being in the adult fused together and forming one bone.

It presents *two surfaces*, *two borders*, and *two extremities*.

Surfaces.

Superior. — Triangular in shape; presents five *superior sacral spines* fused at their bases, and decreasing in size from the first to the last. On each side of the spines are small tubercles representing the oblique processes, and external to these the four *superior sacral foramina* (representing intervertebral foramina).

Inferior. — Smooth and triangular; shows four transverse markings, which occupy the points of union of the sacral centra.

On each side are four *inferior sacral foramina*, the first being the largest, the last the smallest.

Borders.

Right and Left.—Anteriorly they are expanded to form the **auricular facets**, which articulate with the ilium; posteriorly they are sharp.

Extremities.

Anterior, or Base.—Much larger than the posterior extremity. It presents: The laterally elongated *anterior extremity* of the *first sacral body* and its superimposed *neural arch*, with two *oblique processes* possessing concave articular surfaces; an *inter-vertebral notch* is present on each side. Placed laterally to the centrum, and divided from it by notches, are two *articular surfaces*, which come in contact with similar surfaces on the posterior border of the last lumbar transverse processes.

Posterior, or Apex.—Presents: The posterior extremity of the *last sacral centrum* (very slightly concave); a *neural arch* possessing no oblique processes; and rudimentary *transverse processes* and *superior spine*.

The *neural foramen* is very small, and triangular in outline.

COCCYGEAL VERTEBRÆ (15 to 20).

Characteristics.—They are classed as *false* vertebræ.

The *body* is short, and possesses convex extremities.

The *neural ring* is complete, but rudimentary in the first one or two bones; after this it rapidly diminishes, and finally disappears.

Rudimentary *transverse processes* are present in the first five or six.

The last eight or ten bones consist of centra only, constricted in the middle.

THE RIBS (18 pairs).

Class.—Elongated.

Situation.—They help to form the lateral walls of the thorax.

General Description.—Each rib presents *two surfaces, two borders,* and *two extremities.*

Surfaces.

External.—Convex from above to below and from side to side, and smooth, with the exception of a few muscular markings.

Internal.—Smooth, and concave from above to below. In the recent state it is covered with the parietal pleura.

Borders.

Anterior.—In the anterior ribs it is sharp, but in the posterior it is rounded. It is concave from above to below.

Posterior.—Thicker and rougher than the anterior; it is excavated for the passage of the intercostal vessels.

Extremities.

Proximal, or Superior.—Presents a head, a neck, and a tubercle.

The *Head* is a rounded articular eminence, divided by a shallow groove into two portions (anterior and posterior). It articulates with the two contiguous capitular facets of two dorsal vertebræ.

The *Neck* (or Cervix) is a constriction below the head, and is roughened for the attachment of ligaments.

The *Tubercle* is an eminence immediately succeeding the neck; it possesses a flattened facet, which articulates with the tubercular facet on a dorsal transverse process. It is roughened externally for the attachment of muscles.

Distal, or Inferior.—This is expanded and excavated for the reception of the upper extremity of a costal cartilage.

Special Characteristics.—The 1st rib is the shortest and straightest. (The most curved part of a rib is known as the *angle;* this is absent in the 1st.) Its external face carries muscular markings; its anterior border shows smooth grooves for the reception of part of the brachial plexus, and roughenings for the attachment of the scalenus muscle; its posterior border is rounded; the head is undivided and the largest of the series; the tubercle is also the largest. The 9th rib is the longest, the 6th the widest, and the 18th the most curved.

The first eight ribs are known as the *sternal* ribs, because their cartilages are directly connected with the sternum; the last ten ribs are called *asternal*, their cartilages not being directly connected with the sternum.

Articulations.—Each rib articulates with two vertebræ proximally, and a costal cartilage distally. (The first rib articulates with the last cervical and first dorsal vertebræ, the rest with dorsal vertebræ only.)

Development.—From three centres:

1. For the head.
2. For the tubercle.
3. For the rest of the bone.

Reference to Side.—Place the head superiorly and anteriorly, and the convex surface externally.

Costal Cartilages.—These are more or less flattened rods of hyaline cartilage placed at the distal extremities of the ribs. Those connected with sternal ribs articulate with the sternum, and have their distal end wider than their proximal. The first pair of cartilages articulate with each other distally.

The cartilages connected with the asternal ribs have a pointed distal extremity.

THE STERNUM (Breast-bone).

Situation.—Placed mesially, and forming the floor of the thorax.

Structure.—It consists of six or seven bony segments (*sternebræ*), united by cartilage.

It possesses *three surfaces, three borders,* and *two extremities.*

Surfaces.

Superior.—Triangular, with the apex pointing forwards. It is smooth and slightly concave from before to behind.

Lateral (Right and Left).—Superiorly are eight cavities for the reception of the distal extremities of the costal cartilages. Inferiorly is an expanse for the attachment of the pectoral muscles.

Borders.

Two Supero-lateral (Right and Left).—Convergent anteriorly, and separating the superior and lateral surfaces.

Inferior.—Convex. Anteriorly it is thin and prominent.

Extremities.

Anterior.—This is formed by a piece of cartilage flattened from side to side, and (from its shape) called the *cariniform cartilage.* The first pair of costal cartilages articulate with this projection.

Posterior.—This is also cartilaginous, being formed by the *xiphoid* or *ensiform cartilage;* this is heart-shaped and thin, and flattened from above to below. Its upper face is concave, its lower convex.

The cariniform cartilage, with the first bony segment, is known as the *manubrium sterni* or *presternum;* the xiphoid cartilage, with the last bony segment, as the *xiphisternum;* and the intervening portion as the *mesosternum.*

Development.—Each segment ossifies from a separate centre.

ARTICULATIONS.

I. INTERVERTEBRAL ARTICULATIONS.

Class.—Amphiarthrosis between the centra, diarthrosis between the oblique processes.

Formed by the contiguous extremities of the centra and the articular surfaces of the oblique processes. *Intervertebral discs* are placed between the centra; these discs are moulded on the articular surfaces, and consist of fibro-cartilage, densest at the periphery, and pulpy at the centre.

Ligaments.—

A. *Common:*

1. *Superior*, runs along the floor of the neural canal from the sacrum to the dentata; it is flat, and attached to the centra and intervertebral discs, being wider over the latter.
2. *Inferior*, passes under the vertebral bodies from the sacrum to the 6th dorsal vertebra, where its place is taken by the longus colli muscle. It is similar to the superior common in appearance and attachments.
3. *Supraspinous*, attached to the summits of the neural spines from the sacrum to the 4th dorsal vertebra, where its place is taken by the *ligamentum nuchæ*.

B. *Special:*

1. *Interspinous*, connect the neural spines, the fibres running downwards and backwards; best developed in the dorsal region.
2. *Ligamenta subflava*, pass from the posterior edge of one arch to the anterior edge of the next behind.
3. *Intertransverse*, unite adjacent transverse processes; best developed in the lumbar

region, where they form capsular ligaments for the intertransverse articulations.

4. *Capsular*, surround the articular surfaces of the oblique processes.

Synovial Membranes.—One for each oblique process, and in the lumbar region additional ones for the intertransverse articulations.

Movements.—Flexion, extension, and lateral.

Special Vertebral Articulations.

1. **Sacro-lumbar.**—Formed by the last lumbar and first sacral vertebræ.

There are the usual ligaments, and in addition two *capsules* for the *intertransverse articulations.*

2. **Sacral.**—The bones are normally fused together.

3. **Coccygeal.**—The *intervertebral discs* are concave on both faces.

The *common vertebral ligaments* form a fibrous sheath around the coccygeal bones.

II. COSTO-VERTEBRAL ARTICULATION.

May be divided into two joints :

A. Costo-central.

Class.—Ginglymus.

Formed by the head of a rib and the contiguous capitular facets of two dorsal vertebræ.

Ligaments.—

1. *Stellate* (or radiating), situated below the articulation. It arises below the articular

head of the rib, its fibres diverging to become attached to the two dorsal centra and the intervening disc.

2. *Interarticular*, passes from the groove on the head of a rib, across the floor of the neural canal, and underneath the superior common ligament, finally becoming continuous with the corresponding ligament from the other side of the body. The 1st rib does not possess this ligament.

Synovial Membranes.—There are two (anterior and posterior), separated by the interarticular ligament.

Movements.—Flexion and extension.

B. Costo-transverse.

Class.—Arthrosis.

Formed by the articular surface of the tubercle of a rib and the tubercular facet on the transverse process of a dorsal vertebra.

Ligaments.—

1. *Anterior costo-transverse*, from the neck of the rib to the antero-inferior part of the transverse process.
2. *Posterior costo-transverse*, from the rib just below the tubercle to the transverse process.

Synovial Membrane.—One.

Movements.—Gliding.

III. CHONDRO-COSTAL ARTICULATION.

Class.—Gomphosis.

Formed by the excavated distal end of a rib and the proximal end of its costal cartilage. Fibrous tissue—

a prolongation of the periosteum—surrounds the union.

IV. CHONDRO-STERNAL ARTICULATIONS.

Class.—Diarthrosis.

Formed by the first eight costal cartilages and the facets on the sternum.

Ligaments.—

1. *Capsular*, thickened above and below, so forming—
2. *Superior costo-sternal* ligament, and
3. *Inferior costo-sternal* ligament.

Synovial Membranes.—One for each cartilage, with the exception of the first, which has one common to itself and its fellow.

Movements.—Flexion and extension.

V. INTERCARTILAGINOUS UNION.

Each cartilage behind the 8th is united by fibrous tissue to the one in front. The 9th cartilage is also united to the inferior face of the xiphoid cartilage by the *chondro-xiphoid ligament.*

VI. STERNAL ARTICULATIONS.

The last two or three sternebræ coalesce in the adult; the rest are united by the intervening cartilage.

The **superior sternal ligaments** run along the superior face of the sternum, diverging as they pass backwards.

MUSCLES.

THE muscles are divided into the following **groups**:

I. **Subcutaneous.**
II. **Pectoral.**
III. **Costal.**
IV. **Sternal.**
V. **Dorso-lumbar.**
VI. **Coccygeal.**
VII. **Abdominal.**
VIII. **Diaphragmatic.**
IX. **Sublumbar.**

I. SUBCUTANEOUS GROUP.

The **Panniculus Carnosus** is a thin, extensive and triangular muscle connected with the skin.

It is best developed on the thorax and abdomen, its *upper border* forming a convex line from the withers to the flank; its *lower border* extends from the posterior aspect of the olecranon, where it is connected somewhat with the pectoral muscles, to the flank. The *anterior border* extends from the supero-anterior scapular region to the forearm. This muscle has a *bony attachment* to the internal trochanter of the humerus. It is *related* with the skin externally, and with the muscles of the dorsal, lumbar and abdominal regions internally. Its *action* is to shake the skin, and so remove offending objects.

II. PECTORAL GROUP.

Comprises four muscles:

1. **Pectoralis Transversus.**

Synonyms.—Superficial pectoral (part of), sterno-aponeuroticus.

Situation.—Along the lateral and inferior aspects of the thorax.

Origin.—First four segments of the sternum.

Insertion.—By an aponeurosis to the olecranon and anterior face of the humerus.

Relations.—Externally, the skin; superiorly, pectoralis magnus; anteriorly, pectoralis anticus.

Action.—Adducts the limb and tenses the brachial and antibrachial fasciæ.

Blood-supply.—Internal and external thoracic, and inferior cervical.

Nerve-supply.—An inferior thoracic branch of the brachial plexus.

2. **Pectoralis Anticus.**

Synonyms.—Superficial pectoral (part of), sterno-humeralis.

Situation.—Immediately in front of the preceding.

Origin.—Cariniform cartilage and first segment of the sternum.

Insertion.—By an aponeurosis (common to the levator humeri and pectoralis transversus) to a ridge on the anterior surface of the humerus.

Relations.—Externally, the skin; internally, pectoralis parvus; anteriorly, levator humeri and spur vein; posteriorly, pectoralis transversus and magnus.

Action.—Adducts the limb.

Blood-supply.—Internal and external thoracic, and inferior cervical.

Nerve-supply.—An inferior thoracic branch of the brachial plexus.

3. **Pectoralis Magnus.**

Synonyms. — Deep pectoral (part of), sterno-trochineus.

Situation.—The largest of the four; extends along the whole infero-lateral part of the thorax.

Origin.—The tunica abdominalis, cartilages of the false ribs, the ensiform cartilage, and the posterior two-thirds of the inferior margin of the sternum.

Insertion.—Internal humeral trochanter, and by fascia to the external trochanter.

Relations.—Externally, the skin, panniculus, and pectoralis transversus; internally, obliquus abdominis externus, rectus abdominis, ribs and their cartilages, and the serratus magnus; by its superior border, the spur vein; anteriorly, the pectoralis parvus.

Action.—Retracts the whole limb, and acts as a muscle of extraordinary inspiration.

Blood-supply.—Internal and external thoracic.

Nerve-supply.—An inferior thoracic branch of the brachial plexus.

4. **Pectoralis Parvus.**

Synonyms.—Deep pectoral (part of), sterno-prescapularis.

Situation.—Anterior to the preceding, and along the anterior border of the scapula.

Origin.—The first three or four segments of the sternum and its cartilage, and the first three or four ribs and their cartilages.

Insertion.—Anterior border of the scapula and the scapular fascia.

Relations.—Externally, pectoralis transversus and magnus, levator humeri, and cervical trapezius; internally, lateralis sterni, anterior part of the sternum, intercostals, subscapulo-hyoideus, and scalenus.

Action.—Retracts and draws the scapula downwards, and tenses the scapular aponeurosis.

Blood-supply. — Internal and external thoracic, inferior cervical, and prescapular.

Nerve-supply.—An inferior thoracic branch of the brachial plexus.

III. COSTAL GROUP.

Contains nine muscles:

1. **Trapezius** (dorsal portion).

Synonym.—Dorso-acromialis.

Situation, etc.—Triangular, and placed on the side of the withers; its fibres run downwards and forwards.

Origin.—The supraspinous ligament from the 3rd to the 10th dorsal vertebra.

Insertion. — With the cervical portion to the tubercle of the scapular spine.

Relations. — Externally, the skin; internally, rhomboideus brevis, latissimus dorsi, and postea-spinatus.

Action.—Elevates and retracts the scapula.

Blood-supply.—Dorso-spinal.

Nerve-supply.—Spinal accessory.

2. **Rhomboideus Brevis.**

Synonym.—Dorso-subscapularis.

Situation.—Superior and internal to the cartilage of prolongation.

Origin. — Supraspinous ligament and neural spines of from the 1st to the 5th dorsal vertebræ.

Insertion.—Superior part of the inner surface of the scapula and cartilage of prolongation.

Relations.—Externally, the cartilage of prolongation and trapezius; internally, trapezius; anteriorly, rhomboideus longus.

Action.—Raises the scapula.

Blood-supply.—Dorso-spinal.

Nerve-supply.—6th cervical.

3. **Latissimus Dorsi.**

Synonyms.—Great dorsal, dorso-humeralis.

Situation, etc.—Passes obliquely downwards and forwards over the loins and thorax.

Origin.—(Aponeurotic.) Supraspinous ligament from the 5th or 6th dorsal to the last lumbar vertebra.

Insertion.—Internal tuberosity of the humerus (in common with the teres internus).

Relations. — Externally, the skin, panniculus, trapezius, and triceps extensor brachii; internally, postea-spinatus, rhomboideus brevis, cartilage of prolongation, superficialis costarum, longissimus dorsi, gluteus maximus, intercostals, and serratus magnus.

Action. — Raises the humerus and flexes the shoulder. (It may be an expiratory muscle.)

Blood-supply.—Dorso-spinal and suprascapular.

Nerve-supply.—Great dorsal branch of the brachial plexus.

4. **Serratus Magnus.**

Synonym.—Costo-subscapularis.

Situation.—On the sides of the thorax. It is triangular and fan-like.

Origin.—The sternal ribs and their cartilages.

Insertion.—The two triangular roughenings on the internal surface of the scapula.

Relations.--Externally, the subscapularis, antea-spinatus, latissimus dorsi, teres internus, and triceps extensor brachii; internally, the intercostals, ribs, and longissimus dorsi; anteriorly, the cervical serratus.

Action.—Acts as a sling for the support of the trunk between the anterior limbs, draws the scapula downwards and backwards, and acts as a muscle of inspiration.

Blood-supply.—Intercostals.

Nerve-supply.—Superior thoracic branch of the brachial plexus.

5. **Serratus Parvus Anticus.**

Synonyms. — Dorso-costalis, superficialis costarum.

Situation.—Beneath the latissimus dorsi and rhomboideus.

Origin.—From the 2nd to the 13th dorsal spine.

Insertion.—External surface and posterior borders of the ribs from the 5th to the 14th.

Relations. — Externally, the latissimus dorsi, rhomboideus, and serratus magnus; internally, the longissimus dorsi, transversalis costarum, and intercostals.

Action.—Inspiratory.

Blood-supply.—Intercostals.

Nerve-supply.—Dorsal.

6. **Serratus Parvus Posticus.**

Synonyms. — Lumbo-costalis, superficialis costarum.

Situation.—Behind the anticus.

Origin.—The eight posterior dorsal spines and some lumbar spines.

Insertion. — External surfaces and posterior borders of the last nine ribs.

Relations.—Externally, the latissimus dorsi; internally, the longissimus dorsi, transversalis costarum, and intercostals.

Action.—Expiratory.

Blood-supply.—Intercostals.

Nerve-supply.—Dorsal.

7. **Transversalis Costarum.**

Synonyms. — Trachelo-costalis, common intercostal.

Situation.—Along the inferior border of the longissimus dorsi. It is composed of a number of muscular fasciculi.

Origin.—Transverse process of the 1st lumbar vertebra and the ribs near their tubercles.

Insertion.—External surfaces of the ribs and the transverse process of the last cervical vertebra.

Relations.—Externally, the serrati; internally, the ribs and intercostals; superiorly, the longissimus dorsi.

Action.—Expiratory by depressing the ribs.

Blood-supply.—Intercostals.

Nerve-supply.—Dorsal.

8. **Levatores Costarum.**

Synonyms.—Transverso-costalis, supercostals.

Situation.—Under the longissimus dorsi.

Origin. — Transverse processes of the dorsal vertebræ.

Insertion.—The outer faces of the ribs above the angle.

Relations.—Externally, the longissimus dorsi; internally, the intercostals.

Action.—Inspiratory, by drawing the ribs forwards.

Blood-supply.—Intercostal and dorso-spinal.

Nerve-supply.—Dorsal.

9. **Intercostals.**

(*a*) *External.*

Situation.—Between the ribs. Their fibres pass downwards and backwards.

Origin.—Posterior border of a rib.

Insertion.—Anterior border of next posterior rib.

Relations. — Externally, the serratus magnus, transversalis costarum; internally, the internal intercostals.

Action.—Inspiratory.

(*b*) *Internal.*

Situation, Origin, and Insertion.—As for the external, their fibres running downwards and forwards.

Relations.—Externally, the external intercostals; internally, the parietal pleura.

Action.—Expiratory.

Blood-supply.—Intercostals from the superior cervical, dorsal and aorta.

Nerve-supply.—Dorsal (intercostals).

IV. STERNAL GROUP.

Contains two muscles:

1. **Lateralis Sterni.**

Synonyms.—Costo-sternalis, transverse muscle of the ribs.

Situation.—Running obliquely along the inferior and anterior borders of the serratus magnus.

Origin.—External surface of the 1st rib.

Insertion.—Fourth segment of the sternum.

Relations.—Externally, the pectoralis magnus and parvus; internally, the 2nd and 3rd ribs and their intercostals.

Action.—Expiratory.

Blood-supply.—External thoracic.

Nerve-supply.—Intercostals.

2. **Triangularis Sterni.**

Synonyms.—Sternalis, sterno-costalis.

Situation.—Within the thorax and above the sternum and costal cartilages.

Origin.—Superior face of the sternum.

Insertion.—The cartilages of the ribs, from the 2nd to the 8th inclusive.

Relations.—Externally, the costal cartilages, intercostals, and internal thoracic artery; internally, the parietal pleura.

Action.—Expiratory.

Blood-supply.—Internal thoracic.

Nerve-supply.—Intercostals.

V. DORSO-LUMBAR GROUP.

Consists of three muscles :

1. **Longissimus Dorsi.**

Synonym.—Ilio-spinalis.

Situation.—In the groove formed by the lumbar and dorsal spines, the lumbar transverse processes and the ribs, from the ilium to the cervical region.

Attachments.—(1) The iliac crest, anterior iliac spine, part of the internal surface of the ilium, and the sacrum ; (2) the neural spines of all the lumbar, all the dorsal, and the last four cervical vertebræ ; (3) the oblique processes of the lumbar, and the transverse processes of all the dorsal, and the last four cervical vertebræ ; (4) the transverse processes of the lumbar vertebræ and the external face of the last fifteen or sixteen ribs.

That portion of it passing from the anterior dorsal spines to the posterior three or four cervical spines is sometimes described as a separate muscle under the name of *spinalis dorsi.*

Relations.—Externally, the gluteus maximus, latissimus dorsi, small serrati, trapezius, rhomboideus brevis, complexus major and splenius; internally, the intertransversales lumborum, levatores costarum, intercostals, ribs, vertebræ, semispinalis dorsi et lumborum and the ligamentum nuchæ; inferiorly, the transversalis costarum.

Action.—Flexes and extends the vertebral column, raises the neck, assists in rearing, kicking, etc., and may assist in expiration by compression of the ribs.

Blood-supply.—Lumbo- and dorso-spinal.

Nerve-supply.—Cervical, dorsal and lumbar.

2. **Semispinalis Dorsi et Lumborum.**

Synonyms.—Transverso-spinous, transverse spinous muscle of the back and loins.

Situation.—Against the lumbar and dorsal spines.

Origin.—Anterior part of the sacrum, oblique processes of the lumbar and the transverse processes of the dorsal vertebræ.

Insertion.—Consists of a series of bundles which are attached to the neural spines of the sacral, lumbar, dorsal and seventh cervical vertebræ, each bundle passing over two or three spines before becoming attached.

Relations.—Externally, the longissimus dorsi; internally, the sacral, lumbar and dorsal spines and the interspinous ligaments.

Action.—Extends the spine.

Blood-supply.—Lumbo- and dorso-spinal.

Nerve-supply.—Lumbar and dorsal.

3. **Intertransversales Lumborum.**

Synonym.—Intertransverse muscles of the loins.

Situation.—In the interspaces between the transverse processes of the lumbar vertebræ.

Origin.—Anterior border of a transverse process.

Insertion.—Posterior border of the process in front.

Action.—Assist in flexing the spine.

Blood-supply.—Lumbar.

Nerve-supply.—Lumbar.

VI. COCCYGEAL GROUP.

Contains four muscles:

1. **Erector Coccygis.**

Synonym.—Sacro-coccygeus superior.

Situation.—Superior and lateral parts of the tail.

Origin.—Summits and lateral faces of the last three or four sacral spines and a few of the anterior coccygeal vertebræ.

Insertion.—Coccygeal vertebræ.

Relations.—Externally, the coccygeal aponeurosis and the curvator coccygis; internally, its fellow of the opposite side.

Action.—Singly, it draws the tail to one side; when acting with its fellow it raises the tail.

2. **Depressor Coccygis.**

Synonym.—Sacro-coccygeus inferior.

Situation.—On the inferior and lateral parts of the tail.

Origin.—Inferior surface of the sacrum, internal face of the sacro-sciatic ligament, and the anterior coccygeal vertebræ.

Insertion.—Inferior faces of the coccygeal vertebræ.

Relations.—Externally, the sacro-sciatic ligament, curvator coccygis, and coccygeal fascia; internally, its fellow and the suspensory ligament of the rectum; superiorly, the sacrum, curvator coccygis and coccygeal vertebræ; inferiorly, the rectum and coccygeal fascia.

Action.—Depresses the tail and draws it to one side.

3. **Curvator Coccygis.**

Synonym.—Sacro-coccygeus lateralis.

Situation.—Between the erector and depressor.

Origin.—Spines of the last lumbar vertebra, sacrum and coccygeal vertebræ.

Insertion.—Lateral aspect of the coccyx.

Relations.—Externally, the longissimus dorsi and coccygeal aponeurosis; internally, the spinous processes; superiorly, the erector; inferiorly, the depressor.

Action.—Draws the tail to one side.

4. **Compressor Coccygis.**

Synonym.—Ischio-coccygeus.

Situation.—Against the wall of the pelvis. It is thin and triangular.

Origin.—Sacro-sciatic ligament and superior ischiatic spine.

Insertion.—Lateral aspects of the last sacral and first two coccygeal vertebræ.

Relations.—Externally, the sacro-sciatic ligament; internally, the rectum and curvator.

Action.—Depresses the entire tail.

Blood-supply of the Tail.—Coccygeal branch of the lateral sacral.

Nerve-supply of the Tail.—Coccygeal nerves.

VII. ABDOMINAL GROUP.

The muscles of this group—four in number—help to form the inferior and lateral walls of the abdominal cavity.

Two important factors in the formation of these walls are the *tunica abdominalis* and *linea alba.*

The **Tunica Abdominalis** is an expanse of yellow elastic tissue, extending from the pubis to the sternum, and upwards to the fleshy portion of the obliquus abdominis externus. Its thickest portions are at its attachment to the pubis and on each side of the white line; it becomes gradually thinner as the sternum and fleshy part of the external oblique are approached.

Relations.—Externally, the skin and panniculus, sheath and penis in the male, and mammary gland in the female; internally, the aponeurosis of the external oblique muscle.

Function.—To conserve muscular energy.

The **Linea Alba,** or White Line, is a fibrous cord extending from the *prepubian* or common tendon of the abdominal muscles to the inferior surface of the ensiform cartilage. The remains of the umbilicus are represented in a lozenge-shaped space at about the union of the middle and posterior thirds of the line.

1. Obliquus Abdominis Externus.

Synonyms.—Costo-abdominalis, great oblique.

Situation.—On the lateral and inferior parts of the abdominal wall. It is divided into two portions—muscular and aponeurotic.

Attachments, etc.—

A. *Muscular Portion:*

(*a*) The outer faces of the thirteen or fourteen posterior ribs.

(*b*) The fibrous sheath of the latissimus dorsi.

(*c*) The lumbar aponeurosis.

(*d*) The aponeurotic portion.

B. *Aponeurotic Portion.* — This continues the muscular portion, and is attached to the anterior iliac spine, the linea alba, and the prepubian tendon. It forms:

(*a*) The *crural aponeurosis*, which passes down to the patella and covers the internal femoral muscles, blending externally with the fascia lata.

(*b*) *Poupart's Ligament.*—This is a reflection of the aponeurosis which passes upwards and forwards, entering the abdominal cavity, and stretching from the anterior iliac spine to the pubis. It forms the **posterior pillar of the inguinal canal,** affords attachment to some of the fibres of the obliquus internus, and, with the iliacus and sartorius muscles and the pubic brim, forms the **crural ring.**

Relations.—Externally, the pectoralis magnus and abdominal tunic; internally, the posterior ribs and their cartilages, the rectus abdominis and obliquus internus.

Action.—Supports the abdominal viscera, flexes the spine, assists in defæcation, micturition and parturition, and in expiration.

Blood-supply.—Lumbar, intercostal, and asternal.

Nerve-supply.—Last ten intercostals and first two lumbars.

The Inguinal Canal. — An infundibuliform canal placed external to the prepubian tendon.

Its *external opening* is known as the *external abdominal* or *inguinal ring,* and possesses two pillars and two commissures; the pillars (anterior and posterior) are formed by the tendinous expansion of the obliquus externus muscle and Poupart's ligament.

The *internal opening, peritoneal* or *internal abdominal ring,* is imperfectly defined.

The inguinal canal transmits:

In the male, the spermatic cord and its vessels, the external pudic artery and vein, and the inguinal nerves and lymphatics. In the female, the mammary vessels, and the inguinal nerves and lymphatics.

2. **Obliquus Abdominis Internus.**

Synonyms.—Ilio-abdominalis, small oblique.

Situation.—Immediately underneath the obliquus externus. It is divided into muscular and aponeurotic portions.

Attachments, etc.—

A. *Muscular Portion.*—The anterior iliac spine, two or three lumbar transverse processes, the border of the last rib (retractor costæ), and the aponeurosis of the latissimus dorsi. Its antero-inferior border is continuous with the aponeurosis.

B. *Aponeurotic Portion.* — It continues the muscular portion downwards and forwards, and is attached to the last costal cartilages, the linea alba, and by means of the prepubian tendon, to the pubic symphysis.

Relations. — Externally, the obliquus externus; internally, the rectus and transversalis abdominis.

Action. — Compresses the abdomen, acting as a muscle of expiration, etc., and flexes the vertebral column.

Blood-supply.—Lumbar, intercostal and circumflex ilii.

Nerve-supply.—Same as for the obliquus externus.

3. **Rectus Abdominis.**

Synonym.—Sterno-pubialis.

Situation, etc.—Extending the whole length of the abdominal floor from the sternum to the pubis. It is a polygastric muscle, having numerous tendinous intersections known as the *lineæ transversæ.*

Attachments.—The cartilages of the last four sternal and first two asternal ribs; the inferior face of the sternum and xiphoid cartilage; by means of the prepubian tendon to the brim of the pubis. In the middle line it is attached to the linea alba.

Relations. — Superiorly, the transversalis abdominis and the costal cartilages; inferiorly, the aponeurosis of the obliquus internus; antero-inferiorly, the pectoralis magnus; internally, its fellow.

Action.—Compresses the abdomen, supports the abdominal viscera, acts as a muscle of expiration, and flexes the vertebral column.

Blood-supply.—Lumbar, internal thoracic, and anterior and posterior abdominal.

Nerve-supply.—Same as for the obliquus externus.

4. **Transversalis Abdominis.**

Synonyms.—Lumbo-abdominalis, costo-abdominalis internus.

Situation.—In the deeper layer of the abdominal wall, immediately outside the peritoneum. It is divided into muscular and aponeurotic portions.

Attachments.—

A. *Muscular Portion.*—The extremities of the lumbar transverse processes and the internal surfaces of the asternal cartilages and ribs. It is continuous inferiorly with the aponeurosis.

B. *Aponeurotic Portion.*—It continues the muscular portion downwards, and is attached to the linea alba and xiphoid cartilage.

Relations.—Externally, the obliquus internus, rectus abdominis, and asternal cartilages; internally, the peritoneum (the *fascia trans-*

versalis uniting the two structures); anteriorly, the diaphragm.

Action.—Assists in compressing the abdomen.

Blood-supply.—Lumbar, circumflex ilii, asternal, and intercostal.

Nerve-supply.—Same as for the obliquus externus.

VIII. DIAPHRAGMATIC GROUP.

This includes only one muscle, the **Diaphragm.**

Situation, etc.—It forms a partition between the thoracic and abdominal cavities. It is elliptical in outline, slopes downwards and forwards, and has its anterior face convex, the posterior face being correspondingly concave. It is divided into two crura (right and left), a peripheral muscular portion, and a tendinous expansion known as the *phrenic centre* (*speculum Helmontii*).

Attachments.—The *crura* are found in the sublumbar region. The right is the longer and more voluminous; it is attached to the inferior faces of the five anterior lumbar centra. The left arise from the 1st and 2nd lumbar centra. Both crura blend inferiorly with the phrenic centre. The right crus is perforated near its inferior extremity by the *foramen sinistrum*, through which the œsophagus, pneumogastric nerves and pleural artery pass. Near their superior extremities the crura are separated by the *hiatus aorticus*, which gives passage to the posterior aorta, vena azygos, and thoracic duct. A third opening—the *foramen dextrum*—is found near the centre of the diaphragm, in the right half of the phrenic centre; this opening transmits the posterior vena cava.

The *peripheral muscular* portion is attached to the inner faces of the last twelve ribs near their distal extremities, or to the cartilages of these ribs, and to the superior face of the xiphoid cartilage.

Relations.—Anteriorly, the pleura, and indirectly the lungs; posteriorly, the peritoneum, also coming in contact mediately with the liver, stomach, great colon, and spleen.

Action.—It is *the* muscle of inspiration; it assists in defæcation and parturition.

Blood-supply. — Diaphragmatic and internal thoracic.

Nerve-supply.—Phrenic.

IX. **SUBLUMBAR GROUP.**

This contains four muscles:

1. **Psoas Magnus.**

Synonyms. — Sublumbo-trochantineus, lumbo-femoral.

Situation.—Placed in an antero-posterior direction immediately below the lumbar transverse processes.

Origin.—The bodies of the last two dorsal vertebræ, the bodies and transverse processes of the first five lumbar vertebræ, and the inner faces of the last two ribs.

Insertion.—The internal trochanter of the femur along with the iliacus.

Relations.—Superiorly, the last two internal intercostals, and the quadratus and intertransversales lumborum; inferiorly, the pleura, the upper border of the diaphragm, iliac fascia, and the kidney; posteriorly, the iliacus; internally, the psoas parvus.

Action.—When the loins are fixed, it flexes and rotates the femur; when the femur is fixed, it flexes the loins.

Blood-supply.—Lumbar and ilio-lumbar.

Nerve-supply.—Lumbar.

2. **Psoas Parvus.**

Synonyms. — Sublumbo-pubialis or sublumbo-iliacus, lumbo-iliacus.

Situation.—Placed along the inner border of the psoas magnus.

Origin.—The last three or four dorsal and all the lumbar centra.

Insertion.—The ilio-pectineal eminence of the pubis, and the iliac fascia.

Relations.—Inferiorly, the pleura, upper border of the diaphragm, posterior aorta, and vena cava; externally, the psoas magnus.

Action.—When the loins are fixed, it flexes the pelvis on the vertebral column; when the pelvis is fixed, it arches the back. It also tenses the iliac aponeurosis.

Blood-supply.—Lumbar and ilio-lumbar.

Nerve-supply.—Lumbar.

3. **Iliacus.**

Synonyms.—Ilio-trochantineus, iliac psoas.

Situation.—It is placed on the inner face of the ilium. It divides into two portions, between which the tendon of the psoas magnus lies.

Origin.—The venter surface of the ilium, the inferior sacro-iliac ligament, and the ilio-pectineal line.

Insertion.—The internal trochanter of the femur, along with the psoas magnus.

Relations.—Superiorly, the ilium and sacro-iliac articulation; inferiorly, the sartorius and iliac aponeurosis; externally, the tensor vaginæ femoris and rectus femoris; internally, the internal iliac bloodvessels and anterior crural nerve.

Action.—Flexes and rotates the femur.

Blood-supply.—Ilio-lumbar and circumflex ilii.

Nerve-supply.—Lumbar.

4. **Quadratus Lumborum.**

Synonyms.—Sacro-costalis, sacro-lumbalis.

Situation.—It is placed between the lumbar transverse processes and the psoas magnus. It consists of several bundles.

Origin.—The principal bundle arises from the inferior sacro-iliac ligament.

Insertion.—The above bundle terminates on the posterior border of the last rib. The secondary bundles leave the chief bundle, and become attached to the lumbar transverse processes and the internal surface of the last two or three ribs.

Relations. — Superiorly, the intertransversales lumborum and the lumbar vertebræ; inferiorly, the psoas magnus.

Action.—Retracts the last two or three ribs, and produces lateral flexion of the lumbar vertebræ.

Blood-supply.—Lumbar.

Nerve-supply.—Lumbar.

THE THORAX.

The thorax, known also as the *thoracic* or *pectoral cavity*, is that conical cavity formed by the dorsal vertebræ, ribs, and sternum, and the muscles attached. It is the most anterior of the three great body cavities, and possesses:

1. A **roof**, formed by the dorsal vertebræ, the proximal extremities of the ribs as far as their angles, and the muscles of this region.
2. Two **lateral walls**, formed by the ribs and the muscles attached to them.
3. A **floor**, formed by the sternum and the cartilages of the sternal ribs and muscles.
4. An **apex**, directed forwards and situated between the first pair of ribs.
5. A **base**, formed by the diaphragm, presenting a convex surface, and having an oblique direction downwards and forwards.

The chief *contents* of the thorax are:

The lungs, pleuræ, part of the trachea, and the bronchi.

The heart and great bloodvessels.

The œsophagus.

The thoracic duct.

The pneumogastric and diaphragmatic nerves.

THE PLEURÆ

are the two serous membranes which line the thorax; each pleura is confined to its own side, the two meeting in the middle line to form a septum; between the two layers is a cavity known as the *mediastinum*.

The portions of each pleura are:

1. **Parietal**, attached to the walls of the thorax and reflected in the middle line; this is subdivided into:
   - (*a*) *Costal*, attached to the ribs and the internal intercostals.
   - (*b*) *Diaphragmatic*, covering the anterior surface of the diaphragm.
   - (*c*) *Mediastinal*, forming the mediastinum.
2. **Visceral**, or pulmonary (a reflexion from the mediastinal pleura), closely investing the lungs.

The **Mediastinum** is divided into three parts:

I. *Anterior Mediastinum*, that part anterior to the heart.

II. *Middle Mediastinum*, containing the heart.

III. *Posterior Mediastinum*, behind the heart. This portion, in the horse, is peculiar, inasmuch as the pleura is perforated.

The **Anterior Mediastinum** contains:

A. *Arteries:* Anterior aorta, brachial and cephalic.

B. *Veins:* Anterior vena cava, jugular and brachials.

C. *Nerves:* Sympathetic ganglia and nerves, Pneumogastrics, recurrent laryngeals and phrenics.

D. Longus colli muscle.

E. Œsophagus.

F. Trachea.

The **Middle Mediastinum** contains:

A. The heart and pericardium.

B. *Arteries:* Common aorta, parts of the anterior and posterior aortæ, and pulmonary.

C. *Veins:* Anterior and posterior venæ cavæ (parts of), pulmonary, and vena azygos.

D. Thoracic duct.

E. *Nerves:* Sympathetic ganglia and nerves, pneumogastrics, phrenics, and *left* recurrent laryngeal.

F. Longus colli muscle (origin).

G. Œsophagus.

H. Bronchi.

The **Posterior Mediastinum** contains:

A. *Arteries:* Posterior aorta, intercostals (commencement of), and broncho-œsophageal.

B. Vena azygos.

C. Thoracic duct.

D. *Nerves:* Pneumogastrics, sympathetic ganglia and nerves, and *left* phrenic.

E. Œsophagus.

Structure of Pleura.—The structure is similar to that of serous membranes in general, and consists of:

1. A thin layer of connective tissue, containing some elastic fibres.
2. A layer of flattened epithelial (or endothelial) cells, which has at intervals small openings known as *stomata*, leading into the subjacent lymphatics.

THE LUNGS,

two in number, are distensile, spongy and semiconical organs, essential to respiration. Each lung is confined to its own side of the thorax, is covered by its own pleura, and is in connection with the trachea by means of a separate bronchus; they are known as **right and left.**

Each lung presents: *Two faces* (external and internal), *three borders* (superior, inferior and posterior), a *summit*, and a *base*.

External Face.—Smooth, convex, and fitting against the thoracic wall.

Internal Face. — Is divided into: (1) an anterior smooth portion; (2) a notch which lodges the heart; (3) the *root of the lungs* (by which the bronchi and bloodvessels enter the lung); (4) a posterior portion, along which two longitudinal grooves run, the superior one being for the posterior aorta, and the inferior for the œsophagus.

Superior Border.—Thick, rounded, and fitting into the groove formed by the bodies of the dorsal vertebræ and the ribs.

Inferior Border.—Thin, and notched opposite to the heart.

Posterior Border.—Also thin.

Summit.—Directed forwards, and lodged just behind the first rib.

Base.—Concave, fitting upon the anterior face of the diaphragm.

Each lung is divided into **lobes**, the left possessing two, an anterior—forming the apex—and a posterior; and the right three. The extra lobe of the right lung is due to the presence of a notch for the passage of the posterior vena cava and right phrenic nerve.

Blood-supply.—This is of two kinds, venous or *functional*, and arterial or *nutritive*.

The *functional vessels* are the *pulmonary* arteries and veins. The *nutritive vessels* are the *bronchial* arteries and veins.

The **Lymphatics** are (1) *superficial*, beneath the pleura, and (2) *deep* (perivascular and peribronchial); these vessels pour their lymph into the *bronchial glands* situated near the root of the lungs.

Nerve-supply.—Pneumogastric and sympathetic.

Structure of the Lung.—The lung tissue is divided into lobules by plates of connective tissue, known as *interlobular septa*, these being continuous with a fibro-elastic capsule which surrounds each lung. Each *lobule* consists of (1) a terminal *bronchus*, (2) *infundibula*, and (3) *air-cells* or *alveoli*.

A *terminal bronchus* enters each lobule, and divides into smaller tubes known as *bronchioles*; the bronchioles terminate in wider tubes—the *infundibula*—of which the *air-cells* or *alveoli* are diverticula.

The *bronchi* consist of (1) a framework of irregularly-shaped plates of hyaline cartilage, held together by fibrous tissue, which also forms an external coat to the tubes; (2) a continuous coat of non-striated muscular fibres, internal to the cartilaginous tissue; (3) a submucosa, consisting of white fibrous and elastic tissue; (4) a mucous membrane, covered by ciliated epithelium. In the smaller tubes this membrane is thrown into longitudinal folds.

As the tubes become smaller, the cartilage diminishes in quantity, and finally disappears in the terminal bronchi.

THE TRACHEA.

The thoracic portion of the trachea is short, and terminates on a level with the base of the heart by dividing into the two **bronchi.**

Relations.—Superiorly, the longus colli and œsophagus; inferiorly, the anterior aorta and brachial arteries, and the recurrent laryngeal and cardiac nerves; laterally, the inferior cervical sympathetic ganglia; to the right, the vena azygos; to the left, the aorta and thoracic duct.

(For structure of the trachea, see *The Neck*, Part III.)

THE BRONCHI

are two in number, a right and a left, each ramifying in the lung of its own side. They enter the root of the lungs, and branch in a tree-like manner.

Blood-supply.—Bronchial arteries and veins.

Nerve-supply.—Bronchial nerves.

THE HEART, ETC.

The heart is situated between the two lungs, and, together with the roots of the great bloodvessels, is enclosed in a fibro-serous sac, the *pericardium*.

The Pericardium

is a somewhat conical membranous sac, having its apex attached to the upper surface of the sternum, and its base surrounding the roots of the large vessels connected with the base of the heart.

It consists of two layers:

1. A **fibrous** layer, which is strong and resisting. Its external surface is covered by the mediastinal pleura, and its internal face by the parietal portion of the serous layer.

2. A **serous** layer, which is disposed in the manner of serous membranes in general, and not only lines the fibrous layer (*parietal* portion), but is also reflected on to the heart (*visceral* portion, or *epicardium*).

Structure.—The *fibrous* portion is made up of interlacing fibrous tissue. The *serous* portion agrees in structure with serous membranes in general.

The Heart

is a conical, hollow, muscular organ situated opposite to the 3rd, 4th, 5th and 6th ribs, anterior to the diaphragm, and superior to the sternum. It is suspended from the roof of the thorax by means of the *large vessels*, and is enclosed in the pericardium.

Measurements.—From base to apex about 10½ inches; greatest antero-posterior measurement about 7½ inches; greatest transverse measurement 5½ inches.

Weight.—From 5 to 6 pounds.

The **external markings** of the heart are:

1. A *transverse* or *auriculo-ventricular groove* or *furrow* near the base; this divides the heart into auricular and ventricular portions.

2. Two *longitudinal* or *interventricular grooves* or *furrows* mark the position of the partition between the two ventricles. These furrows are filled (partially or completely) with fat and bloodvessels (coronary).

The Cavities of the Heart

are four in number, viz., a right and a left auricle and a right and a left ventricle.

The **auricles** are situated at the base of the heart, and have much thinner walls than the ventricles; they receive the blood brought to the heart by the veins, and pass it on to the ventricles; the ventricles, on the other hand, distribute the blood by means of the arteries through the lungs and the body generally. The cavities of the heart are lined by *endocardium*, which is continuous with the endothelial lining of the bloodvessels.

I. **Right Auricle.**—This consists of two portions: (1) a *sinus venosus*, into which the great veins open; and (2) an *appendix*, or *auricle proper*.

The walls of the auricle present the following objects when the cavity is laid open:

1. The openings of the *anterior and posterior venæ cavæ*, between which is a small eminence, the *tuberculum Lowerii*.

2. The *coronary sinus*, a small diverticulum situated between the opening of the posterior vena cava and the opening into the right ventricle; this sinus is provided with a fold of endocardium called the *valve of Thebesius*.

3. The *auriculo-ventricular opening*, through which the blood passes into the ventricle.

4. The *musculi pectinati*, fleshy columns attached particularly to the walls of the appendix.

5. The *foramina of Thebesius*, numerous depressions in the walls, some of which are cæcal, and others the openings of the *venæ minimæ cordis* (the small veins of the heart).

6. In the *interauricular septum* — the partition dividing the two auricles—is a depression, the *fossa ovalis*, the remains of the *foramen of Botal*, a fœtal opening. This fossa is partially surrounded by a raised margin, the *annulus ovalis* or *isthmus Vieussenii;* this ring is incomplete below.

II. **Right Ventricle.**—This cavity occupies the major part of the anterior surface of the heart. It does not quite reach the apex, that part of the heart being formed by the left ventricle alone.

The objects found within the cavity are:

1. The *auriculo-ventricular opening*, large and oval, guarded by the *tricuspid valve;* this valve really possesses six cusps, three large and three small, arranged alternately.

2. The *chordæ tendineæ* are small fibrous cords

attached to the margin and lower face of the tricuspid valve, and passing to the summits of the

3. *Musculi papillares*, which are conical fleshy projections from the ventricular wall.

The musculi papillares are a variety of

4. *Columnæ carneæ*, of which there are three kinds: (*a*) those attached by both extremities, the rest being free (*moderator bands* or *trabeculæ*); (*b*) those attached by both extremities and a side (*musculi pectinati*); and (*c*) those attached by one extremity only (*musculi papillares*).

5. The *pulmonary opening* is the second and smaller opening at the base of the ventricle. It is superior to and to the left of the auriculo-ventricular opening. The diverticulum of the ventricle which leads to this opening is called the *conus arteriosus* or *infundibulum*.

6. The *sigmoid* or *semilunar* valve, consisting of three flaps, guards the opening of the pulmonary artery, and prevents the regurgitation of blood into the ventricle. Each segment of this valve has a small body on its free margin called the *corpus Arantii* (seldom present in the horse).

III. **Left Auricle.** — This cavity is situated posteriorly and to the left at the base of the heart. It receives the blood from the lungs. Like the right auricle, it consists of an appendix and a sinus.

This cavity differs from the right in the following respects:

1. The openings into it are those of the *pulmonary veins*, four in number as a rule.
2. The foramen ovale is less distinct.
3. The endocardium is lighter in colour.

The left auricle opens into the left ventricle by means of the left auriculo-ventricular opening.

IV. **Left Ventricle.**—This cavity differs from the right in the following respects:

1. It forms the apex of the heart (here its wall is very thin).
2. Its walls are much thicker.
3. The interventricular septum is concave.
4. A transverse section through this ventricle is oval, not crescentic.
5. The auriculo-ventricular opening is guarded by a *bicuspid* or *mitral valve*, which is thicker than the tricuspid.
6. The *musculi papillares* are larger, and two in number.
7. The *aorta* leaves it. The opening into the aorta is guarded by a sigmoid valve similar to that guarding the pulmonary opening, but thicker and stronger.
8. It usually contains one strong *moderator band*.

Structure of the Heart.—The heart is invested externally by a visceral serous membrane, the *epicardium*, and internally it is lined by the *endocardium*. The *myocardium*, or heart muscle, forms the bulk of the organ. The *fibrous* or *tendinous* rings found connected with the auriculo-ventricular and arterial orifices are composed of fibrous tissue and fibro-cartilage, and afford attachment to the muscular fibres. (These rings sometimes partially ossify in the horse, while in the ox they are always bony, and known as the *ossa cordis*.)

The heart muscle is characterized by the extreme complexity of the arrangement of its fibres. The fibres of the auricles are distinct from those of the ventricles, and are arranged in two layers—an external layer common to both auricles, and a deep layer proper to each auricle, the fibres running in an oblique and circular manner.

The walls of the ventricles have been shown to contain seven layers of muscular fibres, arranged chiefly in an oblique manner.

The muscular fibres of the heart are striated, but involuntary; they differ in the following respects from the striated fibres of the other muscular structures of the body: They have no sarcolemma; their nuclei are placed in the centre, and are more numerous than in ordinary fibres; they are branched, and joined together by their branches.

The valves of the heart are folds of endocardium, strengthened by fibrous tissue placed between the two layers.

THE ŒSOPHAGUS

enters the thorax above the trachea, passes over the base of the heart, runs along the lower groove found on the inner surface of the lungs, and finally, passing through the foramen sinistrum of the diaphragm, enters the abdominal cavity.

Relations of the Thoracic Portion of the Œsophagus. —The longus colli, trachea, left bronchus, posterior aorta, lungs, œsophageal artery, and pneumogastric nerves.

(For structure, see *The Neck*, Part III.)

ARTERIES.

PULMONARY ARTERY.

This artery arises from the conus arteriosus of the right ventricle, its orifice possessing the sigmoid valve, behind each segment of which is a diverticulum known as a *sinus of Valsalva.* It carries *venous* blood.

Course.—It passes in a curved manner upwards and backwards; above the left auricle it breaks into two arteries, one being destined for each lung. These accompany the bronchi into the substance of the lungs.

Relations.—At its commencement it has the aorta on the right, and is covered by the visceral pericardium. At about the middle of its course it is attached to the posterior aorta by means of the *ligamentum arteriosum,* a fibrous cord, the remains of a fœtal structure, which allowed of the passage of blood from the pulmonary artery to the posterior aorta.

COMMON AORTA.

Leaves the base of the left ventricle. This trunk is short (about 2 inches), and passes upwards, to terminate in the *anterior* and *posterior aortæ.*

I. Collateral Branches.

The two *cardiac* or *coronary arteries,* which supply the substance of the heart.

1. **Right Cardiac.**

Course.—Arises from a sinus of Valsalva, passes forwards, having the pulmonary artery to the left, gains the auriculo-ventricular furrow, along which it courses until it reaches the right ventricular furrow, when it divides into (1) a *vertical* branch, which passes towards the apex of the heart, and (2) a *transverse* branch, which runs along the auriculo-ventricular groove and anastomoses with a corresponding branch from the left artery.

2. **Left Cardiac.**

Course.—Arises in a similar manner to the right, and, under the left auricle, divides into two branches, which are distributed as those of the right artery.

II. Terminal Branches.

A. ANTERIOR AORTA.

This is smaller in calibre than the posterior aorta, and is only about 2 or 2½ inches in length.

Course.—It passes upwards and forwards, below the trachea and to the left of the anterior cava. Its collateral branches are small and innominate. Its terminal branches are the two *brachial* or *axillary arteries*, right and left.

BRACHIAL ARTERIES.

The right is the larger, and gives off the **common carotid** or **cephalic artery**; from this it is called the *brachio-cephalic artery*.

FIG. 1.—DIAGRAM OF THE ARTERIES OF THE THORAX.

1. Common aorta. 2. Anterior aorta. 3. Brachio-cephalic artery. 4. Cephalic artery. 5. Pulmonary artery. 6. Remains of the ductus arteriosus.

Course.—They pass forwards below the trachea ; at the entrance to the thorax they pass outwards, winding round the first rib below the scalenus; they finally gain the inner face of the scapular region, and terminate as the *humeral artery* (see *Anterior Limb*, Part I.).

Collateral Branches.

1. **Dorsal** (Dorso-muscular, or Transverse Cervical) **Artery.**

Course.—Passes upwards towards the second intercostal space, crossing in its course the trachea, œsophagus, sympathetic and longus colli; after having traversed the intercostal space, it supplies the muscles of the withers, and an anterior branch passes forwards to terminate in the splenius and complexus major.

Its collateral branch is the *subcostal artery*, which is given off before the trunk leaves the thorax, and, passing backwards beneath the heads of the ribs, supplies the 2nd, 3rd and 4th *intercostal arteries.*

2. **Superior Cervical** (or Cervico-muscular) **Artery.**

Course.—Passes upwards to the first intercostal space. It is distributed to the neck. Before it leaves the thorax it supplies the 1st *intercostal artery.*

3. **Vertebral Artery.**

Course.—Leaves the brachial on a level with the 1st rib. It is related to the œsophagus, trachea, and inferior cervical ganglion. Passing beneath the transverse process of the 7th cervical vertebra, it gains the vertebral foramen of the 6th, and from here through the entire series of foramina, ultimately anastomosing with the ramus anastomoticus of the occipital.

4. **Internal Thoracic** (or Internal Mammary) **Artery.**

Course.—Arising on a level with the 1st rib, it passes downwards and backwards to the sternum, it insinuates itself between the triangularis sterni and the sternum, and at the xiphoid cartilage terminates in the *anterior abdominal* and *asternal arteries.*

I. *Collateral Branches.*—

(*a*) *Superior*, to the pericardium and pleura.

(*b*) *Inferior*, pierce the intercostal spaces and anastomose with the external thoracic artery.

(*c*) *External*, pierce the intercostal spaces and anastomose with the first seven intercostal arteries.

II. *Terminal Branches.*—

1. *Anterior Abdominal Artery.*—Passes beneath the xiphoid cartilage, runs along the upper surface of the rectus abdominis, enters this muscle, and anastomoses with the posterior abdominal artery.

2. *Asternal Artery.*—Passes outwards and then forwards round the asternal costal cartilages, and terminates in the 13th intercostal space by anastomosing with the intercostal artery. Its branches are intercostal, diaphragmatic and abdominal.

5. **External Thoracic** (or External Mammary) **Artery.** —This leaves the brachial near the preceding, winds

round the 1st rib, and runs along the inner surface of the pectoralis magnus and parvus, which it supplies. It finally terminates in the panniculus carnosus.

6. **Inferior Cervical** (or Trachelo-muscular) **Artery.** —Arises near the 1st rib, runs between the jugular vein and the pectoralis parvus, and after a short course terminates in *ascending* and *descending* branches.

The *Ascending*, or superior, artery runs up the neck between the levator humeri and subscapulo-hyoideus.

The *Descending*, or inferior, artery, passing between the levator humeri and pectoralis parvus, terminates in the pectoral muscles.

7. **Prescapular** } see *Anterior Limb*.
8. **Subscapular** }

B. POSTERIOR AORTA (Thoracic Portion).

Course.—This artery is much larger than the anterior aorta, and passes upwards and backwards—forming **the arch of the aorta**—until it reaches the left lateral aspect of the 7th dorsal centrum. From this point it courses backwards, at first slightly to the left of the median plane, and afterwards in that plane. It leaves the thorax by means of the hiatus aorticus between the crura of the diaphragm.

Relations.—The arch is to the left of the œsophagus and trachea. The rest of the thoracic portion is in the posterior mediastinum, and is related to the inner surfaces of the lungs.

Its *collateral branches* are: (1) *visceral,* those distributed to the thoracic viscera; and (2) *parietal,* those distributed to the thoracic walls.

I. Visceral Branch.

Broncho-œsophageal Artery.—This arises either in company with the 1st pair of aortic intercostals (the three forming a common trunk), or near to them and to their right. Passing between the aorta and œsophagus, it divides into *bronchial* and *œsophageal* branches.

1. **Bronchial Arteries.**—Two in number, right and left; they enter the root of the lungs along with the bronchi, and ramify in the lung substance, supplying nutritive blood to the lungs.

2. **Œsophageal Arteries.**—Arise as a common trunk, which soon divides into two branches, an *inferior* and a *superior*:

(*a*) The *Inferior Œsophageal Artery* runs along the lower face of the œsophagus, and finally anastomoses with the *pleural* branch of the *gastric artery.*

(*b*) The *Superior Œsophageal Artery* runs along the upper face of the œsophagus, and is much larger than the inferior.

The broncho-œsophageal artery supplies *innominate* branches to the trachea, bronchial glands and pleuræ.

II. Parietal Branches.

1. Aortic Intercostals.—Thirteen pairs in all.

Course.—Given off from the upper face of the aorta, and forming a right angle with that trunk, they pass upwards for a short distance to the intercostal spaces, and there divide into *inferior* (or *intercostal proper*) and *superior* (or *dorso-spinal*) branches.

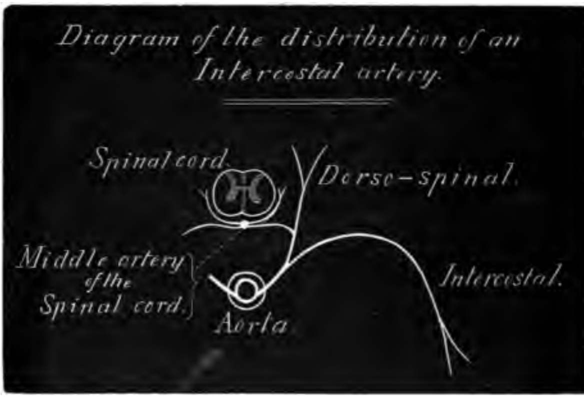

FIG. 2.—DIAGRAM OF THE DISTRIBUTION OF AN INTERCOSTAL ARTERY.

(*a*) The *Inferior Arteries* pass down the posterior borders of the ribs, at first just under the pleura, and afterwards between the intercostal muscles. The anterior eight or nine terminate by anastomosing with the *internal thoracic* and *asternal* arteries; the rest, insinuating themselves between the abdominal muscles, anastomose with the *anterior and posterior abdominals* and the circumflex ilii.

(*b*) The *Dorso-spinal Arteries* pierce the intercostal space, and are distributed to the muscles and skin of the dorsal region. In their course, they give off branches which traverse the intervertebral foramina, gain the under surface of the spinal cord, and unite with the *middle spinal* artery, thus contributing to the volume of that artery.

2. **Diaphragmatic or Phrenic Arteries.**—Two or three in number and small in size; are given off as the aorta passes through the hiatus aorticus.

These arteries are distributed particularly to the crura of the diaphragm, one going to the left crus, and two to the right; in addition, the right supply small branches to the right lung and pleura.

VEINS.

The veins of the thorax are the *anterior and posterior venæ cavæ* and their radicles, and the *cardiac* and *pulmonary veins*.

A. The **Pulmonary Veins** in the lungs are disposed in a manner similar to that of the arteries. Their radicles form from four to eight trunks, which open into the left auricle.

B. The **Cardiac** (or Coronary) **Veins** are one *large* and numerous *small*.

1. The *large coronary* vein arises by two radicles, one of which is lodged in the right longitudinal furrow, the other in the left. The common trunk opens into *the coronary* sinus of the right auricle.

2. The *small coronary* veins (venæ minimæ cordis), numerous and variable, open into the right auricle by means of some of the foramina of Thebesius. It is interesting to note that similar veins open into the left auricle, and also into the ventricles (L. Langer).

The *bronchial veins,* satellites of the arteries, open into the large coronary vein near its termination. In some few instances they enter the auricle directly.

C. **Anterior Vena Cava,** large and short, is formed by the union of the *two jugular* and the *two brachial veins.*

Its branches are:

1. *Internal thoracic,* or mammary vein.
2. *Vertebral* vein.
3. *Superior cervical* vein.
4. *Dorsal* vein.

All these are satellites of the arteries of the same name. On the right side they enter the cava separately, on the left as a common trunk. The *subcostal* branch of the left dorsal is known as the *small vena azygos,* and receives the *intercostal veins* of the left side as far back as the 10th or 11th.

5. The *great vena azygos,* which arises at the 1st lumbar vertebra, passes forwards on the right of the posterior aorta to the level of the 6th dorsal vertebra, where it bends downwards and joins the anterior cava near its termination, or opens into the auricle separately. It receives the posterior thirteen right and the posterior five or six left intercostal veins, as well as the *œsophageal vein.*

The *subcutaneous thoracic* or spur vein sometimes opens into the brachial vein; more commonly, however, it joins the humeral. It commences in the region of the flank, in the substance of the panniculus carnosus; it is related to the upper border of the pectoralis magnus, and passes beneath the posterior brachial muscles to open into the humeral or brachial vein, as the case may be.

D. **Posterior Vena Cava,** which enters the thoracic cavity by the foramen dextrum, passes along the special notch in the right lung in company with the right phrenic nerve, and terminates in the right auricle. It receives the *diaphragmatic* or *phrenic veins,* two or three in number, which arise in the muscular portion of the diaphragm, and enter the cava as it passes through the foramen dextrum.

(For other parts of the posterior cava, see *Abdomen.*)

LYMPHATICS.

I. The **Thoracic Duct** commences as a dilatation at the anterior part of the sublumbar region; this dilatation is known as the *receptaculum chyli,* the *reservoir of Pecquet,* or the *sublumbar reservoir.* The duct passes forwards between the crura of the diaphragm, placed slightly to the right of the aorta. It is *related* to the right intercostal arteries on the left, and the vena azygos above. At about the level of the 6th dorsal vertebra it bends downwards, to open, in the majority of cases, into the jugular confluent, its opening being guarded by valves.

It receives lymph from the whole body, with the exception of the right anterior limb and the right side of the head, neck and thorax.

II. **Glands and Vessels of the Thoracic Viscera.**

1. Numerous small glands along the œsophagus in the posterior mediastinum (*œsophageal glands*).

2. *Bronchial glands*, situated at the bifurcation of the trachea, and receiving *afferent* branches from the lungs.

3. *Tracheal glands*, placed along the lower face of the trachea, and extending from the base of the heart to the level of the first rib. Their *afferents* are from the heart, pericardium, trachea, and œsophagus.

The *efferents* from these three groups of glands open into the thoracic duct at various points.

III. **Glands and Vessels of the Thoracic Walls.**

1. A chain of glands situated on each side of the dorsal vertebræ, which drain the greater part of the lateral thoracic walls.

2. Glands placed anterior to the inferior border of the diaphragm, with afferents from the diaphragm, and efferents which proceed to—

3. Glands related to the internal thoracic artery; the efferents from these either open into the thoracic duct, the ductus lymphaticus dexter, or the prepectoral glands.

THE SPINAL CORD, ETC.

THE **Spinal Cord** is a column of nervous matter extending from the medulla oblongata at the foramen magnum to the anterior third of the sacral region. It is lodged in the *spinal* or *neural canal*, surrounded by the three coverings, or *meninges*.

I. **The Spinal Canal.**—This canal has: (1) A *floor*, formed by the superior faces of the vertebral centra and the interposed discs of cartilage; (2) *lateral walls*, formed by the pedicles; and (3) a *roof*, formed by the laminæ of the vertebræ. The walls and roof together form the **neural arch.** The spinal canal extends from the foramen magnum to the fourth or fifth coccygeal vertebra; its calibre is greatest in the atlas; in the dentata it suddenly becomes much less; in the last few cervical and the anterior dorsal vertebræ the capacity of the tube is increased, as there is freer movement here than in any other part of the vertebral column, and also because of the increase in volume of the cord; about the middle of the dorsal region the canal is very narrow; from this point to the lumbo-sacral union it increases in calibre; in the sacrum itself there is a rapid contraction continued into the coccyx, the canal terminating at about the fourth segment of the coccyx.

II. **The Spinal Meninges**—1. *The Dura Mater.*—The most external covering; it is simply protective, and consists of dense white fibrous tissue arranged in the form of a membranous tube. Anteriorly, it is continuous with the cranial dura mater; posteriorly, it is continued into the coccyx.

Its external surface is very loosely attached to the walls of the neural canal.

The internal surface is smooth, and covered by the external part of the arachnoid.

The tube formed by the dura mater has dilated and contracted portions agreeing with those of the neural canal.

2. *The Arachnoid* (so called from its thin, delicate structure) is the middle covering. It is divided into *parietal* and *visceral portions.*

The *parietal* portion consists of an endothelial layer lining the internal face of the dura mater.

The *visceral* portion is somewhat loosely connected with the *pia mater*, there being a space—the *sub-arachnoid space*—left between the two membranes; this space contains an alkaline fluid—the sub-arachnoid.

The visceral layer is reflected along the spinal nerves as they leave the cord, and is in this way continuous with the parietal layer.

3. *The Pia Mater* is the thin vascular membrane which closely invests the cord, sending numerous processes into its substance and a prolongation into the inferior median fissure. The pia mater is connected with the dura mater by means of an irregular festooned band—the *ligamentum denticulatum*—placed between the superior and inferior roots of the spinal nerves; the processes of the ligamentum are covered by the arachnoid. The posterior extremity of the pia mater is continued beyond the end of the cord, as the

filum terminale, a thin filament enclosed by and uniting with the dura mater.

III. **The Spinal Cord.**—At its commencement the cord is of considerable volume; in its course it has two enlargements, the first extending from near the middle of the cervical region to the 2nd dorsal vertebra—the *cervical enlargement* or *brachio-rachidian bulb*—the second is found in the lumbar region and extends to about the 2nd sacral vertebra; this is known as the *lumbar enlargement,* the *crural* or *lumbo-rachidian bulb;* these enlargements correspond to the points from which the nerves forming the brachial and lumbo-sacral plexuses arise. The posterior extremity of the cord is known as the *conus medullaris.*

Weight.—About 10½ ounces.

External Conformation.—The outer surface of the cord is marked by six fissures: (1) A *superior longitudinal median* fissure; (2) an *inferior longitudinal median* fissure (the pia mater is prolonged into this fissure); (3) two *superior lateral* fissures marking the point of exit of the superior roots of the spinal nerves; and (4) two *inferior lateral* fissures at the points where the inferior roots of the nerves leave the cord. The superior lateral fissures are shallow, and the inferior lateral fissures hardly marked at all.

Structure.—On making a transverse section the cord will be seen to be divided into two symmetrical halves by the superior and inferior median fissures, which, however, do not meet, there being a band of tissue uniting the right and left halves; this band consists of two commissures: (1) a *gray commissure,* found at the bottom of the superior fissure, and containing at its centre the minute *central canal* of the cord, which runs through its entire length, opening anteriorly into the 4th ventricle; (2) a *white commissure*, limiting the inferior median fissure.

Each half of the cord is made up of gray and white nervous matter.

1. The *gray matter* is disposed in a crescentic manner, and is placed internal to the white matter. The tips of the crescent form the **horns** or **cornua.** The superior cornu, sharper than the inferior, is continued to the surface of the cord, where it forms, by means of a single bundle of fibres, the superior root of a spinal nerve. The inferior cornu terminates bluntly at some distance from the surface, and gives off numerous bundles of fibres, which form the inferior root of a spinal nerve.

2. The *white matter* is arranged external to the gray; it is divided into three chief columns: (*a*) The *superior* column, between the superior cornu of gray matter and the superior median fissure; (*b*) the *lateral* column, between the two cornua of gray matter; (*c*) the *inferior* column, between the inferior gray cornu and the inferior median fissure.

The gray matter consists of medullated and non-medullated nerve-fibres, nerve-cells, and connective tissue—*neuroglia.*

The white matter is composed chiefly of medullated fibres.

Blood-supply of the Cord.—The *middle spinal* artery runs underneath the cord in the middle line. It commences in the atlas, being formed by the union of the posterior branches of the two cerebro-spinal arteries; though it is continually supplying branches to the cord and meninges, its volume remains constant. In the cervical region it receives branches—at each intervertebral foramen—from the vertebral artery; in the region of the back, loins and sacrum, similar branches are contributed by the intercostal, lumbar, and lateral sacral arteries respectively.

The *Veins* are arranged in a very tortuous manner on the surface of the cord, and open into two veins placed below it; these veins open into vessels, satellites of the various arteries which join the middle spinal artery.

IV. The **Spinal Nerves** leave the cord by two roots, *superior* and *inferior*.

The *Superior* or *Sensory Root* is composed of nerve-bundles leaving the superior lateral fissure of the cord and piercing the dura mater to gain the intervertebral foramen, where they form a single cord; before it joins the inferior root, a ganglion is formed on this cord.

The *Inferior* or *Motor Root* is similar in origin and disposition to the superior root, which it joins external to the ganglion.

The result of the union of the two roots is a short common cord, which very soon divides into *superior* and *inferior branches*.

NERVES.

I. CEREBRO-SPINAL NERVES.

1. **The Brachial Plexus.**—This large bundle of nerves is found issuing from the space between the two

portions of the scalenus muscles, from which point it is directed downwards and for the most part backwards.

Constitution.—The brachial plexus is formed by the inferior branches of the 6th, 7th and 8th cervical and the 1st and 2nd dorsal nerves. The 6th cervical nerve only supplies a small bundle of fibres; the 7th and 8th, on the other hand, contribute the whole of their inferior branches; the whole of the inferior branch of the 1st dorsal, with the exception of a small filament which forms the 1st intercostal nerve, passes to the plexus, but only a very small branch is furnished by the 2nd dorsal nerve. All these nerves unite to form a common broad band of nervous tissue, placed first between the longus colli and the scalenus, and afterwards between the two portions of the scalenus.

After leaving the interspace of the scalenus, the plexus passes downwards to gain the inner face of the shoulder-joint, at which point it splits up into numerous branches.

Branches.

(*a*) **Diaphragmatic Branches.**—Though the *diaphragmatic* or *phrenic* nerve is not wholly formed from the brachial plexus, yet we will consider it here for the sake of convenience.

The *phrenic* nerve is formed by branches from the 5th, 6th and 7th cervical nerves; the branch from the 5th nerve is not constant. Entering the thorax in company with the pneumogastric, the phrenic nerve gains the base of the heart, from which point the course of each nerve is somewhat different. The *left* passes along the posterior mediastinum, and so gains the diaphragm; the *right* gains the notch in the right lung formed for the passage of the vena cava.

(*b*) **Angularis and Rhomboideal Branches.**—These two branches pass upwards, to terminate in the levator anguli scapulæ (the cervical portion of the serratus magnus) and the rhomboideus.

(*c*) **Serratus Magnus or Superior Thoracic Nerve.**—This nerve is formed by the 7th and 8th cervical nerves. It passes backwards to the serratus magnus, in which muscle it is buried.

(*d*) **Subcutaneous Thoracic Nerve.** — This branch arises principally from the 1st dorsal, some of its filaments, however, coming from the 8th cervical. It is a satellite of the spur vein, and terminates in the panniculus carnosus.

(*e*) **Pectoral or Inferior Thoracic Nerves.** — Five nerves are generally described—one passing to the pectoralis parvus, a second terminating in the transversus and anticus, and three others supplying the magnus.

These nerves are formed by the 7th and 8th cervical and 1st dorsal nerves; the branch to the pectoralis transversus and anticus arises from the median and musculo-cutaneous nerves.

(*f*) **Great Dorsal or Latissimus Dorsi Nerve.**—This is formed by fibres derived chiefly from the 8th cervical nerve. It passes upwards and backwards, to terminate in the latissimus dorsi.

(*g*) **Circumflex or Axillary Nerve.**

(*h*) **Teres Internus Nerve.**

(*i*) **Subscapular Nerve.**

(*j*) **Prescapular Nerve.**

(*k*) **Musculo-cutaneous or Anterior Brachial Nerve.**

(*l*) **Radial Nerve.**

(*m*) **Ulnar or Cubital Nerve.**

(*n*) **Median Nerve.**

These branches are all distributed to the anterior limb, and are described in the section devoted to that part of the body (Part I.).

2. **Pneumogastric or 10th Pair of Cranial Nerves.**— These enter the thorax along with the trachea.

Relations.—The *right nerve* crosses the brachial artery in an oblique manner, then passes upwards, outwards and backwards along the trachea as far as the bronchi.

The *left nerve* passes below the brachial artery, and follows the anterior aorta lying along the trachea; at the root of the lungs it is related with the two aortæ internally.

Both nerves terminate at or near the termination of the trachea in the *bronchial plexus* and *œsophageal nerves.*

A. Collateral Branches (Thoracic).

(*a*) **Inferior or Recurrent Laryngeal Nerves.**—The *right* leaves the parent trunk on a level with the 1st rib, and winds round the dorsal artery, then runs forwards along the side of the trachea.

The *left nerve* leaves the pneumogastric trunk near the root of the lungs, passes round the aortic arch, and, proceeding forwards, gains the lower face of the trachea.

(*b*) Certain filaments are contributed to the formation of the *cardiac plexus.*

B. **Terminal Branches.**

(*a*) **Bronchial Plexus.**—This is formed by numerous filaments which leave the parent trunk at the root of the lungs. They follow the bronchi into the substance of the lungs.

(*b*) **Œsophageal Nerves.**—A *superior* and an *inferior* branch is given off by each pneumogastric. The two superior and the two inferior nerves soon join to form single *superior* and *inferior* nerves, which run along the upper and lower faces of the œsophagus.

The *superior* enters the abdominal cavity, and terminates in the *solar plexus,* after contributing some filaments to the left sac of the stomach and anastomosing with the inferior.

The *inferior* also enters the abdomen, and terminates by forming a plexus on the smaller curvature of the stomach, which sends numerous branches to the right sac.

3. **Dorsal (Spinal) Nerves.**—Seventeen pairs in all. These leave the spinal canal by the intervertebral foramina, and divide into *superior* and *inferior* branches.

(*a*) *Superior Branches.*—These pass upwards and divide into two chief branches, one supplying the dorsal muscles and skin, the other the longissimus dorsi.

(*b*) *Inferior Branches.*—Descend beneath the pleura, and, along with the intercostal artery and vein, down the posterior border of the ribs. Near their origin ntribute numerous small branches to the *ıetic.*

Those *anterior to the ninth* terminate in the pectoral muscles and skin.

The *posterior nine* enter the muscles of the abdominal walls, and, passing between the transversalis and rectus abdominis, terminate in the skin.

Perforating intercostal branches are furnished to the panniculus and skin.

Variations of the Inferior Branches.—The 1st goes to the brachial plexus almost entirely, its intercostal branch being very small.

The 2nd also contributes to the brachial plexus.

The 17th contributes an anastomotic branch to the 1st lumbar.

II. SYMPATHETIC SYSTEM.

The thoracic portion of the sympathetic system consists of a double chain of ganglia (seventeen in number—all, however, not equally well represented), which reaches from the inferior cervical ganglion to the diaphragm. These ganglia, more or less fusiform in shape, are arranged below the articulations of the ribs with the dorsal vertebræ, related to the intercostal arteries, and held in position by their afferent branches and the pleura.

The **Afferent Branches** are derived from the inferior divisions of the dorsal nerves.

The **Efferent Branches** are:

1. Numerous small filaments which supply the pleura, etc.

2. *Great Splanchnic Nerves*, which begin about the 6th or 7th ganglion, and, passing backwards, receive

branches from each successive ganglion except the last two or three. They enter the abdominal cavity, being related to the psoas parvus, and terminate in the *solar* or *semilunar ganglion* (see *Abdominal Cavity*).

3. *Lesser Splanchnic Nerves,* made up of filaments from the posterior two or three ganglia, pass directly to the *solar plexus.*

THE ABDOMEN AND PELVIS.

THESE two cavities will be described together for the sake of simplicity and convenience.

The **roof** is formed by the lumbar and sacral vertebræ and the attached muscles.

The **lateral walls** are formed by the abdominal and other muscles, the ilia, and the sacro-sciatic ligaments.

The **floor** (1) of the abdomen is formed by the abdominal tissue and muscles, (2) of the pelvis is formed by the pubes and ischia.

The **anterior extremity** is concave, and formed by the diaphragm.

The **posterior extremity,** known as the *outlet of the pelvis,* is occupied by the terminal portions of the alimentary and genital (in female) tracts.

For convenience in the location of organs the cavity of the abdomen is divided into nine regions, as shown in the following diagram:

ANTERIOR.

	Right Hypochondriac.	Epigastric.	Left Hypochondriac.	
RIGHT.	Right Lumbar.	Umbilical.	Left Lumbar.	LEFT.
	Right Iliac.	Hypogastric.	Left Iliac.	

POSTERIOR.

THE PERITONEUM

is the serous membrane lining the abdominal cavity and reflected over the viscera contained within it.

Like other serous membranes, the peritoneum consists of two portions, (1) a parietal, and (2) a visceral.

The peritoneum helps to retain the organs in position, and to convey bloodvessels, etc., to and from them; its duplicatures so concerned are known as *mesenteries, omenta* and *ligaments*, and will receive detailed description in connection with the organs to which they are attached.

The **Peritoneal Cavity** is divided into two parts:

1. An anterior smaller cavity existing behind the stomach, and limited posteriorly by the fixed portion of the large colon.

2. A posterior or great peritoneal cavity.

These cavities are in communication by means of the *foramen of Winslow*.

The *structure* of the peritoneum is like that of serous membranes in general.

The **Viscera** of the abdominal and pelvic cavities belong to (1) the *alimentary,* (2) the *urinary,* and (3) the *generative* systems.

A. *THE ALIMENTARY SYSTEM*

includes the œsophagus (a small portion), the stomach, intestines, and various accessory glands.

THE ŒSOPHAGUS.

The abdominal portion of the **Œsophagus** is very short, and related to the fissure in the upper margin of the liver. It opens into the stomach in an abrupt manner, and its mucous membrane forms a fold known as the *valve of Gurlt.*

THE STOMACH

is a somewhat crescentic dilatation of the alimentary tract.

Situation.—In the left hypochondriac and epigastric regions.

Capacity.—3 to 4 gallons.

Weight.—3 to 4 pounds.

External Conformation.—It presents two faces, two curvatures, and two extremities.

The *anterior and posterior faces* are smooth and convex.

The *greater curvature* is convex, forms the inferior border, and has the spleen attached to it by means of the gastro-splenic omentum.

The *lesser curvature* is concave, superior, and attached to the liver by means of the gastro-hepatic

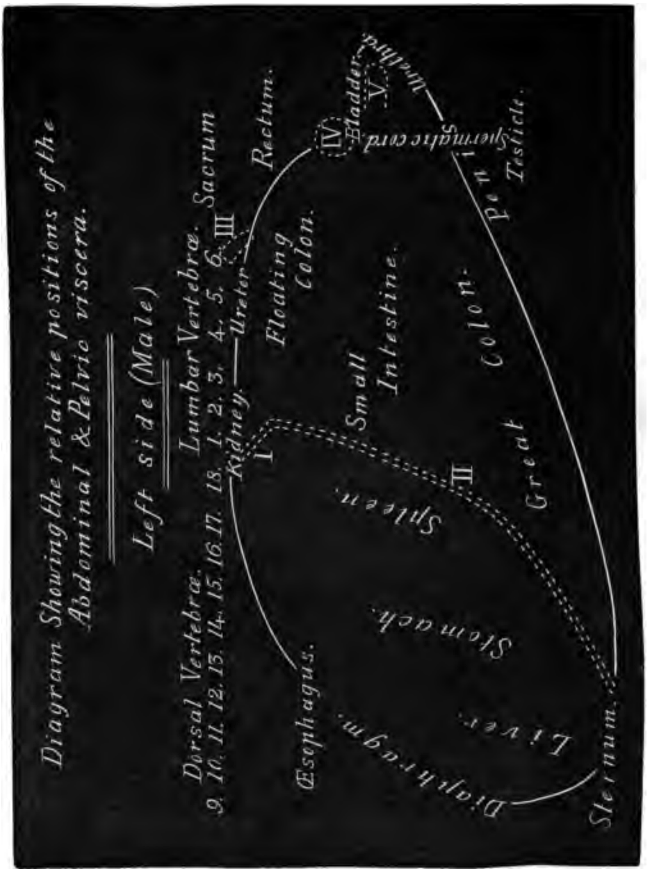

FIG. 3.—DIAGRAM SHOWING THE RELATIVE POSITIONS OF THE ABDOMINAL AND PELVIC VISCERA. (LEFT SIDE—MALE.)

I. Last rib. II. Asternal costal cartilages. III. Anterior iliac spine. IV. Hip-joint. V. Ischial arch.

omentum. The œsophagus joins the stomach in the lesser curvature.

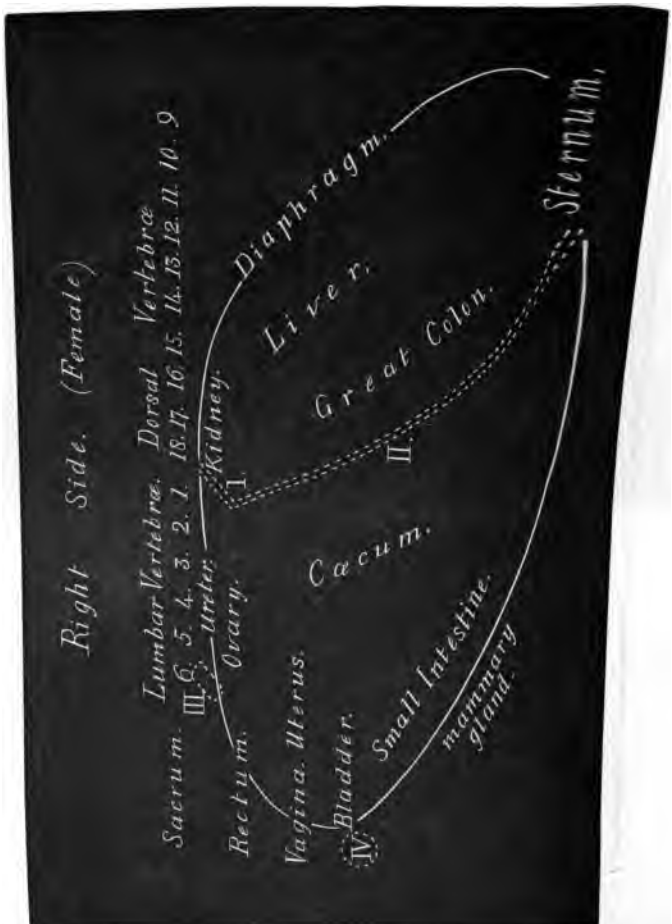

Fig. 4.—Diagram Showing the Relative Positions of the Abdominal and Pelvic Viscera. (Right Side—Female.)

The *left* or *cardiac extremity* is larger than the right, and forms a tuberosity known as the *left cul-de-sac*, or *fundus* of the stomach.

The *right* or *pyloric extremity* leads to the duodenum, there being, however, a constriction between the two. This extremity forms the *right cul-de-sac* of the stomach.

Internal Conformation.—The interior of the stomach is divided into two parts, in each of which the mucous membrane presents distinct appearances; on the left it is pale and hard, on the right it is soft, velvety, and reddish in colour.

The cavity of the left cul-de-sac communicates with the œsophagus by means of the *cardiac orifice*, which in solipeds is narrow and guarded by a fold of mucous membrane.

The cavity of the right cul-de-sac opens into the duodenum, through the *pyloric orifice*, which can be closed by means of a ring of muscular tissue known as the *pyloric ring*.

Relations.—*Anteriorly*, the diaphragm and liver; *posteriorly*, the diaphragmatic flexure of the great colon; *inferiorly*, and *to the left*, the spleen; *to the right*, the right lobe of the liver, and the duodenum.

Structure.—The wall of the stomach consists of four coats:

1. *Serous*, a reflexion from the peritoneum.

2. *Muscular.*—In this coat the fibres are arranged in three directions: (*a*) *Longitudinal* and superficial, principally found at the left extremity and along the curvatures; (*b*) *circular* or middle, distributed over the entire viscus, and forming the pyloric ring; (c)

oblique or internal, found principally at the left extremity, becoming lost over the greater curvature.

3. *Submucous*, consisting of loose connective tissue uniting the muscular and mucous coats.

4. *Mucous.*—This coat is divided into two almost equal portions: (*a*) The *cuticular* portion, occupying the left half of the cavity, has a pale appearance, and resembles the mucous membrane of the œsophagus in structure, possessing stratified squamous epithelium; (*b*) the *villous* portion, situated on the right side, is soft, and velvety in appearance. It differs from the left portion in having a honeycombed appearance (when examined with a low-power lens), and in having columnar epithelium and digestive glands. The villous portion is much more vascular than the cuticular, and is consequently redder in colour.

The line of demarcation between the two portions is known as the *cuticular ridge*.

When the stomach is empty, the mucous membrane is thrown into folds or *rugœ*.

Blood-supply.—From the gastric and right and left gastro-epiploic arteries. The veins open into the vena portæ.

Nerve-supply.—From the pneumogastric and solar plexus of the sympathetic. Two nerve plexuses are found in the substance of the walls of the stomach: *Auerbach's*, in the muscular tissue; and *Meissner's*, in the submucosa.

THE INTESTINES

are divided into **small** and **large**, according to **their** *calibre*.

I. The Small Intestine

extends from the pyloric orifice of the stomach to the *cæcum* (the head of the large intestine), and is arbitrarily divided into three portions:

1. The **Duodenum** (*duodecim*, twelve—twelve fingers' breadth).

2. The **Jejunum** (*jejunus*, empty. It is usually found empty after death).

3. The **Ileum** (εἰλεῖν, to twist).

Situation, etc.—Commencing at the right extremity of the stomach, the small intestine, presenting a dilatation, passes forwards for a short distance, then backwards and to the left; the greater part of its convolutions is situated in the left flank, but its terminal portion crosses to the right to open into the concavity of the arch of the cæcum, below the commencement of the large colon.

External Conformation, etc.—The small intestine presents two curvatures: a *greater*, inferior and free; and a *lesser*, superior and attached to the *mesentery*, a reflection of the peritoneum. The diameter of the tube varies from 1 to 2 inches, and its length is about 72 feet. It is held in position by its attachments to the stomach and cæcum, and by means of the mesentery, which suspends it from the abdominal roof.

Internal Conformation.—The inner face presents a number of longitudinal folds when the tube is not distended. The termination of the tube possesses a ring of mucous membrane known as the *ilio-cæcal valve*, or *valve of Bauhini*, which prevents the passage of ingesta from the cæcum into the ileum.

Structure.—Like the other parts of the abdominal alimentary tract, the small intestine possesses four coats:

1. *Serous*, derived from the peritoneum.

2. *Muscular*, the fibres of which are arranged in two layers and directions: (*a*) *Outer* or *longitudinal*, and (*b*) *inner* or *circular*.

3. *Submucous*.

4. *Mucous*.—This coat is soft and vascular; it has columnar epithelium, a variety of glands, and finger-like projections known as *villi*.

The intestinal glands are:

(*a*) Those possessing ducts—Brunner's and follicular. *Brunner's* glands are confined to the duodenum, and are racemose in structure.

The *follicular glands* or *Lieberkühn's follicles* are very numerous, and scattered throughout the entire extent of the intestine. In shape they are simple tubular depressions.

(*b*) Those without ducts—Solitary and agminated.

Solitary glands are small rounded bodies consisting of lymphoid tissue. (They are more numerous in the large intestine.)

Agminated glands or *Peyer's patches* are collections of solitary glands, and are only found in the jejunum and ileum, more plentifully and larger in the latter. They are circular or oval in shape, having a diameter of about an inch, and situated internal to the greater curvature of the intestine.

Blood-supply.—From the anterior or great mesenteric artery. Its veins join the vena portæ.

Nerve-supply.—From the sympathetic through the solar plexus, the nerves being arranged in two plexuses — *Auerbach's plexus*, between the longitudinal and circular muscular coats; and *Meissner's plexus*, in the submucous coat.

The **Lacteals** (lymphatics) commence in the villi.

Structure of a Villus.—Columnar epithelium on a basement membrane, under which is loose connective (adenoid) tissue containing a few muscular fibres (muscularis mucosæ), a network of capillaries, and in the centre one or two lacteals, which commence near the apex of the villus, by blind extremities.

II. The Large Intestine.

Commences as the cæcum and terminates at the *anus*, the posterior opening of the alimentary canal. It consists of four distinct portions: (1) Cæcum, (2) great colon, (3) floating colon, and (4) rectum.

1. **Cæcum** (Caput Cæcum Coli).

Situation.—Extends downwards and forwards from the right iliac to the left hypochondriac region.

Capacity.—From 6 to 8 gallons.

External Conformation.—It is an elongated conical tube, having a length of about 36 inches. It may be divided into three portions: (*a*) A *base*, or *arch*, with its concavity looking forwards, and the ileum and great colon opening into it; (*b*) a *middle* straight portion; and (*c*) an *apex*, or anterior extremity, which is related to the xiphoid cartilage. The external surface of the cæcum shows numerous sacculations, due to the presence of four longitudinal muscular bands. It is held in position by its attachments to the ileum and great colon, and by means of a duplicature of the peritoneum, known as the *meso-cœcum.*

Internal Conformation.—The internal surface of the cæcum presents a number of transverse ridges, corresponding to the furrows on the outer surface. At the concavity of the arch are two openings, the inferior one of which is the opening of the ileum, and is guarded by the ilio-cæcal valve; the second opening —1½ to 2 inches above the first—marks the communication between the cæcum and large colon.

Structure.—The cæcum possesses the customary four coats:

1. *Serous.*
2. *Muscular.*—The longitudinal fibres of this coat are collected into bands, four in number.
3. *Submucous.*
4. *Mucous.*—The mucous membrane has Lieberkühn's follicles, solitary glands, and a few villi. There are no Peyer's patches or Brunner's glands.

Blood-supply.—From the anterior mesenteric artery; the veins opening into the vena portæ.

Nerve-supply.—From the sympathetic.

2. **Great Colon.**

Situation, etc.—It consists of four portions. Commencing at the arch of the cæcum, it passes downwards and forwards towards the sternum; arriving above the xiphoid cartilage, it bends towards the left, this being known as the *sternal* or *xiphoid* flexure. The second portion runs backwards to the left of the first portion, and, reaching the entrance to the pelvic cavity, turns upwards and to the left. This is the *pelvic flexure.* The third portion passes downwards towards the diaphragm, being placed above and to the left of the second portion. The third portion terminates at the diaphragm by turning to the right, and so forming the *diaphragmatic* or *gastro-hepatic flexure*. At this point the fourth portion has its beginning, and running backwards above and to the left of the first portion, it terminates by a sudden contraction near the base of the cæcum, and opens into the floating colon. The first and fourth portions are united to each other by peritoneum, as are also the second and third portions. The first and second portions lie along the abdominal floor.

Capacity.—As much as 18 gallons.

External Conformation.—The large or great colon presents itself as a sacculated tube, from 9 to 11 feet in length, and of varying calibre. The first and second portions are of about the same diameter, the third is the narrowest part of the tube, and the fourth portion is the widest. The puckered appearance, as in the cæcum, is due to the presence of longitudinal muscular bands; four of these bands exist on the first two portions, only one on the third, and three on the fourth portion.

The great colon is held in position (1) by its attachments to the cæcum and floating colon, (2) by cellular tissue to the pancreas and cæcum, and (3) by peritoneum (the *meso-colon*).

Internal Conformation.—This is the counterpart of the external appearance.

Structure—1. *Serous Coat.*—This is only interrupted where two portions come into contact, or where a part of the colon is attached to other viscera.

2. *Muscular Coat.*—As in the cæcum.

3. *Submucous Coat.*

4. *Mucous Coat.*—Almost identical with that of the cæcum.

Blood-supply.—The two colic branches of the anterior mesenteric artery ; the veins going to the vena portæ.

Nerve-supply.—From the sympathetic.

3. Small or Floating Colon.

Situation, etc.—This continues the great colon, from which it arises, to the left of the base of the cæcum. It is situated in the left flank, its convolutions being mixed with those of the small intestine. It terminates at the pelvic inlet in the rectum.

External Conformation.—It is a sacculated tube about 10 feet in length, and possessing a calibre of about 2 inches. The sacculations are produced by two longitudinal muscular bands, which are continuous with two of those on the fourth portion of the great colon. The floating colon is suspended from the abdominal roof by means of the *colic mesentery*, a duplicature of the peritoneum.

Internal Conformation. — Resembling that of the cæcum and great colon.

Structure—1. *Serous Coat.*

2. *Muscular Coat.*

3. *Submucous.*

4. *Mucous.*

Blood-supply.—Anterior and posterior mesenteric arteries ; the veins join the vena portæ.

Nerve-supply.—Sympathetic.

4. Rectum.

Situation, etc.—This is a straight tube about 18 inches in length, running from the anterior part of the pelvis to the anus.

External Conformation.—This differs from that of the preceding portions of the large intestine in having no puckerings, and in its serous covering being incomplete. It is held in position by (1) the meso-rectum, a prolongation of the colic mesentery; (2) the peritoneum; (3) two triangular fasciculi attached to the lower face of the coccyx; and (4) by the suspensory ligaments of the penis, which form a ring in which its posterior part rests.

Relations.—The relations of the rectum are of an important character, and are: *Superiorly,* the sacrum; *inferiorly,* the bladder, vesiculæ seminales, vas deferens, prostate and Cowper's glands in the male, or the vagina and uterus in the female; *laterally,* the pelvic walls.

Structure.—1. *Serous Coat.*—This is incomplete, being absent posteriorly.

2. *Muscular Coat.*—Very thick, and consisting of longitudinal and circular fibres.

3. *Submucous.*—Loose.

4. *Mucous Coat.*—Very loosely attached to the muscular coat, and thrown into ridges.

Blood-supply.—Posterior mesenteric and internal pudic arteries.

Nerve-supply.—From the hypogastric plexus.

The **Anus** is the posterior opening of the alimentary canal, and is placed just below the base of the tail. It shows itself externally as a rounded projection which becomes less prominent in the aged.

Structure—1. *Skin.*—This is soft, thin, and hairless, and possesses numerous sebaceous glands.

2. *Muscles,* three in number :

(*a*) *Sphincter Ani.* — This is really a double muscle, consisting of an *internal* ring of involuntary fibres continuous with the circular fibres of the rectum, and an *external* ring of voluntary fibres, some of which are attached to the lower surface of the tail.

(*b*) *Retractor Ani* (or Ischio-anal Muscle). — Arises above the acetabulum, and from the inner surface of the sacro-sciatic ligament. It is a broad band of muscular tissue, and blends with the sphincter. It retracts the anus and posterior part of the rectum.

Under the name of *levator ani,* the triangular fasciculi already mentioned are included in the list of anal muscles.

3. *Mucous Membrane.*—This is continuous with the mucous membrane of the rectum, and blends with the skin.

THE LIVER.

Situation.—Behind the diaphragm, in the epigastric, right hypochondriac, and (in a less degree) left hypochondriac regions.

Weight.—From 9 to 11 pounds.

Conformation.—It presents *two surfaces* and a *circumference.*

1. The *anterior surface* is convex and smooth, and opposed to the posterior face of the diaphragm. The

anterior or *longitudinal* fissure passes downwards and forwards along this surface; this fissure is occupied by the posterior vena cava. The hepatic veins leave the liver by the anterior fissure.

2. The *posterior surface* is also smooth, convex, and marked by a fissure, the *transverse* or *posterior*, by means of which the portal vein, hepatic artery and Glisson's capsule *enter*, and the bile-ducts and lymphatics *leave*, the liver.

3. The *circumference* is thin and notched, and has been divided into two *borders*: (*a*) A *superior*, or left, which presents the attachments of the lateral ligaments, the upper extremity of the anterior fissure, and a notch for the œsophagus, (*b*) an *inferior*, or right, which is divided by the two notches separating the middle from the two lateral lobes.

The liver is divided into five lobes:

(*a*) *Right lateral*, or superior, from the supero-posterior part of which springs the

(*b*)* *Lobulus caudatus*, which is small and triangular.

(*c*) *Left lateral*, or inferior, which is sometimes larger than the right. In the young subject, however, the right lobe is invariably the larger.

(*d*) *Middle*, or lobulus quadratus, more or less quadrilateral in shape, and situated inferiorly between the right and left lateral lobes.

(*e*)* *Spigelian lobe*: this, when present, forms a small projection to the left of the lobulus caudatus.

The liver is held in position by means of the blood-

* Some authors reverse these two names, calling the Caudate lobe the Spigelian, and the Spigelian the Caudate.

vessels, etc., which enter and leave it, and by the following six *ligaments* :

1. The *coronary ligament;* passes from the anterior fissure to the phrenic centre. It consists of aponeurotic fibres, which are intimately connected with the posterior cava.

2. The *left lateral ligament;* unites the superior margin of the left lobe to the phrenic centre near the foramen sinistrum.

3. The *right lateral ligament;* passes from the upper margin of the right lobe to the diaphragm.

4. The *ligament of the lobulus caudatus;* is small, and passes from the Caudate lobe to the fibrous tissue about the right kidney.

5. The *broad* or *suspensory ligament;* is (like the above) composed of a double fold of peritoneum, strengthened by fibrous tissue, and unites the middle lobe to the diaphragm and abdominal floor. Between its folds a fibrous cord is found; this has been called

6. The *round ligament,* and differs from the other ligaments in being the remains of a fœtal structure, the umbilical vein. It extends from the anterior fissure of the liver to the umbilicus.

Relations.—Anteriorly, the diaphragm; *posteriorly,* the stomach, the duodenum, the diaphragmatic flexure of the colon, and the pancreas. It also contacts the right kidney.

Structure.—1. A *serous* covering derived from the peritoneum, and continuous over its surface, except at the anterior and posterior fissures.

2. A *fibrous* covering, or *Glisson's capsule.* This is thin and membranous, and closely applied to the

hepatic substance, which it penetrates at the fissures, to form the *portal canals* and *interlobular connective tissue*.

3. *Hepatic substance*. The liver substance is divided into *lobules*, or acini, which on section may be seen by the naked eye as small areas about $\frac{1}{20}$th of an inch in diameter. The lobules are separated from each other by connective tissue. On microscopic examination, in the centre of the lobule will be seen a large vessel—the central or intralobular vein—the rest of the lobule being occupied by large polygonal epithelial cells, the *liver* or *hepatic* cells. Each liver-cell is about $\frac{1}{1000}$th of an inch in diameter, and contains a spherical nucleus with granular protoplasm; fat-globules are frequently found in these cells.

The *Blood-supply* of the liver is from two sources: (1) The portal vein, which supplies it with functional blood; and (2) the hepatic artery, which carries nutritive blood.

The distribution of the *portal vein* is peculiar and important. It drains the stomach, intestines, pancreas, and spleen, and then enters the posterior fissure of the liver; passing along the portal canals, it repeatedly divides until it gains the interlobular connective tissue; here its smaller branches form an *interlobular plexus*, from which capillaries enter the lobule and form the *intralobular plexus;* these capillaries pass to the centre of the lobule, and here pour their blood into the *central* or *intralobular vein*. The intralobular veins unite to form *sublobular* veins, which in their turn form the *hepatic veins*, these leaving the liver by the anterior fissure, and opening into the posterior vena cava.

The *hepatic artery* also enters the liver by the posterior fissure, and ramifies in the portal canals. It divides into three sets of branches:

1. *Rami capsulares*, to the fibrous tissue.
2. *Rami lobulares*, to the lobules.
3. *Rami vasculares*, to the walls of the vessels.

The *bile-ducts* commence as *bile-capillaries*, minute channels between the liver-cells; these open into the *small interlobular bile-ducts*, which have thin fibrous walls and an epithelial lining consisting of a single layer of columnar cells. *Larger interlobular ducts* result from the union of the small ducts; these ducts are found in the portal canals, and are the radicles of the *main bile-duct*, which leaves the liver by the posterior fissure, passes between the folds of the gastro-hepatic omentum, and opens into the duodenum in company with the duct of the pancreas, the common opening being guarded by an elevation of mucous membrane known as the *ampulla of Vater*.

There is no gall-bladder in the horse.

THE PANCREAS.

This organ has been called the *abdominal salivary gland*, from its structure and appearance. It belongs to the class of compound racemose glands.

Situation.—In the sublumbar region, anterior to the kidneys and posterior to the stomach and liver.

Weight.—About 17 ounces.

Conformation.—This is very variable, but usually it is somewhat triangular. The *pancreatic ring* is a channel running obliquely upwards and forwards, and commencing on the lower face of the gland; this ring is occupied by the vena portæ. The pancreas may be said to present *two faces, two borders,* and *two extremities.*

The *superior surface* is lobulated like the surfaces of the salivary glands. It is related to the posterior aorta, posterior cava, cœliac axis, solar plexus, right kidney, and right adrenal, to which structures it is attached by loose fibrous tissue.

The *inferior surface* is also lobulated, and related to the base of the cæcum and the termination of the great colon.

The *anterior border* is concave, and contacts the stomach and duodenum.

The *posterior border* is convex.

The *right extremity* presents the *duct of Wirsung,* the principal excretory duct of the gland.

The *left extremity* is placed between the stomach and left kidney.

Relations.—These have been given above.

Structure.—This is almost identical with that of the true salivary glands. The epithelium lining the intralobular ducts is only faintly striated, but the intermediary duct and its termination in the alveoli are the same as in the salivary glands. The epithelium of the alveoli consists of columnar or pyramidal cells, showing two zones—an outer, homogeneous or only faintly striated; and an inner, more transparent, granular in appearance. The lumen of an alveolus is very small.

There are two excretory ducts: (1) The principal one, or *duct of Wirsung*, commences as two or three roots, and leaves the pancreas at the left extremity; it opens into the duodenum along with the ductus choledochus, after passing obliquely through the wall of that intestine; the common orifice of these two ducts is guarded by an elevation of mucous membrane, the *ampulla of Vater*. (2) The accessory duct, or *ductus pancreaticus minor*: this leaves the principal duct, receives a few branches, and opens into the duodenum opposite to the duct of Wirsung.

Blood-supply.—From the hepatic and anterior mesenteric arteries.

Nerve-supply.—From the sympathetic through the solar plexus.

THE SPLEEN.

This is a ductless gland (unless we consider the splenic vein to be its duct), and belongs to the so-called vascular glands.

Situation.—In the left hypochondriac region, along the greater curvature of the stomach.

Weight.—From 2 to 4 pounds.

Conformation.—It is falciform in shape, and presents *two surfaces*, *two borders*, a *base*, and an *apex*.

The *external surface* is flat, and contacts the diaphragm.

The *internal surface* is somewhat concave, and related to the great colon.

The *posterior border* is convex and thin.

The *anterior border* is concave, thick, and excavated *by the splenic fissure*, or *hilus*, which lodges the splenic vessels and nerves. To this border is attached the gastro-splenic omentum.

The *base*, or superior extremity, is thick and large, contacts the left kidney, and has attached to it the *suspensory ligament.*

The *apex* terminates in a blunt point, and is directed downwards and to the right.

The spleen is held in position by (1) the *gastro-splenic omentum*, which passes from the greater curvature of the stomach; and (2) the *suspensory ligament*, which passes from the base of the spleen to the left kidney and abdominal wall.

Structure.—1. A *serous* membrane, derived from the peritoneum, and covering the whole organ except at the fissure.

2. A *fibrous capsule*, consisting of white fibrous and elastic tissue, with bundles of non-striated muscle fibres. From this external capsule numerous *trabeculæ* —small branching and anastomosing cylindrical bands — pass into the *splenic pulp*, and after frequent branching they disappear in the pulp.

3. The *parenchyma* fills up the meshes of the fibrous network formed by the trabeculæ, and consists of two kinds of tissue, Malpighian corpuscles and pulp.

The **Malpighian Corpuscles** are small collections of lymphoid tissue, and are attached to the wall of the smaller branches of the splenic artery, the outer surface of which is provided with a sheath of this tissue.

The **Pulp** forms the bulk of the organ, and consists of a matrix of large irregular endothelioid cells arranged as a network, the spaces of which intercommunicate, and contain lymph and blood corpuscles.

Blood-supply.—Splenic artery, a branch of the cœliac axis.

Nerve-supply.—Sympathetic.

B. *THE URINARY SYSTEM*

comprises the two *kidneys*, the *ureters*, the *urinary bladder*, and the *urethra*.

I. THE KIDNEYS,

two in number—*right* and *left*—are the essential organs concerned in the excretion of urine.

Situation.—They are placed on each side of the mesian plane, in the sublumbar region, the right being an inch or two in advance of the left. They are held in position by means of fibrous and adipose tissue, by the peritoneum which covers their lower face, and by the upward pressure of the intestines, etc.

Weight.—The right is about 21 ounces, and the left about 19 ounces in weight.

External Conformation.—The two glands differ from each other in this, as in other respects : The right has an outline resembling the heart on a playing card, and the left is more elongated, resembling a kidney bean. Each kidney may be said to possess two surfaces (an upper and a lower), two borders (internal and external), and two extremities.

The *surfaces* are convex and smooth, the lower being covered with peritoneum.

The *extremities* and *outer border* are also convex and smooth.

The *internal border* presents a deep notch, the *hilus* or *fissure* of the kidney, by which the bloodvessels, nerves and ureters enter or leave the gland.

Relations.—The *right: Superiorly*, the psoas magnus, right crus of the diaphragm, and the last rib; *inferiorly*, the peritoneum; *internally*, the posterior vena cava; *anteriorly*, the caudate lobe of the liver.

FIG. 5.—OUTLINES OF THE HORSE'S KIDNEYS.

The *left* differs from the right in its relations in the following particulars: *Internally*, the posterior aorta; *anteriorly*, the base of the spleen and the pancreas.

On section of a kidney, it is found to be hollow, the internal cavity being known as the *pelvis*, and consists of an *infundibulum* and two lateral diverticula, the *arms*.

Structure.—1. A *serous covering*, which is only found on the lower face.

2. A *fibrous capsule* and *framework*, which is thin, and resembles in its disposition the capsules of glands in general.

3. *Gland parenchyma.* On section of the kidney, three zones, or layers, are to be seen—an outer (*cortical layer*), a middle (*boundary layer*), and an internal (*medullary* or *papillary layer*).

The cortex appears granular to the naked eye, owing to the Malpighian bodies and convoluted tubules it contains.

The boundary layer is darker in colour than the other two portions.

The medullary portion appears fibrous or striated, this being due to the straight portions of the uriniferous tubules.

We have to consider the arrangement of the *uriniferous tubules* and the *bloodvessels*.

A **Uriniferous Tubule** consists of a thin, continuous *membrana propria*, which is lined by a single layer of epithelial cells.

Portions of a Uriniferous Tubule.—(1) Each tube commences as a **capsule of Bowman**, which is widened and surrounds a tuft of capillaries known as a *glomerulus;* the two structures form a *Malpighian corpuscle.* The glomerulus is formed by the splitting up of an *afferent vessel* into capillaries, these again uniting to form an *efferent vessel.*

(2) The **neck**, a constricted portion, immediately succeeds the capsule of Bowman.

(3) The **proximal convoluted tube** comes next,

and is of considerable length, ultimately passing into

(4) The **proximal spiral tube.** The above portions are found in the cortex.

At the boundary layer,

(5) The **descending loop-tube of Henle** begins, and runs towards the pelvis of the kidney.

(6) The **loop of Henle** is the turning-point from which

(7) The **ascending loop - tube** commences. This passes back again towards the cortex, where it ends at the

(8) **Irregular tubule**, or **distal spiral tube.** This is succeeded by

(9) The **distal convoluted tube**, which passes into

(10) The **curved collecting tube.** The next portion is

(11) The **straight collecting tube,** which passes into the medullary layer, and, meeting other similar tubes, forms

(12) The **ducts of Bellini**, which finally open into the pelvis of the kidney.

The epithelium possesses different characteristics in the different portions. In (1) and (2) the cells are squamous; in (3) short columnar or cubical; in (4), polyhedral; in (5) and (6) squamous; in (7), (8) and (9) polyhedral or short columnar; in (10) and (11) polyhedral; and in (12) columnar.

The *Blood-supply* is from the renal artery, which has a rather peculiar arrangement; it enters the kidney at or near the hilus by means of a number of branches. It further divides in the boundary layer, and distributes branches to the cortex and medulla.

(*a*) The branches in the cortex are the *interlobular arteries,* and supply the *afferent arterioles* forming the *glomeruli.* Some of the interlobular arteries terminate in the capsule of the gland. From the glomeruli *efferent arterioles* spring, and these divide into a second set of capillaries around the convoluted tubules.

(*b*) The branches in the medulla are called the *arteriæ rectæ.*

The Veins.—(*a*) The veins of the cortex commence as the *venæ stellatæ* under the capsule, and pass towards the boundary layer in company with the interlobular arteries, finally opening into the large venous roots of the renal vein, which are situated in this layer.

(*b*) In the medulla the veins are arranged in a manner similar to the arteries, and are known as the *venæ rectæ;* they pass to the boundary layer, and open into the large branches already mentioned. The renal vein leaves the kidney by the hilus.

The *Nerve-supply* is from the solar plexus.

The *Lymphatics* form a plexus in the capsule, and surround the large vessels; they ultimately join the sublumbar glands.

The **Suprarenal Bodies** (more correctly called the *adrenals*) are applied to the inferior face of the kidneys, just in front of the hilus. They are elongated from before to behind, and flattened laterally, being from 2 to 2½ inches long, and from 1 to 1½ inches wide.

Structure.—1. A *fibrous capsule,* which sends trabeculæ into the substance of the body.

2. *Parenchyma.*—This is divided into a cortex and a medulla. The cortex is again divided into three zones: (1) The outer, *zona glomerulosa*, containing spherical or elongated masses of cells; (2) a middle, *zona fasciculata*, consisting of columns of epithelial cells; and (3) an inner, *zona reticularis*, consisting of various sized groups of polyhedral cells.

Blood-supply. — From the mesenteric and renal arteries.

Nerve-supply.—From the solar plexus.

II. THE URETERS

are the ducts of the kidneys, and lead from the pelvis to the neck of the urinary bladder.

Course.—After leaving the pelvis of the kidney, the ureters pass backwards along with the posterior aorta (the left) or cava (the right); they cross the iliac arteries and gain the lateral faces of the bladder, being retained in this position by peritoneum. They terminate at the upper part of the neck of the bladder. Before opening into this organ, however, they pass for some little distance between the muscular and mucous coats; in this way the mucous membrane forms a kind of valve, which prevents the passage of urine from the bladder into the ureters.

Structure.—1. A *fibrous coat*, which is thin.

2. A *muscular coat*, whose fibres are arranged in two layers and directions: (*a*) An external longitudinal, and (*b*) an internal circular layer.

3. *Submucous*, composed of loose connective tissue.

4. *Mucous membrane*, lined by stratified transitional epithelium.

III. THE BLADDER.

Situation.—In the pelvic cavity; when full, it extends into the abdominal cavity.

Conformation.—It is a pyriform or ovoid sac, with a large anterior extremity, or *fundus*, and a narrow posterior extremity, the *neck*, from which the urethra springs. The bladder is held in position by two sets of ligaments:

1. The *false* ligaments, formed by the peritoneum, are: (*a*) A *broad* or anterior, extending along the abdominal floor to near the umbilicus, and containing the *urachus*, which is the remains of a fœtal structure. (*b*) and (*c*) The two *lateral* ligaments, passing to the pelvic walls, and containing the remains of the umbilical arteries. (*d*) The *superior* ligament, attached to the rectum.

2. The *true* ligaments, formed from the pelvic aponeurosis, are: (*a*) *Inferior*, (*b*) and (*c*) the two *lateral*, and (*d*) the *superior* or *recto-vesical* ligament.

Relations.—In the *male: Superiorly*, the vesiculæ seminales and the rectum; *laterally*, the pelvic walls; *inferiorly*, the pelvic floor.

In the *female: Superiorly*, the uterus and vagina; *laterally* and *inferiorly*, as in the male.

Structure—1. *Serous Covering.*—The peritoneum covers only the anterior part of the bladder, being reflected from it to form the false ligaments.

2. *Muscular Coat.*—Its fibres are arranged in three layers—an outer longitudinal, a middle oblique, and an inner circular. There is no marked sphincter at the neck in the horse, Wilson's muscle taking its place.

3. *Mucous Membrane.*—This is thin and pale, and, when the bladder is empty, thrown into folds. A smooth, very sensitive, triangular surface is found at the neck, in connection with which are the openings of the ureters and the urethra. The epithelium is stratified transitional.

Blood-supply.—From the internal pudic, and sometimes the umbilical artery.

Nerve-supply.—From the hypogastric plexus and the last two sacral nerves.

IV. The **Urethra** is described with the generative organs.

C. *GENERATIVE SYSTEM.*

A. **The Genital Organs of the Male** consist of the *testicles* with their ducts, the *vasa deferentia*, the *vesiculæ seminales*, for the storage of semen, the *ejaculatory ducts*, the *urethra*, and the *penis*, which may be described as the essential organs; in addition there are the accessory glands, the *prostate* and *Cowper's*.

I. THE TESTICLES.

These are two oval glands of the tubular type, suspended between the thighs, and enveloped by several membranous expansions and a pouch of skin, the *scrotum*. We will consider the structures protecting the testicles, proceeding from without inwards.

The Coverings of the Testicle.

1. The **Scrotum** is a pouch formed by the skin between the thighs, and is a single sac enclosing both

testicles. Externally it is covered by very fine short hairs, and is marked in the middle line by an antero-posterior raphe, which corresponds to a septum placed between the testicles.

2. The **Dartos** is a thin layer of elastic and muscular tissue found immediately under the preceding. It is a dependency from the abdominal aponeurosis, and forms two cavities, the partition between them being a double one, and known as the *septum scroti;* the penis passes between the two layers of this partition superiorly.

A *spermatic fascia* is sometimes described as being continuous with the external oblique abdominal muscle.

3. The **Cremaster** is a muscle forming an incomplete covering for the testicle. It arises from the iliac aponeurosis, passes down the inguinal canal, and expands on the outer part of the testicle.

4. The **Infundibuliform Fascia** is very thin, and continuous with the transversalis fascia of the abdomen. It is connected externally with the cremaster and dartos, and internally with the parietal layer of the *tunica vaginalis.*

5. The **Tunica Vaginalis** is the serous covering of the testicle, and is simply a diverticulum from the peritoneum. It consists of two portions—a *visceral,* or *tunica vaginalis propria,* which is intimately connected with the testicle and spermatic cord; and a *parietal,* or *tunica vaginalis reflexa,* which lines the infundibuliform fascia.

The Testicle.

Conformation, etc.—It is somewhat oval in shape, *possessing superior* and *inferior borders*, *internal* and *external faces*, and *anterior* and *posterior extremities*. The *superior border* has the epididymis attached to it. The testicle is suspended by means of the *spermatic* cord.

Blood-supply.—Spermatic artery.

Structure.—1. A *serous* covering, the *tunica vaginalis propria*.

2. A *fibrous* capsule, the *tunica albuginea*. This forms a thick accumulation at the superior border of the gland—the *mediastinum testis*, or *corpus Highmori*. In addition, the fibrous tissue is prolonged into the substance of the organ as thin septa, or *trabeculæ*, which separate the lobules. The tunica albuginea is covered internally with a vascular layer known as the *tunica vasculosa ;* this tunic is continued on to the trabeculæ.

A number of *seminal tubules* are found in each lobule; each tubule commences in a richly convoluted portion, but as it approaches the mediastinum testis it becomes straight, forming the *vas rectum*. The vasa recta enter the mediastinum and form a net-work—the *rete testis*—within this body; the *vasa efferentia* are the vessels which pass from the rete testis, and pierce the tunica albuginea at the anterior extremity of the testicle. The vasa efferentia form conical masses of convoluted tubes—the *coni vasculosi* —outside the tunica albuginea; these coni now unite to form a single tube, which is richly convoluted, and constitutes the body and tail of the *epididymis*. The epididymis is divided into three parts: The *globus major*, or head (the anterior extremity); the *body ;* and the *globus minor*, or tail (the posterior extremity).

The *hydatid of Morgagni*, a cyst-like body, is found below the globus major.

The seminal tubules consist of a membrana propria and several layers of epithelial cells, the innermost of which form spermatozoa, and are known as the *spermatoblast cells.*

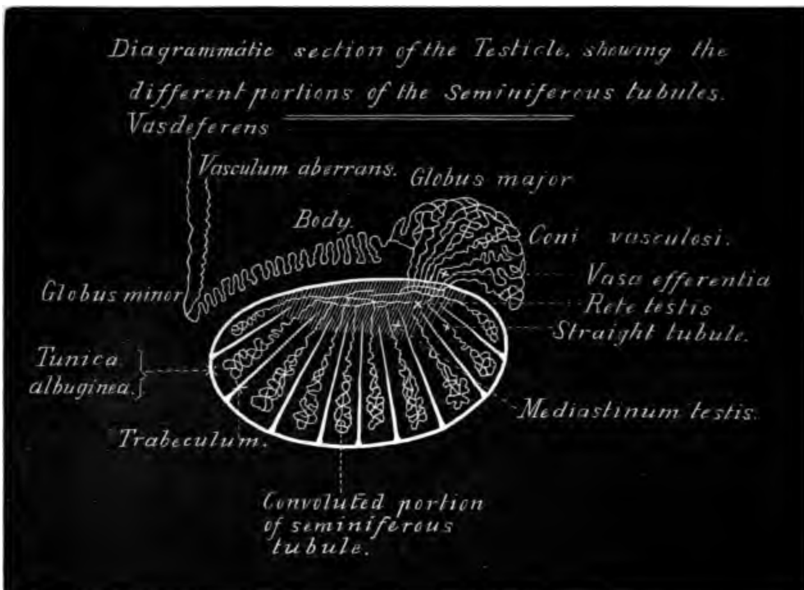

FIG. 6.—DIAGRAMMATIC SECTION OF A TESTICLE.

The vasa recta and the tubes of the rete testis are narrower than the seminal tubules, and are lined by a single layer of short columnar epithelial cells.

The vasa efferentia, the tubes of the coni vasculosi, and the rest of the epididymis, have non-striated muscular fibres in their walls, and are lined by ciliated columnar epithelial cells.

The Spermatic Cord.

The testicle is suspended in the inguinal region by means of the spermatic cord; this structure extends from the upper border of the testicle into the inguinal canal, and consists of the spermatic bloodvessels and nerves, the vas deferens, the cremaster muscle, the tunica vaginalis propria, and some fibrous tissue which binds these structures together. It is noteworthy that, as a rule, the bloodvessels are found in the anterior part of the cord, the vas deferens occupying the posterior part. With the exception of the vas deferens, the above structures receive mention elsewhere.

II. THE VASA DEFERENTIA

are the excretory ducts of the testicles. Each tube is about the thickness of a goose-quill; it continues the tail of the epididymis, and passes up the spermatic cord to gain the pelvic cavity, where it inclines backwards and ascends to the upper face of the bladder; at this point it forms a dilatation—the *bulbous portion*—which terminates near the neck of the bladder in a short constricted portion, opening, under the prostate, into the ejaculatory duct. The bulbous portions of the vasa deferentia are united by a fold of peritoneum.

The vasa deferentia have an external fibro-muscular and an internal mucous coat.

III. THE VESICULÆ SEMINALES.

These are two oval bodies placed above the bladder and below the rectum. They are described as possessing two extremities and a middle portion.

The *anterior extremity* forms a rounded *cul-de-sac;* the *posterior extremity* is narrow, and connected with the ejaculatory duct.

Structure.—1. External partial *serous* covering; only the anterior portion is covered by peritoneum.

2. Middle or *muscular coat.*

3. *Mucous membrane.* This is delicate, and possesses numerous glands.

IV. THE EJACULATORY DUCTS.

Each duct is a short tube, formed beneath the prostate gland by the junction of the vas deferens and the constricted neck of the vesicula seminalis. After a short course between the prostate and urethra, the duct opens at the side of the *veru montanum*, an eminence situated on the roof of the urethra.

V. THE URETHRA.

The urethra of the male is a long membranous tube extending from the neck of the bladder to the glans penis, and common to the urinary and generative systems.

It is usually divided into three portions: (1) The *prostatic portion.* (2) The *membranous portion*, extending from the point where the urethra is free of the prostate to the ischial arch; the prostatic and membranous portions constitute the *intrapelvic* part of the urethra. (3) The *spongy portion.* This forms the *extrapelvic* division, and is by far the longest of the three; it is surrounded by erectile tissue, the *corpus spongiosum.*

Interior.—The commencement of the urethra is very constricted; the membranous portion, however, is dilated; at the ischial arch another narrow portion commences, and is only interrupted by the *fossa navicularis,* a dilatation near the termination of the tube.

On the roof of the prostatic portion a ridge, known as the *veru montanum* or *caput gallinaginus,* is found, on each side of which are the numerous openings of the ducts of the prostate. The ejaculatory ducts open on the sides of the veru montanum, and in front of it is an opening into the *sinus pocularis,* or *uterus masculinus,* a blind pouch situated between the peritoneal folds joining the bulbous portions of the vasa deferentia. Cowper's glands open behind the ridge.

Structure.—1. *Mucous Membrane.*—This is thin, covered by columnar epithelium, and thrown into folds.

2. *Corpus Spongiosum.*—This only surrounds the extrapelvic portion of the urethra. It commences at the ischial arch as an expanded portion—the *bulb*—and it terminates at the anterior extremity of the penis as a second expansion, the *glans penis.*

3. *Muscles.*—The following muscles are connected with the urethra:

(*a*) *Wilson's Muscle.*—This consists of two transverse bundles, stretching across the membranous portion of the urethra and attached to the pelvic walls. It acts as a sphincter, compresses the urethra, and so prevents the semen passing into the bladder, and also, probably, assists in the discharge of the secretion of Cowper's glands.

(*b*) *Accelerator Urinæ.*—This muscle consists of transverse fibres, which embrace the urethra from the ischial arch to its termination. By the contraction of the fibres the expulsion of urine and semen is assisted.

(*c*) *Compressor Urethræ.*—A small thin band placed on the sides of the membranous portion of the urethra. It acts as a compressor of Cowper's glands.

(*d*) The *Transversus Perinei* is scarcely a muscle of the urethra, but is described here for convenience, and because it appears to blend with the accelerator urinæ. It consists of thin bundles of fibres, extending from the ischial tuberosity to the middle line of the perineum. It is connected with the two fibrous layers which cover the urethra in the perineal region, and form the *perineal aponeurosis.*

VI. GLANDS CONNECTED WITH THE URETHRA.

A. The Prostate Gland.

This is a racemose gland embracing the neck of the bladder and the commencement of the urethra. It is sometimes divided into three lobes, a middle and two lateral.

Relations.—Superiorly, the rectum; inferiorly, the neck of the bladder, the commencement of the urethra, the vesiculæ seminales, and ejaculatory ducts.

Structure.—1. *A fibrous and muscular capsule and framework.*

2. *Parenchyma,* consisting of ducts—primary and secondary—and alveoli lined by columnar epithelium.

Blood-supply.—Vesico-prostatic branch of the internal pudic.

Nerve-supply.—From the pelvic plexus.

B. Cowper's Glands.

Two small glands connected with the membranous portion of the urethra, and covered by Wilson's muscle. They are sometimes known as the *small prostates.*

In **structure** they resemble the prostate; their ducts open behind the veru montanum.

VII. THE PENIS.

This is an erectile organ, commencing at the ischial arch and extending forwards under the pelvis and abdomen; it is the male organ of copulation, and is capable of considerable increase of size, particularly in the entire.

The penis consists of *fixed* and *free* portions; the former extends from the ischial arch to the scrotum. The *free* portion is suspended in a cutaneous sling known as the *prepuce,* or sheath, and is covered by smooth fine skin, commonly pigmented. The anterior extremity of the penis presents an enlargement known as the *glans penis;* this enlargement has a prominent margin, called the *corona glandis,* behind which is a constriction—the *neck.* The glans penis is formed by the corpus spongiosum, which has been mentioned in connection with the urethra. In front of the glans a depression is seen into which the urethra projects as the *urethral tube;* the *urethral sinus* is a two-lobed cavity containing the secretion of sebaceous glands, and opening into the depression surrounding the urethral tube. The *suburethral notch* interrupts the continuity of the glans inferiorly.

Muscles connected with the Penis.—1. The *suspensory cords,* or *retractor penis* muscles. These structures, two in number, and composed of non-striated muscular fibres, commence on the inferior surface of the sacrum, pass downwards in front of the sphincter ani, unite below the anus, and finally pass along the inferior face of the penis to the glans, being connected by fibrous tissue with the accelerator urinæ.

2. *Erector Penis.*—This is a small muscle passing from the tuber ischii to the penis, raising and retracting that organ.

Structure.—The penis consists essentially of erectile tissue; it is composed of two bodies—the corpus spongiosum and corpus cavernosum.

The *corpus spongiosum* belongs to the urethra.

The *corpus cavernosum* is sometimes described as a double body; this, however, is unnecessary, as the fibrous septum—*septum pectiniforme*—is very incomplete.

The posterior extremity is expanded to form the *crura* or roots of the penis; these are attached to the ischial arch.

The anterior extremity is blunt, and placed immediately behind the glans.

The corpus cavernosum is provided with a strong, dense, fibrous envelope—the *tunica albuginea*—which forms the incomplete partition in the middle of the corpus—the *septum pectiniforme*—and sends numerous trabeculæ into its interior. Between the trabeculæ large vascular spaces are seen, which become distended with blood during erection. When the penis is in a flaccid condition, the blood passes from the capillaries into the veins in the usual manner.

The corpus cavernosum is attached by means of the crura to the ischial arch, and by means of the *suspensory ligament* to the ischio-pubic symphysis.

Blood-supply.—External and internal pudic and obturator.

Nerve-supply.—Internal pudic and sympathetic.

VIII. THE PREPUCE, OR SHEATH.

This is the fold of skin which supports the free portion of the penis when in a flaccid condition.

Its internal surface is covered with delicate, hairless skin provided with numerous sebaceous glands—the *preputial* glands—which secrete a strong-smelling material known as *smegma.*

The *suspensory ligaments* of the prepuce are yellow elastic expansions continuous with the tunica abdominis.

B. **The Generative Organs of the Female** consist of the *ovaries*, *oviducts*, *uterus*, *vagina*, and *vulva*.

I. THE OVARIES

are the two ovoid or rounded glands which form the ova, and correspond to the testicles of the male.

Situation.—They are found in the sublumbar region behind the kidneys, and attached to the anterior border of the broad ligament of the uterus.

The *ligament of the ovary* is a cord of non-striated muscular fibres extending from the cornu of the uterus to the posterior extremity of the ovary.

External Conformation.—Each ovary has its anterior extremity and its inferior and lateral surfaces smooth and free. The *hilus* is a deep depression found on the superior surface; the hilus affords attachment to a portion of the fimbriated extremity of the oviduct.

Structure.—1. A *serous covering* is described; it appears, however, to be composed of *germinal epithelium*.

2. *Tunica Albuginea.*—This is a fibrous capsule, prolongations from which form the *stroma* of the gland.

3. The substance of the ovary is divided into *cortical* and *medullary portions*.

The *medullary substance*, or *zona vasculosa*, is very vascular, and more spongy than the cortical substance.

The *cortical substance* contains the smallest and youngest Graafian follicles; as we approach the zona vasculosa, the Graafian follicles gradually become larger and more fully developed.

Structure of a Graafian Follicle.—1. The wall of each sac consists of an outer—*tunica fibrosa*—and an inner more delicate layer, the *tunica propria.*

2. Inside the wall is a layer of epithelial cells, the *membrana granulosa ;* the *discus,* or *cumulus proligerus,* is an accumulation of these cells surrounding the *ovum.*

3. In the deeper follicles there is a cavity filled with a fluid, the *liquor folliculi ;* this fluid increases in amount as the follicles enlarge.

4. The *ovum* is a large single cell varying from $\frac{1}{200}$ to $\frac{1}{120}$ of an inch in diameter. Its outer wall is known as the *zona pellucida.* The contents of the cell are: The *vitellus,* or *yolk,* protoplasmic matter; the *germinal vesicle,* representing the nucleus; and the *germinal spot,* representing a nucleolus.

When a Graafian follicle is mature, it bursts through the surface of the ovary near the hilus; the ovum, with the liquor folliculi and some of the membrana granulosa, is received by the expanded anterior extremity of the oviduct, and conducted down to the uterine cornu. The ruptured follicle now fills with blood and heals, forming a yellow body, the *corpus luteum.* If the ovum has been impregnated, the corpus luteum is larger and lasts longer than is the case when no impregnation takes place.

Blood-supply. — The utero-ovarian artery sends branches into the hilus of the ovary.

Nerve-supply. — From the posterior mesenteric plexus.

II. THE OVIDUCTS OR FALLOPIAN TUBES

are small wavy tubes leading from the neighbourhood of the ovaries to the cornua of the uterus, and embedded in the broad ligament. The middle portion of the tube is very narrow, but the extremities, especially the anterior one, are somewhat wider.

The *anterior* or *ovarian extremity* forms an expanded portion—the *pavilion* of the tube—and opens into the peritoneal cavity. Its orifice, the *ostium abdominalæ* is provided with several finger-like projections, known as the *fimbriæ*.

The *posterior extremity* has an opening into the cornua of the uterus, the *ostium uterinum*.

Structure.—1. *Serous coat*, derived from the peritoneum.

2. *Muscular coat*, consisting of two layers of fibres, longitudinal or external, and circular or internal.

3. *Mucous Membrane.*—This is thrown into longitudinal folds and covered with ciliated epithelium.

III. THE UTERUS, OR WOMB,

is a musculo-membranous organ for the purpose of receiving the ovum and containing the embryo and fœtus.

Situation. — Its anterior portion is in the sublumbar region, its posterior in the pelvis.

External Conformation.—The uterus consists of a *body* and two *cornua*.

1. The *body* has its anterior extremity, or *fundus*,

connected with the cornua ; its posterior extremity, or *neck*, is constricted, and projects into the vagina. The supero-lateral aspects of the body have the *broad ligaments* attached.

2. The *cornua* present two *curvatures* and two *extremities :*

The *superior curvature* is concave, and has the broad (or suspensory) ligament attached.

The *inferior curvature* is convex and free.

The *anterior extremity* (or summit) is rounded, and connected with the oviduct.

The *posterior extremity* (or base) is continuous with the uterus.

The uterus is held in position by:

1. The *broad* or *suspensory ligaments*, which are two in number and somewhat triangular in shape; they pass from the sublumbar region to the body and cornua of the uterus; they also support the ovaries and oviducts.

2. The *recto-uterine* and *vesico-uterine* folds of peritoneum.

3. Its attachment to the vagina.

4. Two bands of fibrous tissue, which pass from the body to the inguinal canal.

Relations.—The *body: Superiorly,* the rectum ; *inferiorly,* the urinary bladder ; *anteriorly,* the intestines and cornua ; *posteriorly,* the vagina ; *laterally,* the pelvic walls and broad ligaments.

The *cornua* are related to the intestines.

Internal Conformation.—The cavity corresponds to the three portions. The cavity of the body communicates with the vagina by means of the canal of the *cervix* (os uteri, os externum). The mucous membrane is thrown into numerous folds.

Structure.—1. *Serous covering.*

2. *Muscular coat*, consisting of two layers, external or longitudinal, and internal or circular.

3. *Mucous Membrane.*—This is very uneven, the folds at the cervix being formed by fibrous tissue, and known as *palmæ plicatæ.* The epithelium consists of a single layer of ciliated columnar cells. The glands are tubular or saccular; the *ovula Nabothi* are situated in the cervix, and are especially prominent.

Blood-supply.—From the *uterine* and *utero-ovarian* arteries, the veins being satellites. The *lymphatics* open into the sublumbar glands.

Nerve-supply.—From the posterior mesenteric and pelvic plexuses.

IV. THE VAGINA

is the tube or canal leading from the neck of the uterus to the vulva.

Situation.—Immediately below the rectum and behind the uterus.

External Conformation.—Its widest portion is where it surrounds the cervix uteri. It is held in position by its attachment to the uterus and vulva, and by fibrous tissue to the surrounding organs.

Relations.—*Superiorly,* the rectum; *inferiorly,* the bladder; and *laterally,* the pelvic walls.

Internal Conformation. — The mucous membrane presents a number of longitudinal folds. Anteriorly the cervix of the uterus projects into its cavity.

Structure.—1. *Muscular coat*, consisting of external longitudinal and internal circular fibres.

2. *Mucous membrane*, covered with stratified squamous epithelium.

Blood-supply.—From the internal pudic artery, the vein being a satellite.

Nerve-supply.—From the pelvic plexus.

V. THE VULVA

is the external opening of the genital and urinary systems in the female, and is situated immediately below the anus.

Externally the vulva presents a slit elongated from below upwards, with two *lips* and two *commissures*.

The *lips* (or labiæ) are soft folds of hairless skin.

The *superior* commissure is acute, the *inferior* one being rounded.

Internally the vulva presents: (1) A membranous structure dividing it from the vagina (the *hymen*); (2) the *meatus urinarius;* and (3) the *clitoris*.

The *hymen* is incomplete, and represented by numerous eminences—*carunculæ myrtiformes*.

The *meatus urinarius* is the opening of the urethra. This is from 3 to 5 inches from the external opening, on the floor of the vulva, and is guarded by a valve—a fold of mucous membrane which directs the urine backwards.

The *clitoris* is the representative of the male penis; it is about two inches in length, and commences by two rudimentary crura; it possesses a small suspensory ligament. It is lodged in the *fossa navicularis*, and is provided with a fold of mucous membrane known as the *prepuce of the clitoris.*

Structure—1. *Skin.*—This is soft, smooth, hairless and black (usually).

2. *Muscular Ligaments.*—These represent the suspensory ligaments of the penis in the male, and have a similar disposition.

3. *Constrictor muscles:*

(*a*) *Posterior* (Constrictor Vulvæ Posterior).—This muscle is arranged as a sphincter; its fibres blend with those of the sphincter ani, and are attached to the sacrum by means of the suspensory ligaments; inferiorly it is connected with the base of the clitoris, and continued downwards on to the thighs.

(*b*) *Anterior* (Constrictor Vulvæ Anterior).—This is supposed to represent Wilson's muscle; it is arranged around the vaginal opening, and its fibres become lost on the rectum.

4. *The Vaginal Bulb.*—This body, composed of erectile tissue, arises near the crura of the clitoris, and is covered by the posterior constrictor of the vulva.

5. *Mucous Membrane.*—This is covered by stratified squamous epithelium, and is continuous with that of the vagina.

Numerous glands, which secrete most during œstrum, are found in this membrane.

Blood-supply.—Perineal branch of the internal pudic.

Nerve-supply.—Sacral.

VI. THE MAMMARY GLANDS.

These glands, two in number, are concerned in the secretion of milk.

Situation, etc.—They are placed in the inguinal region, and are intimately connected with the abdominal wall. Each gland possesses a *teat* or *nipple*, which projects from the lowermost and most prominent part.

The mammæ are held in position by the skin which covers them, and by a deeper yellow elastic sheath continuous with the abdominal tunic. The skin is soft, thin, almost hairless (completely so on the teat), and usually pigmented.

Structure—1. *A Fibrous Capsule.*—This is composed of yellow elastic tissue, continuous with the tunica abdominis; it forms a partition between the two glands, and sends numerous processes into their interior.

2. *Gland Substance.*—This consists of secretory acini, or alveoli, and ducts. Each alveolus is tubular or saccular, and lined by a single layer of granular polyhedral cells; when the gland is active these cells have the power of forming oil-globules in their interior; the globules are passed out into the lumen of the alveolus and form the milk. The ducts are arranged in the manner common to racemose glands, and open into the *galactopherous* or *lactiferous sinuses* at the base of the teat; these sinuses are variable in number, there being two, three or four; from the sinuses several tubes pass down the teat to open at its apex. A sphincter of non-striated fibres is

described in connection with the teat, its function being to prevent the loss of milk.

Blood-supply.—Mammary arteries, branches of the external pudic.

Nerve-supply.—First lumbar.

ARTERIES.

POSTERIOR AORTA (Abdominal Portion).

Course. — The aorta on reaching the abdomen passes backwards to terminate, at the junction of the lumbar and sacral regions, as the *internal and external iliac* arteries.

Relations.—*Superiorly*, the lumbar vertebræ, the crura of the diaphragm, the inferior common vertebral ligament, and the receptaculum chyli; *inferiorly*, the pancreas and peritoneum. It is intimately connected with the sympathetic, and has the posterior vena cava on its right.

Its **Collateral** branches are (1) *visceral*, supplying the abdominal organs; (2) *parietal*, distributed to the abdominal walls.

I. Visceral Branches.

1. **Cœliac Trunk or Axis.**—This is given off at a right angle as soon as the aorta has entered the abdomen. It is short, being about ½ to ¾ inch in length. It divides into three branches—gastric, splenic and hepatic.

(*a*) *Gastric Artery.*—This gains the left *cul-de-sac of the stomach*, and divides into :

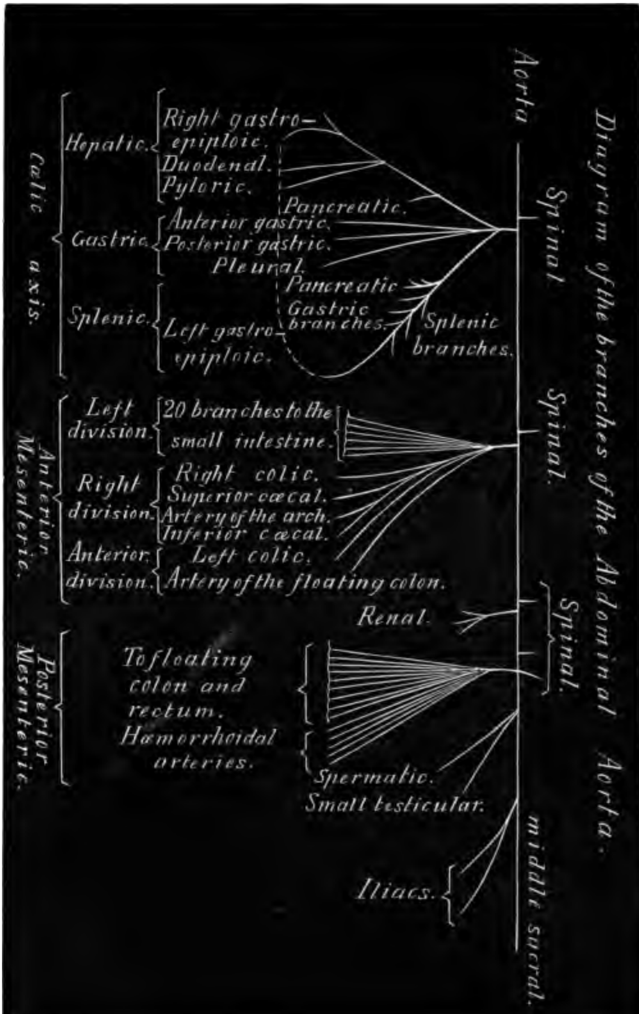

FIG. 7.—DIAGRAM OF THE BRANCHES OF THE ABDOMINAL AORTA.

α. *Anterior or right*, which courses along the lesser curvature, supplying the left *cul-de-sac* in particular.

β. *Posterior or left*, distributed along the greater curvature, and furnishing numerous branches to the right *cul-de-sac.*

γ. *Pleural.*—This accompanies the œsophagus through the foramen sinistrum into the thorax, and anastomoses with the œsophageal and internal thoracic arteries.

(*b*) *Splenic Artery.*—This branch is larger than the other two, and, passing towards the left, gains the hilus of the spleen, along which it runs towards the right, terminating as the *left gastro-epiploic artery.*

Collateral Branches.—

α. *Splenic*, entering the spleen.

β. *Gastric*, passing on to the greater curvature of the stomach.

γ. *Omental*, supplying the gastro-splenic omentum.

Terminal Branch.—

Left gastro-epiploic, which runs along the greater curvature of the stomach to near the right extremity, and there anastomoses with the *right gastro-epiploic* branch of the hepatic artery. In its course it supplies *gastric* and *omental* twigs.

(*c*) *Hepatic Artery.*—This artery in passing towards the right is related to the pancreas and posterior vena cava; it gains the transverse fissure of the liver, by which it enters that organ.

Collateral Branches.—

α. *Pancreatic.*—Numerous, and distributed to the pancreas.

β. *Pyloric*, which arises near the transverse fissure of the liver, passes to the pylorus, and anastomoses with the posterior gastric and right gastro-epiploic.

γ. *Right gastro-epiploic*, which commences near to or in common with the preceding, passes for a short distance along the greater curvature of the stomach, and anastomoses with the left gastro-epiploic. In its course it contributes a *duodenal* branch, which is important from the fact that it anastomoses with the first branch of the left division of the anterior or great mesenteric artery.

Terminal Branches.—These have received the following names:

Rami capsulares, supplying the capsule.

Rami lobulares, supplying the lobules.

Rami vasculares, supplying the bile-ducts and bloodvessels.

2. **Great or Anterior Mesenteric Artery.**— Arises some 2 or 3 inches behind the cœliac axis, is from 1 to 2 inches long, and divides into three branches——*left*, *right*, and *anterior*.

(*a*) *Left Branch.*—This supplies the small intestine by dividing into from fifteen to twenty arteries, which run down the great mesentery; near the lesser curvature of the intestine each artery bifurcates and anastomoses with its neighbours, thus forming a series of arches, from which twigs descend to the intestine. The first artery anastomoses with the duodenal branch of the hepatic, the last with the ilio-cæcal.

(*b*) *Right Branch.*—**This is distributed to the cæcum and great colon, forming four arteries:**

- *a. Ilio-cæcal artery*, **which passes towards the ileum, and anastomoses with the last artery of the left branch.**
- *β. Superior or internal cæcal artery*, **which runs along the upper and anterior fissure of the cæcum.**
- *γ. Inferior or external cæcal artery*, **found in the lower fissure of the cæcum. It contributes the** *artery of the arch*, **which passes along the concavity of the cæcum towards the great colon, where it is lost.**
- *δ. Right* (or direct) *colic artery*, **which passes along the first and second portions of the great colon, and terminates at the pelvic flexure by anastomosing with the** *left colic artery.*

(*c*) *Anterior Branch.*—This supplies the *left colic artery* and the *first artery of the floating colon.*

- *a. Left colic* (or retrograde) *artery:* runs along the third and fourth portions of the great colon, anastomosing with the right colic at the pelvic flexure.
- *β. Artery of the floating colon:* passes to the left into the colic mesentery, where it anastomoses with a branch from the *lesser mesenteric artery.*

3. **Lesser or Posterior Mesenteric Artery.** — This artery supplies the floating colon and rectum, and is given off from the aorta about 4 inches behind the great mesenteric artery.

It divides into thirteen or fourteen branches, which pass down the colic mesentery; the first seven or eight bifurcate and form arches; the remaining posterior branches do not form arches, but supply the termination of the floating colon and the rectum, and are called *hæmorrhoidal arteries.*

4. **Renal Arteries.**—These are two in number—right and left—and leave the aorta very near to the anterior mesenteric artery; they are remarkable for their size. The right is longer than the left, and crosses the posterior vena cava. They enter the kidney at or near the hilus, contributing a branch to the adrenals. (See *Kidney.*)

5. **Spermatic Arteries.**—Two in number—right and left—they arise near the lesser mesenteric artery. Surrounded by a fold of peritoneum, they pass downwards to the internal abdominal ring, where they form part of the spermatic cords; gaining the upper border of the testicle, each artery perforates the tunica albuginea, and terminates by ramifying in the tunica vasculosa.

In the female these branches of the aorta are known as the *utero-ovarian* arteries, which after a short course bifurcate, forming *ovarian* and *uterine* branches; the latter anastomoses with the uterine artery.

6. **Small Testicular Arteries**—right and left—are small, and arise either from the aorta (between the internal and external iliac arteries) or from the external iliac artery. They pass downwards to the spermatic cords, which they supply. In their course they contribute branches to the ureter, vas deferens, peritoneum, and iliac glands.

In the female these branches are called the uterine *arteries.* These possess a greater volume than the small testicular, and divide into *anterior* branches, which anastomose with the utero-ovarian, and *posterior*, which anastomose with the vaginal arteries.

II. Parietal Branches.

The parietal branches of the abdominal aorta are the *lumbar* and *middle sacral* arteries.

1. **Lumbar Arteries.**—Are five or six in number, and are disposed in a manner similar to the intercostals. They divide into:

(*a*) *Superior* or *lumbo-spinal* branches, which pass to the muscles and skin of the lumbar region; these also supply branches to the spinal cord.

(*b*) *Inferior* branches, which supply the psoas magnus and parvus, and transverse and internal oblique abdominal muscles, anastomosing with the circumflex ilii. (The last lumbar artery may arise from the internal iliac.)

2. **Middle Sacral Artery.**—This is not always present, and even when it is found it is very small. It arises between the two internal iliac arteries, and passes along the lower face of the sacrum.

VEINS.

Posterior Vena Cava.—This vein commences by the union of the two common iliac veins at about the lumbo-sacral junction; it passes forwards under the bodies of the lumbar vertebræ until it reaches the upper border of the liver, where it deviates, and is afterwards lodged in the anterior fissure of the liver; after its passage along this fissure, it leaves the abdominal cavity by means of the foramen dextrum of the diaphragm.

The *relations of its sublumbar portion* are: On the *left*, the posterior aorta; on the *right*, the right kidney and adrenal; *superiorly*, the inferior common vertebral ligament; *inferiorly*, the peritoneum and pancreas.

Its *branches* (collateral) are:

1. The lumbar veins.
2. The spermatic veins.
3. The renal veins.
4. The vena portæ.

1. **Lumbar Veins.** — These are satellites of the arteries. (Some of the anterior may open into the vena azygos.)

2. **Spermatic Veins.**—In the male: *Testicular*, arising from the upper border of the testicle, and performing a very complicated course in the spermatic cord. The two veins anastomose freely in the abdomen, and form a *spermatic plexus;* they generally terminate as a single vein.

In the female: *Utero-ovarian*, a satellite of the utero-ovarian artery.

3. **Renal Veins**—two in number—are of considerable volume and have thin walls. They leave the kidney at or near the hilus, and receive branches from the adrenals. The left vein is longer than the right, on account of having to cross the aorta.

4. **Vena Portæ.**—This does not open directly into the vena cava, but transmits its blood to the liver, the hepatic veins finally handing it on to the cava.

Course.—It commences in the sublumbar region, being formed by the *anterior* and *posterior mesenteric*

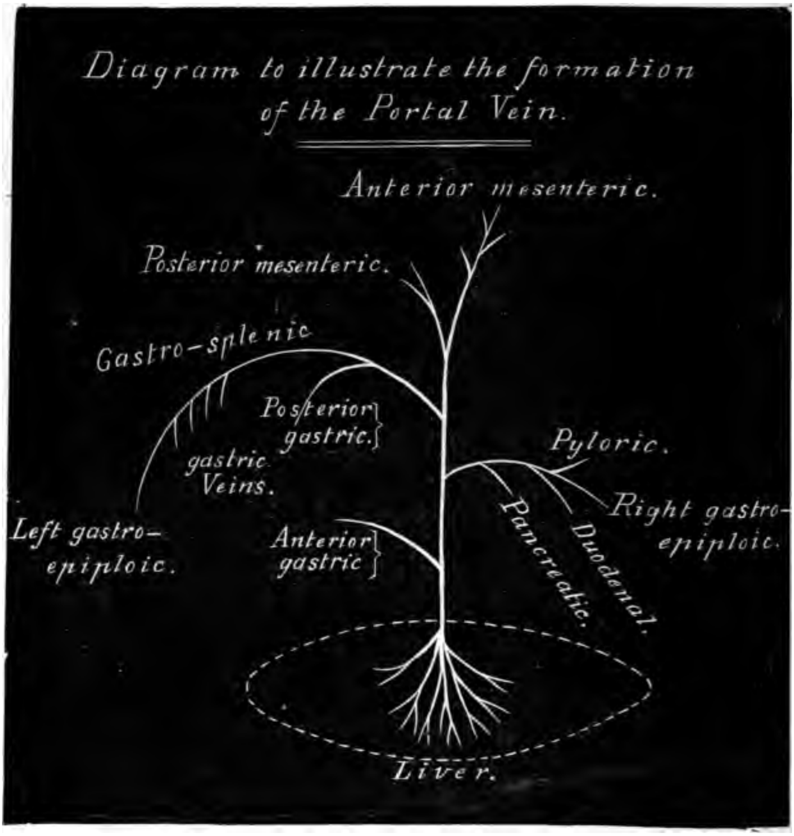

FIG. 8.—DIAGRAM TO ILLUSTRATE THE FORMATION OF THE VENA PORTÆ.

and the *gastro-splenic* veins. It passes forwards and to the right, pierces the pancreatic ring, and gains the posterior fissure of the liver, in which gland it ramifies.

A. *Roots.*—

1. *Anterior Mesenteric Vein.*—This is a satellite of the artery of the same name, having branches corresponding to those of the artery.
2. *Posterior Mesenteric Vein.*—This also corresponds to the artery of the same name.
3. *Gastro-splenic Vein.*—This commences as the *left gastro-epiploic*, the *splenic*, and satellites of the gastric branches of the splenic artery. It has a collateral branch, the *posterior gastric.*

B. *Collateral Branches.*—

1. *Right Gastro-epiploic Vein.*—This receives *pyloric*, *duodenal* and *pancreatic* branches.
2. *Anterior Gastric Vein.*

The **Hepatic Veins**, which are numerous, leave the liver by the anterior fissure, and open into the cava as it passes down this fissure.

LYMPHATICS OF THE ABDOMINAL VISCERA.

1. **Of the Rectum and Floating Colon.**—Consist of three groups of glands:

(*a*) Two or three at the base of the tail.

(*b*) Numerous small bodies along the lesser curvature of the intestine.

(*c*) Some placed between the two layers of the mesentery.

From the mucous membrane the *vessels* pass first to the second group of glands, and from these to the third, finally either opening into the sublumbar glands or uniting with those from the great colon.

2. **Of the Great Colon.**—The *glands* are arranged as a double chain accompanying the colic arteries, and as a few isolated lobules along the collateral branches of these arteries.

The *vessels* arise in the walls of the colon, some passing to the smaller glands and afterwards to the principal ones, others going directly to the principal glands; from these glands efferents pass along with the colic vessels, and form, with those from the small intestine, the two trunks which, with the efferents from the sublumbar glands, form the receptaculum chyli.

3. **Of the Cæcum.**—The *glands* are arranged along the arteries, and receive *vessels* from the walls of the cæcum; the efferents unite with the trunk from the small intestine.

4. **Of the Small Intestine.**—The *glands* are about thirty in number, and are placed between the layers of the mesentery near to the origin of the anterior mesenteric artery; the ilio-cæcal artery has along its course some fifteen additional smaller glands.

The *vessels* from the intestine converge and enter the glands, the efferents from which form the large trunk which so materially assists in the formation of the receptaculum chyli.

5. **Of the Stomach.**—The *glands* are arranged in two series:

(*a*) Along the lesser curvature.
(*b*) Small, along the greater curvature.

The *vessels* leave these glands, and, passing towards the left *cul-de-sac*, meet those from the spleen and liver, some entering the thoracic duct, others uniting with the intestinal trunk.

6. **Of the Spleen.**—The *vessels* are *superficial* and *deep;* they gain the hilus, and, accompanying the splenic vessels, anastomose with the lymphatics from the stomach and liver.

7. **Of the Liver.**—These are also *superficial* and *deep;* they enter a small group of *glands* at the posterior fissure, and then pass on to a large group situated between the pancreas and vena portæ; they finally anastomose with those from the spleen and stomach.

NERVES.

I. SPINAL.

Lumbar Nerves.—Of these there are six pairs.

The Superior Branches.—These are distributed to the muscles and skin of the loins.

The Inferior Branches.—The *first,* after receiving a branch from the last dorsal, passes between the quadratus lumborum and psoas magnus, and afterwards between the transverse and internal oblique abdominal muscles; it finally terminates in the rectus abdominis. A perforating branch reaches the skin of the abdomen.

The *second* is disposed in a manner similar to the first, and sends perforating branches to the skin of the thigh and flank.

The *third* contributes the three *inguinal nerves*—

one internal and two external—which pass down the inguinal canal to the cremaster muscle. One of the inguinal nerves may anastomose with a branch from the fourth.

The *fourth* contributes a branch which joins an inguinal nerve, and finally terminates in the skin of the posterior limb as far down as the stifle. A large branch goes to the lumbo-sacral plexus.

The *fifth* and *sixth* help to form the lumbo-sacral plexus.

All the inferior branches contribute several filaments to the sympathetic.

Sacral Nerves.—Of these there are five pairs.

The *superior branches* are arranged in a manner similar to those of the lumbar nerves. They leave the spinal canal by the superior sacral foramina.

The *inferior branches* leave the spinal canal by the inferior sacral foramina.

The *first*, *second* and *third* pass to the lumbo-sacral plexus.

The *fourth* forms the *internal pudic nerve,* which gains the dorsal aspect of the penis; in its course it contributes branches to the anus and perineum.

The *fifth* is known as the *anal* or *hæmorrhoidal nerve,* and supplies the sphincter ani and adjacent skin.

All the inferior branches communicate with the *pelvic* or *hypogastric plexus.*

Coccygeal Nerves.—Six or seven pairs.

The *superior* and *inferior* branches unite to form two common trunks, the *superior* running under the curvator coccygis, and the *inferior* below the depressor coccygis; they give off muscular and cutaneous branches in their course.

The coccygeal nerves have no communication with the sympathetic.

II. SYMPATHETIC.

The **Solar** or **Semilunar Ganglia**—two in number—are formed chiefly by the *greater splanchnic nerve*, and communicate with each other by means of a thick cord, which winds round the posterior face of the posterior mesenteric artery, and by numerous filaments which pass in front of this artery. The *solar plexus* is the result of this arrangement, and from this plexus secondary plexuses are given off:

1. *Gastric plexus*, which gives off branches to the stomach, these anastomosing with the pneumogastric.
2. *Hepatic plexus*, to the liver, pancreas, duodenum, and pylorus.
3. *Splenic plexus*, to the spleen and stomach.
4. *Anterior mesenteric plexus*, to the organs supplied by the artery of the same name.
5. *Renal* and *adrenal plexuses*, to the kidneys and adrenals.

The *lumbo-aortic plexus* is formed by numerous branches from the solar plexus, and is found along the inferior face of the aorta, terminating in the posterior mesenteric plexus.

The **Lumbar Portion of the Sympathetic** consists of six ganglia, situated upon the psoas parvus.

Afferent branches are received from the lumbar spinal nerves.

Efferent branches join the lumbo-aortic plexus, and form the *posterior mesenteric plexus*, from which branches are given to the anterior mesenteric plexus, the floating colon, and rectum; other branches form a *spermatic plexus* (satellites of the spermatic artery), and finally branches join filaments from the sacral nerves, and form the *pelvic* or *hypogastric plexus*.

The Sacral Portion of the Sympathetic.—Four ganglia are to be found in this portion, and these receive filaments from the sacral nerves; the efferent branches become lost in the fibrous tissue below the sacrum.

The termination of the sympathetic is variable; sometimes a small cord anastomoses with a similar cord from the opposite side, and at other times a filament joins the last sacral nerve.

TRUNK OF THE OX, SHEEP, PIG AND DOG.

(Unless otherwise stated, the horse is throughout taken as a type, and the other animals compared with it.)

BONES.

Ruminant.

Dorsal Vertebræ.—These are thirteen in number. The neural spines are broad, with a narrow posterior border; the first four or five spines are of nearly the same height; from the sixth to the last, however, they gradually shorten. All the neural spines, with the exception of the last, are inclined backwards. The bodies are longer than those of the horse's vertebræ. The posterior intervertebral notch is converted into a foramen in almost all the vertebræ. In the posterior vertebræ the facets on the transverse processes are saddle-shaped.

Lumbar Vertebræ.—There are six lumbar vertebræ, as in the horse. The bodies are long; the transverse processes do not articulate with each other or with the sacrum; these processes are longer and thinner than those of the horse. The neural spines are broad, but relatively short.

Sacrum.—This is composed of five segments. Its superior surface is convex, its inferior surface being concave, and marked in the middle line by a groove which lodges the middle sacral artery. The neural spines, while shorter than those of the horse, are fused together throughout their entire extent. A distinct ridge runs on each side of the neural spines, and marks the position of the oblique processes. The superior sacral foramina are small, with the exception of the most posterior, which is very large; the inferior foramina are large. The base of the bone has no articular surfaces for the last lumbar transverse processes.

Coccygeal Vertebræ.—The number is variable, being from sixteen to twenty. These bones are larger and more perfectly developed than those of the horse, the first five or six possessing a complete neural arch.

Ribs.—There are thirteen pairs, of which eight are sternal and five asternal. Each rib is longer, broader and straighter than in the horse. The necks of the anterior ribs are short, those of the posterior ribs being long. From the 2nd to the 8th inclusive, the ribs articulate with their cartilages by diarthroses. (These diarthroses are absent in the sheep.)

Sternum.—This structure is large and flattened from above to below; it possesses seven sternebræ; the first and second segments articulate with each other by means of a diarthrosis (absent in the sheep). The cariniform cartilage is either very small or absent; the xiphoid cartilage is very well detached from the body of the sternum.

Pig.

Dorsal Vertebræ.—There are fourteen of these vertebræ in the pig. The bodies are rather short, with flatter extremities than those of the horse. The neural spines are broad and long, the first being almost vertical, the rest inclined backwards, with the exception of the last two or three, these inclining forwards. There are mammillary and accessory processes.

Lumbar Vertebræ.—The number is not constant, there being sometimes six, sometimes seven.

The bodies and transverse processes are long. There are no intertransverse articulations. There are sometimes double intervertebral foramina in the anterior vertebræ.

Sacrum.—There are four segments, which do not fuse together so early or so completely as in the horse and ox, interannular spaces being left between the neural arches. The neural spines are very small. The auricular facet is almost vertical.

Coccygeal Vertebræ.—These vary from about eighteen to twenty-three in number. The first four or five have articular *processes* developed.

Ribs.—Of these there are fourteen pairs, of which seven are sternal and seven asternal. They resemble those bones of the ox, except that only the 2nd, 3rd, 4th, and 5th articulate with their cartilages by means of diarthroses.

Sternum..—This is composed of six or seven segments. In general appearance it resembles that of the ruminant, except that it is narrower, carries a small conical cariniform cartilage, and has a more detached xiphoid cartilage.

Dog.

Dorsal Vertebræ.—The dog has thirteen dorsal vertebræ, which in general appearance resemble those of the horse; the neural spines, however, are thicker, and decrease in height from nearly the first to the last.

Lumbar Vertebræ.—There are usually seven vertebræ in this region. The bodies are long, the neural spines short and directed forwards. The transverse processes point downwards and forwards; there are no intertransverse articulations. **Mammillary processes** surmount the anterior oblique processes, and **accessory processes** point upwards from the posterior edges of the neural arches.

Sacrum.—Usually only three segments compose this bone. The outline is almost quadrangular. The neural spines are rudimentary, and form a ridge. The auricular facet is almost vertical.

Coccygeal Vertebræ.—There are from eighteen to twenty-two caudal vertebræ in the dog, the first four or five of which are true vertebræ.

Ribs.—The dog has thirteen pairs of ribs, nine sternal and four asternal. They are thicker and more curved than those of the horse and ox. The last is most commonly a floating rib.

Sternum.—This consists of eight cylindrical sternebræ, with a constriction in the middle of each. The cariniform cartilage is absent. The xiphoid cartilage is small and well detached.

ARTICULATIONS.

There are no intertransverse lumbar articulations in any domesticated animal except the horse.

Ox.

All the sternal ribs, except the 1st, articulate with their cartilages by means of diarthroses, each joint having a strong capsule.

The first and second sternal segments articulate with each other by means of a diarthrodial joint, which is provided with a strong capsule.

Sheep.

The chondro-costal and intersternal joints are like those in the horse.

Pig.

The 2nd, 3rd, 4th and 5th ribs join their cartilages by diarthroses, as do also the first and second sternal segments.

MUSCLES.

Ruminant.

The **Pectoralis Anticus** is small, and not easily separable from the **transversus.**

The **Pectoralis Magnus** and **Parvus** are also more or less blended.

The **Trapezius** and **Serratus Magnus** are large.

The **Abdominal Tunic** is extensive and thick, having to support a considerable weight of viscera.

The **Rectus Abdominis** shows very well-marked tendinous intersections.

The **Obliquus Abdominis Internus** has a large muscular portion, entirely filling the space formed by the last rib, the lumbar transverse processes, and the ilium.

The **Diaphragm** is strong, has large crura, and is attached farther forwards on the inner faces of the ribs than is the case in the horse.

Pig.

The **Pectoralis Parvus** is similar to that muscle of the horse; otherwise the pectoral muscles are arranged in a manner similar to those of the ox.

The **Trapezius** is large.

The **Latissimus Dorsi** is large, and attached to the ribs.

The **Longissimus Dorsi** is divisible into two portions.

The **Abdominal Tunic** is thin.

The **Obliquus Abdominis Externus** has a largely developed fleshy portion and a small aponeurosis.

Dog.

The **Panniculus Carnosus** is large, continued over the haunch, and united to the muscle of the opposite side of the body.

The **Pectoralis Parvus** is small, and attached to the humerus along with the magnus.

The **Quadratus Lumborum** is very well developed.

The **Psoas Magnus** is shorter than the parvus, and is blended with the iliacus.

The **Abdominal Tunic** is very thin.

The costal, dorso-lumbar, and abdominal muscles aré similar to those of the pig.

THE ALIMENTARY SYSTEM.

Ruminant.

I. **The Œsophagus** has striated muscular fibres throughout its extent, and opens into the stomach in an infundibuliform manner.

II. **The Stomach** is divided into four compartments—rumen, reticulum, omasum, and abomasum; the first three compartments, however, should be considered as œsophageal dilatations.

1. **Rumen**, or Paunch.—This sac occupies three-fourths of the abdominal cavity, and is plaçed in the left flank; its capacity may be stated as being from 50 to 60 gallons.

External Conformation.—It is divided into right and left sacs by two fissures; the left sac is the larger, its anterior extremity receiving the œsophagus, and being continuous with the reticulum.

Internal Conformation.—Two fleshy **pillars** divide the interior into four sacs; these pillars correspond to the external fissures, and give off transverse processes. The internal face of the rumen is roughened by papillæ. The openings are two—into the œsophagus and reticulum—and are placed at the anterior extremity of the left sac.

Relations. — Superiorly, the intestines; inferiorly, the abdominal floor; on the right, the abomasum and intestines; on the left, the spleen.

Structure.—(*a*) *Serous coat*, a reflexion from the peritoneum.

(*b*) *Muscular coat*, thick, and forming the pillars.

(*c*) *Submucous.*

(*d*) *Mucous membrane:* this is thick, covered with dense stratified squamous epithelium, and possesses numerous papillæ —conical and fungiform.

2. **Reticulum**, or Honeycomb.—This is the smallest compartment of the stomach, is elongated and slightly crescentic, and placed between the diaphragm and rumen.

External Conformation.—There are two surfaces, two curvatures, and two extremities. The anterior surface is in contact with the diaphragm, the posterior with the rumen. The greater curvature is placed inferiorly, the lesser superiorly and in contact with the omasum. The right extremity forms a rounded prominence, the left contacting the rumen.

Internal Conformation.—The mucous surface is pitted by polyhedral depressions, each primary depression possessing secondary and less marked depressions. The ridges are studded with conical papillæ; long conical papillæ are also seen in the depressions.

The openings are two in number—one into the left sac of the rumen, the other into the omasum. By means of one extremity of the **œsophageal groove**, the reticulum also communicates with the œsophagus.

The **Œsophageal Groove** runs along the lesser curvature of the reticulum to the entrance into the omasum. It is formed by two muscular **pillars**, which increase in size from the œsophagus to the omasum, and are covered by folds of mucous membrane.

Structure.—(*a*) The *serous coat* is incomplete anteriorly.

(*b*) The *muscular coat* is thinner than that of the rumen.

(*c*) The *mucous membrane* is arranged in folds, as mentioned above. The epithelium is dense, stratified, and squamous.

3. **Omasum**, Manyplies or Psalterium.—This compartment is placed above the reticulum. In the large ruminant it is larger than the reticulum, but in the small ruminant it is smaller.

External Conformation.—Its shape is similar to that of the reticulum. Its anterior surface contacts the diaphragm, its posterior the rumen. The greater curvature is placed above. The left extremity is continuous with the reticulum, the abomasum being attached to the right extremity.

Internal Conformation.—The cavity of the compartment is occupied by folds of mucous membrane arranged in the long axis of the sac, and having an attached convex margin along the greater curvature, the free concave margin looking towards the lesser curvature. These leaves are not all of the same size, deep and narrow leaves being arranged alternately. Each leaf consists of muscular fibres covered with mucous membrane. The free surfaces of the leaves are studded with papillæ of various sizes, the largest being found near the entrance of the œsophageal groove.

There are two openings, one at each extremity, the left opening into the reticulum, the right into the abomasum.

Structure—(*a*) *Serous Coat.*—This does not cover the anterior surface.

(*b*) *Muscular Coat.*—The muscular fibres are continued into the leaves.

(*c*) The *Mucous Membrane* helps to form the leaves, is papillated, and covered with dense stratified epithelium.

4. **Abomasum**, Reed, Rennet, or True Digestive Stomach.—This is a pyriform sac, stretching along the right side of the rumen.

External Conformation.—Its greater curvature is placed downwards, the lesser curvature looking upwards and having the great omentum attached. The base is placed in front, and contacts the left extremities of the omasum and reticulum. The apex, or posterior extremity, is continuous with the duodenum.

Internal Conformation.—The mucous membrane is thrown into a number of folds, arranged longitudinally, and having a slight spiral direction. The internal surface is soft, reddish in

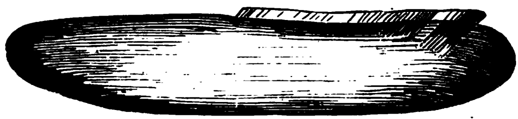

FIG. 9.—SPLEEN OF THE OX.

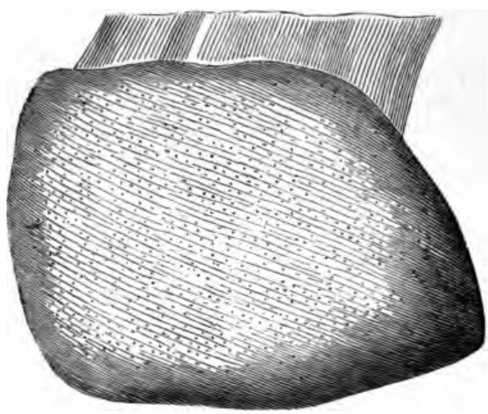

FIG. 10.—SPLEEN OF THE SHEEP.

colour, and covered with columnar epithelium. Gastric glands are present.

The *structure* is similar to that of the stomach of the horse.

III. **Small Intestine.**—This is about twice the length of that structure in the horse, but has a smaller calibre.

Peyer's patches are fewer, but larger. In the small ruminant they often attain to a length of 8 inches or more.

IV. **Large Intestine.**—Altogether this is about 36 feet in length in the large ruminant.

The **Cæcum** is smooth externally, the longitudinal bands being absent. The apex is blunt, and points backwards.

The **Colon** is arranged in an elliptical coil between the two layers of the mesentery. The calibre is nearly the same throughout.

The **Floating Côlon** can scarcely be said to be present, as there is no line of demarcation between it and the great colon.

V. **The Liver.**—This is situated in the right hypochondriac region. It is only slightly notched, and is thick. A **Gall-bladder** is present, and is situated on the posterior surface. The **hepatic duct** passes from the liver and joins the **cystic duct** from the gall-bladder; the common tube so formed is known as the **ductus choledochus,** and opens into the intestine from 20 to 30 inches from the pylorus. In the large ruminant the ductus choledochus opens alone; in the small ruminant the pancreatic duct joins it.

VI. **The Pancreas** is placed between the layers of the mesentery. In the large ruminant the pancreatic duct opens some 14 or 15 inches behind the ductus choledochus.

VII. **The Spleen** is placed on the left face of the rumen. In the large ruminant it is elongated, with rounded extremities. In the small ruminant it resembles an almost circular disc.

Pig.

I. **The Œsophagus** dilates as it opens into the stomach.

II. **The Stomach** is simple, being somewhat like that of the horse in shape, but possessing a distinct conical *cul-de-sac* at the left extremity. The mucous membrane has a small cuticular portion extending about 2 or 3 inches from the cardiac orifice. The capacity varies from 1 to 2 gallons.

III. **Small Intestine.**—Similar to that of the ruminant; it possesses a Peyer's patch of from 5 to 6 feet in length. Length, 56 feet.

IV. **Large Intestine.**—Similar to that of the ruminant.

The **Cæcum** has three longitudinal muscular bands.

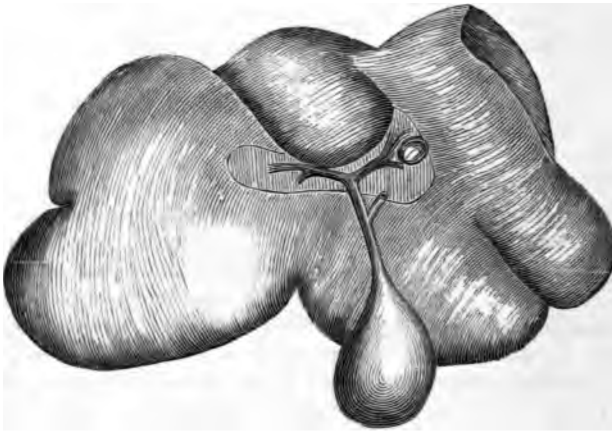

FIG. 11.—LIVER OF THE OX (POSTERIOR FACE).

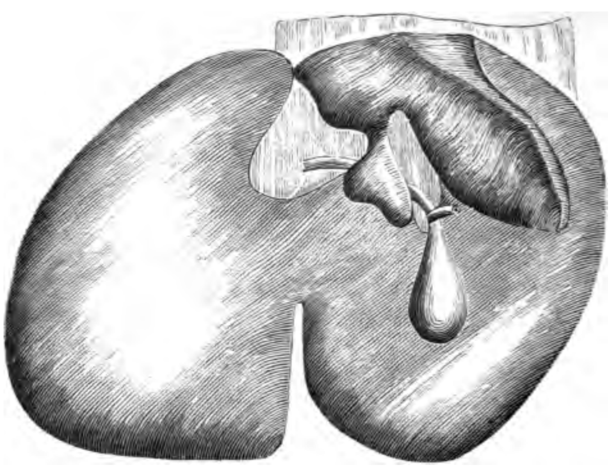

FIG. 12.—LIVER OF THE SHEEP (POSTERIOR FACE).

The **Colon** has only its posterior portion included in the mesentery.

Length of large intestine, 16 feet.

V. **The Liver.**—There are four principal lobes, sometimes named right and left external and right and left internal; the other lobes (Spigelian and caudate) are small.

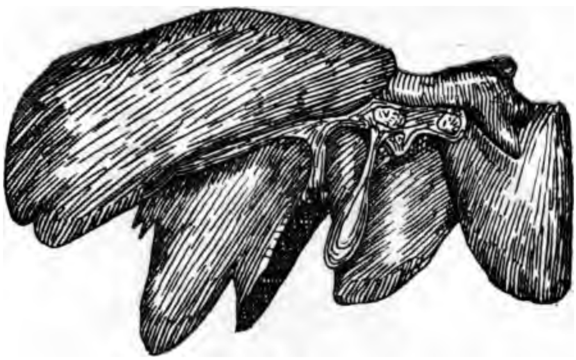

FIG. 13.—LIVER OF THE PIG.

A gall-bladder is present, the ductus choledochus opening alone 1 or 2 inches from the pylorus. The pancreatic ducts open 4 or 5 inches behind the ductus choledochus.

VI. **The Spleen** is elongated, one extremity, as a rule, being more pointed than the other.

FIG. 14.—SPLEEN OF THE PIG.

Dog.

I. **The Œsophagus** becomes much dilated as it enters the stomach.

II. **The Stomach** is simple and pyriform. Its lesser curvature is not so concave as in the horse. The mucous membrane is entirely villous, and thrown into folds when the organ is empty.

III. **Small Intestine.**—This has thick walls, numerous villi, and about twenty Peyer's patches. It is in contact with the abdominal floor.

IV. **Large Intestine.**—The **Cæcum** is short and twisted.

The **Colon** is divided into *ascending*, *transverse* and *de-*

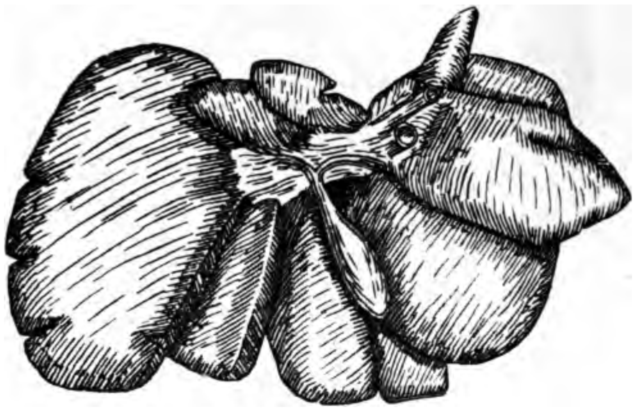

FIG. 15.—LIVER OF THE DOG (POSTERIOR SURFACE).

scending, names derived from human anatomy, and which do not apply very well to the dog.

The **Floating Colon** is absent.

Two glandular diverticuli open out of the anus, and contain a brown, foul-smelling material.

V. **The Liver.**—This is large, the fissures being deep and the lobes numerous—seven can be counted. The ductus choledochus joins the smaller pancreatic duct.

VI. **The Pancreas** follows the lesser curvature of the duodenum, reaching the stomach anteriorly; it has two ducts, the smaller of which joins the ductus choledochus, the larger opening alone into the duodenum.

VII. **The Spleen** is elongated, its anterior extremity being expanded.

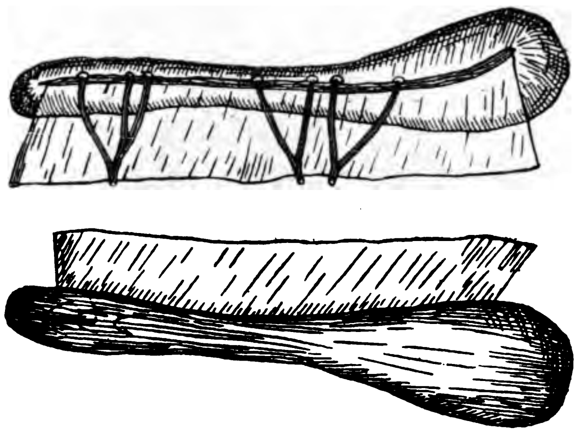

FIG. 16.—SPLEEN OF THE DOG.

THE RESPIRATORY SYSTEM.

Ruminant.

The thoracic capacity is relatively small.

There are three **Bronchi**.

The **Posterior Mediastinum** is not perforated.

The **Left Lung** has two lobes, the **Right Lung** possessing four.

The **Interlobular Septa** are thick.

Pig.

The above remarks apply to the pig, the differences being only of secondary importance.

Dog.

The thoracic capacity is relatively large.

The **Left Lung** has three lobes, and the **Right** has four.

The lungs completely surround the heart, and are almost always pigmented.

THE URINARY SYSTEM.

Ruminant.

In the **large ruminant** the **Kidneys** are much elongated and lobulated; in the **sheep** they are simple.

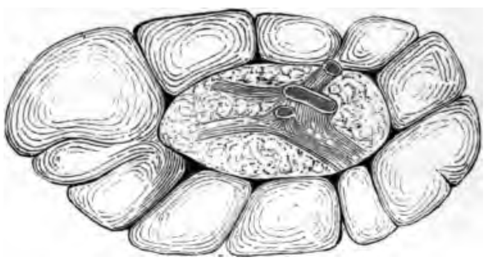

FIG. 17.—KIDNEY OF THE OX (INFERO-INTERNAL FACE).

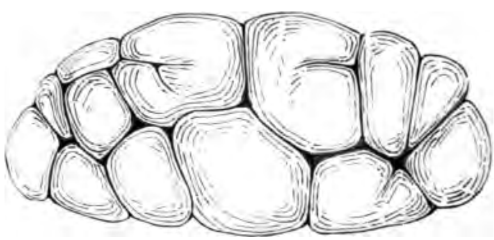

FIG. 18.—KIDNEY OF THE OX (SUPERO-EXTERNAL FACE).

The **Left Kidney** is not firmly attached to the abdominal roof, and is known vulgarly as 'the hanging' kidney, whereas the right is called 'the tied' kidney. Both kidneys are usually embedded in a layer of adipose tissue.

The **Pelvis** of the kidney is divided into a number of **calices**; a papilla, upon which the uriniferous tubes open, is found in each calyx.

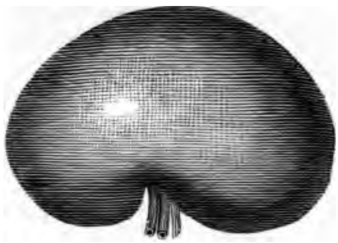

FIG. 19.—KIDNEY OF THE SHEEP.

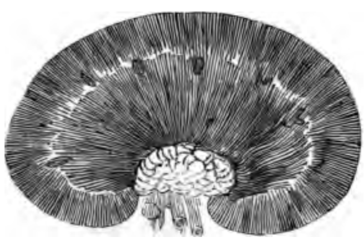

FIG. 20.—KIDNEY OF THE SHEEP (LONGITUDINAL SECTION).

The **Bladder** is thin and capacious, and its serous covering is continued to the neck.

Pig.

The **Kidney** is large and simple; the left is in advance of the right.

The **Bladder** is thin, and similar to that of the ruminant.

Dog.

The **Kidneys** are simple, and shorter, relatively, than those of the other domesticated animals; the left is in advance of the right.

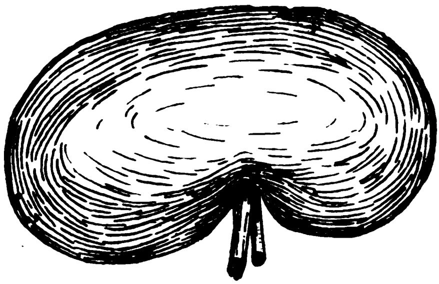

FIG. 21.—KIDNEY OF THE DOG.

The **Pelvis** has no calices.

The **Bladder** has thick walls, due to the large amount of muscular tissue present.

THE GENERATIVE SYSTEM.

I. THE MALE ORGANS.

Ruminant.

The **Testicles** are very large, and suspended, with their long axes almost vertical; the **Corpus Highmori** is well developed.

The **Globus Major** of the epididymis is large.

The two **Vasa Deferentia** unite by means of their bulbous portions and form a common duct, which opens into the urethra by means of two orifices.

The **Vesiculæ Seminales** are large, lobulated, yellow, and glandular.

The **Urethra** is bent in an S-shaped manner; the calibre gradually diminishes from the bladder to its external opening.

The **Prostate Gland** is small, and **Cowper's Glands** are absent.

The **Penis** is long, thin and tapering anteriorly; it is bent in the form of the letter S, the curves being situated slightly in front of the pubis; the second curve is convex posteriorly, and has the **suspensory ligaments** attached to it, these being continued forwards for a considerable distance. The penis terminates in a small pointed glans. The **Sheath** is attached farther forwards than in the horse, and is moved by two pairs of muscles, an anterior pair of **protractors** and a posterior pair of **retractors**. It is interesting to note that these muscles are represented in the female.

Pig.

The **Testicles** are large, somewhat rounded, and situated in the perineal region; they are not pendulous.

The **Vesiculæ Seminales** are rather large and glandular.

The **Prostate Gland** is double, being divided into anterior and posterior portions.

Cowper's Glands are absent.

The **Penis** resembles that of the bull, but its sheath is not provided with muscles. A preputial sac is described, which secretes a foul-smelling fluid.

Dog.

The **Testicles** are somewhat ovoid, situated in the perineal region, and pendulous.

The **Vesiculæ Seminales** are absent.

The **Prostate Gland** is partially divided into two lateral lobes.

Cowper's Glands are absent. (They are described as being present, but small, in the cat.)

The **Penis** is furnished with a bone which presents a groove inferiorly, in which the urethra is found. There are two erectile enlargements: an anterior one—the glans—which is pointed; and a posterior one, which prevents the penis being withdrawn from the vulva until a considerable time has elapsed.

II. THE FEMALE ORGANS.

Ruminant.

The **Ovaries** are smaller than those of the mare.

The **Uterus** extends to the 4th or 5th lumbar vertebra. The lesser curvature of the cornua looks downwards; the body is short. The mucous membrane is studded with the **maternal cotyledons**, rounded eminences, very vascular and pitted on their surface; these structures are most numerous in the cornua, there being only a few in the body. The maternal cotyledons in the sheep have concave summits.

The **Vagina** of the cow is provided with mucous canals, known as the **Canals of Gärtner**; these pass from the lateral walls to near the meatus urinarius; their function is unknown, and they are absent in the small ruminant.

The **Urethra** has a diverticulum near the meatus urinarius.

The **Vulva** is provided with thick lips; the inferior commissure is very acute, and carries a tuft of hairs. The **Vulvo-vaginal Glands**, or glands of Bartholine, are found in the substance of the vulval lips.

In the cow the **Mammary Glands** are large, and divided into anterior and posterior parts, four 'quarters' being the result, each having a separate teat; there are frequently supernumerary teats placed behind the customary posterior teats. The **Galactopherous Sinuses** are large; each teat has one excretory duct only.

In the sheep and goat there are only two mammæ; the goat may have rudimentary posterior glands.

Pig.

The **Ovaries** are lobulated.

The **Uterus** has a very short body, but very long cornua, resembling the small intestine, but possessing a peculiar bluish tinge.

The **Vulva** has Gärtner's canals, as in the cow.

The **Mammæ** are arranged in two rows of five or six each; in position they are inguinal, abdominal and pectoral. There are *no* ***Galactopherous*** **Sinuses**, and each teat has several ducts.

Dog.

The **Uterus** is similar to that of the sow.

Gärtner's Canals are absent.

(The clitoris of the cat is provided with a small bone.)

The **Mammæ** are similar to those of the sow, there being ten in all; each teat has numerous ducts.

THE HEART.

Ruminant.

There are three longitudinal furrows, the third passing down the posterior wall of the left ventricle.

Two **Cardiac Bones** are present; these are placed between the auriculo-ventricular rings, the pulmonary artery and the aorta. The right bone is the larger.

The weight of the ox's heart varies from 3½ to 5 pounds.

Pig.

The heart resembles that of the horse.

Dog.

The heart is relatively shorter than that of the horse, being ovoid; its anterior surface is really inferior, and in contact with the sternum; the apex is pointed backwards, and in contact with the diaphragm.

ARTERIES.

Ruminant.

I. **Posterior Aorta.**—There are nine aortic **Intercostals.**

The **Middle Sacral** artery is of considerable size, and supplies the tail.

Cœliac Axis.—This gains the rumen some little distance posterior to the termination of the œsophagus, and terminates in the **superior and inferior arteries of the omasum and abomasum.**

A. **Collateral Branches**:

(*a*) *Diaphragmatic.*

(*b*) *Splenic.*

(*c*) *Superior and inferior arteries of the rumen.*

(*d*) *Artery of the Reticulum.*—This divides into *superior* and *inferior* branches.

(*e*) *Hepatic.*—This supplies the gall-bladder, and furnishes a *pancreatico-duodenal* branch, which joins the superior artery of the omasum and abomasum and the anterior mesenteric.

B. **Terminal Branches**:

(*a*) *Superior Artery of the Omasum and Abomasum.*—This anastomoses with the duodenal.

(*b*) *Inferior Artery of the Omasum and Abomasum.*

The **Great Mesenteric** artery divides into anterior and posterior portions, the former supplying the small intestine, the latter the cæcum and colon.

The **Lesser Mesenteric** artery is small.

II. **Brachial Artery.** — The anterior aorta is said to be absent; at any rate, it is very short.

The **Dorsal** and **Vertebral** arteries spring from a common trunk; the **Subcostal** also arises from this trunk.

The **Superior Cervical** artery is replaced by a branch from the dorsal.

The **Vertebral** artery is voluminous, but does not anastomose with a branch of the occipital.

Pig.

I. The **Posterior Aorta** is distributed in a manner very similar to that of the horse, with the exception that it terminates as the middle sacral artery, and its mesenteric branches resemble those of the ruminant.

The **Anterior Aorta** is absent.

II. **Brachial Artery.** — The **Right** artery furnishes two separate carotid arteries.

The **Superior Cervical** artery is represented by a branch of the brachial, which furnishes **Dorsal**, **Vertebral** and **Subcostal** arteries.

Dog.

I. **Posterior Aorta.**—The two anterior **Lumbar** arteries are formed from the thoracic aorta.

A ***Middle*** **Sacral** artery is present.

The **Bronchial** arteries are absent.

The **Œsophageal** arteries are four or five in number, and contribute branches to the bronchi and lungs.

The **Cœliac Axis** has three branches, as in the horse; the **Gastric** artery does not divide into anterior and posterior branches.

The **Hepatic** artery furnishes a large pancreatico-duodenal branch, which anastomoses with the great mesenteric.

II. **Brachial Artery.**—The **Dorsal, Superior Cervical** and **Subcostal** arteries arise from a common trunk.

The **Vertebral** artery anastomoses with the ramus anastomoticus of the occipital.

VEINS.

The **Subcutaneous Abdominal** vein of the ruminant is very large; this is especially so in a milch cow.

The **Subcutaneous Thoracic** vein is small.

The other veins of the ruminant (and all those of the other domesticated animals) are not of sufficient importance to call for special mention.

THE THORACIC DUCT.

In the **ruminant** the thoracic duct is very variable; it is frequently double. It has a special opening in the diaphragm.

In the **pig** the duct is single, but sometimes bifurcates near its termination, the two portions reuniting and forming a dilatation. It opens into the left jugular vein.

In the **dog** the receptaculum chyli is very large; the thoracic duct is similar to that of the pig.

NERVES.

The comparative differences are of minor importance.

In the **ruminant** the nerves of the latissimus dorsi and the circumflex nerve are blended at their origin.

In the **pig** the nerve of the serratus magnus is large.

In the **dog** the pneumogastric nerve contributes large and numerous bronchial branches, and its œsophageal plexus is large.

APPENDIX.

TABLE OF MUSCULAR ATTACHMENTS.

Bones, etc., affording Attachment.	*Muscles.*	
DORSAL VERTEBRÆ.		
1st to 6th	Splenius	Belonging to the neck.
	Complexus major	
1st and 2nd	Trachelo-mastoideus	
1st to 6th	Longus colli	
3rd to 11th	Trapezius dorsalis.	
4th to last	Latissimus dorsi.	
2nd to 7th	Rhomboideus brevis.	
2nd to last	Anterior and posterior small serrati.	
	Longissimus dorsi.	
	Semispinalis dorsi.	
	Levatores costarum.	
16th to last	Psoas magnus and parvus.	
LUMBAR VERTEBRÆ.		
1st to 3rd	Latissimus dorsi.	
	Posterior small serratus.	
	Longissimus dorsi.	
	Semispinalis lumborum.	
	Psoas magnus and parvus.	
	Quadratus lumborum.	
	Intertransversalis lumborum.	
	Transversalis abdominis.	
	Diaphragm (crura).	
SACRUM.	Longissimus dorsi.	
	Semispinalis lumborum.	
	Gluteus externus and maximus.	
	Triceps abductor femoris.	
	Biceps rotator tibialis.	
	Pyriformis.	
	Coccygeal muscles (4).	

Bones, etc., affording Attachment.	*Muscles.*
COCCYGEAL VERTEBRÆ.	Coccygeal muscles (4).
RIBS AND COSTAL CARTILAGES.	
1st	Scalenus.
5th to 9th	Anterior small serratus.
9th to last	Posterior „ „
3rd to last	Longissimus dorsi.
	Transversalis costarum.
1st to 8th	Serratus magnus.
1st	Lateralis sterni.
	Levatores costarum.
	Intercostals.
5th to last	Obliquus abdominis externus.
Costal cartilages	Obliquus abdominis internus.
Costal cartilages	Rectus abdominis.
9th to last	Transversalis abdominis.
7th to last	Diaphragm.
2nd to 8th	Triangularis sterni.
17th and 18th	Psoas magnus.
16th to last	Quadratus lumborum.
STERNUM.	Panniculus carnosus.
	Sterno-maxillaris, Sterno-thyro-hyoideus } Belonging to the neck.
	Pectorals (4).
	Lateralis sterni.
	Rectus abdominis.
	Transversalis abdominis.
	Diaphragm.
	Triangularis sterni.

TABLE OF WEIGHTS, MEASUREMENTS, ETC.

HORSE.

Lung:	
Right - - - -	7 pounds.
Left - - - - -	6 pounds.
Heart - - - - -	5 to 6 pounds.
Stomach - - - -	weight, 3 to 4 pounds. capacity, 3 gallons.
Small intestine - - -	length, 72 feet. calibre, $1\frac{1}{2}$ inches.
Cæcum - - - - -	length, 36 inches. capacity, 6 gallons.

HORSE (*continued*).

Great colon - - - -	length, 9 to 11 feet. capacity, 18 gallons.
Floating colon - - -	length, 9 to 11 feet. calibre, 2½ inches.
Rectum - - - -	length, 18 inches.
Liver - - - - -	9 to 12 pounds.
Pancreas - - - -	16 ounces.
Spleen - - - - -	2 to 4 pounds.
Kidney:	
Right - - - -	22 ounces.
Left - - - - -	20 ounces.

OX.

Heart - - - - -	3½ to 5 pounds.
Rumen - - - - -	capacity, 50 to 60 gallons.
Small intestine - - -	145 feet.
Large intestine - - -	36 feet.

PIG.

Small intestine - - -	56 feet.
Large intestine - - -	16 feet.

INDEX.

END OF PART II.

Baillière, Tindall and Cox, King William Street, Strand.

OUTLINES OF

VETERINARY ANATOMY.

OUTLINES OF

VETERINARY ANATOMY.

PART III.

THE HEAD AND NECK.

BY

O. CHARNOCK BRADLEY,

MEMBER OF THE ROYAL COLLEGE OF VETERINARY SURGEONS; PROFESSOR OF ANATOMY IN THE NEW VETERINARY COLLEGE, EDINBURGH.

LONDON:

BAILLIÈRE, TINDALL & COX,

20 & 21, KING WILLIAM STREET, STRAND.

NEW YORK: WILLIAM R. JENKINS.

1897.

CONTENTS.

THE HEAD AND NECK OF THE HORSE.

TABLE OF DIAGRAMS.

VETERINARY ANATOMY.

THE HEAD AND NECK OF THE HORSE.

THE **Head** and **Neck** we may consider as the most important parts of the body, as they lodge the important nervous centres, the organs of special sense, and the beginnings of the alimentary and respiratory systems.

The **Head** has a skeleton formed by the skull, a collection of thirty-two bones (excluding the *hyoid*).

The **Neck** has the seven *cervical* vertebræ for a bony framework.

THE SKULL.

The **Skull**, constituting the skeleton of the head, is formed by a collection of bones, which, with the exception of the inferior maxilla, are all firmly united with each other in the adult by means of the so-called **sutures.** In the young animal the sutures are distinct, but become fainter as the animal grows older. With the exception of the parietals and nasals, the bones of the skull are irregular in shape.

The skull is divided by anatomists into two portions: (1) The **Cranium**, a bony box lodging and protecting the brain, etc.; and (2) the **Face**, in which are found the nasal chambers and mouth—the commencement of the respiratory and digestive systems.

The bones entering into the formation of the **cranium** are the following: Occipital, interparietal, parietal, frontal, sphenoid, petrous and squamous, temporal, and ethmoid.

The **face** is formed by: Nasal, malar, superior maxilla, lachrymal, premaxilla, pterygoid, palatine, vomer, superior and inferior turbinals, and inferior maxilla. The Hyoid Bone will also be considered with the facial bones, as it forms the bony support of the tongue and larynx.

The majority of the bones of the skull are paired; a few are single, and consequently occupy the mesial plane.

Paired Bones.—Parietal, frontal, nasal, petrous and squamous temporals, malar, lachrymal, superior maxilla, premaxilla, pterygoid, palatine, and superior and inferior turbinals.

Single Bones.—Occipital, interparietal, sphenoid, ethmoid, vomer, and inferior maxilla.

We will first consider the bones individually, and afterwards collectively, as comprising the skull in its entirety.

I. BONES OF THE CRANIUM.

OCCIPITAL BONE.

Situation.—This forms the highest and most posterior part of the skull;* it is the bone by means of which the skull articulates with the vertebral column.

It presents *external* and *internal surfaces* and a *circumference.*

Surfaces.

External.—This is very irregular; it is bounded superiorly by the prominent subcutaneous **crest of the occiput,** which is continued laterally by the **occipital** or **mastoid ridge**; below the crest is the **occipital tuberosity,** a marked eminence, with a depression on each side for the attachment of the cordiform portion of the ligamentum nuchæ. The **foramen magnum** will be found in the middle line below the tuberosity; it is bounded laterally by the convex articular **condyles,** which fit into the concavities of the atlas. The **styloid** or **paramastoid processes,** curving forwards and inwards, are separated from the condyles by the **styloid** or **stylo-condyloid notches,** at the bottom of which are found the **condyloid foramina.** The **basilar process**—a thick rod of bone compressed from above to below—runs forwards from the foramen magnum; this process is slightly rounded from side to side, and has a groove—the **basilar groove**—running along its lower face. Where it joins the sphenoid rough muscular

* For the sake of convenience we will assume that the skull is resting by the inferior maxilla on a table—*i.e.*, with its long axis placed in a horizontal direction.

eminences for the anterior recti muscles of the head may be seen.

Internal.—This is irregularly concave, the upper part forming the roof of the cerebellar fossa, the lower part being formed by the upper face of the basilar process; this is slightly hollowed out from side to side. The internal opening of the foramen magnum is seen on this face.

Circumference.

This is thick and very irregular above; the lateral borders of the basilar process are thin, and form the inner boundary of the large and irregular **foramen lacerum basis cranii.**

The occipital **articulates** with nine bones: Two parietals, the interparietal, two squamosals, two petrosals, the sphenoid, and the atlas.

Development.—From four centres:

1. For the basilar process (*basi-occipital*).
2 and 3. For a condyle and styloid process (*ex-occipitals*).
4. For the occipital crest and the bone extending downwards from it (*supra-occipital*).

PARIETAL BONE.

Situation, etc.—This is a curved plate of bone forming the greater part of the roof of the cranial cavity; it is placed immediately in front of and below the occipital crest.

It has *two surfaces* and *four borders*.

Surfaces.

External.—This is divided into three areas: (1) A smooth convex space which enters into the formation of the temporal fossa; (2) a small flat triangular portion placed at the antero-internal angle, and separated from the first area by a curved ridge; and (3) a roughened outer area overlapped by the squamosal.

Internal.—This is concave, and marked by two kinds of depression: (1) Narrow grooves for meningeal vessels, and (2) finger-like impressions for the convolutions of the cerebrum.

Borders.

Internal.—Thick, and much serrated for union with its fellow of the opposite side of the skull; when the two bones are placed together they form the **sagittal crest** along their line of union. This border is notched posteriorly for the interparietal bone.

External.—Thin and irregularly notched; it meets the squamosal and, slightly, the sphenoid.

Posterior.—Thick and irregular; it articulates with the occipital.

Anterior.—This is thin, serrated and bevelled for union with the frontal.

The parietal **articulates** with seven bones: The occipital, its fellow, the interparietal, the frontal, the squamosal, the petrosal, and the sphenoid.

Development.—From one centre.

Reference to Side. — Place the convex surface superiorly, the straightest border internally, and the thickest border posteriorly.

INTERPARIETAL BONE.

Situation, etc.—This bone is wedged in between the occipital and the two parietal bones, and is sometimes described as part of the parietals. It is also known as the **Os triquetrum**, or **Wormian bone.** It is somewhat triangular in shape, and is observed best in young skulls, where it appears externally as a squarish area.

It has *two surfaces* and *four borders.*

Surfaces.

External or Superior.—This is the smooth quadrilateral area seen in young skulls.

Internal or Cranial.—Projects into the cranial chambers as the **ossific tentorium**, helping to form the incomplete partition between the cerebral and cerebellar fossæ, and having folds of dura mater suspended from it.

Borders.

Posterior.—Thick and irregularly dentated for the occipital.

Lateral.—Thin and sharp.

Anterior.—Serrated for articulation with the parietals.

The interparietal **articulates** with three bones: The occipital and two parietals.

Development.—From two centres placed side by side.

FRONTAL BONE.

Situation, etc.—This bone is placed at the anterior and superior limits of the cranial cavity. It is irregularly quadrilateral in shape.

It presents *two surfaces* and *four borders*.

Surfaces.

External.—This surface is divided into two portions, and carries an important and prominent process: (1) The superior portion is flat and subcutaneous. (2) The **orbital process,** or **plate,** is bent nearly at right angles to the above flat area, and helps to form the walls of the orbit; a triangular notch — the **incisura sphenoidalis**—is found in this plate, into which a projection from the orbital process of the sphenoid fits; anterior to this is a smaller rounded notch, which helps to form the **internal orbital foramen.** Close below the supra-orbital process is a slight depression, which marks the position of the loop through which the tendon of the superior oblique muscle plays. (3) The **supra-orbital** or **external orbital process** is a short, curved piece of bone which projects outwards to articulate with the zygomatic arch; it forms the upper limit of the orbit, and is perforated near its internal extremity by the **supra-orbital foramen.**

Internal.—Divided into two portions by a plate of bone, which meets the cribriform plate of the ethmoid: (1) The posterior portion is concave and smooth, forming part of the cranial chamber, and showing finger-like depressions for the cerebral convolutions.

(2) The anterior portion is very irregularly concave, forming the frontal sinus.

Borders.

Anterior. — Slopes towards the mesial line and meets the nasal bone.

Posterior.—Its upper portion is dentated for articulation with the parietal, the lower portion being bevelled and overlapped by the squamosal.

Internal.—Joins the corresponding border of the other frontal; it is straight and triangular in shape.

External.—Very irregular, and articulates with the lachrymal and ethmoid bones.

The frontal **articulates** with nine bones: The parietal, its fellow, the nasal, the squamosal, the sphenoid, the ethmoid, the lachrymal, the palatine, and the superior maxilla.

Development.—From one centre.

Reference to Side. — Place the smooth, flat and triangular surface superiorly, the pointed extremity anteriorly, and the supra-orbital process externally.

TEMPORAL BONE.

Situation, etc.—This bone is placed at the side of the cranium, immediately anterior to the occipital and below the parietal. In the horse two distinct portions are always found, and these are usually described as separate bones—the **Petrosal** and **Squamosal** bones.

PETROSAL BONE.

This is a very important bone, because it lodges the essential parts of the organ of hearing. It is of considerable density—hence its name—and contains four small bones—the malleus, incus, os orbiculare, and stapes—which will be described in connection with the middle ear.

It possesses *four surfaces*, *four borders*, an *apex*, and a *base*.

Surfaces.

Anterior.—This is divided into two areas, the outer of which articulates with the parietal, the inner being smooth and free, and assisting in the formation of the cerebral fossa.

Posterior.—Is flat and triangular, articulating with the occipital.

External.—This face is partially covered by the squamosal, only the posterior part appearing on the surface.

Internal.—This face is free, slightly concave, and forms part of the cerebellar fossa. It presents the **internal auditory meatus**, a short canal at the bottom of which the **aqueduct of Fallopius** has its origin. The **aquæductus vestibuli** and **aquæductus cochleæ** are two slit-like openings situated close to the meatus, the former being the more superior.

Borders.

Antero-internal.—This is thin, and has a fold of dura mater attached.

Antero-external. — Is thicker, and hidden by the squamosal.

Postero-external.—This is the only border of importance; it is seen on the surface of the skull, forming the **mastoid ridge** or **crest** between the squamosal and occipital bones, and terminating inferiorly in the **mastoid process** (sometimes called the posterior mastoid process). The **mastoid fissure** crosses this border about its middle, and lodges the mastoid artery.

The Apex.

This is pointed and directed upwards, articulating with the occipital.

The Base.

The base is very irregular and free, forming the external limit of the foramen lacerum basis cranii. The **external auditory meatus** leads into the middle ear, and is surrounded by a tubular projection of bone—the **auditory process**—presenting a notch. The **hyoid process** is a short rod of bone placed immediately behind the meatus, and surrounded at its base by a rudimentary bony vaginal process; the great cornu of the hyoid bone is attached to this process by a short rod of cartilage.

The **stylo-mastoid foramen** is placed between the hyoid and mastoid processes.

The **auditory bulla**, or **mastoid protuberance,** is a large smooth projection placed behind the hyoid process.

The **styloid process** is a slender, pointed process, directed downwards and forwards. The origin of the tensor and levator muscles of the soft palate is from this process.

The **styloid foramen,** or **Glasserian fissure,** is situated between the auditory meatus and the styloid process.

The **Eustachian orifice**—to which the cartilaginous

Eustachian tube is attached—is found internal to the base of the styloid process.

The petrosal **articulates** with four bones: The occipital, the parietal, the squamosal, and (indirectly) the great cornu of the hyoid.

Reference to Side.—Place the apex upwards, the external auditory meatus externally; the styloid process points downwards and forwards.

SQUAMOSAL BONE.

This is best described as consisting of a plate-like body and two processes—pyramidal and zygomatic.

(1) Chief Part or Body of the Bone.

This has *two surfaces* and a *circumference.*

Surfaces.

External.—Smooth and convex, and helps to form the temporal fossa.

Internal.—Concave. Its central area is smooth, and forms part of the cranial cavity. Its periphery has small projections, and articulates with the frontal, parietal and sphenoid bones.

Circumference.

The greater part is articular and thin. The pyramidal process springs from the posterior part.

(2) Pyramidal Process.

This process arises from the posterior part of the body, and is irregularly triangular.

It possesses *two surfaces, three borders,* and *three angles.*

Surfaces.

External.—Has a ridge which joins the zygomatic process.

Internal.—This face is articular, being placed over the petrosal, the **parieto-temporal canal** or **conduit** running between the two bones.

Borders.

Superior.—This shows a number of openings of the parieto-temporal canal.

Inferior.—This border is concave, hooking round the external auditory meatus of the petrosal.

Posterior.—The mastoid artery is provided with a notch in this border.

Angles.

Anterior.—This is the angle by which the process is attached to the body of the squamosal.

The other angles are not important.

(3) Zygomatic Process.

This process arches outwards and forwards, springing from the outer face of the body.

It has *two surfaces, two borders,* and *two extremities.*

Surfaces.

Internal.—This looks towards the temporal fossa, and is smooth.

External or Inferior.—This face presents three important areas: (1) An **articular eminence** or **condyle,**

(2) a **glenoid cavity**, and (3) the **post-glenoid** (or **anterior mastoid) process.** The **mastoid foramen** is seen at the root of the post-glenoid process.

Borders.

Superior.—This is thick and chiefly convex. The supra-orbital process of the frontal articulates with a roughened area near the anterior extremity.

Inferior.—This border is sharp and concave.

Extremities.

Anterior.—This extremity is rather acute, and articulates with the malar and superior maxillary bones.

Posterior.—Attached to the body of the squamosal.

The squamosal **articulates** with eight bones: The parietal, the petrosal, the frontal, the occipital, the sphenoid, the malar, and the superior and inferior maxillæ.

Reference to Side.—The zygomatic process is on the external face, and points forwards, the glenoid cavity and condyle being below.

Development of the Temporal.—From four centres:

1. For the squamosal.
2. 2, 3, and 4. For the petrosal, being **tympanic** (styloid process, auditory process, and bulla), **mastoid** (mastoid crest and process), and **petrous** (that part forming the bony labyrinth of the internal ear).

SPHENOID BONE.

Situation, etc.—This bone is placed in the middle line, immediately in front of the occipital basilar process, and is one of the bones forming the base of the skull. It is very irregular in shape, somewhat resembling a bird in flight. In the young animal it is easily divided into two separate segments, and it is best to describe it as consisting of two portions, a post-sphenoid and a pre-sphenoid.

(1) Post-Sphenoid.

This consists of a *body* and *two alæ*, or *wings*.

(*a*) The Body.

A short, somewhat cylindrical rod of bone, also known as the **basi-sphenoid**, placed between the basi-occipital and the body of the pre-sphenoid.

It has *two surfaces* and *two borders*.

Surfaces.

External or Inferior.—This is seen when the base of the skull is examined from the outside. It is convex laterally, and carries a few tubercles where it meets the corresponding face of the basi-occipital.

Internal or Superior.—This face is more or less flattened, and carries a slight pit—the **sella turcica** or **pituitary fossa**—for the lodgment of the pituitary body.

Borders.

These are only important because they give origin to the wings.

(*b*) The Wings.

The wings proceed upwards and outwards from the borders of the body. For purposes of description they are each considered to have *two surfaces* and *four borders*.

Surfaces.

External or Inferior.—This face carries a pronounced process, known as the **subsphenoidal** or **pterygoid process,** which projects downwards, backwards and outwards, and articulates with the palatine bone, and slightly also with the pterygoid. The **subsphenoidal canal** or **foramen** (known also as the **pterygoid foramen**) pierces the base of the above-mentioned process. The **Vidian groove**, usually faint, crosses this face close to the body of the bone.

Internal or Superior.—This is smooth, and looks towards the cranial cavity. A groove for the superior maxillary, or second division of the 5th cranial nerve, is seen crossing it.

Borders.

Anterior.—This border meets the wing of the presphenoid, with which it forms the **lacerated** and **pathetic foramina.** It also forms the **foramen rotundum.**

Posterior.—Forms the anterior limit of the foramen lacerum basis cranii, and shows three notches : (1) For the internal carotid artery, (2) for the inferior maxillary division of the 5th cranial nerve, and (3) for the principal meningeal artery, in this order from within outwards.

Superior or External.—This margin is bevelled for articulation with the squamosal and parietal bones.

Internal.—This is the border by which the wing is attached to the body.

(2) Pre-Sphenoid.

This also consists of a *body* and *two wings.*

(*a*) The Body.

A short rod of bone joining the body of the post-sphenoid posteriorly, and helping to form the sphenoidal air sinus anteriorly.

It presents *two surfaces* and *two borders.*

Surfaces.

External or Inferior.—Convex laterally, and partially obscured by the vomer.

Internal or Superior.—Smooth and flat; superiorly it presents an area on which the optic commissure rests. The **optic foramen** leads forwards and outwards from this area.

Borders.

The wings are attached to the borders.

(*b*) The Wings.

Each possesses *two surfaces* and *four borders.*

Surfaces.

External. — This face is convex, and overlapped anteriorly by the frontal.

Internal.—Concave and smooth; this face looks into the cranial cavity.

Borders.

Anterior.—This margin meets the frontal, with which it forms the **internal orbital foramen.**

Superior.—Is received into the incisura sphenoidalis of the frontal.

Posterior.—Meets the anterior border of the wings of the post-sphenoid.

Internal.—The wing is attached to the body by this border.

The sphenoid **articulates** with thirteen bones: The occipital, the ethmoid, the vomer, two superior maxillæ, two frontals, two parietals, two squamosals, and two pterygoids.

Development.—From five centres:

1. For the body of the post-sphenoid.

2 and 3. For the wings of the post-sphenoid.

4 and 5. For the pre-sphenoid.

ETHMOID BONE.

Situation, etc.—This is placed in the mesial plane, separating the cranial and nasal cavities. It consists of two plates, horizontal and vertical, and two lateral masses.

(1) Horizontal Plate.

This is also known as the **cribriform plate,** on account of the large number of **olfactory foramina** piercing it.

It has *two surfaces* and a *circumference.*

Surfaces.

Posterior or Cranial.—This face is divided into two concavities by the vertical plate; these concavities constitute the olfactory fossæ, and lodge the olfactory lobes of the brain.

Anterior or Nasal.—The lateral masses are attached to this surface.

Circumference.

The circumference articulates with the frontal and pre-sphenoid bones.

(2) VERTICAL PLATE.

This coincides with the mesial plane of the skull.

It presents *two surfaces* and *four borders*.

The **Surfaces** are free and present little of interest.

Borders.

Anterior.—The cartilaginous septum nasi is attached to this irregular margin.

Superior.—This meets the frontal bones.

Posterior.—The **crista galli process** formed by this border projects beyond the horizontal plate into the cranial cavity.

Inferior.—Fits into the vomer.

(3) LATERAL MASSES.

These are two masses—right and left—of thin richly convoluted plates of bone, somewhat conical in shape, with their apices pointing forwards. The term **ethmoidal cells** is applied to the spaces found in these masses. The **lamina papyracea** is a thin layer of bone covering the exterior of the masses.

The ethmoid **articulates** with ten bones: The sphenoid, the vomer, two frontals, two superior turbinals, two palatines, and two superior maxillæ.

Development.—From three centres:

1. For the plates.

2 and 3. For the lateral masses.

II. *BONES OF THE FACE.*

NASAL BONE.

Situation, etc.—The nasal bone is placed on the upper face of the skull, immediately in front of the frontal. Each bone is of an elongated pyriform shape, both together somewhat resembling the heart of playing cards.

The nasal bone presents *two surfaces, two borders,* a *base,* and an *apex.*

Surfaces.

External or Facial.—This face is free and subcutaneous; it is convex laterally, and smooth; the anterior portion may be curved from before to behind.

Internal or Nasal.—Concave laterally, and carries a longitudinal ridge, to which the superior turbinated bone is attached. It forms the chief part of the roof of the nasal fossa.

Borders.

Internal.—Straight, and meets the nasal bone of the opposite side.

External.—This margin is irregular, being scaly above for articulation with the superior maxilla and premaxilla. The anterior third, commencing at a notch, is smooth and free.

The Base.

The base, or posterior extremity, is rounded, bevelled and scaly for articulation with the frontal and lachrymal bones.

The Apex.

The apex, or anterior extremity, is pointed, and, with the apex of the opposite nasal, forms the **nasal peak.**

The nasal **articulates** with six bones : Its fellow, the frontal, the lachrymal, the superior maxilla, the premaxilla, and the superior turbinated bone.

Development.—From one centre.

Reference to Side. — Place the convex surface superiorly, the straight border internally, and the apex anteriorly.

LACHRYMAL BONE.

Situation.—A small irregular bone, situated at the lower limit of the orbital cavity.

It presents *two surfaces* and a *circumference.*

Surfaces.

External.—This is divided into two portions—**facial** and orbital—by a curved ridge, which helps to form the orbital rim.

The facial portion is slightly convex, and carries a small and inconstant **lachrymal tubercle** near the orbital rim; this tubercle affords attachment to the orbicularis palpebrarum muscle.

The orbital portion is concave, forms the chief part of the floor of the orbit, and has the **lachrymal fossa**—which lodges the lachrymal sac—and the **lachrymal canal** leading from it. A shallow depression is found below the above fossa, and marks the position of attachment of the inferior oblique muscle of the eye.

Internal.—Irregularly concave, and crossed by a ridge marking the position of the lachrymal canal.

Circumference.

The circumference is thin and irregular; it articulates with the surrounding bones.

The lachrymal **articulates** with four bones: The frontal, the nasal, the superior maxilla, and the malar.

Development.—From one centre.

Reference to Side.—Place the concave surface internally; the lachrymal fossa looks backwards and outwards.

MALAR BONE.

Situation.—This bone is found in part forming the zygomatic arch.

It has *three surfaces, three borders,* a *base,* and an *apex.*

Surfaces.

External or Facial.—Smooth and convex.

Superior or Orbital.—This face forms part of the orbit, and is concave and smooth.

Inferior. — This is chiefly articular, meeting the superior maxilla; a small portion helps to form the superior maxillary sinus.

Borders.

Superior.—Concave, smooth, and forms part of the rim of the orbit.

Internal.—Concave, thin and articular, meeting the superior maxilla.

Inferior.—Straight and thick; it is continued below by the zygomatic spine of the superior maxilla. It is sometimes known as the **zygomatic ridge.**

Base.

The base is directed forwards, and joins the superior maxilla.

Apex.

This is pointed and articular, meeting the zygomatic process of the squamosal.

The posterior part of the malar is known as the **zygomatic process.**

The malar **articulates** with three bones: The lachrymal, the superior maxilla, and the squamosal.

Development.—From one centre.

Reference to Side.—Place the base anteriorly; the concave orbital surface looks upwards and inwards.

SUPERIOR MAXILLA.

Situation, etc.—The superior maxilla occupies the greater part of the lateral aspect of the face, and in point of size comes next to the inferior maxilla.

It may be described as possessing *three surfaces, three borders,* and *two extremities.*

Surfaces.

External or Facial.—This face is concave above and convex below. The **maxillary** or **zygomatic spine** or **ridge** crosses this surface horizontally, being continuous behind with a similar ridge on the malar bone, and terminating anteriorly on a level with the third molar tooth. The **infra-orbital foramen** is placed near the middle of the area above the maxillary spine.

Internal or Nasal.—This is irregularly concave, and presents a longitudinal ridge for the attachment of the inferior turbinated bone. This ridge is sometimes known as the **internal maxillary spine.** The **maxillary sinus** occupies the greater part of the posterior extremity of this surface, the remainder being roughened for articulation with the palatine, and has a groove which, with a corresponding groove on the palatine, forms the **palatine canal.**

Inferior or Palatine.—This bony plate is known as the **palatine plate** or **process**; it is concave from side to side, and externally presents the **palatine groove,** continuous behind with a foramen of the same name. The palatine processes of the two superior maxillæ meet in the middle line, thus forming the greater part of the bony palate.

Borders.

Superior.—This edge is thin, convex, and articular, meeting the malar, lachrymal, nasal, and premaxillary bones in this order from behind forwards.

Inferior. — Six quadrilateral **alveoli** — cavities for molar teeth—are observed in this border. The anterior part of the border carries no alveoli, and is known as part of the **diastema** or **interdental space.** The posterior extremity forms a rounded eminence, the **alveolar tuberosity.**

Internal.—This is serrated, and meets the corresponding border of the other superior maxilla. It has a notched anterior portion, this helping to form the **incisor opening.**

Extremities.

Posterior.—This is the larger of the two, and forms the **maxillary protuberance** or **tuberosity**—a large rounded eminence. Internal to the protuberance is a depression, the **maxillary hiatus**, from the bottom of which three foramina pass: (1) **Dental** or **superior maxillary**, the most superior; leads into the **superior dental canal.** (2) **Spheno-palatine**, placed more internally than the others; leads into posterior part of the nasal chamber. This foramen is formed by the palatine bone. (3) **Superior palatine**, the most inferior; leads into the palatine canal, and is formed by the maxilla and palatine.

External to the protuberance is a small pointed process, the **zygomatic process**, which forms a part of the zygoma.

Anterior.—This extremity is pointed, and in the male assists in the formation of an alveolus for the canine tooth.

The superior maxilla **articulates** with nine bones: Its fellow, the premaxilla, the ethmoid, the nasal, the lachrymal, the malar, the squamosal, the palatine, and the inferior turbinated.

Development.—From one centre.

Reference to Side.—Place the molars (or their alveoli) downwards and outwards, and the pointed extremity anteriorly.

PREMAXILLA.

Situation, etc.—The premaxilla is placed at the most anterior extremity of the skull.

It presents a *body* and *two processes*—nasal and palatine.

(*a*) Body.

The body possesses *three surfaces* and *three borders*.

Surfaces.

Anterior or Labial.—This is convex and smooth, and covered in the recent state by the upper lip.

Inferior or Buccal.—This face is concave and smooth, forming the anterior extremity of the bony palate.

Internal.—This is flat and articular, meeting the corresponding face of the other premaxilla; a groove runs down it, which forms half of the **incisor foramen.**

Borders.

The only important border is the **inferior,** which possesses three **alveoli** for incisor teeth.

(*b*) Processes.

Nasal.—This is by far the larger of the two, and passes upwards towards the nasal bone. It is smooth and convex externally and internally, with a smooth, thick upper margin, and an articular lower one for union with the superior maxilla. The posterior extremity is articulated with nasal bone, the anterior extremity being continuous with the body of the bone.

Palatine.—This is a slender, thin plate of bone placed internal to the nasal process, and forming a small portion of the bony palate. Its external margin is separated from the nasal process and the superior maxilla by the **incisor opening**, or **naso-palatine cleft.**

The premaxilla **articulates** with four bones: Its fellow (forming a **symphysis**), the nasal, the superior maxilla, and the vomer.

Development.—From one centre.

Reference to Side.—The alveoli look downwards, and are placed at the most anterior part; the larger (nasal) process is placed externally.

PTERYGOID BONE.

Situation, etc.—This is found below the sphenoid, and to the side of the posterior nares. It is slight, somewhat twisted, and strap-like.

It has *two surfaces, two borders,* and *two extremities.*

Surfaces.

External.—This face is articular (with the palatine, sphenoid and vomer), and forms the **Vidian canal.**

Internal.—Smooth and covered, in the recent state, by the pharyngeal mucous membrane.

The **Borders** are unimportant.

Extremities.

Posterior.—This end is somewhat pointed, and inserted between the body of the pre-sphenoid and the pterygoid process.

Anterior. — The **hamular process**—a hook-shaped process around which the tendon of the tensor palati plays—is formed by the anterior extremity of this bone.

The pterygoid **articulates** with three bones: The sphenoid, the palatine, and the vomer.

Development.—From one centre.

Reference to Side.—The hamular process points downwards and forwards; the rough articular face looks outwards.

PALATINE BONE.

Situation, etc.—A very irregular bone, to be found immediately behind the palatine process of the superior maxilla.

It presents *two surfaces, two borders,* and *two extremities.*

Surfaces.

External.—Superiorly this face has a smooth area, entering into the formation of the orbit. A middle area is roughened for articulation with the superior maxilla, and crossed by a groove which assists in the formation of the **palatine canal**, as before mentioned (see Superior Maxilla). A third, or palatine, area is smooth and nearly flat, forming the posterior part of the bony palate.

Internal (also known as the **Nasal** Surface).—This is smooth and covered by mucous membrane. It presents an articular area for the pterygoid.

Borders.

Superior.—This margin has a thin and irregular portion for articulation with the superior maxilla and ethmoid. The **spheno-palatine foramen** is placed immediately behind this articular portion, and behind the foramen the border helps to form the sphenoidal air sinus.

Inferior.—Anteriorly the inferior border is smooth and rounded off, behind which it forms, with the superior maxilla, the **staphylin groove.**

Posteriorly it is irregular, and forms the **palatine crest,** which reaches the pterygoid bone and the pterygoid process of the sphenoid.

Extremities.

Anterior.—This portion of the bone curves towards the middle line, and meets the corresponding portion of the opposite bone.

Posterior.—Articulates with the pterygoid process of the sphenoid.

The palatine **articulates** with eight bones: Its fellow, the superior maxilla, the pterygoid, the sphenoid, the frontal, the ethmoid, the vomer, and the inferior turbinated.

Development.—From one centre.

Reference to Side.—The palatine area (that going to form part of the bony palate) looks downwards, curves inwards, and is placed anteriorly.

VOMER.

Situation, etc.—This single bone is placed in the mesial plane of the skull, and may be said to be a thin, elongated plate of bone, so bent that the two margins are parallel and close together.

It presents *two surfaces, two borders,* and *two extremities.*

Surfaces.

These—right and left—are covered in the recent state by the nasal mucous membrane.

Borders.

Superior.—This margin is formed by two thin ridges separated by a groove, into which the cartilaginous septum nasi is received anteriorly, and the perpendicular plate of the ethmoid posteriorly.

Inferior.—Anteriorly this border is flattened and rough for articulation with the superior maxilla and palatine. Posteriorly it is free, straight and thin, forming a partition to the posterior nares.

Extremities.

Anterior.—Pointed, and articulates with the palatine processes of the premaxillæ.

Posterior.—Expanded from side to side, and fitted over the body of the pre-sphenoid.

The vomer **articulates** with ten bones: The sphenoid, two pterygoids, two palatines, the ethmoid, two superior maxillæ, and two premaxillæ.

Development.—From one centre.

TURBINATED BONES.

Situation, etc.—These bones are two in number on each side of the skull, and are known from their position as **Superior** and **Inferior.** They are situated within the nasal chambers, and consequently in the entire skull are concealed from sight. Each bone consists of a thin fragile plate, richly convoluted. These are also known as the **Turbinal Bones.**

SUPERIOR TURBINATED BONE.

This is also called the **Ethmoidal Turbinated Bone,** from its relations with the ethmoid, to which bone it is attached as well as to the nasal. It is continued forwards to near the nostril by means of cartilage. The plate forming this bone is rolled one and a half times on itself, its first turn taking a downward direction. A septum placed about the centre interrupts the cavity formed by this bone; the anterior portion of the cavity is open to the nasal chamber.

INFERIOR TURBINATED BONE.

The **Inferior** or **Maxillary Turbinal** is much smaller than the superior. The first turn is directed upwards from the superior maxilla, to which the bone is attached. A septum similar to that found in the superior bone is also present in this.

The **superior meatus** of the nasal chamber separates the superior turbinal from the roof of the chamber.

The **middle meatus** runs between the two bones, and the **inferior meatus** between the inferior turbinal and the floor of the nasal chamber. The inferior meatus is much larger than the other two.

The superior turbinal **articulates** with two bones: The nasal and the ethmoid.

The inferior turbinal also **articulates** with two bones: The superior maxilla and the palatine.

Development.—Each bone ossifies from one centre.

INFERIOR MAXILLA.

Situation, etc.—The inferior maxilla, mandible or lower jaw, is a large bone (the largest of the skull), placed underneath the foregoing collection of bones, sometimes known as the **syncranium.**

It is composed of a *body* and *two rami.*

(*a*) The Body.

This is the most anterior part of the bone, from which the two rami spring.

It presents *two surfaces* and a *border.*

Surfaces.

Superior or Buccal.—This face is smooth and concave, being covered in the recent state by the mucous membrane of the mouth.

Inferior or Labial.—This is smooth and convex. The position of the **symphysis**—the line of union of the two lateral halves—is usually marked by a slight ridge.

The **Border** possesses six **alveoli** for incisor teeth, and in the male, at a short distance from the incisor alveoli, a smaller one on each side for the canines.

(*b*) The Rami.

Each ramus consists of a triangular plate of bone projecting backwards and upwards from the posterior part of the body. The two rami diverge as they proceed backwards, and so give the entire bone a **V**-like appearance.

Each ramus has *two surfaces, three borders,* and *three angles.*

Surfaces.

External.—This surface is comparatively smooth, only carrying slight ridges for the attachment of the masseter in its posterior portion. The **mental foramen** is situated near the body of the bone.

Internal. — This face is concave, and slightly roughened near the inferior angle of the bone for the attachment of the pterygoideus internus. The **inferior maxillary foramen** is situated on this surface a short distance behind the level of the last molar.

Borders.

Superior.—This is divided into three portions: (1) A smooth anterior portion, forming part of the **diastema**; (2) a part containing six quadrilateral alveoli for the molar teeth; and (3) a posterior thin portion, terminating in the coronoid process. The whole border is distinctly concave.

Inferior.—This margin is nearly straight, thick and rounded.

Posterior.— This is a convex and comparatively smooth border.

Angles.

Anterior.—This is the angle by which the ramus is joined to the body.

Superior.—Here we observe three objects of interest: (1) The **coronoid process**, which projects some distance beyond the other part of the angle, and consists of a curved piece of bone flattened from side to side, and pointing upwards and backwards; (2) the **condyle**, a transversely elongated, convex and smooth projection, which articulates indirectly with the squamosal; and (3) the **sigmoid** or **corono-condyloid notch**, separating the process and the condyle. The **neck** is the constricted portion immediately below the condyle.

Inferior.—This is usually spoken of as **the angle of the lower jaw**. It is convex, and shows muscular imprints.

The inferior maxilla **articulates** with both squamosals.

Development. — From two centres: one for each ramus and corresponding part of the body.

HYOID BONE.

Situation, etc.—This is really a collection of separate pieces of bone, suspended below the skull from the petrosal bone, and supporting the larynx and the base of the tongue.

It consists of a *body*, a *glossal process*, *two thyroid processes*, *two small cornua*, and *two great cornua*.

The **Body** (or **basi-hyal**) is a short rod placed transversely, and having the **Glossal Process** (or **glosso-hyal**) fused to the centre of its anterior face for the support of the tongue.

The **Thyroid Processes** (or **thyro-hyals**) are rods of bone fused to the extremities of the posterior face of the body; they support the larynx.

The **Small Cornua** (or **cerato-hyals**) also spring from the ends of the body, and are directed upwards and forwards. They are succeeded by the **Great Cornua** (or **stylo-hyals**), which pass upwards and backwards.

Each **great cornu** may be said to have two surfaces, two borders, and two extremities.

The **surfaces** are smooth and widest above.

The **borders** are thin and more or less curved.

The **inferior extremity** is joined to the small cornu by cartilage, in which a small ossicle sometimes appears (the **epi-hyal**).

The **superior extremity** is usually likened to the human foot, the 'toe' being united with the hyoid process of the petrosal through the medium of a short rod of cartilage. The 'heel' is thick, and affords attachment to muscles.

Development. — Each segment has its own centre of ossification, with the exception of the glossal process, which ossifies from a centre common to it and the body.

THE SKULL AS A WHOLE.

The skull taken in its entirety forms an irregular pyramid, with the apex directed downwards. We observe in it *four surfaces*, a *base*, and an *apex*.

Surfaces.

Superior.—This face is formed by the parietal, frontal and nasal bones; its posterior limit is the occipital crest, while anteriorly it tapers to the nasal peak. We see towards its posterior extremity the somewhat oval temporal fossæ, separated from each other by the sagittal crest. The supra-orbital process of the frontal limits each fossa anteriorly, the zygoma performing the same office laterally.

Lateral.—On this face we view the temporal fossa from the side. The zygoma and supra-orbital process are again prominent. The **orbit,** in which the organ of vision is lodged, should now be carefully examined; it will be found to be continuous with the temporal fossa posteriorly, though in the recent state the **ocular sheath** serves as a partition between the two cavities. The orbit is somewhat conical in shape, its apex being situated at the optic foramen, and its base at the orbital rim formed by the frontal, lachrymal, malar, and squamosal bones. The other objects of interest on the lateral surface of the skull are the maxillary spine, the infra-orbital foramen, the ramus and body of the lower jaw, and the teeth—molars, canines, and incisors.

Inferior.—The inferior surface of the skull is very irregular, and crowded with structures of the utmost importance, among which we may note the following: Basi-occiput, basi-sphenoid, the petrosal bones, the

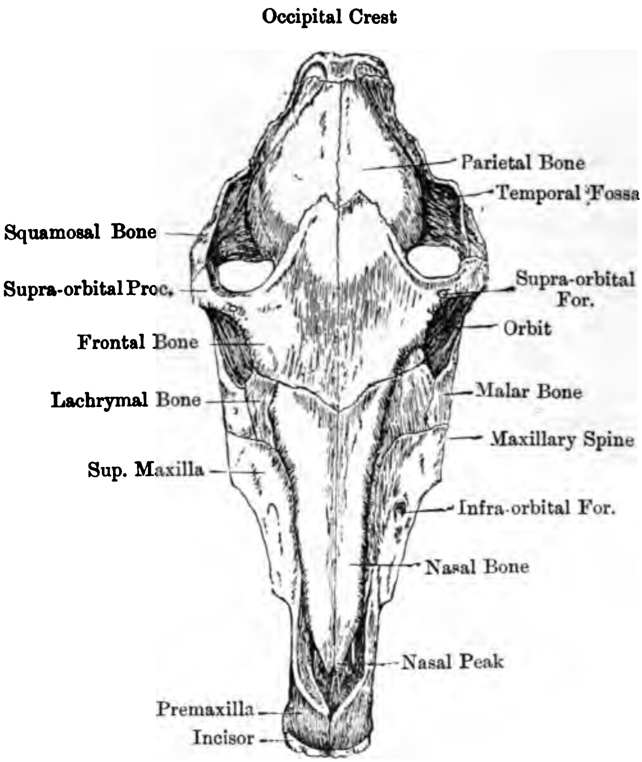

FIG. 1.—THE SKULL OF THE HORSE (SUPERIOR VIEW).

foramen lacerum basis cranii, the rami and body of the inferior maxilla (limiting the intermaxillary space), the posterior nares, and the bony palate.

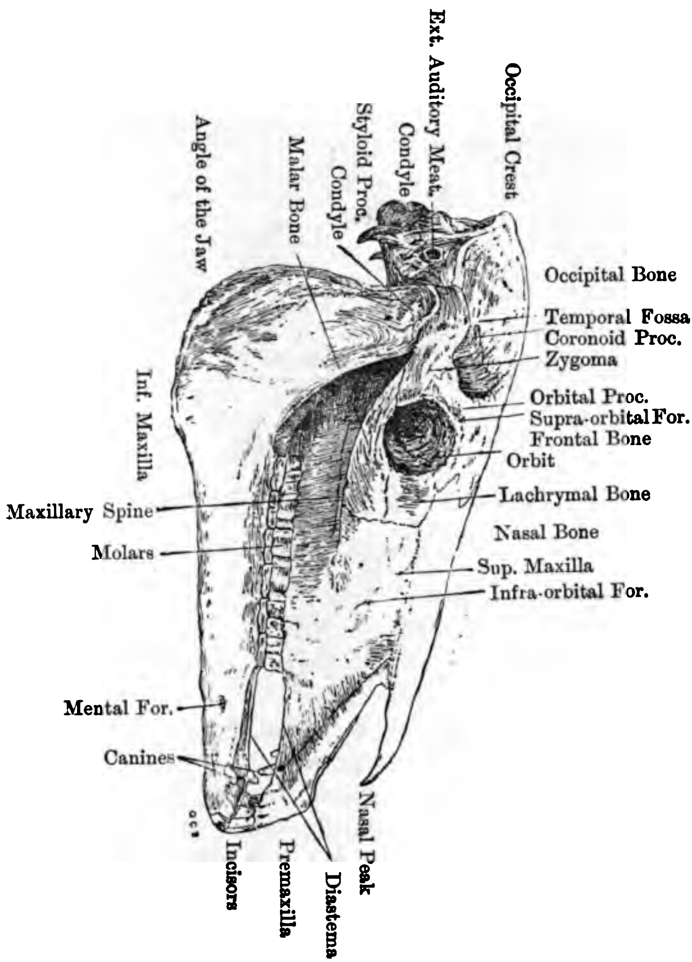

FIG. 2.—THE SKULL OF THE HORSE (LATERAL VIEW).

Base.

The base or posterior extremity of the skull is formed by the occipital bone and the posterior borders of the rami of the lower jaw.

Apex.

The apex, or anterior extremity, is formed by the premaxillæ and the body of the inferior maxilla. The anterior nares are to be observed, as leading into the nasal chambers. The incisor teeth are also to be noted.

THE CAVITIES OF THE SKULL.

The Cranium.

The cranium is the most posterior cavity of the skull, and in it the brain is lodged. It is formed by the occipital, interparietal, parietal, frontal, ethmoid, sphenoid, and temporal bones.

It may be considered to possess a *roof, two lateral walls*, a *floor*, and *two extremities*.

The **roof** is concave, and formed by the occipital, interparietal, parietals, and frontals. The **ossific tentorium** projects downwards from the interparietal.

The **walls** are not distinctly marked off from the roof and floor, and are formed by the occipital, parietal, temporal, and frontal bones.

The **floor** is very irregular; it is formed by the basi-occipital and the sphenoid.

The **anterior extremity** is formed by the two olfactory fossæ, separated from each other by the crista galli process, all parts of the ethmoid.

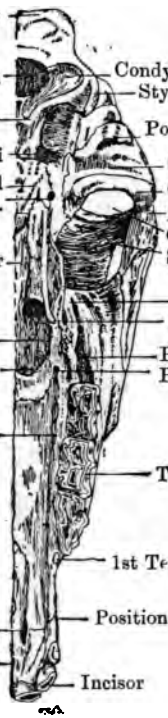

FIG. 3.—THE BASE OF THE HORSE'S SKULL.

At the **posterior extremity** the foramen magnum affords a means of communication between the cranium and spinal canal.

The **Cranium** is usually considered as consisting of two compartments or fossæ: (1) The **Cerebral Fossa,** the larger and more anterior, in which the cerebrum is situated; and (2) the **Cerebellar Fossa,** much the smaller, and containing the cerebellum in the recent state.

The Nasal Chambers.

The nasal chambers or fossæ are situated in the face, and separated from each other by a **nasal septum,** partially bony and partially cartilaginous.

Each fossa has a *roof*, *two walls*, a *floor*, and *two extremities*.

The **roof** is concave from side to side, and formed by the frontal and nasal bones.

The **internal wall** is formed by the septum mentioned above; in the dried skull it is incomplete, being then only formed by the vomer and perpendicular plate of the ethmoid.

The **external wall** is very irregular, and has the turbinated bones attached to it. It is formed by the nasal, premaxilla and supermaxilla. The three meati mentioned when speaking of the turbinated bones are to be noted here.

The **floor** is comparatively flat, and formed by the palatine processes of the palatines, the superior maxillary and premaxillary bones.

The **anterior extremity** (or **anterior nares**) is circumscribed by the nasal and premaxillary bones.

The **posterior extremity** is formed superiorly by the ethmoid; inferiorly the **posterior nares** communicate in the recent state with the nasal pharynx.

The Air Sinuses of the Skull.

The air sinuses of the skull are cavities of considerable size, developed between the two plates of certain cranial and facial bones. They are filled with air and lined by mucous membrane in the recent state. They communicate with the nasal fossæ, either directly or indirectly. They derive their names from the bone which is chiefly concerned in their formation.

The **Sphenoidal Sinus** is the smallest, and is formed by the sphenoid, palatine and ethmoid bones. It communicates with the superior maxillary sinus.

The **Frontal Sinus** is formed by the frontal, nasal, lachrymal, ethmoid, and superior turbinated bones. There is a frontal sinus on each side of the skull, the two being separated by a plate of bone occupying the mesial plane. This sinus also opens into the superior maxillary.

The **Superior Maxillary Sinus** is the largest and most important. It is formed by the superior maxillary, lachrymal, malar, and ethmoid bones. It communicates with the nasal fossa by means of an oval slit placed in the middle meatus. It may be considered to consist of two compartments, external and internal, separated by the superior dental canal and a plate of bone extending downwards from this canal. It is of surgical importance to note that the root of the last and part of the root of the second last molar teeth project into the external compartment of this sinus.

The **Inferior Maxillary Sinus** is formed by the superior maxillary and inferior turbinated bones. This sinus also consists of two compartments, internal and external. It communicates with the nasal fossa, but is completely shut off from the superior maxillary sinus. We must again note that the root of the third and portions of the roots of the second and fourth molar teeth project into the outer compartment of this sinus.

An **Ethmoidal Sinus** is sometimes described as being placed within the lateral mass of the ethmoid.

THE FORAMINA OF THE SKULL.

The foramina of the horse's skull are numerous and important. The following table, with what has gone before, will serve to indicate their position and purpose:

TABLE OF THE FORAMINA OF THE HORSE'S SKULL.

Foramen.	How Formed.	Structures Transmitted.
Foramen magnum.	Occipital.	Spinal cord and its coverings, 11th cranial nerve, basilar artery, and innominate veins.
Condyloid.	Occipital.	12th cranial nerve, a branch of the prevertebral artery, and a root of the occipital vein.
Foramen lacerum basis cranii.	Occipital, petrosal and sphenoid.	9th, 10th and 11th cranial nerves, a branch of the prevertebral artery, internal carotid artery, the Vidian nerve, sympathetic filaments, inferior division of the 5th cranial nerve, great meningeal artery and veins.

	Foramen.	How Formed.	Structures Transmitted.
	Parieto - temporal canal.	Occipital, parietal and temporal.	Mastoid artery and transverse venous sinus.
	Internal auditory meatus.	Petrosal.	7th and 8th cranial nerves.
	Stylo - mastoid.	Petrosal.	7th cranial nerve.
	Styloid.	Petrosal.	Chorda tympani nerve.
	External auditory meatus.	Petrosal.	
	Eustachian orifice.	Petrosal.	
	Pterygoid.	Post-sphenoid.	Internal maxillary artery.
	Vidian canal.	Sphenoid, pterygoid and palatine.	Vidian nerve.
Orbital Hiatus.	Optic.	Pre-sphenoid.	2nd cranial nerve.
	Internal orbital.	Frontal and pre-sphenoid.	Ophthalmic artery and branch of 5th cranial nerve.
	Lacerum orbitale.	Post-sphenoid and pre-sphenoid.	3rd and 6th cranial nerves and ophthalmic division of 5th cranial nerve, and the ophthalmic vein.
	Rotundum.	Post-sphenoid.	Superior maxillary division of the 5th cranial nerve.
	Pathetic.	Post- and pre-sphenoid.	4th cranial nerve.
	Temporal.	Post-sphenoid.	Anterior deep temporal artery.
	Subsphenoidal canal (anterior opening).	*Vide supra.*	*Vide supra.*
	Vidian canal (anterior opening).	*Vide supra.*	*Vide supra.*
	Supra-orbital.	Frontal.	Supra-orbital artery and nerve.
	Olfactory foramina.	Ethmoid.	1st cranial nerve, and nasal branches of the ophthalmic artery and nerve.

	Foramen.	How Formed.	Structures Transmitted.
Maxillary Hiatus.	Superior palatine.	Palatine and superior maxilla.	Palatine artery and nerve.
Maxillary Hiatus.	Spheno-palatine.	Palatine.	Spheno-palatine artery, vein and nerve.
Maxillary Hiatus.	Superior maxillary.	Superior maxilla.	Superior dental artery, vein and nerve.
	Lachrymal canal.	Lachrymal and superior maxilla.	
	Posterior palatine.	Palatine and superior maxilla.	Palatine artery and nerve.
	Infra-orbital.	Superior maxilla.	Infra-orbital nerves and artery.
	Incisor.	Premaxillæ.	Palato-labial artery.
	Incisive cleft.	Premaxillæ.	
	Inferior maxillary.	Inferior maxilla.	Inferior dental artery, vein and nerve.
	Mental.	Inferior maxilla.	Mental artery, vein and nerves.

THE VERTEBRÆ.

The **Vertebræ** are irregular bones placed in the mesial plane of the body, and extending from the skull to the tip of the tail. This **vertebral column** is divided into five regions: Cervical, dorsal or thoracic, lumbar, sacral, and coccygeal.

The **vertebral formula** of the horse is:

C. 7; D. 18; L. 6; S. 5; C. 16 to 20.

The dorsal, lumbar, sacral, and coccygeal vertebræ have been already considered in their proper place (see Part II.); it only remains, therefore, for us to describe the vertebræ of the neck, or the cervical vertebræ. Before doing so, it will be as well if we enumerate the parts found in an ordinary or typical vertebra.

Parts of a Typical Vertebra.

In a typical vertebra we recognise the following parts:

1. A **body** or **centrum**, consisting of a disc or short rod of bone united to the bodies of the vertebræ in front and behind by a cartilaginous disc—the **intervertebral disc.**

2. Two **pedicles**, plates of bone springing from the upper margins of the body, and having notches—the **intervertebral notches**—on the anterior and posterior borders. When the bones are in position, two contiguous notches form an **intervertebral foramen.**

3. Two **laminæ**, placed above the pedicles and converging towards the middle line, where they unite.

4. A **neural arch**, formed by the pedicles and laminæ.

5. A **neural foramen**, circumscribed by the centrum below and the neural arch above, these structures together constituting the **neural ring.** The neural foramina of the entire vertebral column form a canal —the **neural canal**—in which the spinal cord is lodged.

6. A **neural spine**, or **neurapophysis**, a process of bone extending upwards from the point of union of the laminæ.

7. **Anterior and posterior articular processes**, or **zygapophyses**, placed laterally on the neural arch.

8. **Transverse processes**, projecting outwards from either the neural arch, when they are known as

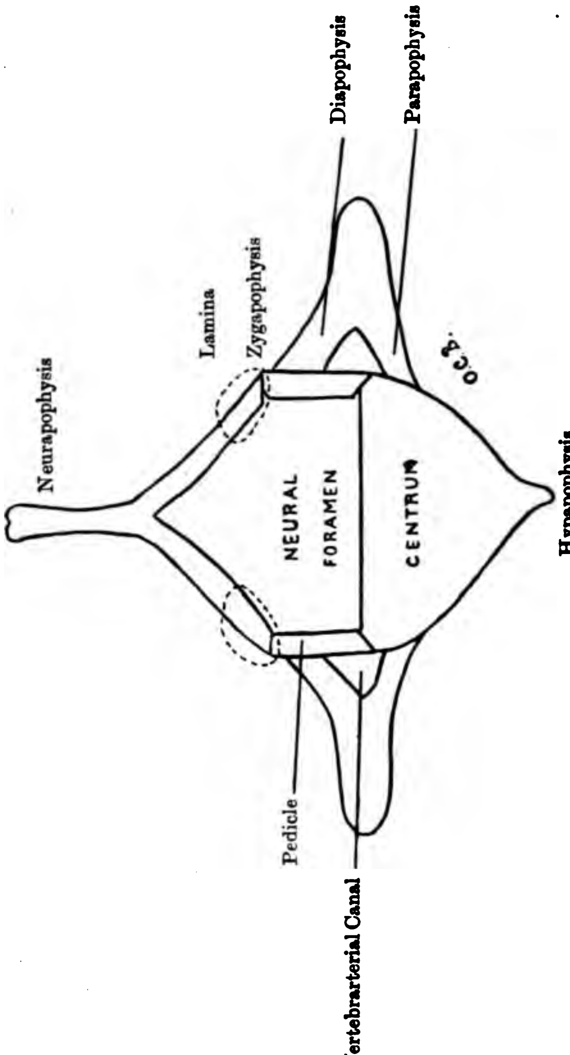

FIG. 4.—DIAGRAM OF A TYPICAL VERTEBRA.

diapophyses, or from the body, when the term **par-apophyses** is applied. Some vertebræ have both dia- and parapophyses, which unite and form a **vertebrar-terial canal or vertebral foramen.**

In addition to the above, some vertebræ also possess **mammillary (metapophysis)** and **accessory (anapophysis)** processes.

An **inferior spinous process**, or **hæmapophysis**, is rarely developed in the vertebræ of domesticated animals. When present, it springs from the lower face of the body.

A **hæmal arch** is formed in some regions, not by parts of the vertebræ themselves, but by separate bones, such as the ribs and chevron bones.

Vertebræ are designated **true** or **false**, indicating that they do or do not remain separate through-out life. The cervical, dorsal and lumbar are true vertebræ; the sacral are false. Some authorities place the coccygeal vertebræ of the horse among the false vertebræ, because they do not possess all the parts of a typical vertebra.

CERVICAL VERTEBRÆ.

There are seven bones in the region of the neck; this number is interesting, as nearly all mammals have seven cervical vertebræ, the exceptions being the two-toed sloth and the manatee, each with six, and the three-toed sloth, with nine.

General Characteristics.

Body.—The body is large, with a very convex anterior and a very concave posterior extremity. On section it is somewhat triangular, the inferior angle being formed by a rather rudimentary **inferior spine**.

The **pedicles** have deep notches.

The **neural arch** is strong.

The **neural ring** is large; its roof is rounded, its floor almost flat.

Neural Spine, or Spinous Process.—In none of the bones does this attain any great height; it is highest anteriorly and broadest posteriorly.

Articular Processes.—Each articular process is large, and carries an oval and almost flat facet. The anterior processes look upwards and inwards; the posterior, downwards and outwards.

Transverse Processes.—Each transverse process consists of both diapophysis and parapophysis, the **vertebrarterial foramen** separating them at the root. This is the special characteristic of a cervical vertebra, as it does not obtain in the other regions.

Special Cervical Vertebræ.

The 1st, 2nd, 6th, and 7th vertebræ possess special characteristics, and must, therefore, be described separately.

The 1st *Cervical or Atlas Vertebra.*

There is no body. It is usually said to consist of a *ring* and a pair of *wings*.

The Ring.

Superior Face.—This is convex, and carries a small spinous process.

Inferior Face.—The **tubercle** of the atlas is placed below the ring towards its posterior edge, and represents an inferior spinous process. At the junction of the ring and a wing is a concavity, in which three foramina are placed: (1) **Antero-external foramen,** passing to the upper face of the ring; (2) **posterior foramen,** also passing through the wing; and (3) an unnamed foramen, leading into the neural foramen.

Anteriorly the ring carries two glenoid cavities, which articulate with the condyles of the occipital bone; these cavities are separated above and below by notches, the upper of which is the larger.

Posteriorly two continuous and undulating surfaces for articulation with the 2nd vertebra occupy the ring below; the rest of its extent is thin and non-articular.

Internal Aspect.—The **neural ring** is of very large size. On the roof anteriorly and on each side are the **antero-internal foramina,** which lead to the upper face of the wing. Posteriorly and on the floor of the ring is a smooth area for articulation with the odontoid process of the 2nd vertebra; this area is continuous with the two smooth articular surfaces on the posterior border of the ring.

The Wings.

The **wings** or **alæ** pass obliquely downwards, outwards and backwards. They represent transverse processes. Their margins afford attachment to muscles. Three foramina are observed on their upper **faces**—antero-internal, antero-external and posterior—mentioned before, the two former being united by a short groove, sometimes called the **alar gutter.**

The 2nd Cervical or Axis Vertebra.

This receives the name of axis because the atlas—and with it the head—rotates about its odontoid process; this process also gives it the name of **dentata.**

Body.—This is very long, having the **odontoid process** attached anteriorly. The upper face of the process is somewhat concave, and shows two **lateral** depressions, into which the odontoid ligament is inserted. The lower face of the process is smooth and convex from side to side, articulating with the ring of the atlas. Placed laterally to the odontoid process are two concavo-convex facets, separated by a notch inferiorly, and for articulation with the posterior margin of the ring of the atlas.

The **anterior notch** of the pedicle is converted into a foramen.

The **neural ring** is of small size.

The **posterior articular processes** are similar to those of the succeeding vertebræ; the anterior are represented by the facets at the lateral part of the base of the odontoid process.

The **inferior spinous process** terminates in a tubercle posteriorly.

The **neural spine** is massive and bifid posteriorly, each part surmounting a posterior articular process.

The **transverse processes** are small and comparatively simple, but possess the usual **vertebrarterial foramen.**

The 6th Cervical Vertebra.

This bone is characterized by the trifid or tri-tubercular character of its transverse processes.

The **inferior spinous process** is very small.

The 7th Cervical Vertebra.

This differs from the ordinary cervical vertebra in the following respects:

Its **body** is short; its **inferior spinous process** is very rudimentary; the **notches** are deep. The **neural spine** is the best developed of the series, and gives the name of **vertebra prominens** to the bone.

The **transverse processes** are simple, and destitute of **vertebrarterial foramina.**

Capitular cavities are found on each side of the posterior extremity of the body; these are for articulation with a part of the head of the first rib.

Development of a Vertebra.—In an ordinary vertebra there are three centres: (1) For the body; (2) and (3) for the right and left halves of the neural arch.

Development of the Atlas.—From two lateral centres, the centre for the body being absent. The margin of each wing and the facet on the posterior edge of the wing have separate and additional centres of ossification.

Development of the Axis.—From five centres—the three usual centres, and two additional for the odontoid process and the facets at its base. The odontoid process of the axis is looked upon as the displaced body of the atlas.

ARTICULATIONS.

ARTICULATIONS OF THE CERVICAL VERTEBRÆ.

IN Part II. a description is given of the inter-vertebral joints of the trunk; this description, with a few alterations, applies to the corresponding joints of the neck. The modifications are found in the ligamenta subflava, the inferior common, interspinous, and supraspinous ligaments.

The **ligamenta subflava** of the cervical region are composed of yellow elastic tissue.

The **inferior common ligament** is replaced by the longus colli muscle, which commences at the 6th dorsal vertebra and extends to the atlas.

The **interspinous ligaments** of the neck differ from those of the trunk in being composed of two strands of yellow elastic tissue.

The **supraspinous ligament** is considerably modified both in structure and size, and is known as the **Ligamentum Nuchæ**, a detailed description of which is here necessary.

The Ligamentum Nuchæ.

This ligament is composed of yellow elastic tissue, and, for purposes of description, is divided into **funicular** and **lamellar** portions.

The **funicular portion** consists of two strong cords placed side by side, and more or less intimately connected. It passes from the summit of the 4th dorsal neural spine to the tuberosity of the occipital bone;

its dorsal extremity is directly continuous with the supraspinous ligament of that region.

The **lamellar portion** separates the muscles of the neck into two lateral groups. Like the funicular portion, it is double, consisting of two imperfect sheets loosely connected by areolar tissue. Its attachments are to the first three dorsal neural spines, the funicular portion, and the neural spines of the posterior six cervical vertebræ. The direction of the fibres of the lamellar portion is downwards and forwards.

The function of the ligamentum nuchæ is to conserve muscular energy by mechanically assisting in the support of the head and in its elevation after it has been depressed.

It will be noticed that the majority of the ligaments of the neck are composed of elastic tissue; this is for the purpose of allowing freer movement in this region than is possible between the trunk vertebræ.

Two articulations of the neck are so much modified as to require a special description; these are the atlo-occipital and atlo-axoid articulations.

ATLO-OCCIPITAL OR OCCIPITO-ATLOID ARTICULATION.

Class.—Ginglymoid.

Formed by the condyles of the occipital bone and the glenoid cavities on the anterior part of the ring of the atlas.

Ligaments.—

A *capsule* with thickenings above and below and on each side.

The capsule is attached around the two articular surfaces, and is loose, thin, and somewhat elastic. The thickenings are sometimes described as separate ligaments: The *superior suspensory*, consisting of fibres arranged in an X-like manner, and passing from above the foramen magnum to the superior notch of the ring of the atlas; the *inferior suspensory*, placed below the joint; two *lateral* or *styloid ligaments*, attached to the bases of the occipital styloid processes and the wings of the atlas.

Synovial Membranes.—Two in number, one for each half of the articulation.

Movements.—Flexion and extension (or elevation and depression) of the head on the spinal column.

ATLO-AXOID ARTICULATION.

Class.—Diarthrosis rotatorius.

Formed by the facets on the posterior border, and the lower posterior part of the internal surface of the ring of the atlas, and the odontoid process and adjacent facets of the axis.

Ligaments.—

1. A *capsule* surrounds the whole joint.
2. The *superior atlo-axoid ligament* passes from the neural process of the axis to the posterior border of the ring of the atlas. This ligament represents the interspinous of the other joints of the region, and is, like them, composed of yellow elastic tissue.

3. The *inferior atlo-axoid ligament* is attached to the inferior spinous process of the axis and the tubercle below the ring of the axis.
4. The *odontoid ligament* may be considered to be a continuation of the superior common vertebral ligament. It arises from two depressions on the upper face of the odontoid process of the axis, and passes forward, expanding somewhat and being attached to the floor of the atlas (short odontoid), and within the occipital condyles (long odontoid).

Synovial Membrane.—One for the whole joint.

Movements.—The atlas (and with it the entire head) rotates about the odontoid process of the axis.

ARTICULATIONS OF THE SKULL.

As already mentioned, with the exception of the inferior maxilla, the bones of the skull are immovably united in the adult, the lines of union being known as sutures. The named **Sutures of the Skull** are as follows:

The **longitudinal suture** extends from the occipital crest to the nasal peak, and is divided into *interparietal* or *sagittal, interfrontal* and *internasal* portions.

The **lambdoidal suture, or sutura limbosa,** is situated between the occipital and parietal bones.

The **coronal suture** is found between the parietal and frontal, and the **transverse suture** between the frontal, nasal and lachrymal bones.

TEMPORO-MAXILLARY ARTICULATION.

Class.—Ginglymoid.

Formed by the condyles of the lower jaw and the condyles and glenoid cavities of the squamosal bones.

Ligaments.—

1. A *capsular*, surrounding the two articular margins, and attached to the borders of a *meniscus*, a disc of cartilage placed between and moulded upon the articular surfaces.
2. The *posterior ligament*, passing from the post-glenoid process to the posterior border of the lower jaw, just below the condyle.
3. The *external ligament*, attached to the zygoma and the neck succeeding the condyle of the lower jaw.

Synovial Membranes.—The capsule being attached to the margin of the meniscus, the joint is virtually a double one; there are therefore two synovial membranes, one above the meniscus, the other below.

Movements.—Flexion, extension, and lateral movements.

THE HYOID ARTICULATIONS.

The body has the glossal and thyroid processes firmly fused with it; the other segments are movably united.

The **basi-cornual joint** is a true diarthrosis, being provided with a capsular ligament and a synovial membrane.

The **intercornual joint** is amphiarthrodial, the union being through the medium of a piece of cartilage, in which the epihyal may be formed.

The **temporo-hyal joint** is also amphiarthrodial, a rod of cartilage being interposed between the 'toe' of the great hyoid cornu and the hyoid process of the petrous temporal bone.

Movements.—A variety of flexion and extension.

MUSCLES.

The muscles may be divided into the following groups:

A. **Anterior maxillary.**
B. **Posterior maxillary.**
C. **Hyoidean.**
D. **Lateral cervical.**
E. **Inferior cervical.**

The first three groups belong to the head, the remainder to the neck.

The lingual, palatine, pharyngeal, laryngeal, palpebral, and auricular muscles will be considered along with the organs to which they belong.

Panniculus Carnosus.

The subcutaneous muscle of the head and neck is much thinner and more rudimentary than in the region of the trunk. The facial portion is little more than aponeurosis, but becomes more muscular in the intermaxillary space; the fibres attached to the commissures of the mouth go by the name of **retractor anguli oris**, or **risorius Santorini.** The cervical portion is attached to the ligamentum nuchæ by aponeurosis; in the lower part of the neck muscular fibres are found forming a band, which meets a similar structure in the mesial line. The cervical panniculus is usually said to have an attachment to the cariniform cartilage of the sternum, but we have described this as part of the levator humani.

A. ANTERIOR MAXILLARY GROUP.

Contains twelve muscles belonging to the lips, nostrils and cheeks, or face properly so called:

1. **Zygomaticus.**

   Synonyms.—Zygomatico-labialis, portion of the cuticularis of Bourgelat, zygomaticus major.

   Situation, etc.—This muscle is thin, pale and ribbon-like, and occupies a superficial position on the side of the face.

   Attachments.—The masseteric fascia and the angle of the mouth.

   Relations. — Superficially, the panniculus and skin; by its deep face, the buccinator.

   Action.—Retracts the commissure of the lips.

2. **Buccinator.**

   Synonyms. — Alveolo-labialis, malaris externus and internus.

   Situation, etc.—A flat, thin muscle forming the bulk of the cheek, and divisible into two layers.

Attachments.—The deep layer is attached to the alveolar tuberosity and the alveoli of the superior and inferior maxilla, and blends with the orbicularis oris anteriorly. The superficial layer is penniform, and attached to the diastema.

Relations. — Externally, the masseter, zygomaticus, the glosso-facial bloodvessels, Steno's duct, and the levator labii superioris alæque nasi; internally, the buccal mucous membrane.

Action.—It prevents food getting between the cheek and the molar teeth.

3. **Orbicularis Oris.**

Synonym.—Labialis.

Situation, etc.—This muscle is a *sphincter*, being found surrounding the orifice between the lips. It is a single muscle.

Attachments.—It has no bony attachment, but is blended with the surrounding muscles.

Relations. — Skin, mucous membrane, labial glands, and the insertions of surrounding muscles.

Action.—It approximates the lips.

4. **Levator Communis.**

Synonyms.—Levator labii superioris alæque nasi, supernaso-labialis, fronto-labialis.

Situation, etc.—It passes in an oblique manner across the side of the face, and is superficial.

Origin. — By aponeurosis from the nasal and frontal bones.

Insertion.—It has two insertions—one to the wing of the nostril, the other to the angle of the mouth. The dilatator naris lateralis passes between the two portions.

Relations.—Externally, the skin; internally, the nasalis longus, the dilatator naris inferioris and lateralis.

Action.—Elevates the wing of the nostril and the upper lip, and retracts the angle of the mouth.

5. **Nasalis Longus.**

Synonyms.—Supermaxillo-labialis, nasalis longus labii superioris.

Situation, etc.—It is placed immediately beneath the levator communis; its fleshy portion is thick and conical, and succeeded by a thin tendon.

Origin.—The superior maxilla and malar.

Insertion.—Its tendon unites with its fellow and disappears in the upper lip.

Relations.—Externally, the levator communis; internally, the superior maxilla, the false nostril, and the dilatator naris inferioris and transversalis.

Action.—It elevates the upper lip, or, acting singly, it draws the lip to one side.

6. **Dilatator Naris Lateralis.**

Synonyms.—Supermaxillo-nasalis magnus, pyramidalis.

Situation.—On the side of the face; its anterior portion passes between the two insertions of the levator communis.

Origin.—The anterior extremity of the maxillary spine.

Insertion.—The wing of the nostril.

Relations.—Externally, the skin and levator communis; internally, the buccinator and levator communis.

Action.—It retracts the wing of the nostril.

7. **Dilatator Naris Transversalis.**

Synonyms.—Transversalis nasi, dilatator naris anterior.

Situation, etc.—This muscle is single, consisting of transverse fibres placed upon the upper extremity of the alar cartilage of the nostril.

Attachments.—It is attached to the nasal peak and the alar cartilage.

Relations.—Externally, the skin and conjoint tendon of the two nasiles longus.

Action.—Dilates the nostril.

8. **Dilatator Naris Superioris.**

Situation, etc.—This is very thin and pale, being attached to the free margin of the nasal bone and the skin of the wing of the nostril.

Action.—Dilates the nostril.

9. **Dilatator Naris Inferioris.**

Synonyms.—Nasalis brevis labii superioris, supermaxillo-nasalis brevis.

Situation, etc.—This muscle is also thin and pale; it is attached to the free border of the premaxillary and superior maxillary bones, its fibres being lost in the skin of the wing of the nostril.

Action.—Dilates the nostril.

10. Depressor Labii Superioris.

Synonyms.—Medius anterior, incisive muscle of the upper lip of Leyh.

Situation, etc.—Thin, and placed immediately beneath the mucous membrane of the upper lip. It is attached to the premaxilla above the alveoli, its fibres blending with the nasal alar cartilage and the substance of the upper lip.

Action.—Depresses the upper lip and probably dilates the nostril.

11. Levator Labii Inferioris.

Synonyms.—Mento-labialis, levator menti.

Situation, etc.—It is similar in its position and attachments to the preceding muscle, being situated beneath the mucous membrane of the lower lip, its fibres passing from the body of the inferior maxilla to the substance of the lip.

Action.—Raises the lower lip and presses it against the incisor teeth.

12. Depressor Labii Inferioris.

Synonym.—Maxillo-labialis.

Situation, etc.—A somewhat fusiform muscle, placed along the inferior margin of the buccinator.

Origin.—The alveolar tuberosity—in common with the buccinator—and the superior border of the inferior maxilla.

Insertion.—By a well-marked tendon into the substance of the lower lip.

Relations.—Externally, the masseter and panniculus; internally, the inferior maxilla; superiorly, the buccinator.

Action.—Depresses the lower lip and draws it to one side, if acting singly.

Blood-supply of the Anterior Maxillary Muscles.—The facial artery supplies all these muscles, those of the upper lip also receiving blood from the palato-labial—the vessel resulting from the inosculation of the two palatine arteries.

Nerve-supply of the Anterior Maxillary Muscles.—7th cranial nerve.

B. POSTERIOR MAXILLARY GROUP.

This group contains six muscles, all of which are concerned in the act of mastication:

1. **Masseter.**

Synonym.—Zygomatico-maxillaris.

Situation, etc.—A very thick and powerful muscle, with numerous tendinous intersections, placed on the posterior portion of the outer face of the inferior maxilla.

Origin.—The zygoma, the maxillary spine, and the superior maxilla below the spine.

Insertion.—To a large area at the posterior part of the external face of the inferior maxilla.

Relations.—Externally, the panniculus, the sub-zygomatic nerve plexus, and the transverse facial artery and vein; internally, the ramus of the lower jaw, the buccinator, the depressor labii inferioris, the alveolar and buccal veins, and the superior malar glands; anteriorly, the glosso-facial bloodvessels and Steno's duct; posteriorly, the parotid gland.

Action.—It elevates the lower jaw, and so approximates the teeth.

Blood-supply.—Maxillo-muscular and transverse facial.

Nerve-supply.—5th cranial nerve.

2. **Temporalis.**

Synonym.—Temporo-maxillaris.

Situation, etc.—This muscle occupies the temporal fossa; it has numerous tendinous intersections.

Origin.—The whole of the temporal fossa.

Insertion.—Coronoid process of the lower jaw.

Relations.—Externally, the scutiform cartilage of the external ear and certain muscles attached to this cartilage, as well as a mass of adipose tissue; internally, the bones forming the temporal fossa; inferiorly, the pterygoid muscles.

Action.—Raises the lower jaw and approximates the teeth; when one muscle acts alone, it produces lateral movement of the jaw.

Blood-supply.—Deep temporal arteries.

Nerve-supply.—5th cranial nerve.

3. **Pterygoideus Internus.**

Synonyms.—Internal masseter, spheno-maxillaris.

Situation, etc.—Placed within the ramus of the inferior maxilla; it is strong and provided with numerous tendinous intersections.

Origin.—The subsphenoidal process of the sphenoid and the palatine crest.

Insertion.—The concave part of the inner face of the ramus of the lower jaw.

Relations.—Externally, the externus, the inferior maxilla, inferior dental vessels and nerve, and the mylo-hyoid muscle; internally, the guttural pouch, glosso-facial vessels, Steno's duct, the submaxillary gland, and the hyoid bone, with numerous muscles attached to it.

Action.—Raises the lower jaw, and if acting singly it produces lateral movement.

Blood-supply.—Pterygoidean and maxillo-muscular arteries.

Nerve-supply.—5th cranial nerve.

4. **Pterygoideus Externus.**

Synonym.—Spheno-maxillaris.

Situation, etc.—It is a short, thick muscle, placed within the temporo-maxillary articulation.

Origin.—Subsphenoidal process and wing of the sphenoid.

Insertion.—An area immediately below the condyle of the inferior maxilla.

Relations.—Externally, the temporo-maxillary articulation and the temporalis muscle; internally, the internus and the inferior maxillary division of the 5th cranial nerve.

Action.—Assists in raising the jaw; when both muscles act together, the lower jaw is drawn forwards.

Blood-supply.—Pterygoidean arteries.

Nerve-supply.—5th cranial nerve.

5. **Stylo-maxillaris.**

Synonym.—Part of the digastricus.

Situation, etc.—A thick and fleshy muscle, extending obliquely downwards and forwards behind the ramus of the inferior maxilla.

Origin. — The styloid process of the occipital bone.

Insertion. — Posterior border of the inferior maxilla, near the 'angle of the jaw.'

Relations.—Externally, the parotid gland; internally, the guttural pouch and the submaxillary gland.

Action.—Depresses and draws the lower jaw backwards.

Blood-supply.—Maxillo-muscular.

Nerve-supply.—7th cranial nerve.

6. **Digastricus.**

Situation, etc.—A long digastric muscle—the two bellies being fusiform—placed within the intermaxillary space. Its middle tendon passes through a loop formed by the hyoideus magnus tendon of insertion.

Origin.—Styloid process of the occipital bone.

Insertion.—The internal face of the lower jaw (from the anterior belly), and the posterior border of the ramus (from the posterior belly).

Relations.—Externally, the parotid gland and the ramus of the inferior maxilla; internally, the guttural pouch and the mylo-hyoideus muscle.

Action.—Assists in depressing and retracting the inferior maxilla, and raises the hyoid apparatus.

Blood-supply.—Sublingual and maxillo-muscular.

Nerve-supply.—7th cranial nerve.

C. HYOIDEAN GROUP.

Six muscles are contained in this group:

1. **Mylo-hyoideus.**

Situation, etc.—This muscle is thin and somewhat membranous, consisting of transverse fibres; it is placed subcutaneously in the intermaxillary space.

Attachments. — A line immediately below the alveoli of the inferior maxilla and the inferior face of the body and spur process of the hyoid bone. It unites with its fellow at the mesial line.

Relations.—Externally, the inferior maxilla, the digastricus, and a chain of lymphatic glands; internally, the submaxillary gland and its duct, the genio-hyoideus, hyo-glossus longus and genio-hyo-glossus muscles, and the 12th and lingual nerves.

Action.—It forms a muscular hammock in which the tongue rests, and it also raises this organ.

Blood-supply.—Sublingual.

Nerve-supply.—5th cranial nerve.

2. **Genio-Hyoideus.**

Situation, etc.—A long fusiform muscle, placed immediately above the mylo-hyoideus, and meeting its fellow in the mesial plane.

Origin.—The inferior maxilla near the symphysis.

Insertion.—The anterior extremity of the spur process of the hyoid bone.

Relations.—Inferiorly, the mylo-hyoideus; superiorly, the genio-hyo-glossus; internally, its fellow.

Action.—Draws the hyoid apparatus forwards.

Blood-supply.—Sublingual.

Nerve-supply.—12th cranial nerve.

3. **Hyoideus Magnus.**

Synonyms. — Stylo-hyoideus, kerato-hyoideus magnus.

Situation, etc.—A fusiform muscle, placed behind and below the cornu of the hyoid bone.

Origin.—The 'heel' of the hyoid cornu.

Insertion.—A tubercle on the thyroid process of the hyoid bone.

Relations.—Externally, the pterygoideus internus; internally, the pharynx, guttural pouch, and 12th cranial nerve; antero-superiorly, the glosso-facial artery and glosso-pharyngeal (9th) nerve; postero-inferiorly, the posterior belly of the digastricus. The tendon of insertion forms a loop, through which the middle tendon of the digastricus plays.

Action.—Draws the hyoid apparatus upwards and backwards.

Blood-supply.—External carotid.

Nerve-supply.—9th cranial nerve.

4. **Hyoideus Parvus.**

Synonyms. — Kerato-hyoideus, kerato-hyoideus parvus.

Situation, etc.—A small, flat and triangular muscle placed supero-anteriorly to the magnus.

Origin.—The anterior portion of the inferior border of the hyoid cornu, and the posterior border of the corniculum.

Insertion.—The body and thyroid process of the hyoid bone.

Relations.—Externally, the hyo-glossus longus muscle and the lingual artery; internally, the mucous membrane.

Blood-supply.—External carotid.

Nerve-supply.—9th cranial nerve.

5. **Hyoideus Transversus.**

Synonym.—Transversalis hyoidei.

A few fibres passing between the two cornicula.

6. **Stylo-hyoideus.**

Synonym.—Occipito-styloideus.

Situation, etc.—A flat muscle, situated in the space formed by the occipital styloid process and the posterior extremity of the hyoid cornu, and attached to these bony processes.

Relations.—Externally, the parotid gland; internally, the guttural pouch; postero-inferiorly, the posterior belly of the digastricus, with which it is blended.

Action.—Depresses and retracts the hyoid bone.

Blood-supply.—Posterior auricular.

Nerve-supply.—7th cranial nerve.

D. LATERAL CERVICAL GROUP.

Fourteen muscles are contained in this group:

1. **Trapezius** (Cervical Portion).

Synonym.—Cervico-acromialis.

Situation, etc.—A thin, flat and triangular muscle, occupying a superficial position in the upper part of the neck. Its fibres pass downwards and backwards, and converge inferiorly.

Origin.—The cordiform portion of the ligamentum nuchæ.

Insertion.—The tubercle of the spine of the scapula and the scapular fascia, in common with the dorsal portion of the muscle.

Relations.—Externally, the panniculus and fascia; internally, the splenius, depressor anguli scapulæ, rhomboideus longus, pectoralis parvus, and antea-spinatus.

Action.—Advances and elevates the scapula.

Blood-supply.—Superior cervical.

Nerve-supply.—Spinal accessory.

2. **Levator Humeri.**

Synonym.—Mastoido-humeralis.

Situation, etc.—A long, flattened muscle, occupying the lateral and inferior parts of the neck, and extending from the head to the arm. It is sometimes divided into anterior or superficial and posterior or deep portions.

Attachments.—The occipital crest, the mastoid process of the temporal bone, the wing of the atlas (with the splenius and trachelo-mastoideus), the 2nd, 3rd and 4th cervical transverse processes, the antero-external part of the humerus—a line continuing the deltoid ridge—the cervical, scapular and brachial fascia, and the cariniform cartilage of the sternum.

Relations.—Externally, the panniculus and the parotid gland; internally, the splenius, trachelo-mastoideus, rectus capitis anticus major, scalenus, depressor anguli scapulæ, subscapulo-hyoideus, and numerous other muscles; inferiorly, the sterno-maxillaris, the carotid artery, and the jugular vein.

Action.—If the head is the fixed point, the limb is brought forwards; if the limb is fixed, the head is either depressed or turned to the side, depending upon whether one or both muscles are contracting.

Blood-supply. — Common carotid and inferior cervical.

Nerve-supply.—Cervical and circumflex.

3. **Rhomboideus Longus.**

Synonym.—Cervico-subscapularis.

Situation.—Placed between the cervical trapezius and the ligamentum nuchæ. It is shaped like an elongated triangle, with the apex pointed forwards.

Origin.—The cordiform portion of the ligamentum nuchæ, usually extending as far forwards as the dentata vertebra.

Insertion.—Ventral aspect of the anterior scapular angle and the cartilage of prolongation.

Relations.—Externally, the trapezius and the cartilage of prolongation; internally, the ligamentum nuchæ; inferiorly, the splenius; posteriorly, the rhomboideus brevis.

Action.—Elevates and advances the scapula.

Blood-supply.—Dorsal and superior cervical.

Nerve-supply.—6th cervical.

4. **Depressor Anguli Scapulæ.**

Synonyms. — Portion of the serratus magnus, levator anguli scapulæ, angularis muscle of the scapula, trachelo-subscapularis.

Situation, etc.—A strong, thick, triangular muscle, situated in front of the scapula.

Origin.—The last five cervical transverse processes.

Insertion.—The anterior triangular roughness on the ventral surface of the scapula.

Relations. — Externally, the trapezius, levator humeri and pectoralis parvus; internally, the splenius, longissimus dorsi, and transversalis costarum; inferiorly, the serratus magnus.

Action.—Advances and depresses the cervical angle of the scapula. If the limb is fixed, it raises the neck when acting with its fellow, or produces lateral movement when acting alone.

Blood-supply. — Dorsal, superior cervical, and vertebral.

Nerve-supply.—6th and 7th cervical.

5. **Splenius.**

Synonyms. — Cervico - trachelian, cervico - mastoideus.

Situation, etc.—A large, flattened, and somewhat triangular muscle, found below the trapezius and rhomboideus longus.

Attachments.—The cordiform portion of the ligamentum nuchæ, the first four or five dorsal spines, the third, fourth and fifth cervical transverse processes, the wing of the atlas (with the trachelo-mastoideus and levator humeri), the occipital crest and mastoid ridge (with the trachelo-mastoideus).

Relations.—Externally, the rhomboideus longus, trapezius, levator humeri, and depressor anguli scapulæ; internally, the complexus major, obliquus capitis posticus and anticus, and trachelo - mastoïdeus; inferiorly, the longissimus dorsi.

Action.—If acting with its fellow, elevation of the head results; if acting alone, it produces lateral flexion.

Blood-supply.—Dorsal and superior cervical.

Nerve-supply.—Cervical and dorsal.

6. **Trachelo-mastoideus.**

Synonyms.—Dorso-mastoideus, complexus minor.

Situation, etc.—An elongated muscle—the fleshy belly of which is divisible into two portions—situated along the inferior border of the splenius.

Origin.—First two dorsal transverse processes, and the last five dorsal articular processes.

Insertion.—(1) The wing of the atlas, with the splenius and levator humeri; (2) the mastoid ridge, with the splenius.

Relations.—Externally, the splenius; internally, the complexus major, spinalis colli, and the obliquus capitis anticus and posticus; posteriorly, the longissimus dorsi.

Action.—Elevates or laterally flexes the head, the action depending upon whether one or both muscles act.

Blood-supply. — Dorsal, superior cervical, and vertebral.

Nerve-supply.—Cervical and dorsal.

7. **Complexus Major.**

Synonym.—Dorso-occipitalis.

Situation, etc.—Immediately beneath the splenius. It is strong, flattened, and somewhat triangular.

Origin.—The anterior five dorsal spinous and transverse processes, and the articular processes of the cervical vertebræ.

Insertion.—Laterally to the occipital tuberosity.

Relations.—Externally, the splenius and trachelo-mastoideus; internally, the ligamentum nuchæ, obliquus capitis anticus and posticus, and the complexus minor; posteriorly, the longissimus dorsi and the superior cervical artery.

Blood-supply. — Dorsal, superior cervical, and vertebral.

Nerve-supply.—Cervical and dorsal.

8. **Complexus Minor.**

Synonym.—Axoido-occipitalis longus.

Situation, etc.—A short, slender muscle, placed above the atlas.

Origin.—Spine of the dentata vertebra.

Insertion.—With the complexus major.

Relations.—Externally, the complexus major; internally, the ligamentum nuchæ; inferiorly, the rectus capitis posticus major.

Action.—Assists the major.

Blood-supply.—Vertebral.

Nerve-supply.—Cervical.

9. **Rectus Capitis Posticus Major.**

Synonym.—Axoido-occipitalis brevis.

Situation, etc.—A slender muscle, placed beneath the complexus minor.

Origin.—The spine of the dentata vertebra.

Insertion. — A roughness below the occipital tuberosity.

Relations.—Externally, the complexus major; internally, its fellow and the ligamentum nuchæ; inferiorly, the rectus capitis posticus minor.

Action.—Extends the head.

Blood-supply.—Musculo-occipital.

Nerve-supply.—Cervical.

10. **Rectus Capitis Posticus Minor.**

Synonyms.—Atloido-occipitalis, atloido-occipitalis superior.

Situation, etc.—Small, and placed below the major.

Origin.—Superior part of the ring of the atlas vertebra.

Insertion.—Immediately below the major.

Relations.—Superiorly, the major; inferiorly, the capsule of the occipito-atloid joint; externally, the anterior oblique muscle; internally, the ligamentum nuchæ.

Action.—Assists the major.

Blood-supply.—Musculo-occipital.

Nerve-supply.—Cervical.

11. **Obliquus Capitis Posticus.**

Synonyms. — Axoido-atloideus, great oblique muscle of the head, obliquus capitis inferior.

Situation, etc.—A flattened, thick muscle, placed between the atlas and dentata vertebræ.

Origin.—Lateral face of the spine of the dentata.

Insertion.—Superior face of the wing and ring of the atlas.

Relations.—Externally, the splenius, complexus major, and trachelo-mastoideus; internally, the atlas and dentata vertebræ, and the capsule between these bones; superiorly, the posterior recti; inferiorly, the rectus capitis anticus major.

Action.—Rotates the head.

Blood-supply.—Ramus anastomoticus and vertebral.

Nerve-supply.—Cervical.

12. **Obliquus Capitis Anticus.**

Synonyms. — Atloido-mastoideus, small oblique muscle of the head.

Situation, etc.—A quadrilateral muscle, occupying the space between the wing of the atlas and the occipital bone.

Origin.—The wing of the atlas vertebra.

Insertion.—The mastoid ridge and styloid process of the occipital bone.

Relations.—Externally, the splenius tendon; internally, the capsule of the occipito-atloid articulation and the posterior recti muscles.

Action.—Assists slightly in extension of the head; when acting singly, it produces lateral flexion.

Blood-supply.—Mastoid and musculo-occipital.

Nerve-supply.—Cervical.

13. **Spinalis Colli.**

Synonyms.—Dorso-spinalis, short spinous, transverse spinous muscle of the neck.

Situation, etc.—It consists of six bundles, placed between the complexus major and the ligamentum nuchæ.

Origin.—The articular processes of the first dorsal and last five cervical vertebræ.

Insertion.—The spines of all the cervical vertebræ except the atlas.

Relations.—Externally, the complexus major and trachelo-mastoideus; internally, the vertebræ, ligamentum nuchæ, and longissimus dorsi.

Action.—Extends and laterally flexes the neck.

Blood-supply.—Vertebral.

Nerve-supply.—Cervical.

14. **Intertransversalis Colli.**

Synonym.—Intercervicalis.

Situation, etc.—Six bundles placed between the articular and transverse processes.

Origin.—Articular processes.

Insertion.—Transverse processes.

Relations.—Externally, the deeper muscles of the neck ; internally, the vertebræ and the vertebral vessels.

Action.—Flexes the neck laterally.

Blood-supply.—Vertebral.

Nerve-supply.—Cervical.

E. INFERIOR CERVICAL GROUP.

Eight muscles are contained in this group :

1. **Sterno-maxillaris.**

Synonym.—Sterno-mastoideus of man, etc.

Situation, etc.—A long, fusiform muscle, placed along the lower margin of the levator humeri.

Origin.—Cariniform cartilage of the sternum; the origins of the two muscles are blended.

Insertion.—The posterior margin of the inferior maxilla above the 'angle.'

Relations.—Externally, the panniculus and the parotid gland; internally, the sterno-thyro-hyoideus, subscapulo-hyoideus, the trachea, the carotid artery, and the submaxillary gland; superiorly, the jugular vein, this muscle and the levator humeri forming the **jugular furrow** or **gutter**; inferiorly, its fellow.

Action.—With its fellow, it depresses the head; singly, it moves the head laterally.

Blood-supply.—Carotid and inferior cervical.

Nerve-supply.—Spinal accessory.

2. **Sterno-thyro-hyoideus.**

Synonyms.—Sterno-hyoideus and sterno-thyroideus.

Situation, etc.—This muscle is placed upon the trachea, and is slender and band-like. At about the middle of the neck it divides into two portions.

Origin.—The cariniform cartilage of the sternum. The two muscles are blended.

Insertion.—(1) The body and spur process of the hyoid bone; (2) the posterior part of the inferior face of the thyroid cartilage.

Relations. — Inferiorly, the sterno-maxillaris; superiorly, the trachea.

Action.—Depresses the hyoid bone and the structures attached.

Blood-supply.—Carotid.

Nerve-supply.—1st cervical.

3. **Subscapulo-hyoideus.**

Synonyms.—Omo-hyoideus, hyoideus.

Situation, etc.—A thin, band-like muscle, placed along the side of the trachea.

Origin.—The subscapular fascia.

Insertion.—Body and spur process of the hyoid bone (with the sterno-hyoideus).

Relations.—Externally, the subscapularis, antea-spinatus, pectoralis parvus, sterno-maxillaris, levator humeri, and jugular vein; internally, the scalenus, trachea, carotid artery, pneumogastric and recurrent laryngeal nerves, rectus capitis anticus major, thyroid gland, and the larynx.

Action.—Depresses the hyoid bone and the structures attached to it.

Blood-supply.—Inferior cervical and carotid.

Nerve-supply.—1st cervical.

4. **Rectus Capitis Anticus Major.**

Synonyms.—Trachelo-suboccipitalis, long flexor of the head, trachelo-occipitalis.

Situation, etc.—Long and flattened in shape; it is placed deep in the anterior half of the neck.

Origin.—The 3rd, 4th and 5th cervical transverse processes.

Insertion.—The tubercles marking the point of union of the basi-occiput and basi-sphenoid.

Relations.—Externally, the levator humeri, subscapulo-hyoideus, and rectus capitis anticus minor; internally, the longus colli and its fellow; anteriorly, the common carotid, pneumogastric nerve, and the guttural pouch; superiorly, the capsule of the occipito-atloid articulation.

Action.—When both muscles contract at the same time, the head is depressed; when one acts alone, the movement is lateral.

Blood-supply.—Vertebral and prevertebral.

Nerve-supply.—Cervical.

5. **Rectus Capitis Anticus Minor.**

Synonyms.—Flexor capitis brevis, atloido-suboccipitalis, atloido-occipitalis inferior.

Situation, etc.—A small and short muscle, situated supero-externally to the major.

Origin.—Lower face of the ring of the atlas.

Insertion.—With the major.

Relations. — Infero-externally, the major; externally, the guttural pouch; superiorly, the capsule of the occipito-atloid articulation.

Action.—Assists the major.

Blood-supply.—Prevertebral.

Nerve-supply.—Cervical.

6. **Rectus Capitis Lateralis.**

Synonyms. — Small lateral straight muscle, atloido - styloideus, flexor capitis parvus, obliquus capitis anticus.

Situation, etc.—This is a very small muscle, placed externally to the rectus capitis anticus minor, arising from the ring of the atlas, and terminating on the styloid process of the occipital bone.

Relations.—Inferiorly, the rectus capitis anticus major; superiorly, the capsule of the occipito-atloid articulation; externally, the parotid gland.

Action.—Assists the other recti muscles.

Blood-supply.—Prevertebral.

Nerve-supply.—Cervical.

7. **Scalenus.**

Synonyms.—Costo-tracheleus, costo-cervicalis.

Situation, etc.—Divisible into two portions, this muscle is situated in the lower part of the neck.

(*a*) *The Superior Portion* (Scalenus Posticus).

Origin.—The last three or four cervical transverse processes.

Insertion.—The superior part of the 1st rib.

(*b*) *The Inferior Portion* (Scalenus Anticus).

Origin—The last four cervical transverse processes.

Insertion.—The anterior border and external face of the 1st rib.

Relations.—Externally, the levator humeri, subscapulo-hyoideus, and pectoralis parvus; internally, the trachea, longus colli, carotid artery and pneumogastric nerve, and—on the left side—the œsophagus; superiorly, the intertransversalis colli; inferiorly, the jugular vein, brachial vessels, and sternomaxillaris. The brachial plexus passes between the two portions.

Action.—If the rib is fixed, the neck will be either depressed or turned to the side, depending upon whether one or both muscles act. If the neck is fixed, the first rib will be drawn forwards, and so inspiration will be assisted.

Blood-supply.—Vertebral.

Nerve-supply.—Cervical.

8. **Longus Colli.**

Synonyms. — Subdorso-atloideus, flexor longus colli.

Situation, etc.—This is a single muscle of considerable size, placed immediately below all the cervical and the anterior six dorsal vertebræ.

Origin.—The inferior faces of the first six dorsal and last six cervical vertebral centra, and also the transverse processes of these bones.

Insertion.—The tubercle on the inferior part of the ring of the atlas vertebra.

Relations.—Superiorly, the vertebræ and intervertebral discs; inferiorly, the trachea, œsophagus, pleuræ, nerves and bloodvessels; laterally, the rectus capitis anticus major and scalenus.

Action.—Flexes the neck as a whole, and also the individual vertebræ upon each other.
Blood-supply.—Vertebral.
Nerve-supply.—Cervical.

THE ALIMENTARY SYSTEM.

THAT part of the alimentary system situated in the head and neck includes the **Mouth** and its associated **Salivary Glands**, the **Pharynx** and the **Œsophagus.**

I. THE MOUTH.

The mouth is a somewhat oval cavity placed between the jaws, and constituting the most anterior portion of the alimentary tract. It possesses an anterior extremity, a roof, a posterior extremity, two lateral walls, and a floor, these being formed respectively by the **lips**, the **hard palate**, the **soft palate**, the **cheeks**, and the **tongue.** The **teeth** are situated within the cavity of the mouth.

1. The Lips or Labia.

The lips—superior and inferior—are movable musculo-membranous curtains limiting the anterior opening into the mouth. They each present two surfaces and two borders.

The *external surface* is covered by skin, and is convex. The hairs are of two kinds—short and delicate, and long and probably tactile. The external surface of the lower lip forms a prominent convexity, known as **the chin.**

The *internal surface* is concave, smooth, and covered by delicate mucous membrane, which mesially forms a very imperfect fold known as the **frænum labii.**

Careful examination of the inner face of the upper lip will reveal numerous small yellowish elevations, formed by the **labial glands.**

The *fixed border* has a bony attachment to the anterior convex extremity of the jaw.

The *free border* is thin, and limited laterally by the **commissures** or **angles of the mouth.** The **fissura oris** is the opening between the lips.

Structure.—The lips consist of skin externally, and mucous membrane internally; muscular tissue, glands, bloodvessels and nerves, etc., forming a middle layer.

The **muscles of the lips** are: the orbicularis oris, the levators and depressors, the zygomaticus, and portions of others already described in the section on Muscles.

Blood-supply.—The superior and inferior coronary or labial. The upper lip also receives blood from the palato-labial artery.

Nerve-supply.—Motor supply from the 7th cranial nerve, and sensory from the 5th.

2. The Hard Palate.

The hard palate is a thick membranous expansion applied closely to the bones of the palate, limited anteriorly by the incisor teeth, laterally by the molars, and posteriorly by the soft palate.

The free surface is marked by a longitudinal mesial groove—commencing anteriorly at a small eminence —and also by from sixteen to eighteen transverse ridges, known as the **bars.** These ridges are curved with their convexities anteriorly; the anterior ridges have very steep posterior declivities; the posterior ridges are not so prominent.

Structure.—Two layers of tissue may be recognised: (1) A thick, hard, superficial layer, provided with dense stratified squamous epithelium; and (2) a looser, vascular, deep layer, applied to the bony surfaces.

Blood-supply.—From the palatine arteries which run in the deep layer.

Nerve-supply.—The superior maxillary division of the 5th cranial nerve.

3. The Soft Palate, or Velum Pendulum Palati.

The soft palate is a musculo-membranous curtain forming the posterior limit of the mouth, and suspended from the palatine arch. The soft palate of the horse is so largely developed as to prevent respiration through the mouth, and to cause vomited material to pass down the nose. It presents two surfaces and four borders.

Anterior Surface.—This surface looks forwards and downwards, and is sometimes known as the **inferior surface.** It is covered by mucous membrane continuous with that of the hard palate and other parts of the mouth. The **anterior pillars** of the soft palate (or posterior pillars of the tongue) are formed by the mucous membrane passing from the soft palate to the base of the tongue.

Posterior Surface.—The posterior or superior **face** is also covered by mucous membrane.

Anterior Border.—The anterior border is attached to the concave palatine arch.

Posterior Border.—The free border of the organ is concave, and directed backwards. The **posterior pillars** of the soft palate are folds of mucous membrane passing on to the sides of the pharynx.

The *lateral borders* are attached to the surrounding structures.

The **isthmus faucium** is the opening leading from the mouth to the pharynx, and is limited superiorly by the soft palate.

The **tonsillar spaces** are found between the anterior and posterior pillars. **Tonsils** are not present in the horse.

Structure.—It is possible to recognise five layers in the soft palate.

1. **Anterior Mucous Layer.**—The mucous membrane of the anterior surface possesses stratified squamous epithelium, and is perforated by the ducts of the staphyline glands.

2. **Glandular Layer.**—The **staphyline glands** form a continuous layer beneath the anterior mucous layer; they secrete a mucous fluid, which lubricates the bolus of food as it passes under the soft palate.

3. **Fibrous Aponeurosis.**—The fibrous layer is attached to the palatine arch.

4. **Muscular Layer.**—The muscles of the soft palate are as follows:

(*a*) Tensor Palati.

Synonym.—Peristaphylinus externus.

An elongated, slender muscle arising from the styloid process of the petrosal bone; its anterior tendon passes round the hamular process of the pterygoid bone, and then, being directed inwards, is expanded and lost in the fibrous aponeurosis.

Action.—Tenses the soft palate.

(*b*) Levator Palati.

Synonyms.—Peristaphylinus internus, stylo-pharyngeus.

A thin, elongated muscle placed between the tensor palati and the Eustachian tube. It arises in common with the tensor, and passes directly to the posterior face of the soft palate, where it expands and meets its fellow.

Action.—Raises the soft palate.

(*c*) Pharyngo-staphylinus.

Synonyms.—Palato-pharyngeus, staphylinus communis.

A broad and thin muscle situated in the lower part of the soft palate, continuous with its fellow in the middle line, and prolonged downwards beneath the hyo-pharyngeus to the thyroid cartilage of the larynx; it is therefore a muscle common to the soft palate and pharynx.

Action.—Tenses the soft palate.

(*d*) **Palato-staphylinus.**

Synonyms.—Staphyleus, azygos uvulæ, circumflex palati.

Sometimes considered as a single muscle, this is small and elongated, and meets its fellow in the middle line. It arises from the fibrous aponeurosis and terminates in the posterior border of the soft palate.

Action.—Elevates the soft palate.

(*e*) **Palato-glossus.**

A very small muscle passing from the margin of the soft palate to the base of the tongue. It is placed under the mucous membrane of the anterior pillar. It probably assists in constricting the isthmus faucium.

It should be remarked that only a small portion of the levator and tensor palati muscles enters into the formation of the soft palate.

5. **Posterior Mucous Layer.**—This differs from the anterior mucous layer in the character of its epithelium.

Blood-supply.—Palatine (staphyline) and pharyngeal arteries.

Nerve-supply.—Superior maxillary division of the 5th cranial nerve and filaments from the sympathetic system.

4. **The Cheeks or Buccæ.**

The cheeks are the musculo-membranous expansions which form the lateral walls of the mouth. They possess two surfaces and circumferential borders.

The *borders* are attached to surrounding structures; the anterior border is confounded with the lips.

The *external surface* is covered by the skin of the face.

The *internal surface* is clothed by the buccal mucous membrane, and presents an important papilla on a level with the anterior part of the third upper molar tooth; the duct of the parotid gland opens at the summit of this papilla.

Structure.—Externally, skin; internally, mucous membrane; between these, muscles, glands, etc.

The **mucous membrane** is thin and delicate, and perforated by the ducts of the molar glands.

The chief **muscle** of the cheek is the buccinator, already described.

The **molar glands** will receive mention with the salivary glands.

Blood-supply.—Glosso-facial, coronary (superior and inferior), and buccal arteries.

Nerve-supply.—Motor supply from the 7th cranial nerve, sensory from the 5th.

5. The Tongue.

The tongue is an elongated, somewhat pyramidal musculo-membranous organ, situated in what is called the **lingual canal**, the space formed by the inferior maxillary rami. It offers three surfaces, three borders, an apex, and a base.

The *superior surface*, or *dorsum*, is convex from side to side, narrower before than behind, and studded with projections—the **lingual papillæ**. A mesial longitudinal groove runs along this surface from the apex to a slight depression—the **foramen cæcum of Morgagni**—near the base of the tongue.

The *lateral surfaces* are smoother and softer than the dorsum. They carry several large papillæ.

The *apex*, or anterior extremity, is also known as the free portion, as it is freely movable. It is flattened from above to below, somewhat expanded or spatulate, and mesially slightly notched.

The **anterior pillar**, or **frænum**, of the tongue is a fold of mucous membrane passing from the under face of the apex to the floor of the mouth.

The *base*, or posterior extremity, is somewhat merged into the surrounding structures, and is fixed to the glossal process of the hyoid bone; the **lingual cartilage** of Brühl, a rod of fibrous tissue, is also best marked at the base.

Structure—1. Mucous Membrane.—This is thickest and densest upon the dorsum, where it possesses numerous **lingual papillæ**. Four varieties of papillæ may be readily recognised:

(*a*) *Filiform*, found over the whole surface and very numerous, and consisting of minute conical projections, simple or composite.

(*b*) *Fungiform*, of mushroom-like shape, and found in greatest numbers about the middle and posterior thirds of the surface.

(*c*) *Circumvallate*, best described as large fungiform papillæ sunk into depressions so that their summits are flush with the surface of the dorsum; these are few in number—usually two, sometimes, though rarely, three—and situated near the base. The circumvallate papillæ are concerned in the special sense of taste.

(*d*) A fourth variety of papilla—*papillæ foliatæ*—will be found on the lateral borders of the base, one on each side, and immediately in front of the anterior pillars of the fauces.

The mucous membrane of the sides of the tongue is thin and delicate, and carries a few papillæ, some of which are important. On each side of the frænum a large papilla—the **barb**—will be found, on the summit of which the submaxillary duct opens.

The **sublingual crest** is an elongated elevation of the mucous membrane of the floor of the mouth to the side of the fixed portion of the tongue; the ducts of the sublingual gland open upon this crest.

2. **Lingual Glands.**—Numerous mucous glands are placed immediately under the mucous membrane on the dorsum of the base of the tongue.

3. **Muscles of the Tongue.**—The muscles of the tongue are divided into two groups—Extrinsic and Intrinsic:

A. Extrinsic Muscles.

Hyo-glossus Longus.

Synonym.—Stylo-glossus.

Situation, etc.—This is a long, ribbon-like muscle, situated along the side of the tongue.

Origin.—The external surface of the hyoid cornu.

Insertion.—The substance of the tongue anteriorly.

Relations.—Externally, the sublingual gland, lingual nerve, Wharton's duct, and the mylo-hyoideus;

internally, the hyo-glossus brevis and genio-hyo-glossus.

Action.—Both muscles acting together, the tongue is retracted; if only one acts, the tongue is moved laterally.

Hyo-glossus Brevis.

Synonyms.—Great hyo-glossus, basio-glossus.

Situation, etc.—A broad, flat muscle, placed immediately internal to the longus.

Origin.—The body, glossal process, and part of the cornu of the hyoid bone.

Insertion.—The lateral part of the substance of the tongue.

Relations. — Externally, the hyo-glossus longus, mylo-hyoideus, 12th cranial nerve, Wharton's duct, and mucous membrane; internally, the hyoideus parvus, superior intrinsic lingual muscle, hyoid corniculum, genio-hyo-glossus, lingual artery, and 9th cranial nerve.

Action.—Retracts and depresses the base of the tongue.

Hyo-glossus Parvus.

A small muscle somewhat intimately connected with the brevis, and arising from the hyoid corniculum. Its fibres pass forwards and expand over the dorsum of the tongue. It probably assists the brevis.

Genio-hyo-glossus.

Synonym.—Genio-glossus.

Situation, etc.—An extensive fan-shaped muscle, placed to the side of the mesial plane.

Attachments.—A long tendon is attached to the lower jaw near its symphysis, and to the spur process of the hyoid bone. Muscular fibres radiate from this tendon, and are lost in the substance of the tongue.

Relations.—Externally, the hyo-glossus longus and brevis, sublingual gland, lingual artery and nerves; internally, its fellow; inferiorly, the genio-hyoideus; antero-superiorly, the frænum linguæ.

Action.—The anterior fibres retract the tongue; the posterior and middle fibres depress the dorsum, and probably assist in protrusion.

Pharyngo-glossus.

This muscle consists of a few fibres, which pass from the tongue to the pharynx, related to the genio-hyo-glossus and hyo-glossus parvus.

Palato-glossus.

This has been mentioned with the soft-palate.

B. Intrinsic Muscles.

There are three sets of intrinsic fibres:

1. Lingualis Superficialis, placed immediately below the mucous membrane of the dorsum.

2. Lingualis Inferior, placed much deeper in the substance of the tongue.

Both these sets of fibres run longitudinally from the apex to the base, some fibres finding an attachment to the hyoid bone.

3. Lingualis Transversus, consists of transverse

fibres, and is placed between the preceding. The action of the transverse fibres is to lessen the width and increase the length of the tongue; the longitudinal fibres are antagonistic to the transversus, and also turn the apex upwards or downwards.

Blood-supply of the Tongue.—From the lingual and sublingual arteries.

Nerve-supply of the Tongue.—The lingual branches of the 5th, 9th and 12th cranial nerves.

6. The Teeth.

The teeth are dense, somewhat bone-like structures, protruding above the mucous membrane, and partially buried in the alveoli of the jaws.

General Description.—A tooth in its simplest form presents three distinct parts: (1) A **crown**, or that portion which shows itself above the mucous membrane, or 'gum'; (2) a **fang** or **root**, embedded within the alveolus of bone; and (3) a **neck**, uniting the crown and fang. The fang is hollow and perforated at its apex, the cavity being known as the **pulp cavity**, and containing the pulp, a soft tissue in which blood-vessels, nerves, etc., ramify.

The bulk of the tooth is composed of **dentine**, or **ivory**, a dense tissue somewhat resembling bone in appearance and chemical composition, but having a different histological structure. The wearing surface of the tooth is clothed with a cap of **enamel**, a very dense white substance presenting a highly-polished surface, and containing only 3 or 4 per cent. of animal matter; it is therefore admirably adapted to resist the effects of friction. The third tissue entering into the structure of a tooth is **crusta petrosa**, or **cement**, which covers that part of the tooth embedded in the alveolus, and also certain portions—such as concavities, grooves, etc.—on the free surface.

A further description of the structure of teeth would be out of place here; the student is therefore referred to the standard works on histology.

Teeth are divided into **incisors**, **canines**, and **cheek-teeth**, or **molars**, this being their order from before to behind.

The Teeth of the Horse—1. *Incisors.*—The incisors of the horse are six in number in each jaw, and differ from the typical tooth as above described in the faintness with which the neck is marked, and in the wearing surface presenting, in the adult, all the three dental tissues to the effects of friction.

The general shape of an incisor is that of a curved, elongated, three-sided pyramid; the convexity is placed forwards, and embraces one of the three surfaces; the base of the pyramid is the wearing surface, or 'table,' of the tooth.

Changes due to Age.—The young incisor presents a **table** entirely covered by enamel, and occupied in its central part by a funnel-shaped cavity—the **infundibulum**. When the tooth has been subjected to friction for some time, the enamel surrounding the infundibulum is worn through, and the dentine comes into wear; the appearance now presented is that of two rings of enamel—one surrounding the whole wearing surface, the other surrounding the infundibulum—

separated by a ring of dentine. After a time the infundibulum is entirely worn out, and the table now presents only one ring of enamel surrounding an island of dentine; some crusta petrosa may be found external to the enamel. Before this has happened, however, wear will have exposed the apex of the pulp-cavity, and the pulp, having become calcified, appears as the **dental star** between the remains of the infundibulum and the anterior margin of the table.

The incisors are usually known, from their relative position, as **central, lateral** and **corner.** The **central incisors** are placed on each side of the mesial plane; the **corners** terminate the diastema anteriorly. The corner incisors sometimes differ from the others in having an imperfect ring of dentine; that is, the enamel behind the infundibulum has not worn through.

The above description applies to the incisors as found in an adult animal, or, in other words, to the **permanent incisors.** The incisors of young animals present certain differences; they have feebler fangs, better-marked necks, an almost ungrooved anterior surface to the crown, and the enamel is whiter owing to the almost complete absence of crusta petrosa on the crown. Such teeth belong to the **temporary dentition**, and are known as **deciduous** or **milk teeth.**

2. *Canines.*—The horse has usually four canines (the female has seldom any canine teeth), separated from the incisors and cheek-teeth by the interdental spaces, or diastemæ. The crown is somewhat conical and slightly curved; its outer face is smooth, its

nner face grooved by two furrows. This tooth is simple; *i.e.*, only one tissue is in wear.

3. *Cheek-teeth, or Molars.*—The cheek-teeth of the horse are six or seven in number in each jaw on each side. They are divided into Premolars and Molars.

Premolars.—The premolars are teeth which have been preceded by temporary cheek-teeth. The number of temporary cheek-teeth is not constant, the first being commonly absent in both jaws. When represented, it appears as a rudimentary conical tooth in the upper jaw, and has no successor.

Molars have no predecessors. Since premolars and molars have the same appearance, it is convenient to give them a common description.

The cheek-teeth are large and massive, having several fangs and quadrilateral tables. These teeth, being complex, have all three tissues in wear at one time; the dentine is arranged in a characteristic **B**-like manner, with a small area added to the anterior loop.

The upper teeth have almost square tables, the tables of the lower being elongated antero-posteriorly. The depth of the crown is greater on the outside of the upper, on the inside of the lower, teeth.

Dental Formulæ—*Temporary.*—

$$\text{I.}\ \frac{3-3}{3-3};\ \text{C.}\ \frac{0-0}{0-0};\ \text{M.}\ \frac{3-3 \text{ or } 4-4}{3-3} = 24 \text{ or } 26;$$

or, more briefly, $\frac{303 \text{ or } 304}{303}$, this being the formula for one side of the mouth only.

Permanent.—

$$\text{I. } \frac{3-3}{3-3};\ \text{C. } \frac{1-1}{1-1};\ \text{P.m. } \frac{3-3}{3-3};\ \text{M. } \frac{3-3}{3-3} = 40,$$

or $\frac{3133}{3133}$. The formula more commonly given by zoologists is $\frac{3143}{3143}$.

II. THE SALIVARY GLANDS.

The salivary glands are of a compound, racemose type, and pour their secretion, the **saliva**, into the mouth.

The Parotid Gland.

This is the largest of the salivary glands, and is situated in the somewhat quadrilateral space formed by the base of the external ear, the posterior border of the inferior maxilla, and the wing of the atlas.

Relations.—The *external surface* is covered by the **abducens** muscle of the external ear.

The *internal surface* is applied to and related with the guttural pouch, the levator humeri, the sterno-maxillaris, digastricus, submaxillary gland, carotid artery and its branches, and the 7th cranial nerve.

The *upper extremity* embraces the base of the conchal cartilage of the ear.

The *lower extremity* is received into the angle described by the jugular and glosso-facial veins.

The *anterior border* is in contact with the posterior border of the lower jaw and the temporo-maxillary articulation. It is also related with the subzygomatic artery, vein and nerves and the maxillo-muscular artery and vein.

The *posterior border* meets the wing of the atlas.

The **duct of the parotid gland**, or **Steno's duct**, is detached from the gland at its antero-inferior angle. It passes along the intermaxillary space in contact with the pterygoideus internus, and at the anterior margin of the masseter passes upwards on to the face behind and in company with the glosso-facial vessels. It opens into the mouth on a level with the anterior part of the 3rd upper premolar, on a papilla which is for the purpose of guarding its orifice.

Blood-supply.—From adjacent vessels.

Nerve-supply.—From the 5th and 7th cranial nerves, and also from the carotid sympathetic plexus.

The Submaxillary Gland.

The submaxillary gland is thin, elongated and crescentic, and situated between the parotid gland and the larynx and pharynx.

Relations.—The *external surface* is in contact with the pterygoideus internus, digastricus, the tendon of insertion of the sterno-maxillaris, and the parotid gland.

The *internal surface* covers the guttural pouch, pharynx and larynx, and the numerous nerves and bloodvessels applied to these structures.

The **duct of the submaxillary gland**, or **Wharton's duct**, runs along the concave upper margin of the gland, and afterwards passes between the mylo-hyoideus and hyo-glossus brevis to gain the interval between the hyo-glossus longus and the sublingual gland. It finally opens on the summit of a papilla near the frænum linguæ.

Blood-supply.—External carotid and glosso-facial arteries.

Nerve-supply. — From the carotid sympathetic plexus.

The Sublingual Gland.

The sublingual gland is smaller than either of the preceding, and is placed between the mylo-hyoideus, hyo-glossus longus and genio-hyo-glossus muscles, extending from the maxillary symphysis to near the glossal process of the hyoid bone. Its upper border is immediately below the mucous membrane on each side of the frænum linguæ, and causes the formation of the **sublingual crest** or **ridge.**

The **ducts of the sublingual gland,** or **ducts of Rivinus,** are numerous—sixteen to twenty—and open on the sublingual crest.

Blood-supply.—The sublingual artery.

Nerve-supply.—Lingual branch of the 5th cranial nerve and the carotid sympathetic plexus.

The remaining salivary glands are the molar, labial, lingual, and staphyline, and have received mention in the treatment of the organs with which they are associated.

III. THE PHARYNX.

Situation, etc.—The pharynx is a musculo-membranous tube situated at the base of the skull behind the mouth and nasal chambers, and common to the digestive and respiratory systems.

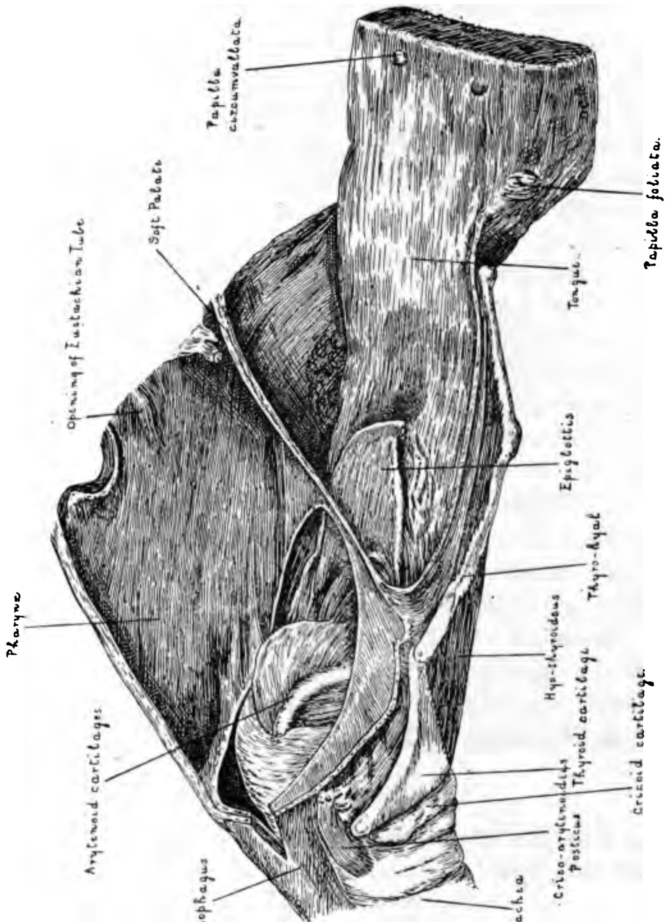

FIG. 5.—THE SOFT PALATE, PHARYNX AND LARYNX (MODIFIED FROM SCHMALTZ).

The relationship of the epiglottis to the soft palate has been disturbed; it should be *above* the velum.

Internal Conformation.—The irregularly cylindrical cavity is compressed laterally, and directed downwards and backwards. When the soft palate is raised in the act of deglutition, the cavity of the pharynx is divided into two portions—an upper or nasal portion, specially concerned with respiration; and a lower portion, common to digestive and respiratory processes.

Seven orifices are to be observed: (1 and 2) The *posterior nares*, communicating with the nasal chambers; (3) the *isthmus faucium*, or opening from the mouth; (4 and 5) the *anterior extremities* of the Eustachian tubes, guarded by a cartilaginous and membranous valve; (6) the *opening into the larynx;* (7) the *œsophagus.*

Relations. — Laterally, the hyoid cornua, pterygoideus internus, and stylo-hyoideus muscles, 9th and 12th cranial nerves, and the glosso-facial arteries; posteriorly, the guttural pouches.

Structure—1. Mucous Membrane.—The epithelium in the upper part of the cavity is ciliated, that of the lower part being stratified squamous.

2. **Muscles of the Pharynx.**—

(*a*) Pharyngo-staphylinus.

This has been already described in connection with the soft palate.

(*b*) Pterygo-pharyngeus.

A thin, triangular muscle, arising from the pterygoid process, and passing downwards and backwards to meet its fellow in the mesial plane.

(*c*) **Kerato-pharyngeus.**

Synonym.—Stylo-pharyngeus.

A narrow, ribbon-like muscle, arising from about the middle of the inner face of the hyoid cornu, and terminating by blending with the pterygo-pharyngeus.

(*d*) **Hyo-pharyngeus.**

Arises from the thyroid process of the hyoid bone—some fibres are attached to the thyroid cartilage—and passes backwards to meet its fellow.

(*e*) **Thyro-pharyngeus.**

Arises from the thyroid cartilage, and joins its fellow.

(*f*) **Crico-pharyngeus.**

Similar to the preceding, but arises from the cricoid cartilage.

(*g*) **Aryteno-pharyngeus.**

A few fibres passing from the arytenoid cartilage to the œsophagus receive this name.

Action of the Pharyngeal Muscles.—They are all constrictors with the exception of the kerato-pharyngeus, which elevates and dilates the organ.

Blood-supply of the Pharynx.—The pharyngeal and thyro-laryngeal arteries.

Nerve-supply of the Pharynx.—The 9th and 10th cranial nerves and the sympathetic.

IV. THE ŒSOPHAGUS.

The œsophagus is the musculo-membranous tube which leads from the pharynx to the stomach, and is for the passage of food from one to the other of these organs. It is divisible into three portions—cervical, thoracic and abdominal. The thoracic and abdominal portions have been described in Part II.; the cervical portion alone will be considered here.

Course and Relations.—The œsophagus leaves the pharynx above the larynx and trachea, but about the middle of the neck it leaves the middle plane, inclining (usually) to the left of the trachea, which position it retains until the two tubes have entered the thorax. The commencement of the œsophagus is placed between the guttural pouches and the larynx. As it passes down the neck, it is related superiorly to the longus colli muscle, laterally to the common carotid artery, pneumogastric and recurrent laryngeal nerves, scalenus and jugular vein, and inferiorly to the trachea.

Structure—1. Muscular Coat.—There are two sets of fibres—external longitudinal and internal circular. The anterior two-thirds of the œsophagus is provided with striated muscular tissue.

2. **Submucous Coat.**—The union between the muscular and mucous coats is very loose.

3. **Mucous Membrane.**—This is pale and thrown into longitudinal folds, which disappear when a bolus of food is passing along the tube. The epithelium is stratified and squamous.

Blood-supply.—Innominate twigs from the common carotid.

Nerve-supply.—The pneumogastric.

THE RESPIRATORY SYSTEM.

THE portions of the respiratory system included in the head and neck are the **Nostrils, Nasal Chambers, Pharynx, Larynx,** and **Trachea.**

I. THE NOSTRILS.

The nostrils, two in number, are the obliquely elongated anterior openings into the nasal chambers, and are limited by **wings** or **alæ.**

Each **ala** has a cartilaginous framework, covered externally and internally by delicate skin, and is joined to its fellow by the **commissures.**

An elongated conical cul-de-sac leads upwards and backwards from the superior commissure; this cavity is known as the **false nostril,** and usually extends as far upwards as the angle formed by the nasal and pre-maxillary bones. The internal surface of the false nostril is lined by thin skin.

Within the inferior commissure a small orifice may be observed; this is the lower opening of the ductus ad nasum.

Structure—1. Skin.—The skin of the face is continued over both outer and inner surfaces. It is thin, delicate, usually pigmented, and carries fine hairs.

2. **Alar Cartilages.**—The alar cartilages of the nostril form a framework which renders the openings constantly patent. Each cartilage is comma-shaped, the head of the comma being placed uppermost, and the convexities of the two commas joined to the expanded anterior extremity of the cartilaginous septum nasi.

3. **Muscles.**—The dilator muscles of the nostril have been described in the anterior maxillary group.

Blood-supply.—The superior coronary, nasal and palato-labial arteries.

Nerve-supply.—Motor from the 7th cranial nerve, sensory from the 5th.

II. THE NASAL CHAMBERS.

The nasal chambers, or fossæ—right and left—are elongated, laterally compressed cavities, occupying the upper part of the face. Each chamber presents a *roof*, a *floor*, *two lateral walls*, and *two extremities*.

The **roof** is formed chiefly by the nasal bone.

The **floor**, wider but shorter than the roof, is formed by the palatine processes of the premaxillary, superior maxillary and palatine bones. The **organ** or **canal of Jacobson** is a short blind tube situated at the anterior part of the floor, and terminating in the plate of cartilage which closes the incisor opening.

The **internal wall** is partially bony and partially cartilaginous. The bones entering into its formation are the vomer and part of the perpendicular plate of the ethmoid; the cartilaginous septum nasi completes the wall.

The **external wall** is very irregular, and formed by the superior maxillary, premaxillary and turbinated bones. Three **meati**, or channels, are recognised: (1) The *superior meatus*, between the superior turbinal and the roof of the chamber; (2) the *middle meatus*, between the two turbinals; and (3) the *inferior meatus*, between the inferior turbinal and the floor; this is the largest of the three.

The **anterior extremity** is formed by the nostril or anterior naris.

The **posterior extremity**, superiorly, is bounded by the lateral ethmoidal mass; inferiorly, the posterior naris communicates with the pharynx.

The mucous membrane of the nasal chambers, the **pituitary** or **Schneiderean membrane**, is delicate and highly vascular, and continuous with the membrane lining the air sinuses of the skull. This membrane is divisible into two portions—a lower, purely **respiratory portion**, provided with ciliated columnar epithelium; and an upper **olfactory area**, with cells—**olfactory cells**—connected with the olfactory nerve-endings. Numerous mucous glands—**glands of Bowman**—are present in the deeper layer of the pituitary membrane.

Blood-supply.—Internal lateral nasal and spheno-palatine arteries.

Nerve-supply.—The 1st cranial or olfactory nerve is distributed in the olfactory portion of the pituitary membrane. The ordinary sensibility of the membrane is due to filaments from the 5th cranial nerve.

III. THE PHARYNX.

This has been already described.

IV. THE LARYNX.

The larynx is a short tube or box, composed chiefly of cartilages and muscles, and situated below the pharynx and at the anterior extremity of the trachea. It is concerned in respiration and the production of voice; in addition, it is provided with a valve which prevents the passage of food into the respiratory tract. The hyoid bone suspends it from the base of the skull.

Structure—1. Cartilages. — Seven cartilages are commonly described, three of which are single. The **Thyroid Cartilage** is the largest, and forms the greater part of the anterior and lateral walls of the larynx. It consists of a central *body* and *two wings* or *alæ.*

The **body** is provided with a convex eminence superiorly for articulation with the epiglottis; inferiorly it affords attachment to the sterno-thyroideus muscle.

Each **wing** presents *two surfaces, two borders,* and *two extremities.*

The **external surface** is slightly convex, and affords attachment to the hyo-thyroideus and thyro-pharyngeus muscles.

The **internal surface** is concave, and in contact with the pharyngeal mucous membrane and the thyro-arytenoideus and crico-arytenoideus lateralis muscles.

The **superior border** has the hyo-thyroid membrane and the palato-pharyngeus muscle attached to it. A process—the **superior cornu**—projects upwards and forwards to articulate with the thyroid process of the hyoid bone.

The **inferior border** affords attachment to the crico-thyroid membrane and muscle.

The **anterior extremity** is united to the body.

The **posterior extremity** or **inferior cornu** articulates with the cricoid cartilage by means of a small convex diarthrodial facet.

The **Cricoid Cartilage** is ring-like, with an expanded portion placed posteriorly. It presents *two surfaces* and *two borders*.

The **external surface** is narrow anteriorly, but of considerable width behind. The wide portion is provided with a mesial ridge, and is covered by the crico-arytenoideus posticus muscle; two small concave facets are placed laterally, and articulate with the posterior extremity of the thyroid cartilage.

The **internal surface** is smooth and clothed by mucous membrane.

The **superior border**, at the wide part of the ring, carries two smooth convex facets for articulation with the arytenoid cartilages.

The **inferior border** is united to the first tracheal ring by the crico-tracheal ligament.

The **Epiglottis** is a leaf-like, soft cartilage situated anterior to the opening of the larynx, and serving as a valve which closes this opening during deglutition. It presents *two surfaces*, *two borders*, a *base*, and an *apex*.

The **anterior surface** is concave from above to below, and convex laterally; it affords attachment to the glosso-epiglottidean fold of mucous membrane and the hyo-epiglottideus muscle.

The **posterior surface** is free, convex from above to below, and concave from side to side; it presents a number of glandular orifices.

The **lateral borders** are also free superiorly, but below they have the aryteno-epiglottidean fold of mucous membrane attached.

The **base** is thickened, and articulates with the body of the thyroid cartilage.

Two cartilaginous processes project backwards from the lateral extremities of the base; these are sometimes known as the **Cuneiform Cartilages**, or **Cartilages of Wrisberg.**

The **apex** points forwards, and rests upon the superior surface of the soft palate.

The **Arytenoid Cartilages**—two in number—limit the laryngeal opening posteriorly. Each is somewhat pyramidal, and presents *three surfaces*, *three borders*, a *base*, and an *apex*.

The **internal surface** is smooth, and covered with mucous membrane.

The **outer surface** affords attachment to the thyro-arytenoideus muscle.

The **posterior surface** is placed under cover of the arytenoideus muscle.

The **superior border** is concave.

The **inferior border (vocal process)** affords attachment to the vocal cord.

The **anterior border** is convex and free.

The **base** possesses a concave facet for articulation with the cricoid cartilage; its postero-external angle is thick and rounded, and affords attachment to the crico-arytenoideus posticus and lateralis muscles. This angle has received the name of **muscular process.**

The **apices** of the two cartilages are placed in juxtaposition and form the **cornicula laryngis.**

2. **Ligaments.**—The laryngeal cartilages are joined to each other and the adjacent structures by ligaments—Extrinsic and Intrinsic.

A. Extrinsic Ligaments.

The thyroid cartilage is joined to the hyoid bone by: (*a*) The **Hyo-thyroid Ligaments**, uniting the superior thyroid cornua to the thyroid processes of the hyoid; and (*β*) the **Hyo-thyroid Membrane**, stretching between the hyoid body and thyroid processes and the body of the thyroid cartilage.

The **Hyo-epiglottidean Ligament** unites the hyoid body to the epiglottis.

The **Crico-trachealis Ligament** is a membranous expansion placed between the cricoid cartilage and the first tracheal ring.

B. Intrinsic Ligaments.

The **Thyro-epiglottidean Ligament** attaches the base of the epiglottis to the body of the thyroid cartilage.

The **Thyro-arytenoidean Ligaments** pass from the inner aspect of the thyroid to the arytenoid cartilages. They constitute the **true vocal cords.**

The cricoid and thyroid cartilages are united by: (*a*) Two thin capsular **Crico-thyroidean Ligaments**, passing from the inferior thyroid cornua to the concavities on the wide portion of the cricoid; and (*β*) the **Crico-thyroidean Membrane**, uniting the two cartilages in front.

The **Arytenoidean Ligament** unites the two arytenoid cartilages.

The **Crico-arytenoidean Ligaments** are thin capsules joining the articular areas of the cricoid and arytenoid cartilages.

3. **Laryngeal Muscles.**—The muscles are divided into Extrinsic and Intrinsic.

A. Extrinsic Muscles.

Sterno-thyro-hyoideus.

Already described.

Hyo-thyroideus.

Somewhat triangular in shape, and occupying the lateral aspect of the larynx.

Origin.—The lower border of the thyroid process of the hyoid bone.

Insertion.—The outer face of the thyroid ala.

Action.—Elevates the larynx and tilts the opening upwards.

Hyo-epiglottideus.

A single pale muscle situated beneath the glosso-epiglottidean fold of mucous membrane.

Origin.—The body of the hyoid bone.

Insertion.—The anterior face of the epiglottis.

Action.—Draws the epiglottis forwards after deglutition.

B. Intrinsic Muscles.

Crico-arytenoideus Posticus.

Situated on the posterior aspect of the larynx.

Origin.—The concave broad portion of the cricoid cartilage.

Insertion.—The postero-external angle of the arytenoid cartilage.

Action.—Dilates the glottis and entrance to the larynx by rotating the arytenoid cartilage outwards.

Crico-arytenoideus Lateralis.

Placed within the wing of the thyroid cartilage.

Origin.—The superior border of the cricoid cartilage.

Insertion.—The postero-external angle of the arytenoid cartilage.

Action.—Constricts the glottis and laryngeal opening by rotating the arytenoid cartilage inwards.

Thyro-arytenoideus.

Also situated beneath the thyroid wing; it consists of two bundles of fibres, long and short.

Origin.—(*a*) The inner face of the wing of the thyroid cartilage near its anterior extremity. (*b*) The wing of the thyroid behind (*a*).

Insertion.—The external face of the arytenoid cartilage, some fibres blending with the arytenoideus muscle.

Action.—Governs the tension of the vocal cords.

Arytenoideus.

Placed supero-posterior to the arytenoid cartilages, passing from one to the other.

Action.—Approximates the arytenoid cartilages.

Crico-thyroideus.

Small, and placed externally and laterally to the cricoid cartilage.

Origin.—The outer face of the narrow portion of the cricoid cartilage.

Insertion.—The inferior border of the thyroid cartilage.

Action.—Shortens the larynx and, by tilting the arytenoid cartilages backwards, tenses the vocal cords.

4. **Mucous Membrane.**—The mucous membrane is continuous with that of the pharynx and trachea; it is provided with numerous mucous glands, and is very sensitive. The epithelium is ciliated columnar, except about the entrance and upon the vocal cords, where it is stratified and squamous in character.

The **Glosso-epiglottidean Fold** passes from the base of the tongue to the epiglottis.

The **Aryteno-epiglottidean Folds** unite the lateral borders of the epiglottis to the arytenoid cartilages.

The **Cavity of the Larynx** is divisible into three portions:

1. The **glottis**, or **rima glottidis**, the triangular opening between the vocal cords; the apex is directed downwards and forwards.

2. The **supra-glottis**, or upper compartment, which is placed above the glottis and provided with several diverticula, viz., the *lateral ventricles* or sinuses, situated between the vocal cords and the aryteno-glottidean folds, and the *middle* or *sub-epiglottic ventricle*, at the base of the epiglottis. The *sub-arytenoid ventricle* is shallow, and placed beneath the point of junction of the cricoid and arytenoid cartilages.

3. The **sub-glottis**, or lower compartment, is found below the glottis.

Blood-supply.—The laryngeal arteries.

Nerve-supply.—The superior laryngeal branch of the pneumogastric nerve supplies sensibility. The inferior or recurrent laryngeal, also a branch of the pneumogastric, is the motor nerve to all the intrinsic muscles except the crico-thyroideus, which receives a filament from the first cervical spinal nerve through the superior laryngeal nerve.

V. THE TRACHEA.

The trachea is an almost cylindrical, cartilaginous and membranous tube extending from the larynx to the base of the heart, where it terminates in the two bronchi.

Length.—About 32 inches.

Calibre.—About 2½ inches.

External Conformation.—On the outer surface from forty to fifty incomplete cartilaginous rings may be counted; the incomplete portion of each ring is placed above. Transverse grooves are present, marking the position of the membranous **tracheal ligaments** which join adjacent rings.

Relations (*Cervical Portion*).—Inferiorly, the sterno-thyro-hyoideus and sterno-maxillaris; laterally, the sterno-maxillaris, subscapulo-hyoideus, scaleni, and œsophagus—on the left side and in the lower part of the neck—the carotid artery and the pneumogastric, sympathetic and inferior laryngeal nerves; superiorly, the œsophagus—in the upper part of the neck—and the longus colli muscle.

Structure—1. Cartilaginous Rings.—These are composed of hyaline cartilage.

2. **Ligaments.**—The tracheal ligaments consist of elastic tissue.

3. **Muscular Tissue.** — The muscular fibres are chiefly found connected with the incomplete part of the rings, and are transverse in direction. Some few longitudinal fibres have been described.

4. **Mucous Membrane.**—Similar to that found in the larynx. Permanent longitudinal folds are present. The epithelium is ciliated columnar, and there are numerous mucous glands.

Blood-supply.—Tracheal twigs from the carotid.

Nerve-supply.—Pneumogastric (recurrent laryngeal branch) and sympathetic.

It is customary at this point to describe two glands unconnected with respiration:

The Thyroid Gland.

The thyroid gland is a small reddish-brown, ductless gland, consisting of two lateral oval lobes and a connecting isthmus.

Situation.—Below and to the sides of the first two tracheal rings.

Weight.—About $\frac{1}{2}$ ounce.

Structure—1. Fibrous Capsule.—This sends processes into the gland substance.

2. **Parenchyma.** — Closed alveoli lined by short columnar or cuboidal cells, and containing a 'colloid' substance.

Blood-supply. — Thyro - laryngeal branch of the common carotid.

Nerve-supply.—1st and 2nd cervical spinal and sympathetic.

The Thymus Gland.

The thymus gland is practically wanting in the adult, being a structure peculiar to the young.

It is situated in the anterior mediastinum, below the trachea. Two lobes may be recognised, but there is no duct.

ARTERIES.

COMMON CAROTID ARTERY.

The common carotid arteries — right and left — arise from the **cephalic artery,** a branch of the right brachial given off within the thorax, and situated below the trachea and above the anterior vena cava. The cephalic artery bifurcates about the entrance to the thorax, the two common carotids being the result.

Course.—Each carotid artery is placed first below and afterwards on the side of the trachea, and is related below with the recurrent laryngeal nerve, and above with the conjoined pneumogastric and sympathetic nerves. The subscapulo-hyoideus separates the artery from the jugular vein in the middle and upper parts of the neck. The carotid terminates at the level of the larynx by dividing into external and internal carotid and occipital arteries—the **carotid trifurcation.**

I. Collateral Branches.

1. **Muscular,** to the muscles of the neck.

2. **Œsophageal,** to the cervical portion of the œsophagus.

3. **Tracheal,** to the cervical portion of the trachea.

4. **Thyroid artery,** a small branch supplying the inferior part of the thyroid gland.

5. **Thyro-laryngeal artery**: arises at about the level of the first ring of the trachea, and proceeds to the thyroid gland and the larynx; a superior branch supplies the pharynx.

II. Terminal Branches.

1. **Occipital.**

Course.—Resulting from the carotid trifurcation, this artery accompanies the internal carotid for about a third of its course, then enters the interstice between the wing of the atlas and the guttural pouch, and gains the antero-external foramen of the atlas, having the submaxillary gland on its outer, and the recti capitis antici muscles on its inner side. It rminates in the alar gutter of the atlas in the cerebro-spinal and musculo-occipital arteries.

I. Collateral Branches.

1. **Prevertebral.**—This is the smallest branch, and it divides into **muscular** and **meningeal** twigs. The former supply the anterior straight muscles of the head and the occipito-atloid joint; the latter gains the dura mater by passing (by two branches) through the

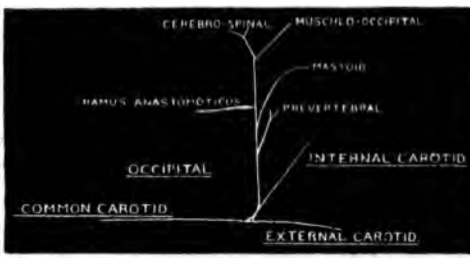

FIG. 6.—DIAGRAM OF THE CAROTID TRIFURCATION AND BRANCHES OF THE OCCIPITAL ARTERY.

condyloid foramen and the foramen lacerum basis cranii.

2. **Mastoid.**—Usually arises opposite to the prevertebral and gains the mastoid fissure, and from this the parieto-temporal conduit, terminating by inosculation with the spheno-spinous artery. It furnishes numerous branches to adjacent muscles, etc., the chief being to the temporalis muscle and dura mater.

3. **Ramus Anastomoticus or Retrograde.**—This leaves the occipital beneath the wing of the atlas, and, proceeding backwards, gains the posterior foramen of that bone; passing through the foramen and beneath the

obliquus capitis posticus, it finally inosculates with the vertebral artery. The calibre of this artery is liable to considerable variation.

II. Terminal Branches.

1. **Musculo-occipital.**—This usually arises within the alar gutter, and passing outwards beneath the obliquus capitis posticus, it divides into **ascending** and **descending** branches, the former supplying the muscles and skin of the occiput, the latter anastomosing with the superior cervical artery.

2. **Cerebro-spinal.**—This artery also arises in the alar gutter; it is directed inwards, and gains the neural canal by means of the antero-internal foramen. After piercing the dura mater, it divides into **anterior** and **posterior** branches. The anterior branch anastomoses with the corresponding branch from the cerebro-spinal artery of the opposite side; the **basilar trunk** results from this anastomosis, and, passing forwards through the foramen magnum, supplies part of the brain. The posterior branch anastomoses in a similar manner, the **middle spinal artery** being thus formed.

2. Internal Carotid.

Course.—This artery, the second terminal branch of the common carotid, arises immediately behind the occipital artery, is directed upwards, and gains the foramen lacerum basis cranii by crossing the anterior straight muscles of the head. For a considerable portion of its course it is placed within a fold of the guttural pouch, and related to the superior cervical ganglion and a portion of the sympathetic. Its intracranial course will be described with the brain.

3. External Carotid.

Course.—This artery may be looked upon as the direct continuation of the common carotid. The first part of its course lies between the parotid gland externally and the guttural pouch internally. Its general direction is forwards and upwards, and, gaining the cornu of the hyoid bone, it passes between this structure and the hyoideus magnus muscle; from this point its direction is more vertical. At about the

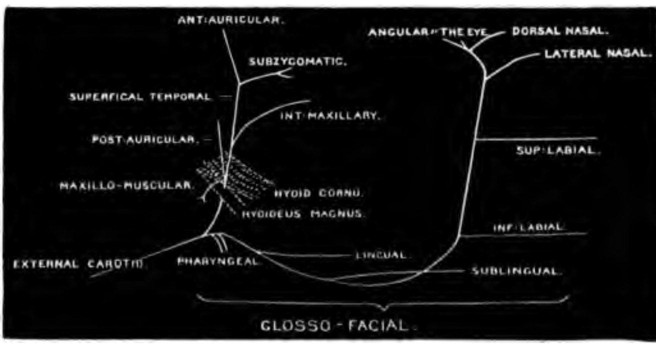

FIG. 7.—DIAGRAM OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY.

level of the neck of the inferior maxillary condyle the external carotid terminates by an unequal bifurcation in **superficial temporal** and **internal maxillary** arteries.

I. Collateral Branches.

1. Glosso-facial, Submaxillary, or Facial.

Course. — The glosso-facial leaves the external carotid artery before that vessel passes between the hyoid cornu and the hyoideus magnus muscle, and takes a downward and forward course. The first part of its course is in relation with the hyoid cornu, the hyoideus magnus, the anterior extremity of the submaxillary gland, and the upper border of the digastricus muscle. On gaining the submaxillary space, it becomes superficial, and winds round the ramus of the inferior maxilla on a level with the anterior border of the masseter muscle. Ascending in front of the masseter, the glosso-facial artery terminates a little above the anterior extremity of the maxillary spine in an **ascending** and a **descending** branch.

I. *Collateral Branches.*

1. *Pharyngeal.*—This branch is sometimes known as the *ascending pharyngeal,* and arises at a variable distance from the point of origin of the glosso-facial. It is directed upwards and forwards between the hyoid cornu and the hyo-pharyngeus muscle, and terminates in the soft palate, contributing ascending and descending branches to the pharynx.

2. *Lingual, or Ranine.* — This vessel is of considerable size, and springs from the glosso-facial at an acute angle under the hyo-glossus brevis muscle, where it is related with the glosso-pharyngeal nerve. From this point it gains the substance of the tongue, and, running in a very flexuous manner between the hyo-glossus longus and brevis and genio-hyo-glossus muscles, it gains the anterior part of that organ.

3. *Sublingual.*—Arises from the parent trunk on a level with the anterior extremity of the submaxillary gland. It gains the outer face of the mylo-hyoideus

muscle, and running forwards reaches the sublingual gland, along the inferior border of which it courses, contributing branches to the gland *en route*. The sublingual artery contributes twigs to the mylo-hyoideus, genio-hyo-glossus and genio-hyoideus muscles, and terminates at the frænum linguæ by supplying the mucous membrane of this region.

4. *Inferior Labial, or Coronary.*—This is the first branch of the facial portion of the glosso-facial artery. It arises near or below the depressor labii inferioris muscle, and runs forwards to the lower lip under cover of this muscle. It supplies the depressor labii inferioris and buccinator muscles, the glands, skin and mucous membrane of the lower lip and cheek, and finally anastomoses with its fellow of the opposite side of the head.

5. *Superior Labial, or Coronary.*—Arises on a level with the anterior extremity of the maxillary spine, and passes forwards under cover of the levator communis, supplying the buccinator, upper lip and nostril, and anastomosing with the palato-labial artery.

II. *Terminal Branches.*

1. *Ascending.*—This divides into the **dorsal nasal artery** and the **angular artery of the eye**, the latter anastomosing with branches from the superior dental artery.

2. *Descending, or Lateral Nasal.*—This branch runs forwards to the false and true nostril.

2. **Maxillo-muscular.**

Course.—The maxillo-muscular leaves the external carotid as that artery emerges from between the hyoid cornu and the hyoideus magnus muscle. Covered by the parotid gland, it descends for a short distance along the posterior border of the inferior maxilla, and terminates in pterygoidean and masseteric branches. The **pterygoidean** or **deep branch** supplies the pterygoideus internus muscles and adjacent organs. The **masseteric** or **superficial branch** winds round the inferior maxilla above the insertion of the stylo-maxillaris, and supplies the masseter muscle, anastomosing with branches from the subzygomatic artery.

3. **Posterior Auricular.**

Course.—This arises from the posterior border of the external carotid a little above the origin of the maxillo-muscular artery. Situated beneath the parotid gland, it gains the base, and finally the apex, of the conchal cartilage, passing upwards between the skin and the posterior aspect of the cartilage. Numerous twigs are contributed to the parotid gland and the muscles of the external ear. A temporal branch divides into deep and superficial portions; the **deep** twig enters the stylo-mastoid foramen, and supplies the tympanum and the deep muscles of the external ear; the **superficial** twig gains the interior of the concha.

II. Terminal Branches.

1. **Superficial Temporal.**

Course.—This is the smaller and less important terminal branch of the external carotid artery. It runs upwards in the space described by the parotid gland externally, the guttural pouch internally, and the neck of the maxillary condyle anteriorly, and after a short course terminates in **anterior auricular** and **subzygomatic** branches.

The **anterior auricular artery** continues the parent trunk upwards between the parotid gland and the temporo-maxillary articulation to the anterior part of the base of the concha. It supplies twigs to the parotid gland, the temporalis muscle, and the interior of the conchal cartilage, and to the skin and muscles connected with this cartilage.

The **subzygomatic artery** winds round the neck of the maxillary condyle, and soon terminates in two almost equal vessels — the **transverse facial** and **masseteric arteries.**

The **transverse facial artery** passes forwards below the maxillary spine, becoming lost in the substance of the masseter muscle, and anastomosing with branches from the glosso-facial and maxillo-muscular arteries.

The **masseteric artery** immediately enters the substance of the masseter muscle, and anastomoses with the masseteric branch of the maxillo-muscular artery. A small twig passes through the sigmoid notch of the lower jaw, and joins the posterior deep temporal artery.

2. Internal Maxillary.

Course.—This is the direct continuation of the external carotid artery, and has its origin immediately internal to the temporo-maxillary articulation. It is directed forwards towards the subsphenoidal canal; before it reaches the canal, it describes an S-shaped curve, the first convexity looking backwards, the second forwards. After traversing the subsphenoidal canal, it again makes its appearance at the orbital hiatus, from which it crosses to the maxillary hiatus, where it terminates as the palatine artery. It will be seen that this artery is readily divisible into three portions: (1) Before entering the subsphenoidal canal, (2) in the canal, (3) after leaving the canal.

The first portion of the artery lies between the pterygoideus externus and the guttural pouch, and is crossed externally by the inferior maxillary nerve.

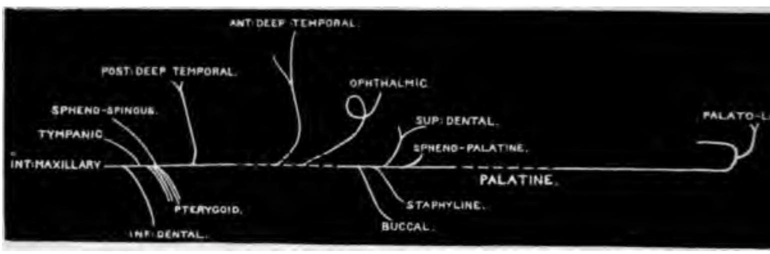

FIG. 8.—DIAGRAM OF THE BRANCHES OF THE INTERNAL MAXILLARY ARTERY.

The dotted lines represent the intraosseous portions of the artery.

The third portion is accompanied by the superior maxillary nerve along the floor of the orbit, and is covered by the mass of orbital adipose tissue.

I. *Collateral Branches.*

A. From the first portion:

1. *Inferior Dental, or Maxillo-dental.*—Arises from the middle of the first curve of the internal maxillary artery. It is directed downwards and forwards be-

tween the pterygoidei muscles to the inferior dental canal. In its course through the canal it supplies the cheek teeth, and arriving at the mental foramen, it terminates in two branches—one proceeding to the canine and incisor teeth, the other leaving the mental foramen and anastomosing with the inferior labial artery. It also supplies the pterygoideus internus and mylo-hyoideus muscles.

2. *Pterygoidean.* — Numerous small branches, destined for the pterygoid muscles, leave the second curve of the internal maxillary artery.

3. *Tympanic.*—This is a very small branch, which gains the tympanum by the Glaserian fissure.

4. *Spheno-spinous, or Great Meningeal Artery.*—Arises opposite the pterygoidean arteries, and passes upwards and backwards, entering the cranial chamber by the foramen lacerum basis cranii, and supplying branches to the dura mater. It finally gains the parieto-temporal canal, and anastomoses with the mastoid artery.

5. *Posterior Deep Temporal.*—This artery arises from the internal maxillary immediately before that artery enters the subsphenoidal canal. It passes upwards in front of the temporo-maxillary articulation, and disappears in the substance of the temporalis muscle.

B. From the second portion:

6. *Anterior Deep Temporal.*—This artery leaves the subsphenoidal canal by the temporal foramen, and runs along the anterior border of the temporalis muscle, which it supplies, as well as the attolentes and the skin of the forehead.

7. *Ophthalmic Artery.*—This is a large branch detached from the internal maxillary artery within the subsphenoidal canal, and destined for the eye and its accessories. Piercing the apex of the ocular sheath, it describes a circular loop, and then enters the cranial cavity through the internal orbital foramen; here it terminates in *meningeal* and *internal lateral nasal arteries.*

The *meningeal artery* supplies twigs to the dura mater, and terminates by anastomosing with its fellow of the opposite side and the anterior cerebral artery.

The *internal lateral nasal artery* pierces the cribriform plate of the ethmoid bone, and, entering the nasal fossa, terminates on the septum nasi and lateral masses of the ethmoid.

The collateral branches of the ophthalmic are:

(*a*) *Muscular*, to the muscles of the eye.

(*b*) *Ciliary*, supplying the eyeball, and chiefly the choroid coat, ciliary processes and iris. Two *long ciliary arteries* form a circle around the circumference of the iris—the *circulus arteriosus iridis.*

(*c*) *Arteria Centralis Retinæ.*—This is peculiar, inasmuch as it pierces the optic nerve, and gains the anterior part of the retina.

(*d*) *Supra-orbital*, passing through the foramen of that name, and supplying the skin and muscles of the forehead.

(*e*) *Lachrymal*, supplying the lachrymal gland and upper eyelid.

(*f*) *Cerebral* or *Cranial*, supplying the anterior lobe of the cerebrum, and anastomosing with the anterior cerebral artery.

C. From the third portion :

8. *Buccal.*—This leaves the parent trunk soon after the orbital hiatus has been reached, and is directed forwards and downwards between the lower jaw and the pterygoideus internus muscle. It gives off small twigs to the pterygoid and masseter muscles, and large ones to the molar glands and the orbital adipose tissue.

9. *Staphyline.* — A small and inconstant branch proceeds along the staphyline groove to the soft palate.

10. *Superior Dental, or Supermaxillo-dental.* — Gains the superior dental canal, along which it passes to the infra-orbital foramen, where it divides into two branches—one supplying the anterior molars and the incisor and canine teeth, the other leaving the infra-orbital foramen and anastomosing with the superior labial artery. The superior dental artery supplies twigs to the posterior molar teeth, the substance of the bone and the membrane lining the maxillary air-sinus, as well as an *orbital* branch which runs along the floor of the orbit to supply the lachrymal sac, and other structures within the inner canthus of the eye, and terminates in the skin of the face, anastomosing with the angular artery of the eye.

11. *Spheno-palatine, or Nasal.*—This artery gains the nasal chamber by passing through the spheno-palatine foramen, and divides into internal and external branches, supplying the inner and outer walls of that chamber.

II. *Terminal Branch.*

Palatine, or Palato-labial.

Course.—The palatine artery continues the internal maxillary from the maxillary hiatus; it traverses the palatine canal, and so gains the deep face of the hard palate. Running forwards on each side of the bony palate, it anastomoses with its fellow by curving round and above a small process of cartilage, and thus gaining the mesial plane. The result of the anastomosis is the formation of the **palato-labial artery**, which pierces the incisive foramen, and terminates by two branches — right and left — in the upper lip and nostrils.

VEINS.

JUGULAR VEINS.

All the blood from the head, and some of that from the neck, is carried away by the jugular veins—right and left—which may be considered as satellites of the common carotid arteries.

Course, etc.—Each jugular vein commences immediately below and behind the temporo-maxillary articulation by the union of two large veins—the **superficial temporal** and **internal maxillary**—usually spoken of as the roots or radicles of the jugular. From its point of origin the jugular passes backwards and downwards, being first supported by the parotid gland, and afterwards by the adjacent borders of the sterno-maxillaris and levator humeri muscles, these forming the **jugular furrow** or **gutter.** At or near the entrance to the thorax the two jugular veins unite to form a single vein—the **jugular confluent**—which is to be looked for between the first pair of ribs and below the trachea. The brachial veins, carrying blood from the anterior extremity, join the jugular confluent.

Relations.—At its commencement the jugular vein is embedded in the parotid gland. In the middle part of its course it is covered by the cervical panniculus, and is in contact with the two muscles forming the jugular furrow; the subscapulo-hyoideus is placed on its inner face, separating the vein and the carotid artery. In the lower part of the neck the vein contacts the artery as well as the trachea, and, on the left side, the œsophagus also.

Roots of the Jugular Vein.

1. **Superficial Temporal Vein.**—This vein is almost an exact satellite of the artery of the same name. It has for its radicles the anterior auricular and subzygomatic veins.

The **anterior auricular vein** receives blood from the temporalis muscle and the external ear, and is connected with the cranial cavity through a branch situated within the parieto-temporal canal.

The **subzygomatic vein** is almost the exact counterpart of the artery. Its masseteric root receives a large vein, which passes through the sigmoid notch from the temporalis muscle, and which is connected with the deep temporal veins.

2. Internal Maxillary Vein.—This is the larger of the two roots of the jugular, and is found between the pterygoid muscles and the inferior maxilla.

The **buccal vein** is the radicle of the internal maxillary. It commences in the facial vein at the anterior border of the masseter, and running upwards and backwards beneath that muscle, it terminates posteriorly in the internal maxillary vein. The buccal

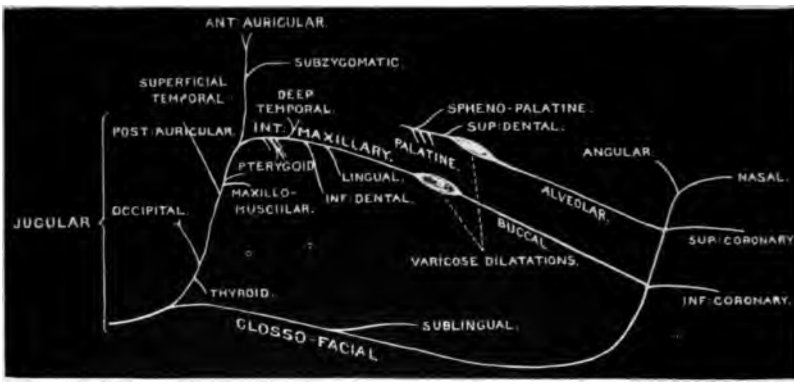

FIG. 9.—DIAGRAM OF THE VEINS OF THE HEAD.

vein is characterized by the possession of a considerable dilatation or varicosity.

The chief collateral affluents of the internal maxillary vein are: (*a*) Lingual; (*b*) inferior dental; (*c*) deep temporal; and (*d*) pterygoid—all satellites of the corresponding arteries.

Collateral Affluents of the Jugular Vein.

The collateral branches of the jugular are as follows:

1. **Maxillo-muscular.**—Two in number, and corresponding to the two branches of the maxillo-muscular artery.

2. **Posterior Auricular.**—This joins the jugular near and opposite to the maxillo-muscular, and drains the posterior part of the concha and a portion of the parotid gland.

3. **Occipital.**—Almost the exact counterpart of the artery of the same name.

4. **Glosso-facial, or External Maxillary.**—This vein differs from the corresponding artery in several important particulars. It commences by two roots—the **angular of the eye** and the **dorsal nasal veins**—and receives the following collateral branches:

(*a*) *Alveolar Vein.*—This vein has no corresponding artery, and is curiously disposed. It is connected anteriorly with the facial vein, and posteriorly it pierces the ocular sheath, enters the cranial cavity by the foramen lacerum orbitale, and terminates by joining the cavernous venous sinus. The anterior portion of this vein is situated between the maxillary spine and the alveoli of the molar teeth, and is protected by the masseter muscle. At or about the alveolar tuberosity the alveolar vein dilates considerably, forming a large receptacle for venous blood. The superior dental, spheno-palatine, palatine, staphyline, and ophthalmic veins open into the alveolar.

(*b*) *Labial or Coronary Veins*—superior and inferior—correspond to the arteries and join the facial vein.

(*c*) *Buccal.*—The buccal vein has been considered as the root of the internal maxillary.

(*d*) *Sublingual.*—This vein is large, and commences by two roots.

5. **Thyroid.**—The thyroid vein is of considerable volume, and drains the larynx and thyroid gland. It opens into the jugular on a level with or above the opening of the glosso-facial vein.

6. **Cephalic.**—The cephalic vein is one of the two terminal branches of the internal subcutaneous vein of the anterior limb. It passes through the space formed by the levator humeri and pectoralis anticus muscles, to open into the jugular vein near its termination.

7. Numerous **Innominate Veins**, carrying blood from the parotid gland and the muscles of the neck, open into the jugular at various points of its course.

The encephalic venous arrangement will be described with the brain.

LYMPHATICS.

THE lymphatic glands of the head are collected into two great groups, the Pharyngeal and Submaxillary.

Pharyngeal Glands.

The pharyngeal or guttural glands are situated along the side of the pharynx. They are numerous, and loosely joined together into an elongated mass.

Afferent vessels proceed from all parts of the head; some come directly from the tongue, soft palate, pharynx and larynx; others are the efferents from the submaxillary glands.

Efferent vessels—four or five in number—pass downwards along the side of the trachea. Small elongated glands, receiving lymph from the œsophagus and trachea, are to be found in connection with these efferents. At the entrance to the thorax they join the prepectoral glands.

Submaxillary Glands.

The submaxillary glands are found subcutaneously in the submaxillary space. They are collected into a row on each side of the space, their position corresponding to the furrow formed by the digastricus and mylo-hyoideus muscles.

Afferent vessels proceed from the tongue, lips, nostrils, nasal fossæ, and cheeks.

Efferent vessels pass to the pharyngeal glands.

Prepectoral Glands.

An elongated mass of lymphatic glands is found on each side of the jugular veins and the jugular confluent; this mass extends for a considerable distance into the thorax.

Afferent vessels are received from the head and neck and the anterior limb.

Efferent vessels from the glands of the right side give rise to the lymphatic vein—**ductus lymphaticus dexter**; those from the left glands open into the thoracic duct, or even into the anterior vena cava itself.

Lymphatic Vein.

The lymphatic vein, or ductus lymphaticus dexter, is formed by the efferent vessels from the right prepectoral glands. It varies in length from a half to two inches, and terminates by opening into the jugular confluent, the orifice being guarded by a valve.

THE BRAIN, Etc.

The **Brain** is lodged in the cranial chamber, and is protected by the bones forming the cranium, as well as by three membranes or meninges.

I. THE CRANIAL CHAMBER

has received notice in the discussion of the skull (p. 46).

II. THE MENINGES OF THE BRAIN

are three in number, and agree with those of the spinal cord in their names and structure. They, however, present certain peculiarities of arrangement which must be here described:

A. **Dura Mater.**—The dura mater is continuous with that of the spinal cord at the foramen magnum. It is closely applied by its outer surface to the cranial bones, for which it supplies an internal periosteum. The inner surface is rendered smooth by the so-called parietal portion of the arachnoid, and presents three processes: (1) The *falx cerebri*, a sickle-shaped structure, is situated in the mesial plane, its upper or convex border being applied to the line of union of the frontal and parietal bones. The lower or concave border is thin and intruded between the cerebral hemispheres. The apex is attached to the crista galli process, and the base to the ossific tentorium. (2) The *tentorium cerebelli* is a transverse fold situated between the cerebrum and cerebellum. The superior border is convex, and attached to the ossific tentorium and the line of union of the parietal and petrosal temporal bones. The inferior border is concave and free. (3) The *pituitary fold* is that process of the dura mater which surrounds the sella turcica, and assists in forming a cavity for the reception of the pituitary body. The **Pacchionian bodies** are yellow masses of variable size, found associated particularly with the false cerebri, and sometimes causing depressions on the inner surface of the cranial bones. These bodies are large arachnoidal villi which have pierced the dura mater.

Blood-supply.—The dura mater is provided with blood by means of the meningeal arteries, these being derived from the cerebro-spinal, mastoid, tympanic, spheno-spinous, and ophthalmic arteries.

B. **Arachnoid.**—The arachnoid membrane is similar to that of the spinal cord. It is applied to the pia mater, but does not follow that membrane into the depressions of the brain, at these points the **subarachnoid space** being formed.

C. **Pia Mater.**—This is similar to the same covering of the cord, being the vascular membrane. The **velum**

interpositum is a remarkable dependency which insinuates itself between the cerebrum and cerebellum, ultimately gaining the interior of the lateral ventricles, where it terminates in the choroid **plexuses.** A somewhat similar fold passes between the cerebellum and medulla oblongata, and ends in the choroid plexuses of the 4th ventricle.

III. THE BRAIN.

The brain, or encephalon, is divisible into four chief parts: (1) The **Cerebrum,** sometimes spoken of as the greater brain, forming the largest and most anterior part of the brain; (2) the **Cerebellum** (lesser or hind brain), placed behind the cerebrum; (3) the **Pons Varolii**; and (4) the **Medulla Oblongata,** passing between the pons Varolii and the spinal cord.

Weight.—The weight of the entire brain is about 22½ ounces.

The Medulla Oblongata.

The medulla oblongata may be considered as the expanded anterior extremity of the spinal cord. It is described as presenting two surfaces, a corresponding number of borders, and two extremities.

The **inferior surface** is convex, and rests upon the basilar process of the occipital bone. It is marked by a median fissure, which continues the inferior median longitudinal fissure of the spinal cord. The **inferior pyramids** are placed on each side of this fissure, and are bounded externally by faint longitudinal grooves, external to which are the **olivary bodies.**

At the posterior extremity of the medulla the fibres of the inferior pyramids decussate.

The **superior surface** lies underneath the cerebellum, and, being hollowed out by the expansion of the superior median fissure of the cord, forms part of the floor of the 4th ventricle.

The **superior pyramids** are placed on each side of the median longitudinal fissure, and are marked off from the **restiform bodies**—which form part of the lateral upper aspects of the medulla—by faint longitudinal grooves.

The rounded **lateral borders** are formed by the **restiform bodies.**

The **posterior extremity** is continuous with the spinal cord, the **anterior** with the pons Varolii.

Structure.—The medulla oblongata consists of grey and white matter; the grey matter is found in the deeper parts (it becomes more superficial on the floor of the 4th ventricle), the white matter being disposed in the columns above mentioned at the periphery of the organ. The fibres of the white matter are chiefly arranged in a longitudinal manner. The greater number of the fibres of the inferior pyramids can be traced to the opposite side of the spinal cord, this arrangement being due to the decussation of the pyramids; followed forwards, they are found to pass through the pons Varolii to the cerebrum.

The olivary bodies contain fibres proceeding from the same side of the cord, which are continued to the cerebrum.

The restiform bodies also derive their fibres from the same side of the cord, but they are continued to the cerebellum, forming the posterior **peduncles** of that organ.

The fibres of the superior pyramids proceed from the same side of the cord, and pass forwards to the cerebrum.

The Pons Varolii.

The pons Varolii is a band of nerve matter placed transversely at the anterior extremity of the medulla oblongata.

The **inferior surface** presents a median furrow, in which the basilar artery lies; otherwise it is convex in both directions, and rests upon the basilar process of the occipital bone.

The **superior surface** forms part of the floor of the 4th ventricle.

The **anterior border** presents two lateral convexities, separated by a shallow notch.

The **posterior border** is only slightly convex.

The **extremities** are connected with the cerebellum, forming its middle peduncles.

Fibres of the Pons Varolii.—The fibres of the white matter are disposed in two directions—longitudinal and transverse.

The longitudinal fibres are continuous with those of the medulla oblongata, and pass forwards towards the cerebrum. The restiform bodies do not contribute any of these fibres.

The transverse fibres consist of superficial and deep layers, the longitudinal fibres being interposed; they bend upwards, and are lost in the cerebellum.

The Cerebellum.

The cerebellum is situated immediately above the medulla oblongata and pons Varolii, and occupies the posterior or cerebellar fossa of the cranial chamber.

It is divided by two antero-posterior grooves into three lobes: a **middle, or vermiform,** and two **lateral lobes.**

The **middle lobe** is somewhat smaller than the other two, and is incurved anteriorly and posteriorly, so that its extremities meet each other on the roof of the 4th ventricle. From their shape, the extremities are known as the **anterior** and **posterior vermiform processes.** The anterior process affords attachment to the posterior border of the valve of Vieussens. A somewhat similar valve has been described by Renault as being attached to the posterior process.

The **lateral lobes** have the three **cerebellar peduncles** attached to their lower face. The peduncles are those structures by means of which the cerebellum is connected to adjacent parts of the encephalon; the **anterior peduncle** proceeds from beneath the corpora quadrigemina, the **middle** from the pons, and the **posterior** from the medulla.

The external surface of each lobe is divided into **folia,** or leaves, by numerous grooves or **sulci.**

Structure.—The cerebellum is composed of grey and white matter, but, contrary to what is found to be the case in the spinal cord or medulla, the grey matter is peripheral. The white matter is collected into a large central mass, from which plate-like processes extend towards the surface; these primary processes divide and subdivide, ultimately ending in the interior of the folia. The term **arbor vitæ** is applied to this arrangement of the white matter, from the characteristic appearance it presents on sagittal section.

The grey matter forms a continuous outer layer, and, in addition, two small nuclei within the central mass of the white matter; each nucleus occupies a position to the side of the mesial plane, and is known as a **corpus dentatum.** The peripheral layer of grey matter is composed of two strata: an outer, simply known as the **grey layer,** and an inner or **rust-coloured layer.**

The 4th Ventricle.—The 4th ventricle may be said to have a roof, two lateral walls, and two extremities. The **roof** is formed by the vermiform processes of the cerebellum and the valve of Vieussens; the **floor** by the pons and medulla; and the **lateral walls** by the anterior cerebellar peduncles and the restiform bodies. The anterior extremity is continuous with the aqueduct of Sylvius, and the posterior, through a small orifice, with the central canal of the spinal cord. The two extremities are narrow, the widest part of the ventricle being between the cerebellar peduncles. The posterior narrow extremity is known as the **calamus scriptorius.**

The Valve of Vieussens.—This structure consists of a thin lamina stretching between the anterior peduncles of the cerebellum, with which its lateral margins are blended; the posterior margin is attached to the anterior vermiform process, and the anterior margin behind the testes. The superior surface contacts the cerebellum; the inferior surface helps to form the roof of the 4th ventricle.

The Choroid Plexuses of the 4th Ventricle.—This is the name applied to two thickened portions of the pia mater which lie between the restiform bodies and the cerebellum, one on each side. It is now customary to consider that these plexuses are shut off from the interior of the 4th ventricle by a thin membrane.

The Cerebrum.

The term 'cerebrum' is applied to all the encephalon not described above—*i.e.*, to all the brain except the medulla, pons and cerebellum.

A. **External Conformation**—Inferior Surface or Base.—On examination of the inferior surface or base of the brain, the following objects will be seen:

Crura cerebri.
Posterior perforated space.
Corpus albicans.
Pituitary body.
Infundibulum.
Tuber cinereum.
Optic tracts and commissure.
Anterior perforated space.
Fissure of Sylvius.
Lamina cinerea.
Longitudinal fissure.
Olfactory tracts, peduncles and bulbs.
Cerebral convolutions.

The **crura cerebri** are two thick rounded cords, which pass forwards in a diverging manner from the anterior border of the pons Varolii. As a result of their divergence, the crura form the posterior and lateral boundaries of the **interpeduncular space**, the anterior boundary of which is formed by the optic tracts and commissure. As each crus is about to enter the cerebral hemisphere, it is crossed obliquely by a flattened white band—the **optic tract.**

Each crus consists of two layers—superficial and deep—of white matter, separated by an intermediate collection of grey matter—the **locus niger.** The superficial fibres constitute the **crusta**, and the deep the **tegmentum.** Both sets are continuous with the longitudinal fibres of the pons, and are continued forwards to the cerebral hemispheres, corpora striata, corpora quadrigemina, and optic thalami.

The **posterior perforated space**, or **pons Tarini**, is the term applied to the grey matter situated in the interpeduncular space, between the corpus albicans and the pons. It is perforated by the bloodvessels which pass to the optic thalami.

The **corpus albicans** is a small white eminence placed in the middle line immediately in front of the posterior perforated space. It is formed by the reflected anterior crura of the fornix.

The **pituitary body**, or **hypophysis cerebri**, is a disc-shaped oval structure of reddish-grey colour, which is lodged in the sella turcica of the sphenoid bone, and connected by a short conical tube of grey matter—the **infundibulum**—with the tuber cinereum. Its structure resembles somewhat a blood-vascular gland. It is largest in the fœtus.

The **tuber cinereum** is a slight eminence composed of grey matter, and situated between the corpus albicans and the optic commissure. The infundibulum before mentioned springs from its inferior face.

The **optic tracts** are two flattened cords of white matter, which, winding round the borders of the crura cerebri, pass forwards and inwards to meet and unite in the middle line, forming the **optic commissure** or **chiasma**, from which are given off anteriorly the two optic nerves, these passing forwards and outwards.

The **anterior perforated spaces** are the areas of grey matter situated on each side of the optic commissure, and perforated by vessels passing to the corpora striata.

The **fissure of Sylvius** is the shallow groove which passes outwards from the anterior perforated space. The middle cerebral artery lies in this fissure.

The **lamina cinerea** is a thin layer of grey matter which connects the corpus callosum and the tuber cinereum. It is situated above the optic commissure, and forms the anterior boundary of the 3rd ventricle.

The **longitudinal fissure** occupies the middle line, is situated in front of the optic commissure, and separates the cerebral hemispheres; it is continuous with the longitudinal fissure seen on the superior aspect of the brain.

The **olfactory tracts** are two strands of white nervous tissue, which pass forwards from the cerebrum towards the olfactory bulbs. Each tract arises by two roots. The **internal root** (or tract) is short, and passes forwards and outwards from the great longitudinal fissure. The **external root** (or tract) is much longer and curved, and arises from the posterior part of the hemisphere; the first part of its course is forwards and outwards, afterwards it proceeds forwards and inwards. The area between the two roots is smooth and convex, and is sometimes known as the **middle** or **grey olfactory root**. A **superior root** is also described as springing from the frontal lobe of the cerebrum.

The **olfactory bulbs** are expanded masses of white matter lodged in the olfactory fossæ, and connected with the tracts by means of the short, cord-like **olfactory peduncles**. The convex free surface of each olfactory bulb gives off the fine olfactory nerves which pierce the cribriform plate of the ethmoid, and gain the nasal chamber.

The olfactory bulbs and peduncles are hollow, their cavity being in communication with the lateral ventricles.

The Cerebral Convolutions.—Several of the convolutions (gyri) of the cerebrum and the grooves (sulci) separating them are visible on the inferior aspect of the brain. Two of these convolutions are named. Between the posterior part of the external olfactory root and the crus cerebri is the **hippocampal convolution**, which passes forwards to terminate behind the fissure of Sylvius in the convex **uncinate convolution**.

SUPERIOR SURFACE.—On the upper face of the cerebrum is seen the **great longitudinal fissure** situated in the middle line, and separating the large convex masses known as the **cerebral hemispheres**.

The **great longitudinal fissure** is continuous with the fissure of the same name seen at the base. On opening the fissure posteriorly, a band of tissue—the **corpus callosum**—connecting the two hemispheres is seen.

The **cerebral hemispheres** are provided with numerous convolutions and sulci, and are separated posteriorly from the cerebellum by the **transverse fissure**, or **fissure of Bichat.**

Each hemisphere is ovoid in shape, and presents *four surfaces* and *two extremities.*

The *superior, external and inferior surfaces* are convex; the *internal* is flattened, and has the corpus callosum attached. A longitudinal convolution on this surface is known as the **gyrus fornicatus**, and is separated from the corpus callosum by a fissure, the **ventricle of the corpus callosum.**

The *anterior extremity* is smaller than the posterior.

The *posterior extremity* is slightly concave for the reception of the cerebellum.

The **corpus callosum** presents *two surfaces, two borders* and *two extremities.*

The *superior surface* is seen at the bottom of the great longitudinal fissure, and consists chiefly of transverse fibres; but on each side of the middle line some longitudinal fibres are visible, forming the **striæ longitudinales**, or **nerves of Lancisi.**

The *inferior surface* forms the roof of the lateral ventricles, but in the middle line posteriorly the fornix is attached to it, and anteriorly the septum lucidum.

The *borders* are lost in the substance of the hemispheres.

The *anterior extremity* is reflected downwards as the **rostrum**, which is continued to the tuber cinereum by the **lamina cinerea.**

The *posterior extremity* is thickened, and forms the **splenium**, which curves forwards and is continuous with the fornix.

B. **Internal Conformation.**—On removal of a slice from a hemisphere, the cerebrum is seen to consist of grey and white matter. The grey matter is found at the periphery surrounding an island of white matter—the **centrum ovale minus**—dotted over with small red points—**puncta vasculosa**—the cut blood-vessels.

A deeper slice will reveal a larger mass of white matter—the **centrum ovale majus.**

On making an incision through the corpus callosum, the lateral ventricles are now opened into.

The Lateral Ventricles.—Each lateral ventricle is a cavity in the interior of a cerebral hemisphere, separated from its fellow by the fornix and septum lucidum. The **foramen of Monro** affords a communication, beneath the fornix, between the two ventricles.

Each ventricle consists of a *body* and *anterior* and *descending cornua.*

The *body* has a floor formed by the **corpus striatum,** the **choroid plexus,** the **tænia semicircularis,** the **tænia hippocampi,** and the **hippocampus.**

The *anterior cornu* communicates with the cavity of the olfactory bulb.

The *descending cornu* forms a curve at first backwards and outwards, and afterwards downwards, forwards and inwards, finally terminating in the interior of the uncinate convolution.

The **foramen of Monro,** in addition to connecting the two lateral ventricles, also puts them in communication with the 3rd ventricle.

The **septum lucidum** is the thin, semi-transparent membrane stretching between the corpus callosum and fornix, and separating the lateral ventricles from each other. It is triangular in shape, the apex being directed backwards. It is attached above and in front to the corpus callosum, and below to the fornix. It consists of two laminæ of grey matter, with white matter interposed.

The **fornix** is a mesial flattened band of white matter situated below the corpus callosum, and blended with it posteriorly.

It consists of a *body* and *anterior* and *posterior crura*.

The *body* is triangular in shape, the apex pointing forwards. Its superior surface is attached posteriorly to the corpus callosum, and anteriorly to the septum lucidum. Its inferior surface rests upon the velum interpositum, its apex being situated above the foramen of Monro and the optic thalami.

The two *anterior crura* are slightly separated from each other, and pass downwards to the base of the brain, where they form the corpus albicans, from which they may be traced into the optic thalami.

The two *posterior crura* diverge, and are placed upon the hippocampi, forming the **tæniæ hippocampi,** or **corpora fimbriata.**

The **corpus striatum** is so called from its striated appearance, due to mixture of grey and white matter. It is situated in the body and anterior cornu of the lateral ventricle, and has a pyriform shape, the apex being directed backwards and outwards. Only a portion of the body projects into the ventricle, this being composed of grey matter and known as the **intraventricular** or **caudate nucleus.** The **extraventricular** or **lenticular nucleus** is embedded in the substance of the hemisphere. The **internal capsule** is a layer of **white** matter separating the two nuclei, and the **external capsule** is a similar layer found on the outer surface of the lenticular nucleus. A layer of grey matter covering the external capsule is known as the **claustrum.**

The **tænia semicircularis** is a narrow curved band of white matter situated between the caudate nucleus and the optic thalamus.

The **choroid plexus** is the very vascular anterior margin of the **velum interpositum**, a fold of pia mater which insinuates itself into the transverse fissure, and is then placed between the hippocampus and optic thalamus.

The **hippocampus** is an eminence of white matter occupying the body and descending cornu of the lateral ventricle. It takes a curved direction outwards, backwards and downwards. Its upper surface is convex; its lower surface is placed above the optic thalami, the velum interpositum intervening.

The **optic thalami** are two grey eminences resting upon the upper surface of the anterior extremities of the crura cerebri, and related in front with the corpora striata; behind, with the corpora quadrigemina.

Internally they are separated from each other by a groove occupied by the pillars of the pineal body. Their internal faces form the lateral walls of the 3rd ventricle.

The superior surface is convex, and forms a portion of the descending cornu of the lateral ventricle.

The two eminences known as the **corpora geniculata**

—external and internal—are placed on the outer side of each optic thalamus. The external corpus geniculatum is the larger and more prominent.

The **pineal body**, or **conarium**, is a small conical body of reddish colour, placed in the middle line and situated between the nates and optic thalami. Two **peduncles** extend forwards from the pineal body, and terminate at the foramen of Monro by joining the anterior crura of the fornix. The pineal body is not composed of nerve matter, but of tissue resembling lymphoid tissue, containing calcareous particles—the **acervulus cerebri.**

The **corpora quadrigemina** are two pairs of eminences situated behind the optic thalami, to which they are connected by the corpora geniculata. The anterior pair, or **nates**, are larger than the posterior pair, or **testes.** The nates are grey in colour, the testes being paler.

The **3rd ventricle** is the narrow chink situated between the optic thalami.

It presents *two lateral walls*, a *roof*, a *floor*, and *two extremities.*

The *lateral walls* are formed by the inner surfaces of the optic thalami.

The *roof* is formed by the velum interpositum.

The *floor* responds to the interpeduncular space.

The *anterior extremity* is formed by the lamina cinerea.

The *posterior extremity* communicates with the 4th ventricle by means of the **aqueduct of Sylvius.**

Three commissures cross the cavity of the 3rd ventricle: (1) The **anterior commissure,** composed of white matter, connects the corpora striata immediately in front of the anterior crura of the fornix; (2) the **middle (or soft) commissure,** composed of grey matter, unites the optic thalami; (3) the **posterior commissure** connects the optic thalami posteriorly, being placed immediately in front of the nates; it consists of white matter.

Blood-supply of the Brain.

The arteries of the brain are branches of the cerebro-spinal branch of the occipital and the internal carotid.

The anterior division of the two cerebro-spinal arteries, as we have seen, unite to form the **basilar artery.**

The **Basilar Artery** enters the foramen magnum, and runs along the middle of the lower face of the medulla oblongata. At the anterior border of the pons it terminates by a bifurcation in the posterior cerebral arteries. Its collateral branches are:

1. Numerous small twigs, which enter the substance of the medulla and pons.

2. The **posterior cerebellar arteries**—right and left—arise behind the pons, and pass upwards to the posterior part of the cerebellum.

3. The **anterior cerebellar arteries,** variable in number, usually arise from the basilar near its termination. They supply the anterior part of the cerebellum.

The **posterior cerebral arteries** diverge and, passing upwards and outwards round the crura cerebri, gain the transverse fissure. They supply the posterior part of the cerebrum and the choroid plexuses. At a variable point near their origin they are joined by the posterior communicating branches of the internal carotid arteries.

The basilar artery commonly gives off two transverse branches about the middle of the pons; these communicate with the internal carotid artery.

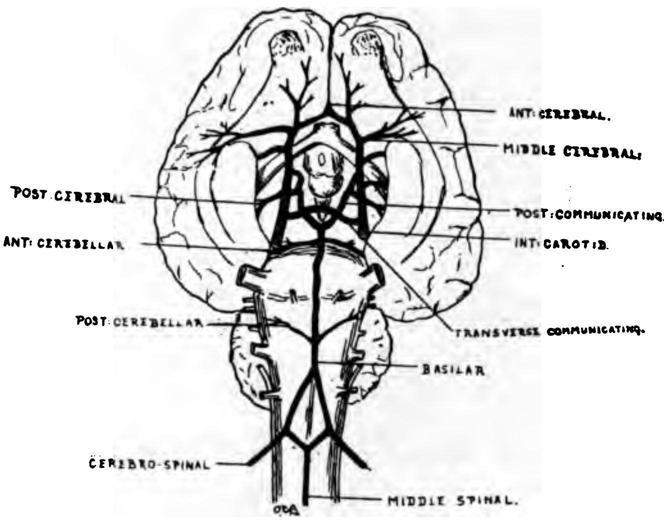

FIG. 10.—THE ARTERIES AT THE BASE OF THE BRAIN (SEMI-DIAGRAMMATIC).

The **Internal Carotid Artery** enters the cranium by the foramen lacerum basis cranii, being placed in the carotid notch on the posterior border of the wing of the sphenoid bone. On passing through the cavernous venous sinus, it forms an **S**-shaped curve. After the second curve, a transverse branch unites the two internal carotid arteries.* At the side of the sella turcica it divides into anterior and posterior branches. The posterior branch is the **posterior communicating artery**, which joins the posterior cerebral. The anterior branch forms the middle and anterior cerebral arteries.

The **middle cerebral artery** passes up the fissure of Sylvius, and anastomoses with the posterior and anterior cerebral arteries.

The **anterior cerebral artery** passes forwards into the great longitudinal fissure, unites with its fellow in the middle line, and winds round the anterior part of the corpus callosum; gaining the upper surface of this body, it divides into right and left branches, which run backwards along the inner surface of the hemispheres. In some cases the two anterior cerebral arteries do not unite directly, but are connected by a transverse artery—the **anterior communicating**.

The term **Circle of Willis** is applied to the arterial arrangement formed by the internal carotid and posterior cerebral arteries.

The Venous Sinuses of the Dura Mater. — These sinuses are formed between two folds of the dura mater, and are:

1. The **superior longitudinal sinus**, situated along the attached border of the falx cerebri.

2. The **inferior longitudinal sinus**, much smaller than the above, is found in the concave border of the falx cerebri.

The **torcular Herophili** is the point of union of the

* We have frequently observed this transverse branch arising from the internal carotid arteries by two roots separated by a short interval.

two longitudinal sinuses; it communicates with the transverse sinuses.

3. The **transverse sinuses** — right and left — are situated in the tentorium cerebelli, and communicate with the parieto-temporal confluent above and with the petrosal sinuses below.

4. The **petrosal sinuses** are small, and serve as a connection between the transverse and cavernous sinuses.

5. The **cavernous sinuses** are situated on each side of the pituitary fossa; they receive the ophthalmic veins anteriorly, and posteriorly they are connected with each other behind the pituitary body. Each opens below into the subsphenoidal confluent, which pierces the foramen lacerum basis cranii.

6. The **occipital sinuses** are small, and connected with the dura mater of the cerebellum. They communicate with the spinal sinuses, and are drained by the occipital vein.

The **Veins** which drain the sinuses of the dura mater are:

1. The **parieto-temporal confluents**, satellites of the mastoid artery.

2. The **subsphenoidal confluents**, which leave the cavernous sinuses and open into the pterygoid and occipital veins.

NERVES.

THE CRANIAL NERVES.

Veterinary anatomists describe the cranial nerves as consisting of twelve pairs, thus following the classification of Sœmmerring. Willis formerly divided them into nine pairs. The following table will serve to indicate the two classifications. Special names are also employed in addition to the numerical names:

Willis.	Sœmmerring.	Special Name.	Function.
1st	1st	Olfactory.	Special sense of smell.
2nd	2nd	Optic.	Special sense of sight.
3rd	3rd	Oculo-motor.	Motor.
4th	4th	Pathetic or trochlear.	,,
5th	5th	Trifacial or trigeminal.	Mixed.
6th	6th	Abducens.	Motor.
7th	7th	Facial or portio dura.	,,
	8th	Auditory or portio mollis.	Special sense of hearing.
8th	9th	Glosso-pharyngeal.	Mixed.
	10th	Pneumogastric or vagus.	,,
	11th	Spinal accessory.	Motor.
9th	12th	Hypoglossal.	,,

The Olfactory Nerves.

These nerves are small, numerous, and non-medullated; they leave the free surface of the olfactory bulb and pass through the foramina in the cribriform plate of the ethmoid bone. Gaining the nasal chamber, they are distributed in the olfactory portion of the mucous membrane.

The Optic Nerve.

The 2nd or optic nerve arises from the corpora quadrigemina and optic thalamus, and winds round the crus cerebri as the **optic tract**; gaining the middle line, the two optic tracts unite and form the **optic commissure** or **chiasma**, in which there is a decussation of fibres. The optic nerves proper arise from the commissure; each nerve passes forwards and outwards, and leaves the cranial chamber by the optic foramen. The nerve terminates by piercing the **lamina cribrosa** of the sclerotic coat of the eyeball and expanding in the **retina.**

The Oculo-motor Nerve.

The 3rd or oculo-motor nerve has a deep origin from the corpora quadrigemina; its superficial origin, however, is from the middle of the crus cerebri, inclining towards the middle line. It leaves the cranium by the foramen lacerum orbitale, terminating in the muscles of the eye. The following are the muscles supplied by this nerve: Levator palpebræ superioris, superior, inferior and internal recti, inferior oblique, internal part of the retractor oculi, the ciliary muscle, and the circular fibres of the iris.

The Pathetic Nerve.

The 4th, pathetic, or trochlear nerve arises from the valve of Vieussens. It makes its appearance on the base of the brain, immediately in front of the pons Varolii. Passing forwards, outwards and downwards, it leaves the cranium by the foramen patheticum, and, gaining the orbit, supplies the superior oblique muscle of the eye, on the deep surface of which it is to be found.

The Trifacial Nerve.

The 5th, trifacial, or trigeminal nerve arises from the side of the pons Varolii by two roots—sensory and motor.

The **sensory root** is the larger and more external, and leaves the pons near the middle cerebellar peduncle. Its fibres may be traced into the grey matter of the pons and medulla. After a short course outwards and forwards, this root is expanded into the crescentic **Gasserian ganglion**, which rests upon the plate of cartilage closing in the foramen lacerum basis cranii. Leaving the ganglion are the three divisions of the 5th nerve—**ophthalmic, superior maxillary** and **inferior maxillary.**

The **motor root** is much smaller than the sensory, to the inner side of which it is placed. It derives its fibres from the grey matter of the pons, and joins the inferior maxillary division of the nerve.

I. The **Ophthalmic Division** leaves the cranium by the foramen lacerum orbitale, in which it divides into three branches :

1. The **Frontal** or **Supra-orbital Nerve** runs along the inner wall of the ocular sheath to the supra-orbital foramen, which it traverses to supply the upper eyelid and the skin of the forehead.

2. The **Lachrymal Nerve** passes forwards between the superior rectus and the levator palpebræ superioris muscles, and supplies the lachrymal gland. Some branches are continued to the muscles and skin of the anterior part of the ear.

3. The **Palpebro-nasal Nerve** accompanies the oph-

thalmic artery through the internal orbital foramen into the cranium, and then, leaving by one of the foramina of the cribriform plate of the ethmoid bone, gains the upper part of the nasal chamber. A branch leaves the parent trunk near the internal orbital foramen, and, passing to the inner canthus of the eye, supplies the lachrymal sac, membrana nictitans, and lower eyelid.

II. The **Superior Maxillary Division** leaves the cranium by the foramen rotundum, passes along the floor of the orbit, and has five branches :

1. The **Orbital Nerve** passes upwards into the orbit, supplying the eyelids and adjacent skin.

2. The **Anterior Palatine** or **Palato-maxillary Nerve** passes into the palatine canal, and supplies the hard palate.

3. The **Staphyline** or **Posterior Palatine Nerve** runs along the staphyline groove to the soft palate.

4. The **Nasal or Spheno-palatine Nerve** traverses the spheno-palatine foramen, and terminates in the mucous membrane of the lower and posterior part of the nasal chamber.

5. The **Dental Nerves** enter the superior dental canal, and supply the molar, canine and incisor teeth.

After traversing the dental canal, the superior maxillary nerve makes its exit by the infra-orbital foramen, and terminates in the muscles and skin of the face, nose, false nostril, and upper lip.

III. The **Inferior Maxillary Division** leaves the cranium by the foramen lacerum basis cranii ; then running downwards and forwards, it gains the interval between the pterygoid muscles, enters the inferior dental canal, and terminates in mental branches which leave the foramen of that name. It may thus be considered to have three portions, and its branches can be classified accordingly.

The branches given off before and during its passage between the pterygoid muscles are:

1. The **Masseteric Nerve**, which passes through the

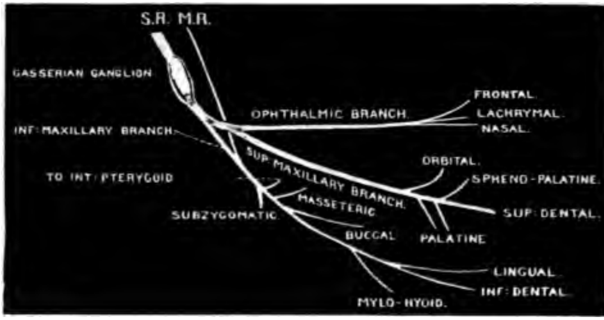

FIG. 11.—DIAGRAM OF THE BRANCHES OF THE 5TH CRANIAL NERVE.

S. R., Sensory root; M. R., Motor root.

sigmoid notch of the inferior maxilla, and supplies the masseter and temporalis muscles.

2. The **Buccal Nerve** pierces the pterygoideus externus, and terminates in the mucous membrane of the cheek, the buccinator muscle, and the lips. It contributes branches to the external pterygoid and temporal muscles, as well as to the molar glands.

3. The **Pterygoid Nerve** supplies the internal pterygoid muscle.

4. The **Superficial Temporal** or **Subzygomatic Nerve** passes round the lower jaw just below the condyle; gaining the face, it mixes with branches from the 7th nerve. It contributes branches to the guttural pouch, parotid gland, and skin of the temporal region.

After passing between the pterygoid muscles, the superior maxillary nerve gives off:

5. The **Lingual Nerve**, which is placed at first between the ramus of the inferior maxilla and the internal pterygoid muscle, but gaining the base of the tongue, it runs forwards beneath the mucous membrane at the side of that organ to its tip. It supplies the mucous membrane of the tongue, mouth and gums, Wharton's duct, and the sublingual and submaxillary glands. It receives the **chorda tympani** branch of the 7th nerve. The name **gustatory** has been given to this nerve upon the assumption that it is concerned in taste.

6. The **Mylo-hyoid Nerve** is applied along the inner face of the ramus of the lower jaw, and supplies the mylo-hyoideus muscle and the anterior belly of the digastricus.

While in the inferior dental canal, the superior maxillary gives off:

7. The **Dental Nerves** to the teeth.

8. The **Mental Nerves** leave the mental foramen and pass to the lower lip.

The Abducens Nerve.

The 6th or abducens nerve leaves the medulla oblongata immediately behind the pons Varolii, its fibres being traceable into the substance of the medulla. Passing forwards, it leaves the cranium by the foramen lacerum orbitale, and terminates in the external rectus muscle of the eye and the outer portion of the retractor oculi.

The Facial Nerve.

The 7th or facial nerve leaves the medulla behind the pons, its fibres originating in the grey matter of the medulla. A very delicate strand of nerve tissue —the **portio intermedia of Wrisberg**—joins the nerve near its origin. The 7th nerve enters the internal auditory meatus, passes through the petrous temporal bone along the aqueduct of Fallopius, in which it forms a small bent ganglion—the **geniculate ganglion** —and finally leaves the aqueduct by the stylo-mastoid foramen. From this foramen the nerve is continued forwards between the parotid gland and the guttural pouch; at the posterior border of the ramus of the lower jaw it becomes superficial, and ends on the face in the **subzygomatic plexus**, which it forms with branches from the 5th nerve.

The branches of the 7th nerve are divided into two groups, those given off in its passage through the aqueduct of Fallopius, and those given off after it has left the stylo-mastoid foramen.

I. **Intra-osseous Branches.**—1. The **Great Superficial Petrosal Nerve** leaves the geniculate ganglion and enters the cranium, passes through the cavernous sinus, receives a filament from the sympathetic plexus at this point, and then passes through the Vidian canal as the **Vidian nerve**, finally terminating by joining Meckel's ganglion.

2. The **Small Superficial Petrosal Nerve** arises close to the above, and terminates in the otic ganglion.

3. A small branch is contributed to the stapedius muscle.

4. The **Chorda Tympani Nerve** springs from the facial close to the stylo-mastoid foramen. It passes through the cavity of the tympanum, and leaves the bone by the Glaserian fissure; it finally joins the lingual branch of the 5th nerve.

5. An anastomotic branch joins the pneumogastric nerve.

II. **Extra-osseous Branches.**—6. The **Occipito-styloid Nerve** is a small branch supplying the structures below the basi-occiput.

7. The **Stylo-hyoid Nerve** supplies the muscle of that name.

8. The **Digastric Nerve** supplies the posterior belly of the digastricus.

9. The **Cervical Nerve** pierces the parotid gland, lies under the abducens aurem muscles, and terminates in the skin of the neck.

10. Branches to the parotid gland and guttural pouch are numerous.

11. The **Posterior Auricular Nerve** passes to the posterior part of the external ear.

12. The **Middle Auricular Nerve** pierces the base of the conchal cartilage, and supplies the interior of this cartilage.

13. The **Anterior Auricular Nerve** is much larger than the two preceding. It passes upwards in the substance of the parotid gland, winds round the zygomatic arch, and gains the deep face of the

attolens maximus muscle, and finally terminates near the inner canthus of the eye. It supplies the attolentes, corrugator supercilii, and orbicularis palpebrarum muscles, and forms the **anterior auricular plexus** by blending with branches of the 5th nerve.

The Auditory Nerve.

The 8th or auditory nerve springs from the medulla close to the origin of the 7th nerve, immediately to its outer side. Its origin is by two roots—anterior and posterior.

The **anterior root** arises from the restiform body, its fibres being traceable to the grey matter forming the floor of the 4th ventricle.

The **posterior root** also has its fibres springing from the floor of the 4th ventricle.

The 8th nerve enters the internal auditory meatus along with the 7th, and, gaining the internal ear, divides into **cochlear** and **vestibular branches**, destined for the cochlea and vestibule.

The Glosso-pharyngeal Nerve.

The 9th or glosso-pharyngeal nerve leaves the side of the medulla by two, three, or more small bundles. Its deep origin is from the grey matter of the floor of the 4th ventricle. The 9th nerve makes its exit from the cranium by the posterior part of the foramen lacerum basis cranii, at which point is situated the small **petrous ganglion**, or **ganglion of Andersch.**

The nerve now passes downwards and forwards upon the guttural pouch, behind the great hyoid cornu, and on the deep face of the digastric and stylo-hyoid muscles; gaining the base of the tongue, it enters that organ in company with the lingual artery. It terminates in the mucous membrane of the base of the tongue.

Its collateral branches are as follows:

1. The **Nerve of Jacobson** leaves Andersch's ganglion, enters the petrous temporal bone, and terminates in the tympanum.
2. Filaments are given off which communicate with the superior cervical sympathetic ganglion.
3. A branch is contributed to the carotid plexus.
4. The **Pharyngeal Branch** arises close to the pharyngeal artery, and passes to the walls of the pharynx.

The Pneumogastric Nerve.

The 10th, pneumogastric, or vagus nerve leaves the side of the medulla by a number of roots, some of which are sensory, others motor, the fibres of which spring from the grey matter of the medulla. It makes its exit from the cranium by the posterior portion of the foramen lacerum basis cranii, at which point it is provided with a ganglion—the **jugular ganglion.** It is then joined by the 11th nerve, a common cord of about one inch in length being thus formed. The 10th nerve now passes backwards and downwards behind the guttural pouch; crossing the occipital artery on the inside, it is joined by the cervical sympathetic nerve. The common cord is now applied to the upper border of the common carotid artery, this relationship being preserved to near the entrance to the thorax, at which point the two nerves separate.

The remainder of the course of the pneumogastric has been already mentioned (Part II., p. 75).

Collateral Branches.—1. Branches of communication join the superior cervical sympathetic ganglion.

2. The **Pharyngeal Nerve** arises at or near the point where the pneumogastric crosses the occipital artery. Passing forwards and downwards on the guttural pouch, related to the external carotid artery, it gains the walls of the pharynx, where it forms a plexus with the sympathetic and the pharyngeal branch of the 9th nerve. A branch descends to the œsophagus, supplying the cervical portion of that tube.

3. The **Superior Laryngeal Nerve** arises near the carotid trifurcation, and, passing over the pharynx, pierces the thyroid cartilage of the larynx close to its superior border. It supplies the mucous membrane of the larynx, and also branches which proceed to the pharynx, œsophagus and posterior part of the tongue. The **External Laryngeal Nerve** is a branch given off near the commencement of the superior laryngeal; this supplies the crico-thyroid and crico-pharyngeus muscles.

4. Branches of communication are given off at the entrance to the thorax, and proceed to the middle and inferior cervical sympathetic ganglia.

5. The **Inferior** (or **Recurrent**) **Laryngeal Nerves** arise within the thorax. The right has its origin on a level with the 1st rib; the left leaves the parent trunk at the root of the lungs (Part II., p. 75). They both gain the inferior border of the common carotid artery, and pass up the neck to the larynx.

The inferior laryngeal nerve supplies all the intrinsic muscles of the larynx with the exception of the crico-thyroid.

The Spinal Accessory Nerve.

The 11th or spinal accessory nerve arises by two sets of roots—spinal and medullary.

The **spinal roots** leave the lateral column of the spinal cord in the cervical region and form a nerve cord, which passes up the spinal canal between the superior and inferior roots of the cervical spinal nerves, and gains the cranium by the foramen magnum.

The **medullary roots** leave the side of the medulla oblongata and join the spinal nerve cord, the common trunk of the 11th nerve being so formed.

The 11th nerve leaves the cranium by the posterior part of the foramen lacerum basis cranii, where it is united with the 10th nerve for about an inch. After separation from the pneumogastric, the 11th nerve passes backwards upon the guttural pouch, crosses the deep face of the levator humeri obliquely, and so gains the upper border of that muscle, along which it runs to the lower part of the neck, where it is placed beneath the cervical trapezius, and terminates in the dorsal trapezius.

It gives branches to the superior cervical sympathetic ganglion, the submaxillary gland, the sterno-maxillaris, and cervical trapezius muscles. In its passage down the neck it is joined by branches from the 1st to the 6th cervical nerves inclusive.

The Hypoglossal Nerve.

The 12th or hypoglossal nerve arises by numerous roots from the inferior surface of the medulla at a line which is continuous with the line of origin of the inferior roots of the spinal nerves. It leaves the cranium by the condyloid foramen, is placed in the angle of divergence of the 10th and 11th nerves, and, passing downwards and forwards on the guttural pouch underneath the stylo-maxillaris, digastric and stylo-hyoid muscles, crosses the external carotid artery and the pharynx to gain the base of the tongue. It supplies motor in-influence to the muscles of the tongue.

Branches of communication pass to the superior cervical sympathetic ganglion and the 1st cervical nerve.

THE CERVICAL SPINAL NERVES.

The spinal nerves (eight in number), like the corresponding nerves of the trunk, leave the cord by two roots—superior or sensory, provided with a ganglion; and inferior or motor, which unite to form a common trunk, which after leaving the spinal canal divides into superior and inferior primary branches.

The first cervical nerve leaves the spinal canal by the antero-internal foramen of the atlas; the succeeding by their respective intervertebral foramina.

Superior Branches.

The **first** passes between the anterior oblique and the posterior straight muscles of the head, and divides into branches which supply these muscles, as well as the complexus major and retrahentes muscles of the ear. A branch passes to the posterior part of the ear, and, along with the posterior auricular branch of the 7th cranial nerve, forms the **posterior auricular plexus.**

The **second** is situated beneath the posterior oblique muscle, which it supplies, afterwards contributing superficial and deep branches to the muscles and skin in the upper part of the neck.

The remaining superior branches are distributed to the splenius, complexus major, trachelo-mastoideus, and semispinalis colli muscles, as well as the skin of the neck. The deep branches form the **deep cervical plexus.**

Inferior Branches.

The **first** passes through the antero-external foramen of the atlas, and accompanies the occipital artery between the lateral straight and the anterior oblique muscles of the head. It divides into branches of supply of the subscapulo-hyoideus, sterno-hyoid and sterno-thyroid muscles. Close to its origin branches for the anterior and lateral straight muscles of the head arise. Other filaments join the 12th cranial nerve and the superior cervical ganglion.

The **second** is situated beneath the posterior oblique muscle, supplying this muscle as well as the anterior straight muscles of the head, the levator humeri, and subscapulo-hyoideus. A branch passes upwards to the base of the external ear, and anastomotic filaments join the cervical part of the 7th cranial and the spinal accessory nerves and the inferior cervical ganglion.

The **third, fourth, fifth** and **sixth** nerves pierce the intertransversalis colli, and divide into superficial and deep branches.

The **sixth** sends a small branch to the brachial plexus.

Branches from the **sixth** and **seventh,** with a small inconstant filament from the fifth, form the **phrenic** or **diaphragmatic nerve.**

The **seventh** and **eighth** pass entirely to the brachial plexus, with the exception of small filaments which communicate with the sympathetic.

The superficial portions of the inferior branches form a **superficial cervical plexus.**

THE SYMPATHETIC NERVOUS SYSTEM.

The sympathetic system of the head and neck includes six ganglia—three associated with the 5th cranial nerve and three in the neck—and their associated afferent and efferent branches.

1. The Ophthalmic Ganglion.

This ganglion is also known as **lenticular** or **ciliary,** and is situated at the point of origin of the branch of the 3rd cranial nerve, which passes to the inferior oblique muscle of the eye. It is very small.

Its **afferent branches** are: (*a*) Motor, from the 3rd cranial nerve; (*b*) sensory, from the palpebro-nasal nerve; and (*c*) sympathetic, from the cavernous plexus.

The **efferent branches** are the **ciliary nerves**, which enter the eyeball by piercing the sclerotic, supply branches to the ciliary muscle and cornea, and terminate in the iris.

2. The Spheno-palatine (or Meckel's) Ganglion.

A small, grey, somewhat fusiform ganglion connected with the spheno-palatine nerve.

Its **afferent branches** are: (*a*) The Vidian nerve, which constitutes both motor and sympathetic roots; (*b*) sensory filaments from the spheno-palatine nerve.

Efferent branches proceed to the ocular sheath, muscles, etc., of the eye, the spheno-palatine, palatine and superior dental nerves.

3. The Otic (or Arnold's) Ganglion.

This name is given to a small ganglion situated at the commencement of the buccal nerve.

The **afferent branches** are: (*a*) Sensory, from the buccal nerve; (*b*) motor, the small superficial petrosal nerve; and (*c*) sympathetic, from the superior cervical ganglion.

Efferent branches are given off to the tensor palati, tensor tympani and pterygoid muscles, and the Eustachian tube.

4. The Superior Cervical Ganglion.

This is an elongated fusiform ganglion, situated, along with the internal carotid artery, on the guttural pouch.

Its **afferent branches** are derived from the last four cranial and the first cervical spinal nerves, the branches of these nerves going to the ganglion constituting the **guttural plexus.**

Efferent branches include : (*a*) Two filaments which accompany the internal carotid artery into the cranial chamber, and form the **cavernous plexus** within the cavernous sinus ; (*b*) numerous branches which pass to the pharynx and guttural pouch ; and (*c*) a thick cord which leaves the inferior part of the ganglion and, along with branches from the 9th and 10th cranial nerves, forms the **carotid plexus** at the carotid trifurcation.

Leaving the superior cervical ganglion is the cervical cord of the sympathetic, which early joins the pneumogastric and passes down the neck with it to the entrance to the thorax, where it becomes separate and terminates in the middle cervical ganglion.

5. The Middle Cervical Ganglion.

This ganglion is situated at the entrance of the thorax and beneath the 1st rib.

It receives a branch from the pneumogastric, contributes two or three cardiac nerves, and is joined to the inferior ganglion by a thick cord.

This ganglion is not constant.

6. The Inferior Cervical Ganglion

is situated upon the longus colli muscle in the angle formed by the superior cervical and vertebral arteries.

Afferent branches are: One formed by filaments derived from the 2nd, 3rd, 4th, 5th, 6th and 7th cervical nerves ; and others proceeding from the 8th cervical and 1st and 2nd dorsal nerves.

Efferent branches are chiefly cardiac.

This ganglion is connected posteriorly with the dorsal portion of the sympathetic nervous system.

THE EYE, ETC.

THE eye, the organ of vision, is lodged in the orbit, and is provided with certain accessory structures—the eyelids, the membrana nictitans, the lachrymal apparatus, and the muscles of the eyeball. In the recent state the orbit is shut off from the temporal fossa by the strong fibrous membrane known as the **ocular sheath.** The ocular sheath has a conical shape; its base is attached to the bones circumscribing the orbit anteriorly, and its apex to the bone surrounding the orbital hiatus.

We will consider first the accessory and protective parts of the eye, and afterwards the eyeball itself.

The Eyelids.

The **eyelids,** or **palpebræ,** are two musculo-membranous curtains—superior and inferior—which are placed in front of the eye, and find attachment to the rim of the orbit. The superior eyelid is larger and more movable than the inferior. The opening between the two lids is known as the **palpebral fissure,** and is terminated by the two **canthi,** or **commissures.**

The **internal** or **nasal canthus** is rounded, and within it may be observed the anterior part of the membrana nictitans, the **caruncula lachrymalis, and the two puncta lachrymalia.** The **external** or **temporal canthus** is acute.

Each eyelid presents *two surfaces, two borders* and *two extremities.*

The **outer surface** is convex, and covered by skin provided with short hairs.

The **inner surface** is smooth, concave and covered by conjunctiva—the delicate mucous membrane which covers the anterior part of the eyeball.

The **attached border** has a connection with the bones of the orbital rim.

The **free border** is sharp, and carries the **Meibomian glands,** small tubular glands, fifty to sixty in number in the upper lid, fewer in the lower, which open by small orifices along this border and secrete a fluid which prevents the lids sticking together. The **eyelashes** are stiff hairs arranged as a fringe on the free border of each lid.

Structure.—Each lid is covered by skin externally and conjunctiva internally. The free margin of the lid is stiffened by the so-called **tarsal cartilage,** on the inner face of which are the Meibomian glands.

The lids contain fibrous tissue and muscles.

Muscles—Orbicularis Palpebrarum.—This muscle is a sphincter, and therefore consists of circular fibres contained within the substance of the lids. Its only bony attachment is to the lachrymal tubercle of the lachrymal bone. The **palpebral tendon** is a fibrous cord placed beneath the orbicularis at the inner part of the eye; it is attached to the orbital rim.

Corrugator Supercilii.—This may be considered as a portion of the orbicularis. It passes from the external surface of the frontal bone, and blends with the orbicularis.

Levator Palpebræ Superioris.—Situated within the ocular sheath, this muscle has its origin from the upper part of the optic foramen; its insertion is by a flat tendon into the tarsal cartilage. Its action is to raise the upper lid.

Blood-supply.—Supra-orbital and lachrymal arteries and the orbital branch of the superior dental artery.

Nerve-supply.—The **sensory** nerves are derived from the supra-orbital and palpebro-nasal branches of the ophthalmic division, and from the orbital branch of the superior maxillary division of the 5th nerve. The **motor** nerves are supplied by the 3rd (levator palpebræ superioris) and 7th (orbicularis palpebrarum) cranial nerves.

The Membrana Nictitans.

The membrana nictitans, or third eyelid, is a thin plate of elastic cartilage, covered anteriorly by conjunctiva, and situated within the inner canthus. Its posterior part is thick, and connected with a pad of fat, which, when the eyeball is retracted, causes the membrana to be pushed over the front of the eyeball.

The **Harderian gland** is situated on the outer surface of the membrana nictitans, and is provided with numerous ducts which open to the exterior.

The Lachrymal Apparatus.

The lachrymal apparatus consists of a gland with its ducts, the caruncula lachrymalis, puncta lachrymalia, lachrymal canals, lachrymal sac, and the lachrymal duct.

The **Lachrymal Gland** is a small racemose gland situated beneath the orbital process of the frontal bone and above the eyeball, from which it is separated by the levator palpebræ superioris and the superior rectus muscles. It secretes the tears. Its ducts are numerous, and known as the **hygrophthalmic canals**; they open on the inner surface of the upper lid near the outer canthus.

The **Caruncula Lachrymalis** is a small rounded (usually pigmented) body, situated within the inner canthus. It contains mucous glands, and carries a few fine hairs.

The **Puncta Lachrymalia** are two small openings found on the inner surface of the lids near their free border, and at a short distance from the caruncula. They lead into the lachrymal canals.

The **Lachrymal Canals** are short, narrow tubes which proceed to the lachrymal sac.

The **Lachrymal Sac** is situated in the lachrymal fossa.

The **Lachrymal Duct**, or **Ductus ad Nasum**, leaves the lachrymal sac and enters the bony canal of the lachrymal bone. The anterior part of its course is beneath the nasal mucous membrane, and its lower orifice is near the outer commissure of the nostril.

The lachrymal canals, sac and duct are lined by mucous membrane, with stratified squamous epithelium, which is continuous on the one hand with the conjunctiva, and on the other with the delicate skin lining the nostril.

Muscles of the Eyeball.

The eyeball is moved by seven muscles—four recti, two oblique and a retractor.

The **Recti** are named from their respective positions —**superior, inferior, internal,** and **external.** They all arise from the margin of the optic foramen, and are inserted by thin, flattened tendons into the anterior part of the sclerotic.

The **Retractor Oculi** is placed within the recti, and is funnel-shaped, its fibres arising from the margin of the optic foramen and being inserted into the sclerotic. It surrounds the optic nerve.

The **Superior Oblique** (or **Trochlearis**) arises from above the optic foramen, and plays through a fibrous pulley on the inner wall of the orbit. It is inserted into the sclerotic between the superior and external recti muscles.

The **Inferior Oblique** arises from a small depression close to the lachrymal fossa, becoming inserted to the sclerotic between the inferior and external recti.

Action of the Muscles of the Eyeball.—The internal rectus adducts; the external rectus abducts; the inferior rectus turns the anterior part of the eyeball downwards, the superior turning it upwards. The retractor draws the eyeball backwards. The oblique muscles rotate the eyeball about an antero-posterior horizontal axis.

Nerve-supply of the Muscles of the Eyeball.—The 4th nerve supplies the superior oblique; the 6th nerve supplies the external rectus and the outer part of the retractor; the remaining muscles are supplied by the 3rd nerve.

THE EYEBALL.

The eyeball is provided with three coats and three refractive media. The coats are: (1) The **sclerotic** and **cornea**, protective in function; (2) the **choroid** and **iris**, vascular and pigmentary in character; and (3) the **retina**, a nervous coat.

The refractive media are: (1) The **aqueous humour**, (2) the **crystalline lens**, and (3) the **vitreous humour**.

The Sclerotic.

The sclerotic is the strong, white, fibrous membrane which forms the posterior five-sixths of the outer coat of the eye.

Externally it is in contact with the muscles of the eye, which are inserted into it. Its anterior part constitutes the 'white of the eye,' and has a portion of the conjunctiva attached.

Internally the sclerotic contacts the choroid, the two coats being joined by a delicate cellular layer—the **lamina fusca**.

The anterior part of the sclerotic presents a somewhat elliptical opening, into which the cornea fits.

At the posterior part are a number of openings, through which the fibres of the optic nerve pass; this area is known as the **lamina cribrosa**. One of the openings is larger than the rest, and is termed the **porus opticus**; it allows of the passage of the arteria centralis retinæ into the interior.

The thickest part of the sclerotic is about the lamina cribrosa.

Structure.—The sclerotic consists of white fibres, with some elastic fibres intermixed. These fibres are arranged in a longitudinal and circular manner. Flattened connective-tissue corpuscles, some of which contain pigment, are described.

Only few bloodvessels are found in this coat, and the presence of nerves is doubted.

The Cornea.

The cornea is the anterior, transparent and projecting portion of the outer coat. Like the opening in the sclerotic, into which it fits, its greatest diameter is transverse, and the junction of the cornea and sclerotic is likened to that of a watch-glass and its rim. At the corneo-sclerotic junction the circular venous **canal of Schlemm** is situated.

Structure.—Five layers are usually described:

1. The **anterior epithelium**, or **conjunctival layer**, consists of stratified squamous epithelium.

2. The **anterior elastic lamina**, or **Bowman's membrane**, is a very thin, structureless, elastic layer.

3. The **substantia propria** consists of tough layers of fibrous tissue, the layers running parallel to the free surface. Between the layers irregular spaces—**corneal spaces**—are found, and are said to contain irregular **corneal corpuscles**; the presence of these corpuscles has been denied.

4. The **posterior elastic layer**, or **Descemet's membrane**, is similar to the anterior elastic layer, but thicker.

5. The **posterior epithelium** consists of a single layer of polygonal cells continuous with those lining the remainder of the anterior chamber of the eye.

Except about the corneo-sclerotic junction, the cornea has no bloodvessels. The nerves are numerous, and form a **subepithelial plexus** beneath the anterior epithelium.

The Choroid.

The choroid is the thin, pigmented and vascular coat internal to the sclerotic, to which it is attached by the lamina fusca.

Its anterior margin is inflected to form the **ciliary processes**, more than a hundred in number, which rest internally upon the suspensory ligament of the lens, and are covered externally by the **ciliary muscle.**

The anterior extremity of each process is placed behind the iris and at the periphery of the lens.

Structure.—The **lamina supra-choroidea** is the outermost layer, and is continuous with the lamina fusca, and consists of lamellæ of elastic fibres, which are covered by endothelium and form spaces.

The **venæ vorticosæ** and the larger arteries form the second layer.

The **tunica Ruyschiana** contains the capillaries of the short ciliary arteries.

The **lamina vitrea** is the innermost structureless layer of the choroid, and is connected with the **stroma** of this coat. The stroma consists of connective tissue with branched corpuscles containing the pigment—**melanin.** The pigment is absent over a considerable surface—the **tapetum lucidum.**

The Iris.

The iris is the pigmented, circular muscular curtain situated in front of the lens. It is provided with a central elliptical opening—the **pupil**—which is closed in the fœtus by the transparent vascular **membrana pupillaris.**

The **anterior surface** of the iris is flattened or slightly convex.

The **posterior surface** is related with the capsule of the lens and the ciliary processes.

The **outer border** is connected to the corneo-sclerotic junction.

The **inner border** circumscribes the pupil, and has a variable number—usually two or three—of black bodies—**corpora nigra**—depending from its upper part.

Structure.—The **anterior epithelium** is a single layer of pigmented polyhedral cells continuous with the posterior epithelium of the cornea.

The **muscular tissue** consists of non-striped fibres arranged in two directions: (*a*) The **sphincter of the pupil** consists of circular fibres situated around the pupil; (*b*) the **dilator of the pupil** is composed of radiating fibres placed at the periphery, and blending internally with the sphincter.

The **posterior epithelium** consists of several layers of pigmented cells. It is also known as the **uvea,** and the corpora nigra are connected with it.

A **stroma** of connective tissue with branched pigmented cells forms a framework.

The **ciliary muscle** is a circular band of non-striped fibres placed behind the periphery of the iris, and arranged in **radiating** and **circular** sets. The radiating fibres pass from the sclerotic to the choroid and ciliary processes; the circular fibres are situated around the periphery of the iris.

The iris is supplied with blood by the long ciliary arteries, which form a circle at its periphery. The nerves are the ciliary, derived from the lenticular ganglion.

The Retina.

The retina is the most internal and essential coat of the eye. It is situated in the posterior chamber of the eye, and is produced by the expansion of the optic nerve. It becomes thinner as it passes forwards, and its nervous elements cease to exist at a wavy line—the **ora serrata**—an epithelial portion being continued forwards as the **pars ciliaris retinæ.**

The **outer surface** is attached to the choroid, and is covered by a layer of hexagonal pigment cells.

The **inner surface** contacts the vitreous humour, and presents a **papilla optica,** marking the position of commencement of expansion of the optic nerve.

Structure.—The following ten layers are described from within to without:

1. The **membrana limitans interna** is merely the inner limit of the supporting framework of the retina.

2. The **fibrous layer** consists of the radiating fibres of the optic nerve.

3. The **vesicular** or **ganglionic layer** consists of a single layer of branched nerve cells.

4. The **internal molecular layer** is composed of nerve fibres and granular material.

5. The **internal nuclear layer** contains nerve cells, chiefly bipolar.

6. The **external molecular layer**
7. The **external nuclear layer**

are similar to the internal layers of the same name.

8. The **membrana limitans externa** is similar to the inner limiting membrane.

9. The **layer of rods and cones** contains two kinds of nerve-endings—long rods and shorter cones.

10. The **pigmentary layer** is composed of hexagonal pigment cells.

The *framework* of the retina is formed by the **sustentacular fibres of Müller**, which radiate between the two limiting layers.

The *blood-supply* of the retina is from the arteria centralis retinæ.

The Refractive Media.

The **Aqueous Humour** fills the anterior part of the eyeball, and is an alkaline fluid consisting chiefly of water, with some salts, principally sodium chloride, in solution.

The **Crystalline Lens** is a solid, bi-convex body, having its posterior convexity greater than the anterior. It is placed immediately behind the iris, and is provided with a **capsule.** The **capsule of the lens** is a strong transparent membrane, forming anteriorly the posterior boundary of the aqueous humour chamber, and posteriorly contacting the vitreous humour. Peripherally the capsule is blended with the **suspensory ligament** of the lens. The suspensory ligament, a transparent membrane, is situated between the ciliary processes and the vitreous humour. The **canal of Petit** is the triangular interval bounded in front by the suspensory ligament, behind by the vitreous humour, and internally by the capsule of the lens.

Structure of the Lens.—In a fresh specimen the consistence of the lens is not uniform; its exterior is soft, its interior much harder.

A hardened lens is seen to consist of concentric laminæ, each lamina being composed of elongated **lens fibres** with serrated interlocking margins.

The adult lens is non-vascular. In the fœtus it is supplied with blood by a branch of the arteria centralis retinæ, which pierces the vitreous humour.

The Vitreous Humour.

The vitreous humour is the jelly-like material found in the posterior part of the eyeball. It is somewhat globular in form, but presents a depression anteriorly, into which the lens fits. It contains a delicate fibrous network, and is enclosed in the thin **hyaloid membrane** which blends with the capsule and suspensory ligament of the lens anteriorly. The **canal of Stilling** runs in the vitreous humour from the arteria centralis retinæ to the capsule of the lens; it is the remains of an artery which in the fœtus supplies the lens with blood.

The vitreous humour of the adult contains no bloodvessels.

THE EAR.

THE organ of hearing is divisible into three parts, viz., the **external**, the **middle**, and the **internal** ear.

The External Ear.

This comprises three cartilages (conchal, scutiform and annular), the muscles which move them, and the auditory process of the petrous temporal bone.

Cartilages.—1. The **conchal cartilage** is the trumpet-

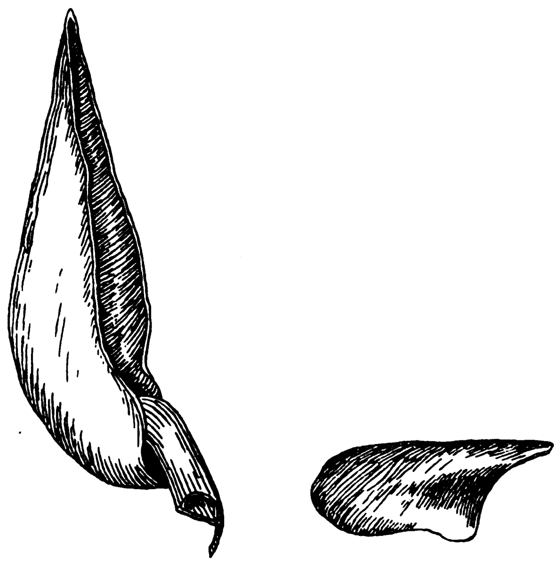

Fig. 12.—Conchal and Scutiform Cartilages of the External Ear.

like cartilage which projects from the general level of the head. Its external opening is somewhat elliptical, the upper part being pointed, owing to the borders of the cartilage meeting at an acute angle to form 'the tip of the ear.' The lower part of the cartilage is so rolled upon itself as to form a tube, which terminates below by becoming narrow and embracing the annular cartilage. A **styliform process** is projected downwards from the tube, and continued on to the surface of the guttural pouch by a fibrous appendage.

2. The **annular cartilage** is, as its name indicates, a ring-shaped cartilage, joining the conchal cartilage to the auditory tube of the petrous temporal bone. The annular cartilage embraces the auditory process, and is in its turn embraced by the tube of the conchal cartilage.

3. The **scutiform cartilage** is the thin, irregularly triangular plate of cartilage placed on the superficial face of the temporal muscle. Its base is concave, and situated in front of the base of the conchal cartilage.

All the cartilages of the external ear are composed of yellow elastic fibro-cartilage.

Muscles—1. **Attolens Anticus** (Zygomatico-auricularis, Temporo-auricularis).—Usually capable of being divided into two bundles.

It takes its *origin* from the zygomatic process of the squamous temporal bone, and finds *insertion* by its inferior slip to the base of the conchal cartilage, and by its superior slip to the scutiform cartilage.

Its *action* is to draw the ear forwards.

2. **Attolens Maximus** (Temporo-auricularis Externus, Parieto-auricularis Externus).—An extensive and thin muscle spread over the temporal muscle.

Its *origin* is from the parietal crest, and its *insertion* to the scutiform cartilage and the inner part of the conchal cartilage.

Its *action* is to adduct and draw forwards the ear, and also to turn the opening forwards.

3. **Attolens Posticus** (Temporo-auricularis Internus, Parieto-auricularis Internus).—A triangular muscle placed beneath the attolens maximus.

Its *origin* is from the posterior part of the parietal crest, and its *insertion* to the inner aspect of the concha.

Its *action* is to adduct the ear.

4. **Cervico-auricularis** (Retrahentes Aurem — Externus, Medius and Internus).—A series of three muscles situated behind the ear.

They have a common *origin* from the ligamentum nuchæ.

Their *insertion* varies as follows: The **externus** finds attachment to the internal face of the concha; the **medius** towards the outer side of the base of the concha; and the **internus** to the posterior face of the base of the concha.

Actions.—The externus draws the ear downwards and backwards; the medius turns the opening outwards and backwards; the internus assists the medius.

5. **Scuto-auricularis Externus** (Anterior Conchæ).—This consists of two thin bundles of fibres, which pass between the external surface of the scutiform cartilage and the conchal cartilage.

Its *action* is to turn the opening forwards.

6. **Scuto-auricularis Internus** (Posterior Conchæ).—This muscle is formed by two distinct bundles of fibres arranged in a cruciform manner. It is situated beneath the scutiform cartilage.

Its *origin* is from the inner surface of the scutiform cartilage, its *insertion* being to the posterior part of the base of the concha.

Its *action* is to turn the opening outwards and backwards.

7. **Parotido - auricularis** (Abducens or Deprimens Aurem).—This is a broad, thin, strap-like muscle, placed on the outer surface of the parotid gland, from which it takes its *origin*.

The *insertion* is to the outer part of the base of the concha.

Its *action* is to abduct the ear.

8. **Mastoido-auricularis.**—This term is applied to a small bundle of fibres *arising* from the auditory process to its inner side, and *inserted* into the base of the conchal cartilage.

Its *action* is to shorten the tube of the external ear.

A pad of adipose tissue is always found embracing the anterior, inner and posterior aspects of the base of the concha, and facilitating its movements.

Blood-supply.—The anterior and posterior auricular arteries.

Nerve-supply.—The posterior, middle and anterior auricular branches of the 7th cranial nerve, branches from the 1st and 2nd cervical spinal nerves, and a branch from the lachrymal nerve.

The Middle Ear.

The middle ear, or tympanum, is an irregular cavity in the petrous temporal bone.

Two walls and a *circumference* may be described.

The **external wall** is formed chiefly by a thin membrane—the **membrana tympani**—which is fixed to a rim of bone at the bottom of the external auditory meatus, and is encircled by the cavities of the mastoid cells. The inner surface of the membrana tympani is slightly convex, and has the handle of the malleus attached; this surface, in addition to looking inwards, also looks slightly upwards. The external surface of the membrana is slightly concave, and looks towards the external auditory meatus; in addition it also looks slightly downwards. The membrana tympani is composed of three layers: (1) A middle fibrous layer, formed by both radial and circular fibres; and (2 and 3) outer and inner epithelium.

The **internal wall** of the tympanum is formed by the petrous temporal bone, and presents the following objects: A superior opening, the **fenestra ovalis**, into which the foot or base of the stapes fits; an inferior opening, the **fenestra rotunda**, closed by a thin membrane — the **membrana tympani secundaria**; and a rounded projection, the **promontory**, between the two openings.

The **circumference**: The posterior and part of the lower portions have openings which communicate with the **mastoid cells**. The anterior extremity is continued into the Eustachian tube.

The Auditory Ossicles.—The tympanum contains a chain of bones stretching from the outer to the inner wall.

The **Malleus**, the most external and largest bone, is so named from its resemblance to a hammer. It presents a *head*, a *handle* and *two processes*. The **head** looks upwards, and articulates with the incus by a synovial joint. The **handle** is adherent to the inner face of the membrana tympani. The **processes** are distinguished as **long** and **short**: the former points forwards and is received into a slit in the petrous temporal bone; the latter is very short, and attached to the membrana tympani.

The **Incus** somewhat resembles an anvil. It possesses a *body* and *two processes*. The **body** articulates with the head of the malleus. The **long process** points inwards and downwards, and articulates with the stapes; its articular extremity is sometimes described as a separate ossicle—the **os orbiculare**. The **short process** points backwards, and is fixed to the wall of the tympanum.

The **Stapes** resembles a stirrup, and presents a *head*, a *neck*, *two crura*, and a *base*. The **head** articulates with the incus. The **neck** is the slight constriction succeeding the head. The **crura** diverge from the head, and are attached to the extremities of the base. The **base** is an oval flattened plate fitting into the fenestra ovalis.

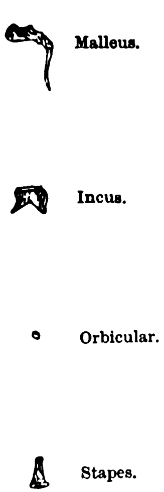

FIG. 13.—THE AUDITORY OSSICLES.

The auditory ossicles are acted upon by two **muscles**:

1. The **tensor tympani** has its *origin* from the petrous temporal bone, close to the Eustachian opening. It is *inserted* near the root of the handle of the malleus. Its *action* is to tense the membrana tympani.

2. The **stapedius** *arises* from the interior of a process of bone—the **pyramid**—situated at the posterior part of the tympanum, and is *inserted* into the neck of the stapes. Its *action* is to regulate the vibrations of the stapes.

The tympanum is lined by a delicate **mucous membrane**, continuous with that of the pharynx, through the Eustachian tube.

Blood-supply.—The tympanic branch of the internal maxillary artery.

Nerve-supply.—The tympanic branch of the 9th cranial nerve is the sensory nerve. The 7th and 5th cranial nerves supply the stapedius and tensor tympani muscles respectively.

Intimately connected with the tympanum is the **Eustachian tube** and its diverticulum, the **guttural pouch.**

The **Eustachian Tube** is a fibro-cartilaginous tube connecting the tympanum with the interior of the pharynx. Nearly the whole of its outer border is occupied by a slit, which opens into the guttural pouch. The anterior or pharyngeal opening is an oblique slit opening on a level with the posterior nares, the end of the cartilage projecting on its outer side.

The **Guttural Pouch** is the large membranous cavity situated between the base of the cranium and the pharynx. The great hyoid cornu forms part of its lateral boundary, the pouch slightly overhanging this bone. The two pouches meet in the mesial plane, their cavities being separated by a thin partition formed by their united walls. The guttural pouch is lined by mucous membrane continuous, through the Eustachian tube, with that of the pharynx, and, like the tympanum and Eustachian tube, its cavity is filled with air.

The Internal Ear.

The internal ear, or labyrinth, is the essential part of the organ of hearing, inasmuch as within it the auditory nerve terminates. It is divided into an **osseous labyrinth,** consisting of excavations in the petrous temporal bone; and a **membranous labyrinth,** formed by soft structures, and contained within the osseous labyrinth.

The **Osseous Labyrinth** is divided into the **vestibule,** the **semicircular canals** and the **cochlea.**

The **Vestibule** is the cavity from which the other portions of the labyrinth may be said to radiate—the cochlea anteriorly, the semicircular canals posteriorly. It is placed between the internal wall of the tympanum and the internal auditory meatus.

Its **outer wall** contains the fenestra ovalis.

The **inner wall** shows a small depression, the **fovea hemispherica,** in which is an area perforated by small holes for the passage of the filaments of the auditory nerve. At the posterior part of the inner wall is an orifice which leads into the **aqueductus vestibuli.**

In **front** the vestibule communicates with the cochlea; **behind,** with the semicircular canals (by five openings).

The **roof** presents the **fovea hemi-elliptica**, an elongated depression.

The **Semicircular Canals**, three in number, and known as **superior, posterior** and **external**, open into the vestibule by five orifices. Each canal presents a dilatation, or **ampulla**, at one of its ends. The three ampullated ends open into the vestibule separately, but the non-ampullated ends of the superior and posterior canals open by a common orifice.

The **Cochlea**, so called from its resemblance to a snail's shell, is situated in front of the vestibule. It consists of a conical central axis, the **modiolus**, around which a tapering tube is wound two and a half times.

A delicate lamina of bone—the **osseous lamina spiralis**—projects about halfway into the tube, which is thus imperfectly divided into two portions—the **scala tympani** and the **scala vestibuli.** These are the parts of the osseous cochlea, but it is convenient to describe the membranous parts also at this point.

A thin membrane, known as the **basilar membrane**, stretches across from the free margin of the osseous lamina spiralis to the opposite wall of the cochlea, to which it is attached by the **spiral ligament.** A second membrane, **Reissner's membrane**, thinner than the first, extends from a ridge—the **crista spiralis**—on the free margin of the osseous lamina spiralis, and is attached to the outer wall of the cochlea a short distance above the point of attachment of the basilar membrane. In this way the cavity of the cochlear tube is divided into three smaller tubes, which are known as the **scala tympani**, the **scala vestibuli**, and the **scala media.**

The scala tympani begins at the fenestra rotunda and passes up to the apex of the cochlea, where it is continuous with the scala vestibuli through a small orifice known as the **helicotrema.**

The scala vestibuli, the second in point of size, communicates at the apex of the cochlea with the scala tympani, but at the base it opens directly into the vestibule.

The scala media, the membranous cochlea, is the smallest of the three scalæ. It terminates blindly at the apex of the cochlea; at the base it is placed in communication with the sacculus by the small **canalis reuniens.**

The scala media contains the **organ of Corti.** On looking at the basilar membrane from the scala media side, a spirally-winding papilla—the **papilla spiralis**—will be seen extending all the way from the base to the apex. On making a transverse section, this papilla is found to consist of two rows of rod-like cells—the **rods of Corti**—the lower extremities of which are placed on the basilar membrane, the upper extremities meeting so as to form a small, somewhat triangular canal, the **canal of Corti.** External to the outer rods four or five rows of shorter cells are observed, each cell terminating at its free extremity in a bunch of hair-like processes. Internal to the inner rods a single layer of similar cells will also be observed. These **hair-bearing cells** give place to **supporting cells,** which gradually become shorter, and are continuous with the cells lining the interior of the scala media.

The **membrana reticularis** is a very delicate membrane spread over the outer hair-bearing cells, and provided with holes through which the bundles of hair-like processes protrude.

The **membrana tectoria** is another delicate membrane spread over the organ of Corti, and attached to the free margin of the osseous lamina spiralis.

The **Membranous Labyrinth** consists of a **vestibular portion**, comprising **two sacs**—the **utricle** and **saccule**—the **semicircular canals**, and the **scala media** of the cochlea.

The **Utricle** lies in the fovea hemi-elliptica, and communicates by five openings with the membranous semicircular canals.

The **Saccule** is smaller than the utricle, and is situated in the fovea hemispherica, and communicates with the scala media by means of the narrow **canalis reuniens.**

The saccule and utricle communicate indirectly with each other through a Y-shaped tube, the **ductus vestibuli**, which ends in the aqueductus vestibuli by a blind extremity.

Both saccule and utricle are provided in their interior with an elevation known as the **macula acoustica**, on which are found hair-bearing cells.

The membranous **Semicircular Canals** are similar in disposition to the osseous canals, to the interior of which they are moored by numerous fibrous bands. The ampulla of each of these canals is provided in its interior with a ridge (crista acoustica) similar to the elevations found in the saccule or utricle.

The term **Perilymph** is applied to a fluid found between the osseous and membranous labyrinths.

The **Endolymph** is a similar fluid filling the interior of the membranous labyrinth.

The **Otoliths** are minute calcareous particles suspended in a jelly-like substance over the cristæ and maculæ acousticæ.

Nerve-supply of the Internal Ear.—The 8th or auditory nerve divides into **cochlear** and **vestibular** branches. The cochlear branch pierces the modiolus and passes outwards in the osseous lamina spiralis, to end in the hair-bearing cells of the organ of Corti. The vestibular branch terminates in the saccule and utricle and in the ampullæ of the membranous semicircular canals.

THE HEAD AND NECK OF THE OX, SHEEP, PIG AND DOG.

THE SKULL.

Ruminant.

Occipital Bone.—In the ox this does not form the highest point of the skull. The occipital crest is represented by a curved line, and the occipital protuberance is not prominent. The basilar process is shorter and broader than in the horse, and presents two well-marked eminences anteriorly for muscular attachment. The styloid processes are shorter and more incurved than in the horse. The condyloid foramen is double; the upper foramen leads to a canal which, running obliquely upwards, opens into the cranium close to the posterior end of the parieto-temporal canal.

If the skull of the sheep be viewed from its upper surface, the occipital bone is seen, forming a somewhat thick and rough occipital crest.

Interparietal Bone.—This bone early fuses with the supra-occipital and parietals, and does not form an ossific tentorium.

Parietal Bones.—The parietal bones are confined to the posterior part of the skull; each is represented by a transversely elongated plate of bone bent at a right angle, so that the external surface is divided into two parts by a ridge. One area looks directly backwards, and might be called the nuchal surface; the other helps to form the temporal fossa. The two bones early fuse together; they do not help to form the parieto-temporal canal. The frontal air sinus is prolonged backwards into the parietal bone of the ox, but this is not the case in the sheep, in which animal also the parietal takes part in the formation of the parieto-temporal canal.

Frontal Bone.—This bone is very large and of considerable thickness. The two frontal bones form the whole of the roof of the cranium. The **horn core**, or **flint**, is a curved rough process from the supero-external angle of the frontal bone; it supports the horn, and is hollow, its interior being occupied by a number of irregular cavities continuous with the frontal air sinus. The bases of the horn cores are connected by a prominent blunt ridge. The supra-orbital foramen is placed nearer the middle line of the head than in the horse, and there is a groove running upwards and downwards from it. In the sheep this groove only runs downwards. The supra-orbital process is short and relatively weak; it articulates with the malar bone. The internal orbital foramen is formed by the frontal bone alone. The frontal air sinus is very extensive, being prolonged into the parietal, interparietal and (sometimes) occipital bones. The frontal does not articulate with the palatine or temporal bones.

The frontal bone of the sheep is not as prominent as in the ox.

Temporal Bone.—This bone is not divisible into two distinct parts. The zygomatic process articulates with the malar only. The condyle is more extensive, the glenoid cavity less deep, than in the horse. The parieto-temporal canal is entirely formed by this bone. The mastoid process of the petrous temporal of the horse is represented by an obtuse projection at the superior root of the zygoma. Both mastoid crest and process of the petrous portion are absent. The hyoid process is small, and concealed by the vaginal process. The foramen lacerum basis cranii is small, due to encroachment of the auditory bulla. The styloid process is better developed than in the horse. The auditory process projects outwards.

Sphenoid Bone.—The pituitary fossa is deeper than in the horse, and bounded posteriorly by irregular **posterior clinoid processes.** A large **foramen ovale** takes the place of the notches for the spheno-spinous artery and the inferior maxillary division of the 5th cranial nerve. The subsphenoidal processes are large, but thin. There is no subsphenoidal canal. The pathetic, round and lacerated orbital foramina are represented by a single large foramen.

The sheep has no sphenoidal air sinus.

Ethmoid Bone.—The lateral masses are very large, and are sometimes regarded as third turbinated bones.

Nasal Bone.—The two nasal bones are not firmly articulated with each other; their posterior extremities fit into a notch formed by the frontal bones. The anterior extremity of each bone is notched, and thus the nasal peak is trifid.

In the sheep the bones are even more loosely attached to each other and their neighbours, there being a narrow fissure between them and the supermaxillary and premaxillary bones. In this animal the nasal peak is single, as in the horse.

Lachrymal Bone.—The facial area is more extensive than in the horse, and in the sheep it is distinctly concave. There is no lachrymal tubercle. The orbital part forms a large **lachrymal protuberance,** which is formed by a very delicate plate of bone, and has the maxillary sinus prolonged into it.

Malar Bone.—The posterior extremity of this bone is bifid, one portion joining the supra-orbital process of the frontal bone, the other the zygomatic process of the temporal. The facial area is more extensive than in the horse.

Superior Maxilla.—There is no zygomatic ridge; it is represented by a blunt eminence. The infra-orbital foramen is on a level with the 1st premolar tooth. The palatine plate has the maxillary air sinus prolonged into it, and does not help to form the palatine foramen. The maxillary protuberance is absent. The superior maxilla forms less of the hard palate than in the horse. There is no canine alveolus.

The superior maxilla of the sheep assists in the formation of the palatine canal.

Premaxilla.—The body is compressed from above to below, and does not form alveoli for teeth. The bodies of the two bones do not meet in the middle line, and consequently the incisor foramen is represented by a space. The incisor opening is very wide.

Palatine Bone.—This bone is much larger than in the horse, forming almost one-third of the hard palate. It forms the whole of the palatine canal. There are usually a few accessory palatine foramina. It does not form part of the sphenoidal air sinus, but the maxillary sinus is continued into its palatine process in the ox (this is not the case in the sheep). The spheno-palatine foramen is large.

Pterygoid Bone.—This is well developed; the two bones form nearly the whole of the lateral boundaries of the posterior nares.

Vomer.—It articulates with the anterior part of the superior maxilla only, so that there is a large interval posteriorly between its inferior border and the superior maxilla.

Turbinated Bones.—The superior bone is small, the inferior large. The frontal sinus is prolonged into the superior bone, but the inferior bone does not communicate with the maxillary sinus.

Inferior Maxilla.—The two halves of the body unite late in life. The alveolar edge of the body carries eight teeth. The inferior border of the ramus is distinctly convex. The condyle is convex from before to behind, concave from side to side. The coronoid process is long, and curved backwards more than in the horse.

Hyoid Bone.—Epi-hyals are always present, and almost as long as the kerato-hyals. The glosso-hyal is short and obtuse. The thyro-hyals are usually separable from the body.

In the sheep the glosso-hyal is either very rudimentary or wanting.

Pig.

Occipital Bone.—This forms the highest point of the skull. The occipital crest is prominent, and two ridges are prolonged downwards from its extremities to the foramen magnum. The occipital protuberance is absent. The foramen magnum is triangular. The styloid processes are well developed, and point straight downwards. The basilar process is somewhat triangular, with a truncated apex pointing forwards. The condyloid foramen is single.

Interparietal Bone.—Absent.

Parietal Bone.—Somewhat resembles that of the ruminant in shape, its external surface being divided into two portions by a prominent concave ridge. The two bones fuse together early. There is no parieto-temporal canal. The frontal air sinus is prolonged into the parietal, and even into the supra-occipital bone.

Frontal Bone.—This bone is relatively larger and stronger than in the horse. The supra-orbital process is imperfectly developed, and does not meet the zygomatic arch. The supra-orbital foramen is situated on a level with the lower boundary of the orbit, and a groove passes downwards from it. The internal orbital foramen is formed by this bone alone. The frontal articulates with the superior maxilla.

Temporal Bone.—This cannot be divided into two portions. The articular surface for the inferior maxilla is extensive, and there is no post-glenoid process. The zygomatic process fits into a notch in the zygomatic process of the malar bone. The mastoid process is very small. The auditory process is long, and projects for a considerable distance upwards. The auditory bulla encroaches considerably upon the foramen lacerum basis cranii. The styloid process is very rudimentary. The hyoid process is situated in a deep depression.

Sphenoid Bone.—This bone is short; its sella turcica is deep and provided with posterior clinoid processes. The subsphenoidal processes are large and strong, and flattened from before to behind. There is no subsphenoidal canal. A single foramen represents the pathetic, round and lacerated orbital foramina. The orbital processes articulate with the frontal bones by sutures.

Ethmoid.—The lamina papyracea appears in the orbit between the palatine, superior maxilla and sphenoid, forming the **Os Planum.**

Nasal Bone.—This is long, strong, and firmly joined to its fellow and neighbours. The nasal peak is single. The external surface presents a groove continuous with that on the frontal bone.

Os Rostri or Prenasal Bone.—This is a nodule of bone developed in the anterior part of the cartilaginous septum nasi.

Lachrymal Bone.—The facial portion is large and presents two openings, the osseous lachrymal canals.

Malar Bone.—This bone has a small facial portion. The zygomatic process is very strong, and notched posteriorly for the reception of the zygomatic process of the temporal bone. It does not articulate with the frontal bone.

Superior Maxilla.—This is large. Its facial surface is concave. The zygomatic crest is rudimentary. The infra-orbital foramen is large, and situated about the middle of the facial surface. There are seven alveoli for cheek-teeth, and one for the canine. A rough tuberosity surmounts the canine alveolus. The maxillary protuberance and alveolar tuberosity are absent. The palatine plate is extensive, being broadest opposite the canine teeth; it forms the whole of the palatine foramen. The maxillary sinus is small. The superior maxillary and dental foramina are large; the spheno-palatine foramen is small. The superior maxilla articulates with the frontal bone.

Premaxilla.—This bone is strong and well developed. The nasal process is large and strong, and contracts an extensive articulation with the nasal bone. The incisor foramen is represented by an interval between the bodies of the two bones. The incisor openings are oval in shape.

Palatine Bone.—The palatine process is extensive, but does not form, or help to form, the palatine foramen. A tuberosity, against which the hamular process of the pterygoid rests, represents the palatine crest. It does not articulate with the frontal bone.

Pterygoid Bone.—The hamular process, with the sub-sphenoidal process and the tuberosity of the palatine bone, form a trifid tuberosity.

Vomer.—This bone is well developed and has an extensive articulation with the hard palate.

Turbinated Bones.—Much stronger and (relatively) longer than in the horse. The inferior bone is better developed than the superior.

Inferior Maxilla.—This bone is both large and strong. Its two halves are early and firmly united. There are seven alveoli for cheek-teeth. Several foramina take the place of the mental foramen. The condyle is distinctly convex in both directions. The coronoid process is small, and its summit is about on a level with the condyle.

Hyoid Bone.—The glossal process is absent. The kerato-hyals are short. The epi-hyals are represented by yellow elastic ligaments. The stylo-hyals are curved and imperfectly ossified.

Dog.

Occipital Bone.—A prominent occipital crest is formed. The styloid processes are short, and might be designated the **Jugular Eminences.** The basilar process is short and ridged mesially; the auditory bulla touches its margins, and thus the foramen lacerum basis cranii is much modified, being divided into two parts—the **Foramen Lacerum Posterius** posteriorly, and the **Foramen Lacerum Medium** anteriorly. A short venous canal is also formed between the auditory bulla and the basilar process; this canal opens posteriorly into the foramen lacerum posterius, and anteriorly into the cranium.

Interparietal Bone.—This bone early fuses with the supra-occipital. The ossific tentorium is large, but the parietal bones assist materially in its formation.

Parietal Bone.—The outer surface is chiefly concerned in the formation of the temporal fossa, the depth of which is greatly added to in some breeds of dog by a very prominent sagittal crest. The parieto-temporal canals are prolonged into the ossific tentorium, and are there continuous with each other.

Frontal Bone.—The supra-orbital process is very small, and the foramen of the same name is absent. The internal orbital foramen is formed entirely by this bone. The frontal of the dog articulates with the superior maxilla.

Temporal Bone.—A separation into two portions cannot be made. The zygomatic process forms a deep curve, and articulates with the malar, but not with the frontal bone. The condyle is absent. The post-glenoid process is large, and assists in the formation of an extensive glenoid cavity. The auditory process is short, the external auditory meatus large. The styloid and hyoid processes are short. The auditory bulla is large, and meets the basilar process of the occipital. The **Carotid Canal** perforates the inner part of the auditory bulla, running from the foramen lacerum posterius to the foramen lacerum medium.

Sphenoid Bone.—The pituitary fossa is deep, and bounded anteriorly and posteriorly by the anterior and posterior clinoid processes. A foramen ovale is present corresponding to that of the ox. A subsphenoidal canal is present.

Ethmoid Bone.—This bone is very large. The crista galli process is rather rudimentary. The olfactory fossæ are deep. The lateral masses are large.

Nasal Bone.—This, as all the facial bones, differs in different breeds. It is relatively short, and usually the anterior extremity is wider than the posterior. The nasal peak is replaced by a notch formed by the concave extremities of the two bones.

Lachrymal Bone.—This bone is almost entirely confined to the orbit, its facial portion being very small. It does not articulate with the nasal, but always with the palatine bone.

Malar Bone.—This consists almost entirely of a zygomatic portion. It does not articulate with the frontal bone.

Superior Maxilla.—The facial portion is relatively extensive, and articulates with the frontal bone. The zygomatic ridge is absent. The infra-orbital foramen is large. The palatine plate is small, and helps to form the palatine foramen. The alveolar tuberosity is absent. A large alveolus for the canine tooth is partially formed by the superior maxilla. The maxillary sinus is small.

Premaxilla.—The body is strong. The palatine process is short, but strong. The incisor foramen is usually absent. The incisor opening is oval in outline.

Palatine Bone.—A relatively large bone. Two or three accessory palatine foramina pierce the palatine process. The sphenoidal air sinus is not prolonged into this bone.

Pterygoid Bone.—This bone may be described as a four-sided plate of bone. It is relatively strong, and more firmly attached in its place than in the horse.

Vomer.—Not so easily seen on examination of the entire skull.

Turbinated Bones. — These bones are richly convoluted. They do not assist in the formation of the frontal or maxillary air sinuses.

Inferior Maxilla.—The two halves of this bone do not fuse together until comparatively late in life. Several mental foramina are present. The external surface of the ramus is distinctly concave for the attachment of the masseter. The 'angle of the jaw' is marked by a strong, rough tubercle. The condyle is much elongated transversely. The sigmoid notch is shallow. The coronoid process is developed into a large, strong quadrangular plate.

Hyoid Bone.—The glossal process is absent. The epi-hyals are very large. The thyro-hyals do not fuse to the body.

THE CERVICAL VERTEBRÆ.

Ruminant.

General Characters.—The centra are shorter than in the horse. The transverse processes consist of two portions, an upper tuberous and a lower plate-like. The anterior and posterior articular processes are connected by a prominent ridge. The neural spines increase in length from the 2nd to the 7th.

Atlas.—The posterior foramen is absent. The wings are only slightly oblique in direction. The superior spine is represented by a rough tuberosity. The posterior facets for the axis are flattened and joined inferiorly; superiorly they are separated by three notches.

Axis.—The centrum is shorter than in the horse. The odontoid process is hollowed out on its upper face, and its apex is blunt, or even notched. The facets for articulation with the atlas are continuous beneath the odontoid process. The neural spine is single. The foramen representing the anterior notch is placed farther back than in the horse.

7th.—The neural spine is very long; the inferior spine is absent.

Pig.

General Characters.—The centra are short, and their extremities flatter than in the horse. The transverse processes consist of two parts, as in the ruminant. The anterior articular process is connected with the tubercular part of the transverse process by a ridge of bone pierced by a supernumerary foramen. The superior spines are acute, the inferior spines wanting.

Atlas.—A very short bone, with wings almost horizontal. The posterior foramen pierces the posterior border of the wing.

Axis.—The centrum is short. The odontoid process is conical and short, and its articular surface is separated from the facets at its base. The superior spine is simple. The transverse processes are small, and the vertebrarterial foramina large.

7th.—The neural spine is long.

Dog.

General Characters.—Similar to the corresponding bones of the horse, except that the extremities of the centra are more flattened and the neural spines longer.

Atlas.—A very short bone, with no representative of a neural spine. The wings project outwards and backwards. The place of the antero-external foramen is taken by a notch on the anterior border of the wing.

Axis.—A relatively long bone. The odontoid process is conical, with a blunt apex; the facets at its base are convex, and look forwards and outwards. The neural spine is large and projects forwards, so that its anterior extremity is placed above the ring of the atlas. The anterior notch is not represented by a foramen.

7th.—The neural spine is as long as that of the 1st dorsal vertebra.

ARTICULATIONS.

Ruminant.

Temporo-maxillary Articulation. — The movements are freer than in the horse.

Ligamentum Nuchæ.—This is stronger than in the horse. The anterior part of the lamellar portion is attached to the 2nd, 3rd and 4th cervical neural spines, the posterior part finding attachment to the 1st dorsal neural spine and the funicular portion, and ending on the last three cervical spines.

Pig.

Temporo-maxillary Articulation.—The pig has the power of protraction and retraction of the lower jaw, but lateral movements are limited.

The **Ligamentum Nuchæ** is very rudimentary, being only represented by a thin fibrous cord.

Odontoid Ligament.—This is divisible into right and left portions. A **transverse ligament** passes across the upper face of the odontoid process, a synovial bursa being interposed between the two structures.

Occipito-atloid Articulation.—There is only one synovial membrane.

Dog.

Temporo-maxillary Articulation.—The meniscus is thin and the posterior ligament absent. Movements are restricted to elevation and depression.

The **Ligamentum Nuchæ** is represented by a rudimentary funicular portion.

The **Interspinous Ligaments** are replaced by muscles.

The **Odontoid** and **Transverse Ligaments** are similar to those of the pig.

Occipito-atloid Articulation.—There is only one synovial membrane, and it is prolonged backwards to communicate with the joint behind.

MUSCLES.

Ruminant.

The **Zygomaticus** is large, and arises from the zygomatic arch.

The **Levator Communis** is present in the large ruminant, its anterior portion covering the dilatator naris lateralis. This muscle is not found in the small ruminants.

The **Dilatator Naris Lateralis** is the only dilator of the nostril, and is accompanied by two accessory muscular bundles, which terminate in the upper lip.

The **Lachrymalis** is larger and stronger than in the horse.

The **Frontalis** is a thickened portion of the facial panniculus, and extends from the base of the horn-core to the upper eyelid.

The **Masseter** and **Temporalis** are smaller than in the horse.

The **Pterygoidei** arise nearer the middle plane of the head.

The **Digastricus** has only one fleshy belly, and this is joined to its fellow by a thin, quadrangular, transverse muscle.

The **Hyoideus Magnus** forms no sheath for the middle tendon of the digastricus.

The **Sterno-suboccipitalis** represents the sterno-maxillaris of the horse, and is inserted to the basi-occiput along with a tendon of the levator humeri.

The **Levator Humeri** is divided into two portions—superficial and deep. The **superficial** terminates superiorly in two parts: (*a*) The **Clavicular portion of the Trapezius**, attached to the mastoid process, occipital crest and ligamentum nuchæ; (*b*) the **Cleido-mastoideus**, joining the tendon of the sterno-sub-occipitalis. The **deep** portion is attached to the wing of the atlas, its tendon being distinct from those of the splenius and trachelo-mastoideus.

The **Sterno-thyro-hyoideus** is not digastric.

The **Trachelo-atloideus** covers the great anterior straight muscle of the head. It arises from the 6th cervical vertebra, and is attached to the 5th, 4th, 3rd, and 2nd, and finally to the atlas.

Pig.

The **Lachrymalis, Levator Communis** and **Dilatator Naris Transversus** are absent.

The **Digastricus** has only one fleshy belly.

The **Cervical Panniculus** is divided into two portions: An inferior one, arising from the sternum; and a superior one, from the external scapular region. These parts unite anteriorly and expand over the face.

The **Levator Humeri** is divided, the inferior portion being attached to the occipital protuberance and mastoid process, and the superior to the wing of the atlas.

The **Sterno-thyroideus** is double.

The **Scalenus** passes backwards to the 3rd rib.

The **Longus Colli** may be divided into right and left muscles.

Dog.

The **Orbicularis Oris** and **Buccinator** are thin.

The **Zygomaticus** is blended with the attollens anticus.

The **Levator Labii Superioris** has no nasal portion.

The **Dilatator Naris Lateralis** is the only dilator of the nostril, and is blended with the **Nasalis Longus.**

The **Stylo-hyoideus** arises from the mastoid portion of the temporal bone.

The **Rhomboideus Longus** is divided anteriorly.

The **Oblique** and **Posterior Straight Muscles of the Head** are very large.

The **Cervical Panniculus** is divided as in the pig, but is thicker. Its superior portion passes over the parotid gland on to the face and into the submaxillary space.

The **Levator Humeri** is similar to that muscle of the pig.

The **Sterno-mastoideus** represents the sterno-maxillaris.

The **Sterno-thyro-hyoideus** is not digastric.

The **Subscapulo-hyoideus** is absent.

The **Longus Colli** is divisible into right and left portions.

The **Scalenus** reaches the 8th rib.

THE ALIMENTARY SYSTEM.

Ruminant.

I. **Mouth.** — The **Lips** are very thick and possess little mobility. The **upper lip** is blended with the **muffle** or **muzzle,** a large patch of hairless skin common to the lip and nostrils. The muffle is always moist in health, and studded with papillary eminences.

In the **small ruminant** the lips are thin and prehensile, the upper one possessing no muffle and being marked by a median groove.

The **Cheeks** possess numerous large papillæ on their mucous surface.

The **Hard Palate** is relatively large; the **bars** are only found on the anterior two-thirds. A pad of fibro-cartilage takes the place of the upper incisors, and is marked by a **T**-shaped figure; Jacobson's canal opens into the extremity of the transverse line.

The **Tongue** has large muscles, is prehensile, has a pointed tip, and is covered by hard conical papillæ. The circumvallate papillæ are numerous, being arranged on each side of the base in an irregular double row; as a rule, there are about twelve on each side in the ox, and about twenty in the sheep.

The tongue of the **small ruminant** is relatively small.

The **Soft Palate** is not so large as that of the horse.

The **Teeth** are thirty-two in number in the adult. There are no incisors or canines in the upper jaw, their place being taken by the pad before-mentioned.

The incisors (six) in the lower jaw are simple, have well-marked necks, and are placed so that their upper surfaces come in contact with the pad of the upper jaw; their anterior borders are sharp and thin. The canines (two) are placed close up to the corner incisors, which they closely resemble. Both incisors and canines are loosely fixed in their alveoli.

The molars are compound teeth, smaller than those of the horse, and increasing in size from first to last.

Dental Formulæ of the Ox and Sheep.—

(*a*) Temporary teeth:

$$\frac{003}{313}=20.$$

(*b*) Permanent teeth:

$$\frac{0033}{3133}=32.$$

II. **Salivary Glands—Parotid Gland.**—This is small and reddish in colour. In the small ruminant Steno's duct crosses the masseter.

Submaxillary Gland.—Large and yellow in colour; its duct opens near the incisors.

Sublingual Gland.—This is divided into anterior and posterior portions. The anterior portion has numerous ducts; the posterior has only one duct—the **ductus Bartholinianus.**

The **Molar Glands** are large.

III. **The Pharynx** is capacious, but its muscles are not easily separated. In the small ruminant a mucous fold continues the nasal septum down the posterior wall.

IV. **The Œsophagus** is very dilatable; its muscular fibres are striated in all its parts, and it opens into the stomach in a funnel-like manner.

Pig.

I. **Mouth.**—The **Upper Lip** is cleft and continuous with the **snout**; the lower lip is pointed and spout-like.

The **Cheeks** are thin, and have smooth mucous membrane.

The **Hard Palate** is widest between the canine teeth; there are about twenty bars. The organ of Jacobson opens on this surface anteriorly.

The **Tongue** is smoother than that of the ruminant.

The **Soft Palate** is similar to that of the ruminant.

The **Teeth** number forty-four. The incisors differ very much in shape. The canines are large, especially in the male. The molars hold an intermediate place between herbivorous and carnivorous teeth; they increase in size from first to last.

Dental Formulæ of the Pig.—

(*a*) Temporary teeth:

$$\frac{3\,1\,3}{3\,1\,3}=28.$$

(*b*) Permanent teeth:

$$\frac{3\,1\,4\,3}{3\,1\,4\,3}=44.$$

II. **Salivary Glands.**—The **Parotid Gland** is small.

The **Sublingual Gland** is double.

III. **The Pharynx.**—The posterior wall presents a pouch above the entrance into the larynx.

IV. The **Œsophagus** is similar to that of the ruminant.

Dog.

I. **Mouth.**—The **Lips** are thin; the upper is notched in the middle; in some breeds it overhangs the lower lip in a marked degree. The lower lip is serrated near the commissures.

The **Cheeks** are thin.

The **Hard Palate** is frequently pigmented; there are only seven to nine bars.

The **Tongue** is very mobile. In the dog the papillæ are soft, in the cat hard and recurved. Tonsils are present.

The **Soft Palate** is short, and the isthmus faucium wide.

The **Teeth** number forty-two, and are all simple, only enamel being in wear. The incisors in young animals possess a trifid crown. The canines are large, the upper being the larger. The molars have sharp cutting edges.

Dental Formulæ of the Dog.—

(*a*) Temporary teeth:

$$\frac{313}{313}=28.$$

(*b*) Permanent teeth:

$$\frac{3142}{3143}=42.$$

II. **Salivary Glands.**—The **Parotid Gland** is small; Steno's duct crosses the masseter and opens on a level with the 4th molar.

The **Submaxillary Gland** is large; a small accessory gland has been described.

The **Sublingual Gland** is absent.

A **Subzygomatic Gland** has been described; this seems to take the place of the superior molar gland.

III. The **Pharynx** is very capacious. Only three constrictors can be made out.

IV. The **Œsophagus** is very distensible, and opens into the stomach in a marked infundibuliform manner.

THE RESPIRATORY SYSTEM.

Ruminant.

The **Nostrils** are narrow, and, on account of the presence of the muffle, are not so dilatable as in the horse.

The **Nasal Chambers** possess a so-called third turbinal bone, and communicate with the mouth by means of the organ of Jacobson.

The **Frontal Sinus** is extensive, being prolonged into the parietal and occipital bones and into the horn-cores.

The **Larynx** has a comparatively simple cavity, its ventricles and vocal cords being only imperfectly developed.

The **Trachea** terminates in three bronchi.

Pig.

The **Snout** is somewhat similar to the muffle of the ox. It contains the os rostri, a nodule of bone resulting from ossification of the anterior extremity of the cartilaginous septum nasi.

The **Nasal Chambers** are narrow, but long.

The **Frontal Sinus** is continued into the parietal bone.

The **Larynx** is very loosely attached to the hyoid bone. The epiglottis and lateral ventricles are well developed.

The **Trachea** terminates in three bronchi.

Dog.

There are no **Alar Cartilages**, the septum nasi replacing them.

The tip of the nose is hairless, moist, and usually pigmented.

The **Nasal Chambers** are short.

The **Turbinated Bones** are very richly convoluted.

There is only a frontal and a single maxillary sinus on each side.

The **Larynx** is very similar to that of the horse.

ARTERIES.

Ruminant.

The **Common Carotid** artery terminates in the external carotid and occipital arteries.

The **Internal Carotid** is absent.

Occipital Artery.—This artery enters the cranium by means of the condyloid foramen. It contributes a branch of anastomosis to the artery of the spinal cord, a branch from this anastomosis supplying the muscles in the occipital region.

External Carotid.—The **lingual** artery is given off directly from the external carotid, and supplies a **sublingual** artery. The **Posterior Auricular** artery furnishes a branch which takes the place of the **Mastoid** artery of the horse. The **coronary** arteries of the small ruminant are formed by the **transverse facial.**

The **Internal Maxillary** artery has no intra-osseous course; its branches are similar to those of the horse, but in addition it contributes two extra branches, which help to form the **rete mirabile.**

The **rete mirabile** is an arterial plexus situated at the side of the pituitary fossa, replacing the circle of Willis of the horse. It is formed by the **spheno-spinous** artery (which gains the cranium by the foramen ovale) and the **two arteries of the rete,** also branches of the internal maxillary, which enter the cranium by the common foramen.

From the superior part of the rete the **encephalic** artery springs; this contributes anterior, middle and posterior cerebral arteries. The two posterior cerebral arteries unite to form a **basilar** artery similar to that of the horse.

Another **rete** is formed on the course of the **ophthalmic** artery.

Pig.

The **Common Carotid** arteries arise separately from the right brachial, so there is no **cephalic** artery. The common carotid terminates as in the horse.

The **Cerebro-spinal** branch of the occipital is absent.

A **rete mirabile** is formed by the **internal carotid** and **ophthalmic** arteries; cerebral arteries spring from the rete, the posterior cerebrals uniting to form the **basilar** artery.

The **lingual** and **buccal** arteries are large.

The **Internal Maxillary** is considered as a part of the external carotid artery.

Dog.

The **Common Carotid** arteries arise separately as in the pig.

The **Internal Carotid** forms a small **rete** with the ophthalmic and spheno-spinous arteries.

The **Facial** and **Lingual** arteries arise separately; there is therefore no **Glosso-facial** artery proper.

The **superior dental** artery is the continuation of the **internal maxillary**.

VEINS.

Ruminant.

The **Angular Vein of the Eye** is very large in the sheep.

There is an **Accessory Jugular** vein, which arises in the occipital vein and lies alongside the carotid artery; it joins the principal jugular vein near its termination.

Pig and Dog.

The veins of these animals present nothing of importance.

The pig has an **Accessory Jugular** as in the ruminant.

THE BRAIN.

The differences in the brain of the domestic animals are of only small importance.

The respective weights are as follows (Chauveau):

Ox - - - -	16 ounces	15 drachms.
Sheep and goat -	4 ,,	9½ ,,
Pig - - - -	5 ,,	10 ,,
Dog - - - -	6 ,,	5½ ,,
Cat - - - -	1 ,,	1 ,,

THE CRANIAL NERVES.

Ruminant.

The **Optic Nerve** is larger than in the horse.

The **Pneumogastric Nerve** has a large ganglion and **pharyngeal** branch. The **recurrent laryngeal** nerve is separated from the parent trunk by the œsophagus.

Dog.

The **Olfactory** apparatus and nerves are largely developed.

THE EYE.

Ruminant.

The **Tapetum Lucidum** is golden green in colour, with a blue periphery.

The **Pupil** of the small ruminant is more elongated transversely than in the horse.

Harder's Gland is present on the membrana nictitans

Pig.

The **Tapetum Lucidum** is said to be absent.

The **Pupil** is circular.

Dog.

The eyeball is more spherical than in the other animals.

The **Tapetum Lucidum** is whitish, with a blue periphery.

The **Pupil** is circular.

Harder's Gland is said to be absent.

THE EAR.

The chief differences are found in the external ear. The **Conchal Cartilage** of the ruminant has a wider opening than in the horse; in the pig and dog it differs with the breed.

The **Guttural Pouch** is only found in the Equidæ.

APPENDIX.

RATIO OF THE WEIGHT OF THE HORSE'S VISCERA TO THE BODY-WEIGHT.

(*Vide* '*Veterinary Journal*,' *July*, 1896.)

ON comparing the weight of a viscus with the body-weight of the horse, a fairly constant ratio will be found to exist. The following table shows the conclusions arrived at after extensive observation :

Body-weight	= 1
Liver	= $\frac{1}{85}$
Spleen	= $\frac{1}{280}$
Right lung	= $\frac{1}{130}$
Left lung	= $\frac{1}{150}$
Heart	= $\frac{1}{160}$
Stomach	= $\frac{1}{250}$
Right kidney	= $\frac{1}{730}$
Left kidney	= $\frac{1}{800}$
Brain	= $\frac{1}{730}$
Spinal cord	= $\frac{1}{1440}$
Pancreas	= $\frac{1}{950}$
Bladder	= $\frac{1}{950}$

TABLE OF MUSCULAR ATTACHMENTS.

THE SKULL.

Bones affording Attachment.	*Muscles.*
OCCIPITAL BONE.	Complexus major and minor. Obliquus capitis anticus. Rectus capitis posticus major and minor. Levator humeri. Splenius. Rectus capitis lateralis. Stylo-hyoideus. Stylo-maxillaris. Digastricus.
PARIETAL BONE.	Temporalis.
FRONTAL BONE.	Levator communis. Corrugator supercilii.
TEMPORAL BONE.	Levator humeri. Trachelo-mastoideus. Splenius. Temporalis. Mastoido-auricularis.
SPHENOID BONE.	Rectus capitis anticus major and minor. Pterygoideus externus and internus.
SUPERIOR MAXILLA.	Panniculus. Buccinator. Masseter. Nasalis longus. Dilatator naris lateralis.
PREMAXILLA.	Dilatator naris inferioris. Depressor labii superioris.
NASAL BONE.	Dilatator naris superioris.
LACHRYMAL BONE.	Orbicularis palpebrarum.
MALAR BONE.	Nasalis longus.
PALATINE BONE.	Pterygoideus internus.

Bones affording Attachment.	*Muscles.*
INFERIOR MAXILLA.	Sterno-maxillaris. Stylo-maxillaris. Masseter. Buccinator. Temporalis. Pterygoideus externus and internus. Digastricus. Levator labii inferioris. Depressor labii inferioris. Mylo-hyoideus. Genio-hyoideus.
HYOID BONE.	Sterno-hyoideus. Subscapulo-hyoideus. Mylo-hyoideus. Genio-hyoideus. Hyoideus magnus, parvus, and transversus. Stylo-hyoideus. Hyo-glossus longus, brevis, and parvus. Genio-hyo-glossus.

INDEX.

THE END.

Baillière, Tindall and Cox, King William Street, Strand.

ERRATA.

Part I. P. 26, line 1, delete 'and magnum.'
" P. 111, line 8, read '*metatarsals*' for '*metacarpals.*'
" P. 150, line 15, read '*sartorius*' for '*adductor longus.*'
" P. 181: the plantaris muscle should be given as arising from the fibula, not astragalus.

Part II. P. 24, line 1, read '*cephalic vein*' for '*spur vein.*'
" P. 138, second last line, read '*above* the curvator coccygis and the inferior *above* the depressor coccygis.'