ANATOMY

DESCRIPTIVE AND SURGICAL.

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THE DRAWINGS

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THE DISSECTIONS

JOINTLY BY THE AUTHOR AND DR. CARTER.

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1858.
PREFACE.

This Work is intended to furnish the Student and Practitioner with an accurate view of the Anatomy of the Human Body, and more especially the application of this science to Practical Surgery.

One of the chief objects of the Author has been, to induce the Student to apply his anatomical knowledge to the more practical points in Surgery, by introducing, in small type, under each subdivision of the work, such observations as shew the necessity of an accurate knowledge of the part under examination.

Osteology. Much time and care have been devoted to this part of the work, the basis of anatomical knowledge. It contains a concise description of the anatomy of the bones, illustrated by numerous accurately-lettered engravings, shewing the various markings and processes on each bone. The attachments of each muscle are shewn in dotted lines (after the plan recently adopted by Mr. Holden), copied from recent dissections. The articulations of each bone are shewn on a new plan; and a method has been adopted, by which the hitherto complicated account of the development of the bones is made more simple.

The Articulations. In this section, the various structures forming the joints are described; a classification of the joints is given; and the anatomy of each carefully described: abundantly illustrated by engravings, all of which are taken from, or corrected by, recent dissections.

The Muscles and Fasciae. In this section, the muscles are described in groups, as in ordinary anatomical works. A series of illustrations, shewing the lines of incision necessary in the dissection of the muscles in each region, are introduced, and the muscles are shewn in fifty-two engravings. The Surgical Anatomy of the muscles in connection with fractures, of the tendons or muscles divided in operations, is also described and illustrated.

The Arteries. The course, relations, and Surgical Anatomy of each artery are described in this section, together with the anatomy of the regions containing the arteries more especially involved in surgical operations. This part of the work is illustrated by twenty-seven engravings.

The Veins are described as in ordinary anatomical works; and illustrated by a series of engravings, shewing those in each region. The veins of the spine are described and illustrated from the well-known work of Breschet.
The Lymphatics are described, and figured in a series of illustrations copied from the elaborate work of Mascagni.

The Nervous System and Organs of Sense. A concise and accurate description of this important part of anatomy has been given, illustrated by seventy-two engravings, showing the spinal cord and its membranes; the anatomy of the brain, in a series of sectional views; the origin, course, and distribution of the cranial, spinal, and sympathetic nerves; and the anatomy of the organs of sense.

The Viscera. A detailed description of this essential part of anatomy has been given, illustrated by fifty large, accurately-lettered engravings.

Regional Anatomy. The anatomy of the perinæum, of the ischio-rectal region, and of femoral and inguinal herniae, is described at the end of the work; the region of the neck, the axilla, the bend of the elbow, Scarpa's triangle, and the popliteal space, in the section on the arteries; the laryngo-tracheal region, with the anatomy of the trachea and larynx. The regions are illustrated by many engravings.

Microscopical Anatomy. A brief account of the microscopical anatomy of some of the tissues, and of the various organs, has also been introduced.

The Author gratefully acknowledges the great services he has derived, in the execution of this work, from the assistance of his friend, Dr. H. V. Carter, late Demonstrator of Anatomy at St. George's Hospital. All the drawings from which the engravings were made, were executed by him. In the majority of cases, they have been copied from, or corrected by, recent dissections, made jointly by the Author and Dr. Carter.

The Author has also to thank his friend, Mr. T. Holmes, for the able assistance afforded him in correcting the proof-sheets in their passage through the press.

The engravings have been executed by Messrs. Butterworth and Heath; and the Author cannot omit thanking these gentlemen for the great care and fidelity displayed in their execution.

Wilton-Street, Belgrave-Square,
August, 1858.
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DESCRIPTIVE AND SURGICAL ANATOMY.

DESCRIPTIVE ANATOMY comprises a detailed account of the numerous organs of which the body is formed, especially with reference to their outward form, their internal structure, the mutual relations they bear to each other, and the successive conditions they present during their development.

Surgical Anatomy is, to the student of medicine and surgery, the most essential branch of anatomical science, having reference more especially to an accurate knowledge of the more important regions, and consisting in the application of anatomy generally to the practice of surgery.

The Study of Anatomy is commonly divided into several distinct branches, according to the mutual resemblance of the organs; and these branches have corresponding denominations.

Osteology.

In the construction of the human body, it would appear essential, in the first place, to provide some dense and solid texture capable of giving support and attachment to the softer parts of the frame, and at the same time to protect in closed cavities the more important vital organs; and such a structure we find provided in the various bones, which form what is called the Skeleton.

Bone is one of the hardest structures of the animal body; it possesses also a certain degree of toughness and elasticity. Its colour, in a fresh state, is of a pinkish white externally, and deep red within. Chemical analysis resolves bone into an organic, or animal, and an inorganic, or earthy material, intimately combined together; the animal matter giving to bone its elasticity and toughness, the earthy part its hardness and solidity. The animal constituent may be separated from the earthy, by steeping bone in a dilute solution of nitric or muriatic acid: by this process the earthy constituents are gradually dissolved out, leaving a tough semi-transparent substance which retains, in every respect, the original form of the bone. This is often called cartilage, but differs from it in being softer, more flexible, and, when boiled under a high pressure, it is almost entirely resolved into gelatine. The earthy constituent may be obtained by subjecting a bone to strong heat in an open fire with free access of air. By these means, the animal matter is entirely consumed, the earthy part remaining as a white brittle substance still preserving the original shape of the bone.

The organic or animal constituent of bone, forms about one-third, or 33⅓ per cent.; the inorganic or earthy matter, two-thirds, or 66⅔ per cent.: as is seen in the subjoined analysis by Berzelius:

| Animal Matter, | Gelatine and Blood-vessels | 33'30 |
| Inorganic | Phosphate of Lime | 51'04 |
| or | Carbonate of Lime | 11'30 |
| Earthy Matter, | Fluoride of Calcium | 2'00 |
| | Phosphate of Magnesia | 1'16 |
| | Soda and Chloride of Sodium | 1'20 |
The proportion between these two constituents varies at different periods of life, as is seen in the following table from Schreger:

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<td>Animal matter</td>
<td>47·20</td>
<td>20·18</td>
<td>12·2</td>
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<tr>
<td>Earthy matter</td>
<td>48·48</td>
<td>74·84</td>
<td>84·1</td>
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There are facts of some practical interest, bearing upon the difference here seen in the amount of the two constituents of bone, at different periods of life. Thus, in the child, where the animal matter forms nearly one-half of the weight of the bone, it is not uncommon to find, after an injury happening to the bones, that they become bent, or only partially broken, from the large amount of flexible animal matter which they contain. Again, also in aged people, where the bones contain a large proportion of earthy matter, the animal matter at the same time being deficient in quantity and quality, the bones are more brittle, their elasticity is destroyed; and, hence, fracture takes place more readily. Some of the diseases, also, to which bones are liable, mainly depend on the disproportion between the two constituents of bone. Thus, in the disease called rickets, so common in the children of scrofulous parents, the bones become bent and curved, either from the superincumbent weight of the body, or under the action of certain muscles. This depends upon some deficiency of the nutritive system, by which bone becomes minus its normal proportion of earthy matter, whilst the animal matter is of unhealthy quality. In the vertebra of a rickety subject, Dr. Bostock found in 100 parts 79·75 animal, and 20·25 earthy matter.

The relative proportions of the two constituents of bone are found to differ in different bones of the skeleton. Thus the petrous portion of the temporal bone contains a large proportion of earthy matter, the bones of the limbs contain more earthy matter than those of the trunk, and those of the upper extremity, a larger proportion than those of the lower.

On examining a section of any bone, it is seen to be composed of two kinds of tissue, one of which is dense and compact in texture like ivory; the other open, reticular, spongy, enclosing cancelli or spaces, and hence called spongy or cancellated tissue. The compact tissue is always placed on the exterior of a bone; the cancellous tissue is always internal. The relative quantity of these two kinds of tissue varies in different bones, and in different parts of the same bone, as strength or lightness is requisite.

Form of Bones. The various mechanical purposes for which bones are employed in the animal economy require them to be of very different forms. All the scientific principles of Architecture and Dynamics are more or less exemplified in the construction of this part of the human body. The power of the arch in resisting superincumbent pressure is well exhibited in various parts of the skeleton, such as the human foot, and more especially in the vaulted roof of the cranium.

Bones are divisible into four classes: Long, Short, Flat, and Irregular.

The long bones are found chiefly in the limbs, where they form a system of levers, which have to sustain the weight of the trunk, and to confer extensive powers of locomotion. A long bone consists of a lengthened cylinder or shaft, and two extremities. The shaft is a hollow cylinder, the walls consisting of dense compact tissue of great thickness in the middle, and becoming thinner towards the extremities; the spongy tissue is scanty, and the bone is hollowed out in its interior to form the medullary canal. The extremities are generally somewhat expanded for greater convenience of mutual connexion, and for the purposes of articulation. Here the bone is made up of spongy tissue with only a thin coating of compact substance. The long bones are the clavicle, humerus, radius, ulna, femur, tibia, fibula, metacarpal, and metatarsal bones and the phalanges.

Short Bones. Where a part is intended for strength and compactness, and the motion at the same time slight and limited, it is divided into a number of small pieces united together by ligaments, and the separate bones are short and compressed, such as the bones of the carpus and tarsus. These bones, in their struc-
GENERAL ANATOMY OF BONE.

3

ture, are spongy throughout, excepting at their surface, where there is a thin crust of compact substance.

Flat Bones. Where the principal requirement is either extensive protection, or the provision of broad surfaces for muscular attachment, we find the osseous structure remarkable for its slight thickness, becoming expanded into broad flat plates, as is seen in the bones of the skull and shoulder-blade. These bones are composed of two thin layers of compact tissue, enclosing a layer of cancellous tissue of variable thickness. In the cranial bones, these layers of compact tissue are familiarly known as the tables of the skull; the outer one is thick and tough, the inner one thinner, denser, and more brittle, and hence termed the vitreous table. The intervening cancellous tissue is called the diploe. The flat bones are the occipital, parietal, frontal, nasal, lacrymal, vomer, scapule, and ossa innominata.

The Irregular or Mixed bones are such as, from their peculiar form, cannot be grouped under either of the preceding heads. Their structure is similar to that of other bones, consisting of an external layer of compact, and of a spongy cancellous substance within. The irregular bones are the vertebrae, sacrum, coccyx, temporal, sphenoid, ethmoid, superior maxillary, inferior maxillary, palate, inferior turbinated, and hyoid.

Vessels of Bone. The blood-vessels of bone are very numerous. Those of the compact tissue consist of a close and dense network of vessels, which ramify in a fibrous membrane termed the periosteum, which covers the entire surface of the bone in nearly every part. From this membrane, vessels pass through all parts of the compact tissue, running through the canals which traverse its substance. The cancellous tissue is supplied in a similar way, but by a less numerous set of larger vessels, which, perforating the outer compact tissue, are distributed to the cavities of the spongy portion of the bone. In the long bones, numerous apertures may be seen at the ends near the articular surfaces, some of which give passage to the arteries referred to; but the greater number, and these are the largest of them, are for the veins of the cancellous tissue which run separately from the arteries. The medullary canal is supplied by one large artery (or sometimes more), which enters the bone at the nutritious foramen (situated, in most cases, near the centre of the shaft), and perforates obliquely the compact substance. This vessel, usually accompanied by one or two veins, sends branches upwards and downwards, to supply the medullary membrane, which lines the central cavity and the adjoining canals. The ramifications of this vessel anastomose with the arteries both of the cancellous and compact tissues. The veins of bone are large, very numerous, and run in tortuous canals in the cancellous texture, the sides of which are constructed of a thin lamella of bone, perforated here and there for the passage of branches from the adjacent cancelli. The veins thus enclosed and supported by the hard structure, have exceedingly thin coats; and when the bony structure is divided, they remain patulous, and do not contract in the canals in which they are contained. Hence the constant occurrence of purulent absorption after amputation, in those cases where the stump becomes inflamed, and the cancellous tissue is infiltrated and bathed in pus. Lymphatic vessels have been traced into the substance of bone. Nerves, also, accompany the nutritious arteries into their interior.

Development of Bone. From the peculiar uses to which bone is applied, in forming a hard skeleton or framework for the softer materials of the body, and in enclosing and protecting some of the more important vital organs, we find its development takes place at a very early period. Hence the parts that appear soonest in the embryo, are the vertebral column and the skull, the great central column, to which the other parts of the skeleton are appended. At an early period of embryonic life, the parts destined to become bone consist of a congeries of cells, which constitutes the simplest form of cartilage. This temporary cartilage, as it is termed, is an exact miniature of the bone which in due course is to take its place; and as the process of ossification is slow, and not completed until adult life, it increases in bulk by an interstitial development of new cells. The next step in
this process is the ossification of the intercellular substance, and of the cells composing the cartilage. Ossification commences in the interior of the cartilage at certain points, called points or centres of ossification, from which it extends into the surrounding substance. The period of ossification varies much in different bones. It commences first in the clavicle, in which the primitive point appears during the fifth week; next in the lower jaw. The ribs also, and the long bones of the limbs, appear soon after. The number of ossific centres varies in different bones. In most of the short bones, it commences by a single point in the centre, and proceeds towards the circumference. In the long bones, there is a central point of ossification for the shaft or diaphysis; and one for each extremity, the epiphyses. That for the shaft is the first to appear; those for the extremities appear later. For a long period after birth, a thin layer of unossified cartilage remains between the diaphysis and epiphyses, until their growth is finally completed. Processes such as the trochanters that have separate centres of ossification, are called epiphyses previous to their union.

Growth of Bone. Increase in the length of a bone, is provided for by the development of new bone from either end of the shaft (diaphysis); and in the thickness, by the deposition of new matter upon the surface; but when growth is at an end, the epiphyses become solidly united to the ends of the diaphysis, and the bone is completely formed. A knowledge of the exact periods when the epiphyses become joined to the shaft, aids the surgeon in the diagnosis of many of the injuries to which the joints are liable; for it not unfrequently happens, that on the application of severe force to a joint, the epiphyses become separated from the shaft, and such injuries may be mistaken for fracture.

The order in which the epiphyses become united to the shaft, follows a peculiar law, which appears to be regulated by the direction of the nutriitious artery of the bone. Thus the arteries of the bones of the arm and forearm converge towards the elbow, and the epiphyses of the bones forming this joint become united to the shaft before those at the opposite extremity. In the lower extremities, on the contrary, the nutriitious arteries pass in a direction from the knee; that is, upwards in the femur, downwards in the tibia and fibula; and in them it is observed, that the upper epiphysis of the femur, and the lower epiphyses of the tibia and fibula, become first united to the shaft.

A diseased condition of any joint makes considerable variation in the period of development of the several bones which enter into its formation. Thus, in chronic inflammation occurring in a joint at an early period of life, the epiphysal cartilages take on premature ossification; this process proceeding so rapidly, that it speedily becomes converted into bone, which becomes united to the shaft, and the bone ever after is considerably diminished in length: hence partial atrophy of the limb is the result.

The entire skeleton in an adult, consists of 206 distinct bones. These are—

<table>
<thead>
<tr>
<th>Category</th>
<th>Bones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranium</td>
<td>8</td>
</tr>
<tr>
<td>Oscicula auditus</td>
<td>6</td>
</tr>
<tr>
<td>Face</td>
<td>14</td>
</tr>
<tr>
<td>Vertebral column (sacrum and coccyx included)</td>
<td>26</td>
</tr>
<tr>
<td>Os hyoides, sternum, and ribs</td>
<td>26</td>
</tr>
<tr>
<td>Upper extremities</td>
<td>64</td>
</tr>
<tr>
<td>Lower extremities</td>
<td>62</td>
</tr>
</tbody>
</table>

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In this enumeration, the sesamoid and Wormian bones are excluded, as also are the teeth, which differ from bone both in structure, development, and mode of growth. The skeleton consists of a central column or Spine; of three great cavities, the Skull, Thorax; and Pelvis; and of the Superior and Inferior Extremities.
THE SPINE.

The Spine is a flexuous column, formed of a series of bones called *Vertebrae.*

The *Vertebrae* are divided into *true* and *false.*

The *true vertebræ* are twenty-four in number, and have received the names *cervical,* *dorsal,* and *lumbar,* according to the position which they occupy; seven being found in the cervical region, twelve in the dorsal, and five in the lumbar.

The *false vertebræ,* nine in number, are firmly united, so as to form two bones—five entering into the formation of the upper bone or *sacrum,* and four into the terminal bone of the spine or *coccyx.*

\[
\begin{align*}
\text{True Vertebræ, 24} & \quad 7 \text{ Cervical.} \\
& \quad 12 \text{ Dorsal.} \\
& \quad 5 \text{ Lumbar.} \\
\text{False Vertebræ, 9} & \quad 5 \text{ Sacrum.} \\
& \quad 4 \text{ Coccyx.}
\end{align*}
\]

GENERAL CHARACTERS OF THE VERTEBRÆ.

Each *vertebra* consists of two parts, an anterior solid segment or body, forming the chief pillar of support; a posterior segment, the arch, forming part of a hollow cylinder for protection. The arch is formed of two pedicles and two *laminae,* supporting seven processes; viz. four articular, two transverse, and one spinous process.

*The Body* is the largest and most solid part of a *vertebra,* serving to support the weight of the cranium and trunk. Above and below it is slightly concave, presenting a rim around its circumference; and its surfaces are rough, for the attachment of the intervertebral fibro-cartilages. In front it is convex from side to side, concave from above downwards. Behind, flat from above downwards, and slightly concave from side to side. Its anterior surface is perforated by a few small apertures, for the passage of nutrient vessels; whilst on the posterior surface is a single irregular-shaped, or occasionally several large apertures, for the exit of veins from the body of the *vertebra,* the *vææ basis vertebrae.*

*The Pedicles* project backwards, one on each side, from the upper part of the body of the *vertebra,* at the line of junction of its posterior and lateral surfaces; they form the lateral parts of the arch, which is completed posteriorly by the two *laminae.* The concavities above and below the pedicles are the *intervertebral notches,* they are four in number, two on each side, the inferior ones being always the deeper.

*The Laminae* consist of two broad plates of bone, which complete the vertebral arch behind, enclosing a foramen which serves for the protection of the spinal cord; they are connected to the body through the intervention of the pedicles. Their upper and lower borders are rough, for the attachment of the *ligamenta subflava.*

*The Spinous Process* projects backwards from the junction of the two *laminae,* and serves for the attachment of muscles.

*The Transverse Processes,* two in number, project one at each side from the point where the articular processes join the pedicle. They also serve for the attachment of muscles.

*The Articular Processes* are four in number; two superior, the smooth surfaces of which are directed more or less backwards; and two inferior, the articular surfaces of which look more or less forwards.

CHARACTERS OF THE CERVICAL VERTEBRÆ (fig. 1).

*The Body* is smaller than in any other region of the spine, thicker before than behind, and broader from side to side than from before backwards. Its upper surface is concave transversely, and presents a projecting lip on each side; its lower
surface being convex from side to side, concave from before backwards, and presenting laterally a shallow concavity, which receives the corresponding projecting lip of the adjacent vertebra. The pedicles are directed obliquely outwards, and the superior intervertebral notches are slightly deeper, but narrower, than the inferior. The laminae are narrow, long, thinner above than below, and imbricated, i.e. overlapping each other; enclosing the foramen, which is very large, and of a triangular form. The spinous processes are short, bifid at the extremity, the two divisions being often of unequal size. They increase in length from the fourth to the seventh. The transverse processes are short, directed downwards, outwards, and forwards, bifid at their extremity, and marked by a groove along their upper surface, which runs downwards and outwards from the superior intervertebral notch, and serves for the transmission of one of the cervical nerves. The transverse processes are pierced at their base by a foramen, for the transmission of the vertebral artery, vein, and plexus of nerves. Each of these processes is formed by two roots: the anterior or smaller, which is attached to the side of the body, corresponds to the ribs in the dorsal region; the posterior is larger, springs from the pedicle, and corresponds to the true transverse processes. It is by the junction of these two processes, that the vertebral foramen is formed. The extremities of each of these roots form the anterior and posterior tubercles of the transverse processes. The articular processes are oblique: the superior are of an oval form, flattened, and directed upwards and backwards; the inferior downwards and forwards.

The peculiar vertebrae in the cervical region are the first or Atlas; the second or Axis; and the seventh or Vertebra prominens.

The Atlas (fig. 2) (so named from supporting the globe of the head). The chief
peculiarities of this bone are, that it has neither body, spinous process, nor pedicles. It consists of an anterior arch, a posterior arch, and two lateral masses. The anterior or lesser arch, which forms about one-fifth of the bone, represents the front part of the body of a vertebra; its anterior surface is convex, and presents about its centre a tubercle for the attachment of the Longus colli muscle; posteriorly it is concave, and marked by a smooth oval surface, for articulation with the odontoid process of the axis. The posterior or greater arch, which forms about two-fifths of the circumference of the bone, terminates behind in a tubercle, which is the rudiment of a spinous process, and gives origin to the Rectus capitis posticus minor. The posterior part of the arch presents above a rounded edge; whilst in front, immediately behind the superior articular processes, are two grooves, sometimes converted into foramina by delicate bony spicula. These grooves represent the superior intervertebral notches, and are peculiar from being situated behind the articular processes, instead of before them, as in the other vertebrae. They serve for the transmission of the vertebral artery, which, ascending through the foramen in the transverse process, winds around the lateral mass in a direction backwards and inwards. They also transmit the sub-occipital nerves. On the under surface of the posterior arch, in the same situation, are two other grooves, placed behind the lateral masses, and representing the inferior intervertebral notches of other vertebrae. They are much less marked than the superior. The lateral masses, which are the most bulky and solid parts of the Atlas, present two articulating processes above, and two below. The two superior are of large size, oval, concave, and approach towards one another in front, but diverge behind; they are directed upwards, inwards, and a little backwards, forming a kind of cup for the condyles of the occipital bone, and are admirably adapted to the nodding movements of the head; whilst the inferior, which are circular in form, and flattened, are directed downwards, inwards, and a little backwards, articulating with the axis, and permitting the rotatory movements. Just below the inner margin of each superior articular surface, is a small tubercle, for the attachment of a ligament which, stretching across the ring of the Atlas, divides it into two unequal parts; the anterior or smaller segment receiving the odontoid process of the Axis, the posterior allowing the transmission of the spinal cord and its membranes. This ligament and the odontoid process are marked in the figure in dotted outline. The transverse processes are of large size, long, not bifid, perforated at their base by a canal for the vertebral artery, which is directed from below, upwards and backwards.

The Axis (fig. 3) (so named from forming the pivot upon which the head rotates). The most distinctive character of this bone is the existence of a strong prominent process, tooth-like in form (hence the name odontoid), which arises perpendicularly from the upper part of the body. The body is of a triangular form;
its anterior surface deeper than the posterior, presents a median longitudinal ridge, separating two lateral depressed surfaces for the attachment of the Longi collii muscles. The odontoid process presents two oval articulating surfaces: one in front, for articulation with the Atlas; another behind, for the transverse ligament; the apex is pointed, and on either side of it is seen a rough impression for the attachment of the odontoid or cheek ligaments; whilst the base, where attached to the body, is constricted, so as to prevent displacement from the transverse ligament, which binds it in this situation to the anterior arch of the Atlas. On each side of this process are seen the superior articular surfaces; they are round, convex, directed upwards and outwards, and are peculiar in being supported on the body, pedicles, and transverse processes. The inferior articular surfaces, which are posterior and external to these, have the same direction as those of the other cervical vertebrae. The superior intervertebral notches are very shallow, and lie behind the articular processes; the inferior in front of them, as in the other cervical vertebrae. The transverse processes are very small, not bifid, and perforated by the vertebral foramen, which is directed obliquely upwards, and outwards. The laminae are thick and strong, and the spinous process is of large size, very strong, deeply channelled on its under surface, and presenting a bifid tubercular extremity for the attachment of muscles.

Seventh Cervical. The most distinctive character of this vertebra is the existence of a very large, long, and prominent spinous process; hence the name 'Vertebra prominens.' This process is thick, nearly horizontal in direction, not bifurcated, and has attached to it the ligamentum nuchae. The foramina in the transverse processes are small, often wanting, and when present do not give passage to the vertebral artery; their upper surface presents only a slight groove, and generally only a trace of bifurcation at their extremity.

Characters of the Dorsal Vertebrae.

The Dorsal Vertebrae (fig. 4) are intermediate in size between the cervical and lumbar. The body is somewhat triangular in form, broader in the antero-posterior than

4.—A Dorsal Vertebra.

in the lateral direction, more particularly in the middle of the dorsal region, thicker behind than in front, flat above and below, deeply concave behind, and marked on each lateral surface, near the root of the pedicle, by two demi-facets, one above, the other below. These are covered with cartilage in the recent state; and, when
articulated with the adjoining vertebrae, form oval surfaces for the reception of the heads of the corresponding ribs. The pedicles are strong, and the inferior intervertebral notches of large size. The laminae are broad and thick, and the spinal foramen small, and of a round or slightly oval form. The articular surfaces are flat, the superior being directed backwards and a little outwards and upwards, the inferior forwards and a little inwards and downwards. The transverse processes are thick, strong, and of great length, directed obliquely backwards and outwards, presenting a clubbed extremity, lipped on its anterior part by a small concave surface, for articulation with the tubercle of a rib. The spinous processes are long, directed obliquely downwards, and terminated by a tubercle.

The peculiar dorsal vertebrae are the first, ninth, tenth, eleventh, and twelfth (fig. 5).

5.—Peculiar Dorsal Vertebrae.

The First Dorsal Vertebra may be distinguished by the existence on each side of the body, of a single entire articular facet for the head of the first rib, and a
OSTEOLOGY.

half facet for the upper half of the second. The upper surface of the body is like
that of a cervical vertebra, being broad transversely, concave, and lipped on each
side. The superior articular surfaces are oblique, and the spinous process thick,
long, and almost horizontal.

The Ninth Dorsal has no demi-facet below.
The Tenth Dorsal has an entire articular facet at each side above; no demi-
facet below.

In the Eleventh Dorsal, the body approaches in its form to the lumbar; and
has a single entire articular surface on each side. The transverse processes are
very short, and have no articular surfaces at their extremities.

The Twelfth Dorsal has the same characters as the eleventh; but may be
distinguished from it by the transverse processes being quite rudimentary, and the
inferior articular surfaces being convex and turned outwards, like those of the
lumbar vertebrae.

The smallest dorsal vertebra is the fourth. The vertebrae increase in size from
that point downwards to the twelfth, and upwards to the first. The spinous
processes also, from the eighth downwards, become shorter, and are directed more
horizontally.

Characters of the Lumbar Vertebrae.

The Lumbar Vertebrae (fig. 6) are the largest segments of the vertebral column.
The Body is large, broad from side to side, flat above, and below, and thicker

6.—A Lumbar Vertebra.

before than behind. The pedicles are very strong, directed backwards; and the
inferior intervertebral notches are of large size. The laminae are short, but broad
and strong; and the foramen triangular, larger than in the dorsal, smaller than in
the cervical region. The superior articular processes are concave, and directed
backwards and inwards; the inferior, convex, and directed forwards and outwards.
Projecting backwards from each of the superior articular processes is a tubercle,
the representative of the transverse processes in the dorsal and cervical regions.
The transverse processes are long, slender, directed a little backwards, and present,
at the posterior part of their base, a small tubercle, which is directed downwards.
The spinous processes are thick and broad, somewhat quadrilateral, horizontal in
direction, and thicker below than above.

The Fifth Lumbar vertebra is peculiar from having the body much thicker in
front than behind, which accounts for the prominence of the sacro-vertebral
articulation.

Structure of the Vertebrae. The structure of a vertebra differs in different parts.
The Body is composed almost entirely of light spongy cancellous tissue, having a
thin coating of compact tissue on its external surface, permeated throughout its
interior with large canals for the reception of veins, which converge towards a
single large irregular or several small apertures at the posterior part of the body of each bone. The arch and processes projecting from it have, on the contrary, an exceedingly thick covering of compact tissue.

**Development.** Each vertebra is formed of three primary centres of ossification (fig. 7), one for each lamella and its processes, and one for the body. Those for the lamellæ appear about the sixth week of fetal life, in the situation where the transverse processes afterwards project, the ossific granules shooting backwards to the spine, forwards to the body, and outwards into the transverse and articular processes. That for the body makes its appearance in the middle of the cartilage about the eighth week. At birth, these three pieces are perfectly separate. During the first year, the lateral portions become partly united behind, in the situation of the spinous process, and thus the arch is formed. About the third year, the body is joined to the arch on each side, in such a manner, that the body is formed from the three original centres of ossification. Before puberty, no other changes occur, excepting a gradual increase of growth of these primary centres, the upper and under surface of the bodies, and the ends of the transverse and spinous processes, being tipped with cartilage, in which ossific granules are not as yet deposited. At sixteen years (fig. 8), four secondary centres appear, one for the tip of each transverse process, and two (sometimes united into one) for the spinous process. At twenty-one years (fig. 9), two thin circular plates of bone are formed, one for the upper, and one for the under surface of the body. All these become joined, and the bone is completely formed about the thirtieth year of life.

Exceptions to this mode of development occur in the first, second, and seventh cervical, and in those of the lumbar region.

7.—Development of a Vertebra.

**By 3 primary centres**

1 for Body (8th week)

1 for each Lamella (6th week)

8.

**By 4 Secondary Centres**

1 for each Trans. Proc. 16 y. 7!

2 sometimes 1 for Spun. proc. (16 y. 7!)

9.

**By 2 additional plates**

1 for upper surface of body 21 y. 3

1 for under surface of body

10.—Axis.

**By 3 centres**

1 for axis arch (4th y.)

1 for each lateral mass before birth

11.—Axis.

**By 5 centres**

2 for odontoid proc. (6th mo)

1 for each lateral mass

1 for body (6th mo)

12.—Lumbar Vertebra.

2 additional centres

for tubercles on Sup. Artic. Proc.
OSTEOMETRY.

The *Atlas* (fig. 10) is developed by *three* centres. One (sometimes two) for the anterior arch, and one for each lateral mass. The osseous centres for each lateral mass commence before birth. At birth, the anterior arch is altogether cartilaginous, and the two lateral pieces are separated from one another behind. The nucleus for the anterior arch appears in the first year, between the second and third years the two lateral pieces unite, and join the anterior part at the age of five or six years. There is frequently a separate epiphysis for the rudimentary spine.

The *Axis* (fig. 11) is developed by *five* centres; three for its anterior part, and two for the posterior. The three anterior centres are, one for the lower part of the body, and two for the odontoid process and upper part of the body; the two posterior ones are, one for each lamella. At about the sixth month of foetal life, those for the body and odontoid process make their appearance, the two for the odontoid process joining before birth. At birth the bone consists of four pieces, two anterior and two lateral. At the fourth year the body and odontoid process are completely joined.

The *Seventh Cervical*. The anterior or costal part of the transverse process of the seventh cervical, is developed from a separate osseous centre at about the sixth month of foetal life, and joins the body and posterior division of the transverse process between the fifth and sixth years. Sometimes this process continues as a separate piece, and becoming lengthened outwards, constitutes what is known as a cervical rib.

The *Lumbar Vertebrae* (fig. 12) have *two additional centres* (besides those peculiar to the vertebrae generally), for the tubercles, which project from the back part of the superior articular processes. The transverse process of the first lumbar is sometimes developed as a separate piece, which may remain permanently unconnected with the remaining portion of the bone; thus forming a lumbar rib, a peculiarity which is sometimes, though rarely, met with.

**Progress of Ossification in the Spine generally.** Ossification of the laminae of the vertebrae commences at the upper part of the spine, and proceeds gradually downwards; hence the frequent occurrence of spina bifida in the lower part of the spinal column. Ossification of the bodies, on the other hand, commences a little below the centre of the spinal column, and extends both upwards and downwards. Although, however, the osseous nuclei make their first appearance in the lower dorsal vertebra (about the ninth), the lumbar and first sacral are those in which these nuclei are largest at birth.

**The False Vertebrae.**

The False Vertebrae consist of nine pieces, which are united so as to form two bones, five entering into the formation of the sacrum, four the coccyx.

The *Sacrum* (fig. 13) is a large triangular bone, situated at the lower part of the vertebral column, and at the upper and back part of the pelvic cavity, where it is inserted like a wedge between the two osa innominata; its upper part, or base, articulating with the last lumbar vertebra, its apex with the coccyx. The sacrum is curved upon itself, and placed very obliquely; its upper extremity projecting forwards, forming, with the last lumbar vertebra, a very prominent angle, called the *promontory* or *sacro-vertebral angle*, whilst its central part is directed backwards, so as to give increased capacity to the pelvic cavity. It presents for examination an anterior and posterior surface, two lateral surfaces, a base, an apex, and a central canal.

The *Anterior Surface* is deeply concave from above downwards, and slightly so from side to side. In the middle are seen four transverse lines, indicating the original division of the bone into five separate pieces. The portions of bone intervening between the lines correspond to the bodies of the vertebrae; they are slightly concave longitudinally, and diminish in size from above downwards. At the extremities of each of these lines, are seen the *anterior sacral foramina*, analogous to the intervertebral foramina, four in number on each side, somewhat rounded in
form, diminishing in size from above downwards, and directed outwards and forwards; they transmit the anterior branches of the sacral nerves. External to these foramina, is the lateral mass, formed by the coalesced transverse processes.

13.—Sacrum, Anterior Surface.

of the sacral vertebrae, traversed by four broad shallow grooves, which lodge the anterior sacral nerves as they pass outwards, the grooves being separated by prominent ridges of bone, which give attachment to the slips of the Pyriformis muscle.

The Posterior Surface (fig. 14) is convex, and much narrower than the anterior. In the middle line, are three or four tubercles, sometimes connected together, which represent the rudimentary spinous processes. Of these tubercles, the first is usually very prominent, and perfectly separate from the rest; the second, third, and fourth, existing either separate, or united into a ridge, which diminishes in size as it descends; the fifth, and sometimes the fourth, remaining undeveloped, and exposing below, the lower end of the sacral canal. External to the spinous processes on each side, are the laminae, broad and well marked in the three first pieces; the lower part of the fourth, and the whole of the fifth, being undeveloped: in this situation the sacral canal is exposed. External to the laminae are a linear series of indistinct tubercles representing the articular processes; the upper pair are well developed; the second and third are small; the fourth and fifth (usually blended together) are situated on each side of the sacral canal: they are called the sacral cornua, and articulate with the cornua of the coccyx. External to the articular processes are the four posterior sacral foramina; they are smaller in size, and less regular in form than the anterior, and transmit the posterior branches of the sacral nerves. On the outer side of the posterior sacral foramina are a series of tubercles, representing the rudimentary transverse processes. The first pair of transverse tubercles are very distinct, and correspond with each superior
angle of the bone; the second, small in size, enter into the formation of the sacro-iliac articulation; the third give attachment to the oblique sacro-iliac ligaments;

14.—Sacrum Posterior Surface.

and the fourth and fifth to the great sacro-ischiatic ligaments. The interspace between the spinous and transverse processes of the sacrum, presents a wide shallow concavity, called the *sacral groove*; it is continuous above with the vertebral groove, and lodges the origin of the Erector Spinae.

The *Lateral Surface*, broad above, becomes narrowed into a thin edge below. Its upper half presents in front a broad ear-shaped surface for articulation with the ilium. This is called the *auricular or ear-shaped surface*, and in the fresh state is coated with cartilage. It is bounded posteriorly by deep and rough impressions, for the attachment of the sacro-iliac ligaments. The lower half is thin and sharp, and gives attachment to the greater and lesser sacro-ischiatic ligaments; below, it presents a deep notch, which is converted into a foramen by articulation with the transverse process of the upper piece of the coccyx, and transmits the anterior branch of the fifth sacral nerve.

The *Base* of the sacrum, which is broad and expanded, is directed upwards and forwards. In the middle is seen an oval articular surface, which corresponds with the under-surface of the body of the last lumbar vertebra, bounded behind by the large triangular orifice of the sacral canal. This orifice is formed behind by the spinous process and laminae of the first sacral vertebra, whilst projecting from it on each side are the superior articular processes; they are oval, concave, directed backwards and inwards, like the superior articular processes of a lumbar vertebra, in front of each articular process in an intervertebral notch, which forms the lower half of the last intervertebral foramen. Lastly, on each side of the articular surface is a broad and flat triangular surface of bone, called the *auct
of the sacrum; they extend outwards, and are continuous on each side with the iliac fossa.

The Apex, directed downwards and forwards, presents a small oval concave surface for articulation with the coccyx.

The Sacral Canal runs throughout the greater part of the bone; it is large and triangular in form above, small and flattened from before backwards below. In this situation, its posterior wall is incomplete, from the non-development of the laminae and spinous processes. It lodges the sacral nerves, and is perforated by the anterior and posterior sacral foramina, through which these pass out.

Structure. It consists of much loose spongy tissue within, invested externally by a thin layer of compact tissue.

Differences in the Sacrum of the Male and Female. The sacrum in the female is usually wider than in the male, and it is much less curved, the upper half of the bone being nearly straight, the lower half presenting the greatest amount of curvature. The bone is also directed more obliquely backwards; which increases the size of the pelvic cavity, and forms a more prominent sacro-vertebral angle. In the male the curvature is more evenly distributed over the whole length of the bone, and is altogether greater than in the female.

Peculiarities of the Sacrum. This bone, in some cases, consists of six instead of five pieces; occasionally the number is reduced to four. Sometimes the bodies of the first and second vertebrae are not joined, or the laminae and spinous processes have not coalesced with the rest of the bone. Occasionally the superior transverse tubercles are not joined to the rest of the bone on one or both sides; and, lastly, the sacral canal may be open for nearly the lower half of the bone, in consequence of the imperfect development of the laminae and spinous processes. The sacrum also varies considerably with respect to its degree of curvature. From the examination of a large number of skeletons, it would appear, that, in one set of cases, the anterior surface of this bone was nearly straight, the curvature, which was very slight, affecting only its lower end. In another set of cases, the bone was curved throughout its whole length, but especially towards its middle. In a third set, the degree of curvature was less marked, and affected especially the lower third of the bone.

Development of Sacrum (fig. 15). The sacrum, formed by the union of five vertebrae, has thirty-five centres of ossification. Each of the three first pieces is developed by seven centres; viz., three for the body, one for its central part, one for each epiphysal lamella on its upper and under surface, and one for each of the laminae; so far the first three sacral vertebrae, as well as the two last, are developed like the other pieces of the vertebral column. One of the characteristic points in the development of this bone, consists in the existence of two additional centres for each of the first three pieces, which appear one on each side, close to the anterior sacral foramina, and correspond to the transverse processes of the lumbar vertebrae.
Each of the two last pieces is developed by five centres: three for the body; viz., one for its central part, and one for each of the epiphysial lamellae; and one for each of the lamina.

A second characteristic point in the development of this bone consists in each lateral surface of the sacrum being developed by two epiphysial points, one for the auricular surface, and one for the thin lateral border of the bone.

**Period of Development.** At about the eighth or ninth week of foetal life, ossification of the central part of the bodies of the three first vertebrae commences, and, at a somewhat later period, that of the two last. Between the sixth and eighth months, ossification of the lamellae takes place; and at about the same period the characteristic osseous tubercles for the three first sacral vertebrae make their appearance. The lateral pieces join to form the arch, and are united to the bodies, first, in the lowest vertebra. This occurs about the second year, the uppermost segment appearing as a single piece about the fifth or sixth year. About the sixteenth year the epiphysial lamellae for the bodies are formed; and between the eighteenth and twentieth years those for each lateral surface of the sacrum make their appearance. At about this period, the two last segments are joined to one another; and this process gradually extending upwards, all the pieces become united, and the bone completely formed from the twenty-fifth to the thirtieth year of life.

**Articulations.** With four bones; the last lumbar vertebra, coccyx, and the two ossa innominata.

**Attachment of Muscles.** The Piriformis and Coccygeus on either side, behind the Gluteus maximus and Erector Spinae.

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**The Coccyx.**

The Coccyx (κοκκυξ, cuckoo), so called from resembling a cuckoo's beak, (fig. 16) is formed of four small segments of bone, the most rudimentary parts of the vertebral column. Of these, the first is the largest, and often exists as a separate piece, the three last diminishing in size from above downwards, are blended together so as to form a single bone. The gradual diminution in the size of the pieces gives this bone a triangular form, articulating by its base with the apex of the sacrum. It presents for examination an anterior and posterior surface, two borders, a base, and an apex. The anterior surface is slightly concave, and marked with three transverse grooves, indicating the points of junction of the different pieces. It has attached to it the anterior sacro-coccygeal ligament and levator ani muscle, and supports the lower end of the rectum. The posterior surface is convex, marked by grooves similar to those on the anterior surface, and presents on each side a linear row of tubercles, which represent the articular processes of the coccygeal vertebrae. Of these, the superior pair are very large; they are called the cornua of the coccyx, and projecting upwards, articulate with the cornua of the sacrum, the junction between these two bones completing the fifth sacral foramen for the transmission of the posterior branch of the fifth sacral nerve. The lateral borders are thin, and present a series of small eminences, which represent the transverse processes of the coccygeal vertebrae. Of these, the first on each side is of large size, flattened from before backwards, and often ascends upwards to join the lower part of the thin lateral edge of the sacrum, thus completing the fifth sacral foramen; the others diminish in size.
from above downwards, and are often wanting. The borders of the coccyx are narrow, and give attachment on each side to the sacro-sciatic ligaments and Coccygeus muscle. The base presents an oval surface for articulation with the sacrum. The apex is rounded, and has attached to it the tendon of the external Sphincter ani muscle. It is occasionally bifid, and sometimes deflected to one or other side.

Development. The coccyx is developed by four centres, one for each piece. Occasionally one of the three first pieces of this bone is developed by two centres, placed side by side. The periods when the ossific nuclei make their appearance is the following: in the first segment, at birth; in the second piece, at from five to ten years; in the third, from ten to fifteen years; in the fourth, from fifteen to twenty years. As age advances, these various segments become united in the following order: the two first pieces join, then the third and fourth; and, lastly the bone is completed by the union of the second and third. At a late period of life, especially in females, the coccyx becomes joined to the end of the sacrum.

Articulation. With the sacrum.

Attachment of Muscles. On either side, the Coccygeus; behind, the Gluteus maximus; at its apex, the Sphincter ani; and in front, the Levator ani.

Of the Spine in general. — The spinal column, formed by the junction of the vertebrae, is situated in the median line, at the posterior part of the trunk; its average length is about two feet two or three inches; the lumbar region contributing seven parts, the dorsal eleven, and the cervical five.

Viewed in front, it presents two pyramids joined together at their bases, the upper one being formed by all the true vertebrae from the second cervical to the last lumbar; the lower one by the false vertebrae, the sacrum, and coccyx. Viewed somewhat more closely, the uppermost pyramid is seen to be formed of three smaller pyramids. Of these the most superior one consists of the six lower cervical vertebrae, its apex being formed by the axis or second cervical, its base by the first dorsal. The second pyramid, which is inverted, is formed by the four upper dorsal vertebrae, the base being at the first dorsal, the smaller end at the fourth. The third pyramid commences at the fourth dorsal, and gradually increases in size to the fifth lumbar.

Viewed laterally (fig. 17), the spinal column presents several curves. In the dorsal region, the seat of the principal curvature, the spine
is concave anteriorly; whilst in the cervical and lumbar regions it is convex anteriorly, especially in the latter. The spine has also a slight lateral curvature, the convexity of which is directed towards the right side. This is most probably produced, as Bichat first explained, from the effect of muscular action; most persons using the right arm in preference to the left, especially in making long-continued efforts, when the body is curved to the right side. In support of this explanation, it has been found by Beclard, that in one or two individuals who were left-handed, the lateral curvature was directed to the left side.

The spinal column presents for examination an anterior, a posterior, and two lateral surfaces, a base, summit, and vertebral canal.

The anterior surface presents the bodies of the vertebrae separated in the fresh state by the intervertebral discs. The bodies are broad in the cervical region, narrow in the upper part of the dorsal, and broadest in the lumbar region. The whole of this surface is convex transversely, concave from above downwards in the dorsal region, and convex in the same direction in the cervical and lumbar regions.

The posterior surface presents in the median line the spinous processes. These are short, horizontal, with bifid extremities in the cervical region. In the dorsal region, they are directed obliquely above, assume almost a vertical direction in the middle, and are horizontal, like the spines of the lumbar vertebrae, below. They are separated by considerable intervals in the loins, by narrower intervals in the neck, and are closely approximated in the middle of the dorsal region. On either side of the spinous processes; extending the whole length of the column, is the vertebral groove, formed by the laminae in the cervical and lumbar regions, where it is shallow, and by the laminae and transverse processes in the dorsal region, where it is deep and broad. In the recent state, these grooves lodge the deep muscles of the back. External to the vertebral grooves are the articular processes, and still more externally the transverse processes. In the dorsal region, these latter processes stand backwards, on a place considerably posterior to the same processes in the cervical and lumbar regions. The transverse processes in certain regions of the spine are formed of two different parts, or segments. In the cervical region, these two segments are distinct; the one arising from the side of the body, the other from the pedicle of the vertebra; and these uniting, enclose the vertebral foramen. In the dorsal region, the anterior segment is wanting; the posterior segment retaining the name of the transverse process. In the lumbar region, the anterior segments (which are largely developed) are called the transverse processes; but, in reality, they are lumbar ribs, the posterior segments or true transverse processes existing in a rudimentary state, and being developed from the superior articular processes, as in the cervical region. In the cervical region, the transverse processes are placed in front of the articular processes, and between the intervertebral foramina. In the lumbar, they are placed also in front of the articular processes, but behind the intervertebral foramina. In the dorsal region, they are posterior both to the articular processes and foramina.

The lateral surfaces are separated from the posterior by the articular processes in the cervical and lumbar regions, and by the transverse processes in the dorsal. These surfaces present in front the sides of the bodies of the vertebra, marked in the dorsal region by the facets for articulation with the heads of the ribs. More posteriorly are the intervertebral foramina, formed by the juxtaposition of the intervertebral notches, oval in shape, smallest in the cervical and upper part of the dorsal regions, and gradually increasing in size to the last lumbar. They are situated between the transverse processes in the neck, and in front of them in the back and loins, and transmit the spinal nerves. The base of the vertebral column is formed by the under surface of the body of the fifth lumbar vertebra, and the summit by the upper surface of the atlas. The vertebral canal follows the different curves of the spine; it is largest in those regions in which the spine enjoys the greatest freedom of movement, as in the neck and loins, where it is wide and triangular; and narrow and rounded in the back, where motion is more limited.
THE SKULL.

The Skull is divided into two parts, the Cranium and the Face. The Cranium is composed of eight bones; viz., the occipital, two parietal, frontal, two temporal, sphenoid, and ethmoid. The Face is composed of fourteen bones; viz., the two nasal, two superior maxillary, two lachrymal, two malar, two palate, two inferior turbinated, vomer, inferior maxillary. The ossicula auditus, the teeth, and Worman bones, are not included in this enumeration.

Cranium, 8 bones.

Skull, 22 bones.

Face, 14 bones.

THE OCCIPITAL BONE.

The Occipital Bone (fig. 18) is situated at the posterior and inferior part of the cranium, is trapezoid in form, curved upon itself, and presents for examination two surfaces, four borders, and four angles.

18.—Occipital Bone. Outer Surface.
Osteology.

External Surface. Midway between the summit of the bone and the posterior margin of the foramen magnum is a prominent tubercle, the external occipital protuberance, for the attachment of the ligamentum nuchae; and descending from it, as far as the foramen, a vertical ridge, the external occipital crest. Passing outwards from the occipital protuberance on each side are two semicircular ridges, the superior curved lines; and running parallel with these from the middle of the crest, are the two inferior curved lines. The surface of the bone above the superior curved lines presents on each side a smooth surface, which, in the recent state, is covered by the occipito-frontalis muscle, whilst the ridges, as well as the surfaces of the bone between them, serve for the attachment of numerous muscles. The superior curved line gives attachment internally to the Trapezius, externally to the Occipito-frontalis, and Sterno-celeido mastoidiens; to the extent shewn in the figure. The depressions between the curved lines to the Complexus internally, the Splenius capitis and Obliquus superior externally. The inferior curved line, and the depressions below it, afford insertion to the Rectus capitis posticus, major and minor.

The foramen magnum is a large aperture, with rounded shelving margins, oblong in form, and wider behind than in front; it transmits the spinal cord and its membranes, the spinal accessory nerves, and the vertebral arteries. On each side of the foramen magnum are the occipital condyles, for articulation with the Atlas; they are convex articular surfaces, oval in form, and directed downwards and outwards; they approach each other anteriorly, and encroach more upon the anterior than the posterior segment of the foramen. On their inner surface is a rough tubercle, for the attachment of the check ligaments; whilst external to them is a rough tubercular prominence, the transverse, or jugular process, channelled in front by a deep notch, which forms part of the jugular foramen. The under surface of this process affords attachment to the Rectus capitis lateralis muscle; its upper or cerebral surface presents a deeply curved groove, which lodges part of the lateral sinus, whilst its prominent extremity is marked by a quadrilateral rough surface, covered with cartilage in the fresh state, and articulating with a similar surface on the petrous portion of the temporal bone. On the outer side of each condyle is a depression, the anterior condyloid fossa, perforated at the bottom by the anterior condyloid foramen. This foramen (sometimes double) is directed downwards outwards, and forwards, and transmits the lingual nerve. Behind each condyle is seen an irregular fossa, also perforated at the bottom by a foramen, the posterior condyloid, for the transmission of a vein to the lateral sinus. This fossa and foramen are less regular in form and size than the anterior, and do not always exist. Sometimes they are found on one side only, and sometimes are altogether absent. In front of the foramen magnum is the basilar process, somewhat quadrilateral in form, wider behind than in front; its under surface, which is rough, presenting in the median line a tubercular ridge, the pharyngeal spine, for the attachment of the tendinous raphe and Superior constrictor of the pharynx; and on each side of it, rough depressions for the attachment of the Recti capitis anticii, major and minor.

The Internal or Cerebral Surface (fig. 19) is deeply concave. The occipital part is divided by a crucial ridge into four fosse. The two superior, the smaller, receive the posterior lobes of the cerebrum, and present eminences and depressions corresponding to their convolutions. The two inferior, which receive the lateral lobes of the cerebellum, are larger than the former, and comparatively smooth; both are marked by slight grooves for the lodgment of arteries. At the point of meeting of the four divisions of the crucial ridge is an eminence, the internal occipital protuberance, which rarely corresponds to that on the outer surface. From this eminence, the superior division of the crucial ridge, called sulcus longitudinalis, runs upwards to the superior angle of the bone; it presents a deep groove for the superior longitudinal sinus, whilst its margins give attachment to the falx cerebri. The inferior division, the internal occipital crest, runs to the margin of the foramen magnum, on the edge of which it becomes gradually lost.
OCCIPITAL BONE.

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this ridge, which is bifurcated below, serves for the attachment of the falx cerebelli, and is slightly grooved for the lodgment of the occipital sinuses. The transverse grooves (sulci transversales) pass outwards to the lateral angles; they are deeply grooved, for the lodgment of the lateral sinuses, their prominent margins affording attachment to the tentorium cerebelli. At the point of meeting of these four grooves is a depression for the torcular Herophili, placed a little to the right of the internal occipital protuberance. In the centre of the basilar portion of the bone is the foramen magnum, and above its margin, but nearer its anterior than its posterior part, the internal openings of the anterior condylloid foramina; the internal openings of the posterior condylloid foramina being a little external and posterior to them, and protected above by a small arch of bone. In front of the foramen magnum is the basilar process, presenting a shallow longitudinal depression, the basilar groove, for supporting the medulla oblongata; whilst on its lateral margins is observed a narrow channel on each side, which, when united with a similar channel on the petrous portion of the temporal bone, forms a groove, the inferior petrosal, which lodges the inferior petrosal sinus.

Angles. The superior angle is acute, and is received into the interval between the posterior superior angles of the two parietal bones: it corresponds with that part of the head in the fetus which is called the posterior fontanelle. The inferior angle is represented by the square-shaped surface of the basilar process. At an early period of life, a layer of cartilage separates this part of the bone from the sphenoid; but in the adult, the union between them is osseous. The lateral

19.—Occipital Bone. Inner Surface.

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angles correspond to the outer ends of the transverse grooves, and are received into the interval between the posterior inferior angles of the parietal and the mastoid portion of the temporal.

Borders. The superior extends on each side from the superior to the lateral angle, is deeply serrated for articulation with the parietal bone, and forms by this union the lambdoid suture. The inferior border extends from the lateral to the inferior angle; its upper half is rough, and articulates with the mastoid portion of the temporal, forming the masto-occipital suture: the inferior half articulates with the petrous portion of the temporal, forming the petro-occipital suture: these two portions are separated from one another by the jugular process. In front of this process is a notch, which, with a similar one on the petrous portion of the temporal, forms the foramen lacerum posterior. This notch is often subdivided into two parts by a small process of bone.

Structure. The occipital bone consists of two compact laminae, called the outer and inner tables, having between them the diploic tissue; this bone is especially thick, at the ridges, protuberances, condyles, and basilar process; whilst at the bottom of the fossa it is thin, semi-transparent, and destitute of diploe.

Development (fig. 20). The occipital bone has seven centres of development; four for the posterior or occipital part, one for the basilar portion; and one for each condylar portion.

The four centres for the occipital portion are arranged in pairs above and below the occipital protuberance, and appear about the tenth week of fetal life; the inferior pair make their appearance first, and join; the superior pair become also united: these two segments now join together, and form a single piece. The condylar portions then ossify; and, lastly, the basilar portion. At birth, the bone consists of these four parts, separate from one another, the posterior being fissured in the direction of the original segments. At about the fourth year, the occipital and the two condylar pieces join; and at about the sixth year the bone consists of a single piece. At a later period, between the eighteenth and twenty-fifth years, the occipital and sphenoid become united, forming a single bone.

Articulations. With six bones; two parietal, two temporal, sphenoid, and Atlas.

Attachment of Muscles. To the superior curved line are attached the Occipitofrontalis, Trapezius, and Sterno-cleido-mastoid. To the space between the curved lines, the Complexus, Splenius capitis, and Obliquus superior; to the inferior curved line, and the space between it and the foramen magnum, the Rectus posticus major and minor; to the transverse process, the Rectus lateralis; and to the basilar process, the Recti antici majores and minores, and Superior Constrictor of the pharynx.

The Parietal Bones.

The Parietal Bones form the sides and roof of the skull; they are of an irregular quadrilateral form, and present for examination two surfaces, four borders, and four angles.

Surfaces. The External Surface (fig. 21) is convex, smooth, and presents about its centre an eminence, called the parietal eminence, which indicates the point where ossification commenced. Crossing the centre of the bone in an arched direction
is a curved ridge, the temporal ridge, for the attachment of the temporal fascia. Above this ridge, the surface of the bone is rough and porous, and covered by the aponeurosis of the Occipito-frontalis; below it the bone is smooth, and affords attachment to the Temporal muscle. At the back part of the superior border is a small foramen, the parietal foramen, which transmits a vein to the superior longitudinal sinus. Its existence is not constant, and its position varies considerably.

The Internal Surface (fig. 22), concave, presents numerous eminences and depressions for lodging the convolutions of the brain, and minute furrows for the ramifications of the meningeal arteries: these run upwards and backwards from deep grooves, which commence in the anterior inferior angle, and at the central and posterior part of the lower border of the bone. Along the upper margin is part of a shallow groove, which, when joined to the opposite parietal, forms a channel for the superior longitudinal sinus, the elevated edges of which afford attachment to the falx cerebri. Near the groove are seen several depressions; they lodge the Pacchionian bodies. The internal opening of the parietal foramen is also seen when that aperture exists.

Borders. The superior, the longest, is dentated to articulate with its fellow of the opposite side, forming the sagittal suture. The inferior is divided into three parts; of these, the anterior is thin and pointed, bevelled at the expense of the outer surface, and overlapped by the tip of the great wing of the sphenoid; the middle portion is arched, bevelled at the expense of the outer surface, and overlapped by the squamous portion of the temporal; the posterior portion being thick and serrated for articulation with the mastoid portion of the temporal. The anterior border, deeply serrated, is bevelled at the expense of the outer surface above, and of the inner below; it articulates with the frontal bone, forming
the coronal suture. The *posterior* border, deeply denticulated, articulates with the occipital, forming the lambdoid suture.

**Angles.** The *anterior superior*, thin and pointed, corresponds with that portion of the skull which in the fetus is membranous, and is called the *anterior fontanelle*. The *anterior inferior angle* is thin and lengthened, being received in the interval between the great wing of the sphenoid and the frontal. Its inner surface is marked by a deep groove, sometimes a canal, for the middle meningeal artery. The *posterior superior angle* corresponds with the junction of the sagittal and lambdoid sutures. In the fetus this part of the skull is membranous, and is called the *posterior fontanelle*. The *posterior inferior* articulates with the mastoid portion of the temporal bone, and presents on its inner surface a broad shallow groove for the lateral sinus.

**Development.** The parietal bone is developed by one centre, which corresponds with the parietal eminence, and makes its first appearance about the fifth or sixth week of fetal life.

**Articulations.** With five bones; the opposite parietal, the occipital, frontal, temporal, and sphenoid.

**Attachment of Muscles.** To one only, the Temporal.

**The Frontal Bone.**

This bone, which resembles a cockle-shell in form, consists of two portions—a *vertical* or *frontal* portion, situated at the anterior part of the cranium, forming the forehead; and a *horizontal* or *orbito-nasal* portion, which enters into the formation of the roof of the orbits and nose.

**Vertical Portion. External Surface** (fig. 23). In the median line, traversing the bone from the upper to its lower part, is a slightly elevated ridge, and in young subjects a suture, which represents the point of union of its two lateral
halves: in the adult, this suture usually disappears. On either side of this ridge, a little below the centre of the bone, is a rounded eminence, the frontal eminence, which indicates the point where ossification commenced. The whole surface of the bone above this part is smooth, and covered by the aponeurosis of the Occipito-frontalis muscle. Below the frontal protuberance, and separated from it by a slight groove, is the superciliary ridge, a curved eminence, broad internally where it is continuous with the nasal eminence, less distinct externally as it arches outwards. Beneath the superciliary ridge is the supra-orbital arch, a curved and prominent margin, which forms the upper boundary of the orbit, and separates the vertical from the horizontal portion of the bone. At the inner third of this arch is a notch, sometimes converted into a foramen by a bony process or ligament, and called the \textit{supra-orbital notch} or \textit{foramen}. It transmits the supra-orbital artery, veins, and nerve. The supra-orbital arch terminates externally in the external angular process, and internally in the internal angular process. The external angular is a strong prominent process, which articulates with the malar: running upwards and backwards from it is a sharp curved line, the temporal ridge, for the attachment of the temporal fascia; and beneath it a slight concavity, that forms part of the temporal fossa, and gives origin to the Temporal muscle. The internal angular processes are less marked than the external, and articulate with the lachrymal bones. Between the two is a rough, uneven interval, called the \textit{nasal notch}, which articulates in the middle line with the nasal, and on either side with the nasal process of the superior maxillary bones.

\textit{Vertical Portion. Internal Surface} (fig. 24). Along the middle line of this surface is a vertical groove, sulcus longitudinalis, the edges of which unite below to form a ridge, the frontal crest; the groove lodges the superior longitudinal sinus, whilst its edges afford attachment to the falx cerebri. The crest terminates below, at a small opening, the foramen coecum, which is generally completed be-

23.—Frontal Bone. Outer Surface.
hind by the ethmoid; it lodges a process of the falx cerebri, and occasionally transmits a small vein from the nose to the superior longitudinal sinus. On either side of the groove, the bone is deeply concave, presenting eminences and depressions for the convolutions of the brain, and numerous small furrows for lodging the ramifications of the anterior meningeal arteries. Several small, irregular fosae are also seen on either side of the groove, for the reception of the Pacchionian bodies.

**Horizontal Portion. External Surface.** This portion of the bone consists of two thin plates, which form the vault of the orbits, separated from one another by the ethmoidal notch. Each orbital vault consists of a smooth, concave, triangular plate of bone, marked at its anterior and external part (immediately beneath the external angular process) by a shallow depression, the lachrymal fossa, for lodging the lachrymal gland; and at its anterior and internal part, by a depression, sometimes a tubercle, for the attachment of the fibrous pulley of the superior oblique muscle. The ethmoidal notch separates the two orbital plates: it is quadrilateral; and filled up, when the bones are united, by the cribiform plate of the ethmoid. The edges of this notch present several half-cells, which, when united with corresponding half-cells on the upper surface of the ethmoid, complete the ethmoidal cells: two grooves are also seen crossing these edges transversely; they are converted into canals by articulation with the ethmoid, and are called the anterior and posterior ethmoidal canals; they open on the inner wall of the orbit. In front of the ethmoidal notch is the nasal spine, a sharp eminence, which projects downwards and forwards, and the grooved base of which forms part of the roof of the nose. It articulates in front with the crest of the nasal bones, behind with the perpendicular plate of the ethmoid. On either side of this spine are the openings of the frontal sinuses. These are two irregular cavities,
TEMPORAL BONE.

which extend upwards and outwards, a variable distance, between the two tables of the skull, and are separated from one another by a thin bony septum. They give rise to the prominences above the root of the nose, called the nasal eminences. In the child they are absent, and they become gradually developed as age advances. They are lined by mucous membrane, and communicate with the nose by the infundibulum.

The Internal Surface of the Horizontal Portion presents the convex upper surfaces of the orbital plates, separated from each other in the middle line by the ethmoidal notch, and marked by eminences and depressions for the convolutions of the anterior lobes of the brain.

Borders. The border of the vertical portion is thick, strongly serrated, bevelled at the expense of the internal table above, where it rests upon the parietal, at the expense of the external table at each side, where it receives the lateral pressure of those bones: this border is continued below, into a triangular rough surface, which articulates with the great wing of the sphenoid. The border of the horizontal portion is thin, bevelled at the expense of the internal table, and articulates with the lesser wing of the sphenoid.

Structure. The vertical portion consists of diploic tissue, contained between two compact laminae, the bone being especially thick in the situation of the nasal eminences and external angular processes. The horizontal portion is thinner, more translucent, and composed entirely of compact tissue.

Development. The frontal bone is developed by two centres, one for each lateral half, which make their appearance, at an early period of foetal life, in the situation of the orbital arches. At birth it consists of two pieces, which afterwards become united along the middle line, by a suture which runs from the vertex to the root of the nose. This suture becomes obliterated within a few years after birth; but it occasionally remains throughout life.

Articulations. With twelve bones; two parietal, sphenoid, ethmoid; two nasal, two superior maxillary, two lachrymal, and two malar.

Attachment of Muscles. To three pairs; the Corrugator supercilii, Orbicularis palpebrarum, and Temporal.

THE TEMPORAL BONES.

The Temporal bones, situated at the side and base of the skull, present for examination a squamous, mastoid, and petrous portion.

The Squamous Portion (fig. 25), the most anterior and superior part of the bone, is flattened and scale-like in form, thin and translucent in texture. Its outer surface is smooth, convex, and grooved for the deep temporal arteries; it affords attachment to the fibres of the Temporal muscle, and forms part of the temporal fossa. At its back part may be seen a curved ridge—part of the temporal ridge; it serves for the attachment of the temporal fascia, limits the origin of the Temporal muscle, and marks the boundary between the squamous and mastoid portions of the bone. Projecting from the lower part of the squamous portion, is a long and arched process of bone, the zygomatic process. It is at first directed outwards, its two surfaces looking upwards and downwards; it then appears as if twisted upon itself, and takes a direction forwards, its surfaces now looking inwards and outwards. The superior border of this process is long, thin, and sharp, and serves for the attachment of the temporal fascia. The inferior, short, thick, and arched, has attached to it some of the fibres of the Masseter muscle. Its outer surface is convex and subcutaneous. Its inner, concave, also affords attachment to the Masseter. The extremity, broad and deeply serrated, articulates with the malar bone. This process is connected to the temporal bone by three divisions, called the roots of the zygomatic process, an anterior, middle, and posterior. The anterior, which is short, but broad and strong, runs transversely inwards into a rounded eminence, the eminentia articularis. This eminence forms the front boundary of the glenoid fossa, and in the recent state is covered with cartilage. The middle root runs obliquely inwards, and terminates at the
edge of a well-marked fissure, the Glaserian fissure; whilst the posterior, which is strongly marked, runs from the upper border of the zygoma, in an arched direction, upwards and backwards, forming the posterior part of the temporal ridge. At the junction of the anterior and middle roots is a projection, called the tubercle, for the attachment of the external lateral ligament of the lower jaw; and between these roots is a large oval depression, forming part of the glenoid fossa, for the reception of the condyle of the lower jaw. This fossa is bounded in front by the eminentia articularis; behind, by the vaginal process; and externally by the auditory process; and is divided into two parts by a narrow slit, the Glaserian fissure: the anterior part, formed by the squamous portion of the bone is smooth, covered in the recent state with cartilage, and articulates with the condyle of the lower jaw; the posterior part, rough and uneven, and formed chiefly by the vaginal process of the petrous portion, lodges part of the parotid gland. The Glaserian fissure, dividing the two, leads into the tympanum; it

lodges the processus gracilis of the malleus, and transmits the laxator tympani muscle and the anterior tympanic artery. The chorda tympani nerve passes through a separate canal parallel to the Glaserian fissure, on the outer side of the Eustachian tube, in the retiring angle between the squamous and petrous portions of the temporal bone.

The internal surface of the squamous portion (fig. 26) is concave, presents numerous eminences and depressions for the convolutions of the cerebrum, and two well marked grooves for the branches of the middle meningeal artery.

Borders. The superior border is thin, bevelled at the expense of the internal surface, so as to overlap the lower border of the parietal bone, forming the squamous suture. The anterior inferior border is thick, serrated, and bevelled alternately at the expense of the inner and outer surfaces, for articulation with the great wing of the sphenoid.
The Mastoid Portion is situated at the posterior part of the bone, its outer surface is rough, and perforated by numerous foramina, one of these, of large size, situated at the posterior border of the bone, is termed the mastoid foramen, it transmits a vein to the lateral sinus and a small artery. The position and size of this foramen are very variable, being sometimes situated in the occipital bone, or in the suture between it and the occipital. The mastoid portion is continued below into a conical projection, the mastoid process, the size and form of which varies considerably in different individuals. This process serves for the attachment of the Sterno-mastoid, Splenius capitis and Trachelo-mastoid (see fig. 25); on the inner side of the mastoid process is a deep groove, the digastric fossa, for the attachment of the Digastric muscle, and running parallel with it, but more internal, the occipital groove, which lodges the occipital artery. The internal surface presents a deeply curved groove which lodges the lateral sinus, and into it may be seen opening the mastoid foramen.

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

The Petrous Portion, so named from its extreme density and hardness, is a pyramidal process of bone, wedged in at the base of the skull between the sphenoid and occipital bones. Its direction from without is forwards, inwards, and a little downwards. It presents for examination a base, an apex, three surfaces, and three borders. The base is applied against the internal surface of the squamous and mastoid portions, its upper half being concealed, but its lower half is exposed by their divergence, which brings into view the oval expanded orifice of a canal leading into the tympanum, the meatus auditorius externus. This canal is situated between the mastoid process and the posterior and middle roots of the zygoma; its upper margin is smooth and rounded, its lower surrounded by a curved plate of
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bone, the auditory process, the free margin of which is rough for the attachment of the cartilage of the ear. The apex of the petrous portion, rough and uneven, is received into the angular interval between the spinous process of the sphenoid, and the basilar process of the occipital; it presents the anterior orifice of the carotid canal, and forms the posterior and external boundary of the foramen lacerum medium. The anterior surface (fig. 26) of the petrous portion, forms the posterior boundary of the middle fossa of the skull. This surface is continuous with the squamous portion, to which it is united by a suture, the temporal suture, the remains of which are distinct at a late period of life. Proceeding from the base to the apex, this surface presents five points for examination. 1. An eminence which indicates the situation of the superior semicircular canal. 2. A shallow groove, sometimes double, leading backwards to an oblique opening, the hiatus Fallopii, for the passage of the petrosal branch of the Vidian nerve. 3. A smaller opening immediately beneath and external to the latter for the passage of the smaller petrosal nerve. 4. Near the apex of the bone is seen the termination of the carotid canal, the wall of which in this situation is deficient in front. 5. Above the foramen is a shallow depression for the reception of the Gasserian ganglion.

The posterior surface forms the front boundary of the posterior fossa of the skull, and is continuous with the inner surface of the mastoid portion of the bone. It presents three points for examination. 1. About its centre is a large orifice, the meatus auditorius internus. This aperture varies considerably in size, its margins are smooth and rounded, and it leads into a short and oblique canal which is directed outwards and forwards. It transmits the auditory and facial nerves and auditory artery. 2. Behind the meatus auditorius is a small slit almost hidden by a thin plate of bone, and leading to a canal, the aquaeductus vestibuli; it transmits a small artery and vein, and lodges a process of the dura mater. 3. In the interval between these two openings, but above them, is an angular depression which lodges a process of the dura mater, and transmits a small vein into the cancellous tissue of the bone.

The inferior or basilar Surface (fig. 27) is rough and irregular, and forms part of the base of the skull. Passing from the apex to the base, this surface presents eleven points for examination; 1. A rough surface, quadrilateral in form, which serves partly for the attachment of the Levator palatini, and Tensor tympani muscles. 2. The opening of the carotid canal, a large circular aperture, which ascends at first vertically upwards, and then making a bend, runs horizontally forwards and inwards. It transmits the internal carotid artery, and the carotid plexus. 3. The aquaeductus cochleæ, a small triangular opening, lying on the inner side of the latter, close to the posterior border of the bone; it transmits a vein from the cochlea, which joins the internal jugular. 4. Behind these openings is a depression, the jugular fossa, which varies in depth and size in different skulls; it lodges the internal jugular vein, and with a similar depression on the margin of the occipital bone, forms the foramen lacerum posticus. 5. A small foramen for the passage of Jacobson’s nerve (the tympanic branch of the glossopharyngeal). This is seen on the ridge of bone dividing the carotid canal from the jugular fossa. 6. The canal for Arnold’s nerve, seen on the inner wall of the jugular fossa. 7. Behind the jugular fossa is a smooth square-shaped facet, the jugular surface, which articulates with the jugular process of the occipital bone. 8. The vaginal process, a very broad sheath-like plate of bone, which extends from the carotid canal to the mastoid process; it divides behind into two laminae, receiving between them the 9th point for examination, the styloid process; a long sharp spine, about an inch in length, continuous with the vaginal process, between the laminae of which it is received, and directed downwards, forwards, and inwards. It affords attachment to three muscles, the Stylo-pharyngeus, Stylo-glossus, and Stylo-hyoides, and two ligaments, the stylo-hyoid and stylo-maxillary. 10. The stylo-mastoid foramen, a rather large orifice, placed between the styloid and mastoid processes; it is the termination of the aquaeductus Fallopii, and transmits the facial nerve and stylo-mastoid artery. 11. The auricular fissure, situated between the vaginal
and mastoid processes, and transmitting the auricular branch of the pneumogastric nerve.

Borders. The superior, the longest, is grooved for the superior petrosal sinus, and has attached to it the tentorium cerebelli; at its inner extremity is a semilunar notch, upon which reclines the fifth nerve. The posterior border is intermediate in length between the superior and the anterior. Its inner half is marked by a groove, which, when completed by its articulation with the occipital, forms the channel for the inferior petrosal sinus. Its outer half presents a deep excavation for the jugular fossa, which, with a similar notch on the occipital, forms the foramen lacerum posterius. A projecting eminence of bone occasionally stands out from the centre of the notch, and divides the foramen into two parts. The anterior border is divided into two parts, an outer, joined to the squamous portion by a suture the remains of which are distinct; an inner, free, articulating with the spinous process of the sphenoid. At the angle of junction of these two parts, are seen two canals, separated from one another by a thin plate of bone, the processus cochleariformis; they both lead into the tympanum, the upper one transmitting the Tensor tympani muscle, the lower one the Eustachian tube.

Structure. The squamous portion is like that of the other cranial bones, the mastoid portion cellular, and the petrous portion dense and hard.

Development (fig. 28). The temporal bone is developed by four centres, exclusive of those for the internal ear and the ossicula, viz.:—one for the squamous portion including the zygoma, one for the petrous and mastoid parts, one for the styloid, and one for the auditory process (tympanic bone). The first traces of the development of this bone are found in the squamous portion, they appear about the time when osseous matter is deposited in the vertebrae; the auditory process succeeds
next, it consists of an elliptical portion of bone, forming about three-fourths of a circle, the deficiency being above; it is grooved along its concave surface for the attachment of the membrana tympani, and becomes united by its extremities to the squamous portion during the last months of intra-uterine life. The petrous and mastoid portions then become ossified, and lastly the styloid process, which remains separate a considerable period, and is occasionally never united to the rest of the bone. At birth the temporal bone, excluding the styloid process, is formed of three pieces, the squamous and zygomatic, the petrous and mastoid, and the auditory. The auditory process joins with the squamous about the ninth month. The petrous and mastoid join with the squamous during the first year, and the styloid process becomes united between the second and third years. The subsequent changes in this bone are the extension outwards of the auditory process so as to form the meatus auditotius, the g Toloid fossa becomes deeper, and the mastoid part enlarges from the development of numerous cellular cavities in its interior.

Articulations. With five bones, occipital, parietal, sphenoid, inferior maxillary and malar.

Attachment of Muscles. To the squamous portion, the Temporal; to the zygoma, the Masseter; to the mastoid portion, the Occipito-frontalis, Sfero-mastoid, Splenius capitis, Tracheo-mastoid, Digastricus and Retrahens aurem; to the styloid process, the Stylo-pharyngeus, Stylo-hyoidens and Stylo-glossus; and to the petrous portion, the Levator palati, Tensor tympani, and Stapedius.

The Sphenoid Bone.

The Sphenoid (σφης, a 'wedge'; eidos, 'like') is situated at the anterior part of the base of the skull, articulating with all the other cranial bones, which it binds firmly and solidly together. In its form it somewhat resembles a bat, with its wings extended; and is divided into a central portion or body, two greater and two lesser wings extending outwards on each side of the body; and two processes, the pterygoid processes, which project from it below.

The Body presents for examination four surfaces—a superior, an inferior, an anterior, and a posterior.

The superior surface (fig. 29). From before, backwards, is seen a prominent spine, the ethmoidal spine, for articulation with the ethmoid; behind this a smooth surface, presenting in the median line a slight longitudinal eminence, with a depression on each side, for lodging the olfactory nerves. A narrow transverse groove, the optic groove, bounds the above-mentioned surface behind; it lodges the optic commissure, and terminates on either side in the optic foramen, for the passage of the optic nerve and ophthalmic artery. Behind the optic groove is a small eminence, olive-like in shape, the olivary process; and still more posteriorly, a deep depression, the pituitary fossa, or sella Turcica, which lodges the pituitary body. This fossa is perforated by numerous foramina, for the transmission of nutrient vessels to the substance of the bone. It is bounded in front by two small eminences, one on either side, called the middle clinoid processes, and behind by a square-shaped plate of bone, terminating at each superior angle in a tubercle, the
SPHENOID BONE.

posterior clinoid processes, the size and form of which vary considerably in different individuals. The sides of this plate of bone are notched below, for the passage of the sixth pair of nerves; and behind, it presents a shallow depression, which slopes

29.—Sphenoid Bone, Superior Surface.

obliquely backwards, and is continuous with the basilar groove of the occipital bone; it supports the medulla oblongata. On either side of the body may be seen a broad groove, curved somewhat like the italic letter J; it lodges the internal

30.—Sphenoid Bone, Anterior Surface.

carotid artery and the cavernous sinus, and is called the cavernous groove. The posterior surface, quadrilateral in form, articulates with the basilar process of the occipital bone. During childhood, a separation between these bones exists by means of a layer of cartilage; but in after-life this becomes ossified, and the two bones are immovably connected together. The anterior surface (fig. 30) presents, in the middle line, a vertical lamella of bone, which articulates in front with the
perpendicular plate of the ethmoid. On either side of it are the irregular openings leading into the sphenoidal sinuses. These are two large, irregular cavities, hollowed out of the interior of the body of the sphenoid bone, and separated from one another by a more or less complete perpendicular septum; their form varies considerably, being often subdivided by irregular osseous laminae. These sinuses do not exist in children; but they increase in size as age advances. They are partially closed, in front and below, by two thin triangular plates of bone, the sphenoidal turbinate bones, leaving a round opening at their upper parts, by which they communicate with the upper and back part of the nose, and occasionally with the posterior ethmoidal cells. The lateral margins of this surface present a serrated edge, which articulates with the os planum of the ethmoid, completing the posterior ethmoidal cells; the lower margin, also rough and serrated, articulates with the orbital process of the palate bone; and the upper margin with the orbital plate of the frontal bone. The inferior surface presents, in the middle line, a triangular spine, the rostrum, which is continuous with the vertical plate on the anterior surface, and is received into a deep fissure between the ale of the vomer. On each side may be seen a projecting lamina of bone, which runs horizontally inwards from near the base of the pterygoid process: these plates, termed the vaginal processes, articulate with the edges of the vomer. Close to the root of the pterygoid process is a groove, formed into a complete canal when articulated with the sphenoidal process of the palate bone; it is called the pterygo-palatine canal, and transmits the pterygo-palatine vessels and pharyngeal nerve.

The Greater Wings are two strong processes of bone, which arise at the sides of the body, and are curved in a direction upwards, outwards, and backwards; being prolonged behind into a sharp-pointed extremity, called the spinous process of the sphenoid. Each wing presents three surfaces and a circumference. The superior or cerebral surface forms part of the middle fossa of the skull; it is deeply concave, and presents eminences and depressions for the convolutions of the brain. At its anterior and internal part is seen a circular aperture, the foramen rotundum, for the transmission of the second division of the fifth nerve. Behind and external to this, a large oval foramen, the foramen ovale, for the transmission of the third division of the fifth, the small meningeal artery, and the small petrosal nerve. At the inner side of the foramen ovale, a small aperture may occasionally be seen opposite the root of the pterygoid process; it is the foramen Vesali, transmitting a small vein. Lastly, in the apex of the spine of the sphenoid is a short canal, sometimes double, the foramen spinosum; it transmits the middle meningeal artery. The external surface is convex, and divided by a transverse ridge, the pterygoid ridge, into two portions. The superior or larger, convex from above downwards, concave from before backwards, enters into the formation of the temporal fossa, and attaches part of the Temporal muscle. The inferior portion, smaller in size and concave, enters into the formation of the zygomatic fossa, and affords attachment to the External pterygoid muscle. It presents, at its posterior part, a sharp-pointed eminence of bone, the spinous process, to which is connected the internal lateral ligament of the lower jaw, and the Laxator tympani muscle. The pterygoid ridge, dividing the temporal and zygomatic portions, gives attachment to the upper origin of the External pterygoid muscle. At its inner extremity is a long triangular spine of bone, which serves to increase the extent of origin of this muscle. The anterior or orbital surface, smooth and quadrilateral in form, assists in forming the outer wall of the orbit. It is bounded above by a serrated edge, for articulation with the frontal bone; below, by a rounded border, which enters into the formation of the sphenomaxillary fissure; internally, it enters into the formation of the sphenoidal fissure; whilst externally it presents a serrated margin, for articulation with the malar bone. At the upper part of the inner border is a notch, for the transmission of a branch of the ophthalmic artery; and at its lower part a small pointed spine of bone, which serves for the attachment of part of the lower head of the external rectus. One or two small foramina may occasionally be seen, for the passage of
arteries; they are called the external orbitar foramina. Circumference: from the body of the sphenoid to the spine (commencing from behind), the outer half of this margin is serrated, for articulation with the petrous portion of the temporal bone; whilst the inner half forms the anterior boundary of the foramen lacerum medium, and presents the posterior aperture of the Vidian canal. In front of the spine, the circumference of the great wing presents a serrated edge, bevelled at the expense of the inner table below, and of the external above, which articulates with the squamous portion of the temporal bone. At the tip of the great wing a triangular portion is seen, bevelled at the expense of the internal surface, for articulation with the anterior inferior angle of the parietal bone. Internal to this is a broad serrated edge, for articulation with the frontal bone: this surface is continuous internally with the sharp inner edge of the orbital plate, which assists in the formation of the sphenoidal fissure.

The Lesser Wings (processes of Ingassias) are two thin triangular plates of bone, which arise from the upper and anterior part of the body of the sphenoid; and, projecting transversely outwards, terminate in a more or less acute point. The superior surface of each is smooth, flat, broader internally than externally, and supports the anterior lobe of the brain. The inferior surface forms the back part of the roof of the orbit, and the upper boundary of the sphenoidal fissure, or foramen lacerum anterius. This fissure is of a triangular form, and leads from the cavity of the cranium into the orbit; it is bounded internally by the body of the sphenoid; above, by the lesser wing; and below, by the orbital surface of the great wing; and is converted into a foramen by the articulation of this bone with the frontal. It transmits the third, fourth, ophthalmic division of the fifth and sixth nerves, and the ophthalmic vein. The anterior border of the lesser wing is serrated, for articulation with the frontal bone; the posterior, smooth and rounded, is received into the fissure of Sylvius of the brain. The inner extremity of this border forms the anterior clinoid process. The lesser wing is connected to the side of the body by two roots, the upper thin and flat, the lower thicker, obliquely directed, and presenting on its outer side a small tubercle, for the attachment of the common tendon of the muscles of the eye. Between the two roots is the optic foramen, for the transmission of the optic nerve and ophthalmic artery.

The Pterygoid processes (fig. 31), one on each side, descend perpendicularly from the point where the body and great wing unite. Each process consists of an external and an internal plate, separated behind by an intervening notch; but joined partially in front. The external pterygoid plate is broad and thin, turned a little outwards, and forms part of the inner wall of the zygomatic fossa. It gives attachment, by its outer surface, to the External pterygoid; its inner surface forms part of the pterygoid fossa, and gives attachment to the Internal pterygoid. The internal pterygoid plate is much narrower and longer, curving outwards at its extremity, into a hook-like process of bone, the hamular process, around which turns the tendon of the Tensor-palati muscle. At the base of this plate is a small, oval, shallow depression, the scaphoid fossa, from which arises the Tensor-palati, and above which is seen the posterior orifice of the Vidian canal. The outer surface of this plate forms part of the pterygoid fossa, the inner surface forming the outer boundary of the posterior aperture of the nares. The two pterygoid plates are
separated below by an angular notch, in which the pterygoid process, or tuberosity, of the palate bone is received. The anterior surface of the pterygoid process is very broad at its base, and supports Meckel’s ganglion. It presents, above, the anterior orifice of the Vidian canal; and below, a rough margin, which articulates with the perpendicular plate of the palate bone.

Development. The sphenoid bone is developed by ten centres, six for the posterior sphenoidal division, and four for the anterior sphenoid. The six centres for the post-sphenoid are, one for each greater wing and external pterygoid plate; one for each internal pterygoid plate; two for the posterior part of the body. The four for the anterior sphenoid are, one for each lesser wing and anterior part of the body; and one for each sphenoidal turbinate bone. Ossification takes place in these pieces in the following order: the greater wing and external pterygoid plate are first formed, ossific granules being deposited close to the foramen rotundum on each side, at about the second month of fetal life; ossification spreading outwards into the great wing, and downwards into the external pterygoid process. Each internal pterygoid plate is then formed, and becomes united to the external about the middle of fetal life. The two centres for the posterior part of the body appear as separate nuclei, side by side, beneath the sella Turcica; they join about the month of fetal life into a single piece, which remains ununited to the rest of the bone until after birth. Each lesser wing is formed by a separate centre, which appears on the outer side of the optic foramen, at about the third month; they become united and join with the body at about the eighth month of fetal life. At about the end of the third year, ossification has made its appearance in the sphenoidal spongy bones.

At birth, the sphenoid consists of three pieces; viz. the greater wing and pterygoid processes on each side; the lesser wings and body united. At the first year after birth, the greater wings and body are united. From the tenth to the twelfth year, the spongy bones commence their junction to the sphenoid, and become completely united by the twentieth year. Lastly, the sphenoid joins the occipital.

Articulations. The sphenoid articulates with all the bones of the cranium, and five of the face; the two malar, two palate, and vomer: the exact extent of articulation with each bone is shewn in the accompanying figures.

Attachment of Muscles. The Temporal, External pterygoid, Internal pterygoid, Superior constrictor, Tensor-palati, Laxator-typani, Levator-palpebrae, Obliquus superior, Superior rectus, Internal rectus, Inferior rectus, External rectus. For the exact attachment of the muscles of the eye to the sphenoid bone, see fig. 133.

The Sphenoidal Spongy Bones.

The Sphenoidal Spongy Bones are two thin, curved plates of bone, which exist as separate pieces up to the fifteenth year. They are situated at the anterior and inferior part of the body of the sphenoid, serving to close in the sphenoidal sinuses in this situation. They are irregular in form, thick, and tapering to a point behind, broader and thinner in front. Their inner surface, which looks towards the cavity of the sinus, is concave; their outer surface convex. Each bone articulates in front with the ethmoid, an aperture of variable size being left in their anterior wall, which communicates with the posterior ethmoidal cells: behind, its point is placed under the vomer, and is received between the root of the pterygoid process on the outer side, and the rostrum of the sphenoid on the inner: externally, it articulates with the palate.
THE ETHMOID.

The *Ethmoid* (ηθυμος, a sieve), is an exceedingly light spongy bone, of a cubical form, situated at the anterior part of the base of the cranium, between the two orbits, at the root of the nose. It consists of three parts: a horizontal plate, which forms part of the base of the cranium; a perpendicular plate, which forms part of the septum nasi; and two lateral masses of cells.

The *Horizontal or Cribriform Plate* (fig. 33) forms part of the anterior fossa of the base of the skull, and is received into the ethmoid notch of the frontal bone between the two orbital plates. Projecting upwards from the middle line of this plate, at its fore part, is a thick smooth triangular process of bone, the *cribri* galli, so called from its resemblance to a cock's-comb. Its base joins the cribriform plate. Its posterior border, long, thin, and slightly curved, serves for the attachment of the *falx cerebri*. Its anterior, short and thick, articulates with the frontal bone, and presents at its lower part two small projecting alae, which are received into corresponding depressions in the frontal, completing the foramen eecum behind. Its sides are smooth, and sometimes bulging, when it is found to enclose a small sinus. On each side of the *cribri* galli, the cribriform plate is concave, to support the bulb of the olfactory nerves, and perforated by numerous foramina for the passage of its filaments. These foramina consist of three sets, corresponding to the three sets of olfactory nerves; an inner, which are lost in grooves on the upper part of the septum; an outer set, continued on to the surface of the upper spongy bones; whilst the middle set run simply through the bone, and transmit nerves distributed to the roof of the nose. At the front part of the cribriform plate, by the side of the *cribri* galli, is a small fissure, which transmits the nasal branch of the ophthalmic nerve; and at its posterior part a triangular notch, which receives the ethmoidal spine of the sphenoid.

The *Perpendicular Plate* (fig. 34) is a thin central lamella of bone, which descends from the under surface of the cribriform plate, and assists in forming the septum of the nose. Its anterior border articulates with the frontal spine and crest of the nasal bones. Its posterior, divided into two parts, is connected by its upper half with the rostrum of the sphenoid; its lower half with the vomer. The infe-
rior border serves for the attachment of the triangular cartilage of the nose. On each side of the perpendicular plate numerous grooves and canals are seen, leading from the foramina on the cribriform plate; they lodge the filaments of the olfactory nerves.

The Lateral Masses of the ethmoid are made up of a number of thin walled cellular cavities, called the ethmoidal cells. In the disarticulated bone, many of these appear to be broken; but when the bones are articulated, they are closed in in every part. The superior surface of each lateral mass presents a number of these apparently half-broken cellular spaces; these, however, are completely closed in when articulated with the edges of the ethmoidal fissure of the frontal bone. Crossing this surface are seen two grooves on each side, converted into canals by articulation with the frontal; they are the anterior and posterior ethmoidal foramina. They open on the inner wall of the orbit, and transmit; the anterior, the anterior ethmoidal vessels and nasal nerve; the posterior, the posterior ethmoidal artery and vein. The posterior surface also presents large irregular cellular cavities, which are closed in by articulation with the sphenoidal turbinate bones, and orbital process of the palate. The cells at the anterior surface are completed by the lachrymal bone and nasal process of the superior maxillary, and those below also by the superior maxillary. On the outer surface of each lateral mass is a thin smooth square plate of bone, called the os planum; it forms part of the inner wall of the orbit, and articulates above with the frontal; below, with the superior maxillary and orbital process of the palate; in front, with the lachrymal; and behind, with the sphenoid.

The cellular cavities of each lateral mass, thus walled in by the os planum on the outer side, and by its articulation with the other bones already mentioned, are divided by a thin transverse bony partition into two sets, which do not communicate with each other; they are termed the anterior and posterior ethmoidal cells; the former, the most numerous, communicate with the frontal sinuses above, and the middle meatus below, by means of a long flexuous cellular canal, the infundibulum; the posterior, the smallest and least numerous, open into the superior meatus, and communicate (occasionally) with the sphenoidal sinuses behind. If the inner wall of each lateral mass is now examined, it will be seen how these cellular cavities communicate with the nose. The internal surface of each lateral mass presents, at its upper and back part, a narrow horizontal fissure, the superior meatus of the nose, bounded above by a thin curved plate of bone, the superior turbinate bone of the ethmoid. By means of an orifice at the top part of this fissure, the posterior ethmoidal cells open into the nose. Below the superior meatus is seen the convex surface of another thin convoluted plate of bone, the middle turbinate bone. It extends along the whole length of the inner wall of each lateral mass; its lower margin is free and thick, and its concavity, directed outwards, assists in forming the middle meatus. It is by means of a large orifice at the upper and front part of this fissure, that the anterior ethmoid cells, and through them the frontal sinuses, by means of a funnel-shaped canal, the infundibulum, communicate with the nose. It will be remarked, that the whole of this surface is rough, and marked with numerous grooves and orifices, which run nearly vertically downwards from the cribriform plate; they lodge the branches of the olfactory nerve, which are distributed on the mucous membrane covering this surface. From the inferior part of each lateral mass, immediately beneath the os planum, there projects downwards and backwards an irregular lamina of bone, called the unifor\textit{m process}, from its hook-like form; it serves to close in the upper part of the orifice of the antrum, and articulates with the inferior turbinate bone.

Development. By three centres; one for the perpendicular lamella, and one for each lateral mass.

The lateral masses are first developed, ossific granules making their first appearance in the os planum between the fourth and fifth months of fetal life, and afterwards in the spongy bones. At birth, the bone consists of the two lateral
masses, which are small and ill-developed; but when the perpendicular and horizontal plates begin to ossify, as they do about the first year after birth, the lateral masses become joined to the cribiform plate. The formation and increase in the ethmoidal cells, which complete the formation of the bone, take place about the fifth or sixth year.

Articulations. With fifteen bones; the sphenoid, two sphenoidal turbinated, the frontal, and eleven of the face—two nasal, two superior maxillary, two lachrymal, two palate, two inferior turbinated, and vomer.

THE WORMIAN BONES.

The Wormian* bones, called also, from their generally triangular form, *ossa triqueta*, are irregular plates of bone, presenting much variation in situation, number, and size. They are most commonly found in the course of the sutures, especially the lambdoid and sagittal, where they occasionally exist of large size; the superior angle of the occipital, and the anterior superior angle of the parietal, being occasionally replaced by large Wormian bones. They are not limited to the vertex, for they are occasionally found at the side of the skull, in the situation of the anterior inferior angle of the parietal bone, and in the squamous suture; and more rarely they have been found at the base, in the suture between the sphenoid and ethmoid bones. Their size varies, in some cases not being larger than a pin's head, and confined entirely to the outer table; in other cases so large, that a pair of these bones formed the whole of that portion of the occipital bone above the superior curved lines, as described by Beclard and others. Their number is most generally limited to two or three; but more than a hundred have been found in the skull of an adult hydrocephalic skeleton. It appears most probable that they are separate accidental points of ossification, which, during their development and growth, remain separate from the adjoining bones. In their development, structure, and mode of articulation, they resemble the other cranial bones.

BONES OF THE FACE.

The Facial Bones are fourteen in number, viz., the

Two Nasal,
Two Superior Maxillary,
Two Lachrymal,
Two Malar,
Two Palate,
Two Inferior Turbinated,
Vomer,
Inferior Maxillary.

NASAL BONES.

The Nasal Bones (figs. 35, 36) are two small oblong bones, varying in size and form in different individuals; they are placed side by side at the middle and upper part of the face, forming by their junction the bridge of the nose. Each bone presents for examination two surfaces, and four borders. The outer surface is concave from above downwards, convex from side to side, it is covered by the Compressor nasi muscle, marked by numerous small arterial furrows, and perforated about its centre by a foramen, sometimes double, for the transmission of a small vein. Sometimes this foramen is absent on one or both sides, and occasionally the foramen coecum opens on this surface. The inner surface

* Wormius, a physician in Copenhagen.
is concave from side to side, convex from above downwards; in which direction it is traversed by a well marked longitudinal groove, sometimes a canal, for the passage of a branch of the nasal nerve. The superior border is narrow, thick, and serrated for articulation with the nasal notch of the frontal bone. The inferior border is broad, thin, sharp, directed obliquely downwards, outwards and backwards; serving for the attachment of the lateral cartilage of the nose. This border presents about its centre a notch, which transmits the branch of the nasal nerve above referred to, and is prolonged at its inner extremity into a sharp spine, which, when articulated with the opposite bone, forms the nasal angle. The external border is serrated, bevelled at the expense of the internal surface above, and of the external below, to articulate with the nasal process of the superior maxillary. The internal border, thicker above than below, articulates with its fellow of the opposite side, and is prolonged behind into a vertical crest, which forms part of the septum of the nose; this crest articulates with the nasal spine of the frontal above, and the perpendicular plate of the ethmoid below.

Development. By one centre for each bone, which appears about the same period as in the vertebrae.

Articulations. With four bones; two of the cranium, the frontal and ethmoid, and two of the face, the opposite nasal and the superior maxillary.

No muscles are directly attached to this bone.

Superior Maxillary Bone.

The Superior Maxillary is one of the most important bones of the face in a surgical point of view, on account of the number of diseases to which some of its parts are liable. Its minute examination becomes, therefore, a matter of considerable importance. It is the largest bone of the face, excepting the lower jaw, and forms, by its union with its fellow of the opposite side, the whole of the upper jaw. Each bone assists in the formation of three cavities, the roof of the mouth, the floor and outer wall of the nose, and the floor of the orbit; enters into the formation of two fosses, the zygomatic and sphenomaxillary, and two fissures, the sphenomaxillary, and pterygo-maxillary. Each bone presents for examination a body and four processes, malar, nasal, alveolar, and palatine.

The body is somewhat quadrilateral, and is hollowed out in its interior to form a large cavity, the antrum of Highmore. It presents for examination four surfaces, an external or facial, a posterior or zygomatic, a superior or orbital, and an internal.

The external or facial surface (fig. 37) is directed forwards and outwards. In the median line of the bone, just above the incisor teeth, is a depression, the incisive or myrtiform fossa, which gives origin to the Depressor labii superioris alaeque nasi. Above and a little external to it, the Compressor naris arises. More external and immediately beneath the orbit, is another depression, the canine fossa, larger and deeper than the incisive fossa, from which it is separated by a vertical ridge, the canine eminence, corresponding to the socket of the canine tooth. The canine fossa gives origin to the Levator anguli oris. Above the canine fossa is the infra orbital foramen, the termination of the infra-orbital canal; it transmits the infra-orbital nerve and artery. Above the infra-orbital foramen is the margin of the orbit, which affords partial attachment to the Levator labii superioris proprius muscle.

The posterior or zygomatic surface is convex, directed backwards and outwards, and forms part of the zygomatic fossa. It presents about its centre two or three grooves leading to canals in the substance of the bone; they are termed the posterior dental canals, and transmit the posterior dental vessels and nerves. At the lower part of this surface is a rounded eminence, the maxillary tuberosity, especially prominent after the growth of the wisdom-tooth, rough on its inner side for articulation with the tuberosity of the palate bone. At the upper and inner part of this surface is the commencement of a groove, which, running down on the
nasal surface of the bone, is converted into a canal by articulation with the palate bone, forming the posterior palatine canal.

The superior or orbital surface is thin, smooth, irregularly quadrilateral, and forms part of the floor of the orbit. It is bounded internally by an irregular margin which articulates with three bones; in front, with the lachrymal; in the middle, with the os planum of the ethmoid; and behind, with the orbital process of the palate bone; posteriorly, by a smooth rounded edge which enters into the formation of the spheno-maxillary fissure, and which sometimes articulates at its anterior extremity with the orbital plate of the sphenoid; bounded externally by

37.—Left Superior Maxillary Bone. Outer Surface.

Outer Surface.

the malar process, and in front by part of the circumference of the orbit continuous, on the inner side, with the nasal, on the outer side, with the malar process. Along the middle line of this surface is a deep groove, the infra-orbital, for the passage of the infra-orbital nerve and artery. This groove commences at the middle of the posterior border of the bone, and, passing forwards, terminates in a canal which subdivides into two branches; one of the canals, the infra-orbital, opens just below the margin of the orbit; the other, the smaller and most posterior one, runs in the substance of the anterior wall of the antrum; it is called the anterior dental, transmitting the anterior dental vessels and nerves to the front teeth of the upper jaw.

The internal surface (fig. 38) is unequally divided into two parts by a horizontal projection of bone, the palatine process; that portion above the palate-process forms part of the outer wall of the nose; the portion below it forms part of the cavity of the mouth. The superior division of this surface presents a large irregular shaped opening leading into the antrum of Highmore. At the upper border of this aperture are a number of broken cellular cavities, which, in the articulated skull, are closed in by the ethmoid and lachrymal bones. Below the aperture, is a smooth concavity which forms part of the inferior meatus of the nose, traversed by a fissure, the maxillary fissure, which runs from the lower part of the orifice of the antrum obliquely downwards and forwards, and receives the maxillary process of the palate. Behind it, is a rough surface which articulates with the perpendicular plate of the palate bone, traversed by a groove which, com-
mencing near the middle of the posterior border, runs obliquely downwards and forwards, and forms, when completed by its articulation with the palate bone, the posterior palatine canal. In front of the opening in the antrum is a deep groove, converted into a canal by the lachrymal and inferior turbinated bones, and lodging the nasal duct. More anteriorly is a well marked rough ridge, the inferior turbinated crest, for articulation with the inferior turbinated bone. The concavity above this ridge forms part of the middle meatus of the nose, whilst that below it forms part of the inferior meatus. The inferior division of this surface is concave, rough and uneven, and perforated by numerous small foramina for the passage of nutrient vessels.

38.—Left Superior Maxillary Bone. Inner Surface.

The Antrum of Highmore, or Maxillary Sinus, is a large triangular-shaped cavity, hollowed out of the body of the maxillary bone; its apex, directed outwards, is formed by the malar process; its base, by the outer wall of the nose. Its walls are everywhere exceedingly thin, its roof being formed by the orbital plate, its floor by the alveolar process, bounded in front by the facial surface, and behind by the zygomatic. Its inner wall, or base, presents, in the disarticulated bone, a large irregular aperture, which communicates with the nasal fossa. The margins of this aperture are thin and ragged, and the aperture itself is much constricted by its articulation with the ethmoid above, the inferior turbinated below, and the palate bone behind. In the articulated skull, this cavity communicates with the middle meatus of the nose generally by two small apertures left between the above-mentioned bones. In the recent state, usually only one small opening exists, near the upper part of the cavity, sufficiently large to admit the end of a probe, the rest being filled in by the lining membrane of the sinus.

Crossing the cavity of the antrum are often seen several projecting laminæ of bone, similar to those seen in the sinuses of the cranium; and on its outer wall are the posterior dental canals, transmitting the posterior dental vessels and nerves to the teeth. Projecting into the floor are several conical processes, corresponding to the roots of the first and second molar teeth; in some cases, the floor is even perforated by the teeth in this situation. It is from the extreme thinness of the walls of this cavity, that we are enabled to explain how tumours, growing from the
The \textit{Malar Process} is a rough triangular eminence, situated at the angle of separation of the facial from the zygomatic surface. In front, it is concave, forming part of the facial surface; behind, it is also concave, and forms part of the zygomatic fossa; superiorly, it is rough and serrated for articulation with the malar bone; whilst below, a prominent ridge, marks the division between the facial and zygomatic surfaces.

The \textit{Nasal Process} is a thick triangular plate of bone, which projects upwards, inwards, and backwards, by the side of the nose, forming its lateral boundary. Its external surface is concave, smooth, perforated by numerous foramina, and gives attachment to the Levator labii superioris alaeque nasi, the Orbicularis palpebrarum, and Tendo oculi. Its internal surface forms part of the inner wall of the nares; it articulates above with the frontal, and presents a rough uneven surface which articulates with the ethmoid bone, closing in the anterior ethmoid cells; below this is a transverse ridge, the superior turbinated crest, for articulation with the middle turbinated bone of the ethmoid, bounded below by a smooth concavity, which forms part of the middle meatus; below this is the inferior turbinated crest (already described), for articulation with the inferior turbinated bone; and still more inferiorly, the concavity which forms part of the inferior meatus. The anterior border of the nasal process is thin, and serrated for articulation with the nasal bone: its posterior border thick, and hollowed into a groove for the nasal duct; of the two margins of this groove, the inner one articulates with the lachrymal bone, the outer one forming part of the circumference of the orbit. Just where this border joins the orbital surface is a small tubercle, the lachrymal tubercle. This serves as a guide to the surgeon in the perforation of the operation for fistula lachrymalis. The lachrymal groove in the articulated skull is converted into a canal by the lachrymal bone, and lachrymal process of the inferior turbinated; it is directed downwards, and a little backwards and outwards, is about the diameter of a goose-quill, slightly narrower in the middle than at either extremity, and lodges the nasal duct.

The \textit{Alveolar Process} is the thickest part of the bone, broader behind than in front, and excavated into deep cavities for the reception of the teeth. These cavities are eight in number, and vary in size and depth according to the teeth they contain: those for the canine teeth being the deepest; those for the molars being widest, and subdivided into minor cavities; those for the incisors being single, but deep and narrow.

The \textit{Palate Process}, thick and strong, projects horizontally inwards from the inner surface of the bone. It is much thicker in front than behind, and forms the floor of the nares, and the roof of the mouth. Its upper surface is concave from side to side, smooth, and forms part of the floor of the nose. In front is seen the upper orifice of the anterior palatine (incisor) canal, which leads into a fossa formed by the junction of the two superior maxillary bones, and situated immediately behind the incisor teeth. It transmits the anterior palatine vessels, the naso-palatine nerves passing through the inter-maxillary suture. The inferior surface, also concave, is rough and uneven, and forms part of the roof of the mouth. This surface is perforated by numerous foramina for the passage of nutritious vessels, channelled at the back part of its ayecolar border by a longitudinal groove, sometimes a canal, for the transmission of the posterior palatine vessels, and a large nerve, and presents little depressions for the lodging of the paltine glands. This surface presents anteriorly the lower orifice of the anterior palatine fossa. The outer border is firmly united with the rest of the bone. The inner border is thicker in front than behind, raised above into a ridge, which, with the corresponding ridge in the opposite bone, forms a groove for the reception of the vomer. The anterior margin is bounded by the thin concave border of the opening of the nose, prolonged forwards internally into a sharp process, forming,
with a similar process of the opposite bone, the anterior nasal spine. The posterior border is serrated for articulation with the horizontal plate of the palate bone.

Development (fig. 39). This bone is formed at such an early period, and ossification proceeds in it with such rapidity, that it has been found impracticable hitherto to determine with accuracy its number of centres. It appears, however, probable that it has four centres of development, viz., one for the nasal and facial portions, one for the orbital and malar, one for the incisive, and one for the palatal portion, including the entire palate except the incisive segment. The incisive portion is indicated in young bones by a fissure, which marks off a small segment of the palate, including the two incisor teeth. In some animals, this remains permanently as a separate piece, constituting the intermaxillary bone; and in the human subject, where the jaw is malformed, a detached piece is often found in this situation, most probably depending upon arrest of development of this centre. The maxillary sinus appears at an earlier period than any of the other sinuses, its development commencing about the fourth month of fetal life.

Articulations. With nine bones; two of the cranium—the frontal and ethmoid, and with seven of the face, viz., the nasal, malar, lachrymal, inferior turbinated, palate, vomer, and its fellow of the opposite side. Sometimes it articulates with the orbital plate of the sphenoid.

Attachment of Muscles. Orbicularis palpebrarum, Obliquus inferior oculi, Levator labii superioris alaeque nasi, Levator labii superioris proprius, Levator anguli oris, Compressor naris, Depressor alae nasi, Masseter, Buccinator.

The Lachrymal Bones.

The Lachrymal are the smallest and most fragile of all the bones of the face, situated at the front part of the inner wall of the orbit, and resemble somewhat in form, thinness, and size, a finger-nail; hence they are termed the ossa unguis. Each bone presents for examination, two surfaces and four borders. The external (fig. 40) or orbital surface is divided by a vertical ridge into two parts. The portion of bone in front of this ridge presents a smooth, concave, longitudinal groove, the free margin of which unites with the nasal process of the superior maxillary bone, completing the lachrymal groove. The upper part of this groove lodges the lachrymal sac; the lower part is continuous with the lachrymal canal, and lodges the nasal duct. The portion of bone behind the ridge is smooth, slightly concave, and forms part of the inner wall of the orbit. The
ridge, and part of the orbital surface immediately behind it, affords attachment to the Tensor tarsi; it terminates below in a small hook-like process, which articulates with the lachrymal tubercle of the superior maxillary bone, and completes the upper orifice of the lachrymal canal. It sometimes exists as a separate piece, which is then called the lesser lachrymal bone. The internal or nasal surface presents a depressed furrow, corresponding to the elevated ridge on its outer surface. The surface of bone in front of this forms part of the middle meatus; and that behind it articulates with the ethmoid bone, filling in the anterior ethmoidal cells. Of the four borders, the anterior is the longest, and articulates with the nasal process of the superior maxillary bone. The posterior, thin and uneven, articulates with the os planum of the ethmoid. The superior border, the shortest and thickest, articulates with the internal angular process of the frontal bone. The inferior is divided by the lower edge of the vertical crest into two parts, the posterior articulating with the orbital plate of the superior maxillary bone; the anterior portion being prolonged downwards into a pointed process, which articulates with the lachrymal process of the inferior turbinate bone, assisting in the formation of the lachrymal canal.

Development. By a single centre, which makes its appearance soon after ossification of the vertebrae has commenced.

Articulations. With four bones; two of the cranium, the frontal and ethmoid, and two of the face, the superior maxillary and the inferior turbinated.

Attachment of Muscles. The Tensor tarsi.

THE MALAR BONES.

The Malar are two small quadrangular bones, situated at the upper and outer part of the face, forming the prominence of the cheek, part of the outer wall and floor of the orbit, and part of the temporal and zygomatic fossae. Each bone presents for examination an external and an internal surface; four processes, the frontal, orbital, maxillary, and zygomatic; and four borders. The external surface (fig. 41) is smooth, convex, perforated near its centre by one or two small apertures, the malar canals, for the passage of small nerves and vessels, covered by the Orbicularis palpebrarum muscle, and affords attachment to the Zygomaticus major and minor muscles.

The internal surface (fig. 42), directed backwards and inwards, is concave, presenting internally a rough triangular surface, for articulation with the superior maxillary bone; and externally, a smooth concave surface, which forms the anterior boundary of the temporal fossa above, wider below, where it forms part of the zygomatic fossa. This surface presents a little above its centre the aperture of one or two malar canals, and affords attachment to part of two muscles, the temporal above, and the masseter below. Of the four processes, the frontal is thick and serrated, and articulates with the external angular process of the frontal bone. The orbital process is a thick and strong plate, which projects backwards from the orbital margin of the bone. Its upper surface, smooth and concave, forms, by its junction with the great ala of the sphenoid, the outer wall of the orbit. Its under surface, smooth and convex, forms part of the temporal fossa. Its anterior margin is smooth and rounded, forming part of the circumference of the orbit. Its superior margin, rough, and
directed horizontally, articulates with the frontal behind the external angular process. Its posterior margin is rough and serrated, for articulation with the sphenoid; internally it is also serrated for articulation with the orbital process of the superior maxillary. At the angle of junction of the sphenoid and maxillary portions, a short rounded non-articular margin is sometimes seen; this forms the anterior boundary of the sphenomaxillary fissure: occasionally, no such non-articular surface exists, the fissure being completed by the direct junction of the maxillary and sphenoid bones, or by the interposition of a small Wormian bone in the angular interval between them.

On the upper surface of the orbital process are seen the orifices of one or two malar canals; one of these usually opens on the posterior surface, the other (occasionally two), on the facial surface: they transmit filaments of the orbital branch of the superior maxillary nerve. The maxillary process is a rough triangular surface, which articulates with the superior maxillary bone. The zygomatic process, long, narrow, and serrated, articulates with the zygomatic process of the temporal bone. Of the four borders, the superior, or orbital, is smooth, arched, and forms a considerable part of the circumference of the orbit. The inferior, or zygomatic, is continuous with the lower border of the zygomatic arch, affording attachment by its rough edge to the Masseter muscle. The anterior or maxillary border is rough, and bevelled at the expense of its inner table, to articulate with the superior maxillary bone; affording attachment by its outer margin to the levator labii superioris proprius, just at its point of junction with the superior maxillary. The posterior or temporal border, curved like an italic ł, is continuous above with the commencement of the temporal ridge; below, with the upper border of the zygomatic arch; it affords attachment to the temporal fascia.

Development. By a single centre of ossification, which appears at about the same period when ossification of the vertebrae commences.

Articulations. With four bones: three of the cranium, frontal, sphenoid, and temporal; and one of the face, the superior maxillary.

Attachment of Muscles. Levator labii superioris proprius, Zygomaticus major and minor, Masseter, and Temporal.

The Palate Bones.

The Palate Bones are situated at the posterior part of the nasal fossæ, wedged in between the superior maxillary and the pterygoid process of the sphenoid. In form they are somewhat like the letter L. Each bone assists in the formation of three cavities: the floor and outer wall of the nose, the roof of the mouth, and the floor of the orbit; and enters into the formation of three fossæ; the zygomatic, sphenomaxillary, and pterygoid. Each bone consists of two portions; an inferior or horizontal plate, a superior or vertical plate.

The Horizontal Plate is thick, of a quadrilateral form, and presents two surfaces and four borders. The superior surface, concave from side to side, forms the back part of the floor of the nares. The inferior surface, slightly concave and rough, forms the back part of the hard palate. At its posterior part may be seen a transverse ridge, more or less marked, for the attachment of the tendon of the Tensor palati muscle. At the outer extremity of this ridge is a deep groove, con-
verted into a canal by its articulation with the tuberosity of the superior maxillary bone, and forming the posterior palatine canal. Near this groove, the orifices of one or two small canals, accessory posterior palatine, may frequently be seen. The anterior border is serrated, bevelled at the expense of its inferior surface, and articulates with the palate process of the superior maxillary bone. The posterior border is concave, free, and serves for the attachment of the soft palate. Its inner extremity is sharp and pointed, and when united with the opposite bone, forms a projecting process, the posterior nasal spine, for the attachment of the Azygos uvula. The external border is united with the lower part of the perpendicular plate almost at right angles. The internal border, the thickest, is serrated for articulation with its fellow of the opposite side; its superior edge is raised into a ridge, which, united with the opposite bone, forms a groove, in which the vomer is received.

The **Vertical Plate** (fig. 43) is thin, of an oblong form, and directed upwards and a little inwards. It presents two surfaces, an external and an internal, and four borders.

The **internal surface** presents at its lower part a broad shallow depression, which forms part of the lateral boundary of the inferior meatus. Immediately above this is a well marked horizontal ridge, the inferior turbinated crest, for the articulation of the inferior turbinated bone; above this, a second broad shallow depression may be seen, which forms part of the lateral boundary of the middle meatus, surmounted above by a horizontal ridge, less prominent than the inferior, the superior turbinated crest, for the articulation of the middle turbinated bone. Above the superior turbinated crest is a narrow horizontal groove, which forms part of the superior meatus. The external surface is rough and irregular throughout the greater part of its extent, for articulation with the inner surface of the superior maxillary bone, its upper and back part being smooth where it enters into the formation of the zygomatic fossa; it is also smooth in front, where it covers the orifice of the antrum. This surface presents towards its back part a deep groove, converted into a canal, the posterior palatine, by its articulation with the superior maxillary bone. It transmits the posterior palatine vessels and a large nerve. The anterior border is thin, irregular, and presents opposite the inferior turbinated crest, a pointed projecting lamina, the maxillary process of the palate bone, which is directed forwards, and closes in the lower and back part of the opening of the antrum, being received into a fissure that exists at the inferior part of this aperture. The posterior border (fig. 44) presents a deep groove, the edges of which are serrated for articulation with the pterygoid process of the sphenoid. At the lower part of this border is seen a pyramidal process of bone, the *pterygoid process* or tuberosity of the palate, which is received into the angular interval between the two pterygoid plates of the sphenoid at their inferior extremity. This process presents at its back part three grooves, a median and two lateral ones. The former is smooth, and forms part of the pterygoid fossa, affording attachment to the Internal pterygoid muscle;
whilst the lateral grooves are rough and uneven, for articulation with the anterior border of each pterygoid plate. The base of this process, continuous with the horizontal portion of the bone, presents the apertures of the accessory descending palatine canals; whilst its outer surface is rough, for articulation with the inner surface of the body of the superior maxillary bone. The superior border of the vertical plate presents two well marked processes, separated by an intervening notch or foramen. The anterior, or larger, is called the orbital process; the posterior, the sphenoidal. The Orbital Process, directed upwards and outwards, is placed on a higher level than the sphenoidal. It presents five surfaces, which enclose a hollow cellular cavity, and is connected to the perpendicular plate by a narrow constricted neck. Of these five surfaces, three are articular, two non-articular, or free surfaces. The three articular are the anterior or maxillary surface, which is directed forwards, outwards, and downwards, is of an oblong form, and rough for articulation with the superior maxillary bone. The posterior or sphenoidal surface, is directed backwards, upwards, and inwards. It ordinarily presents a small half-cellular cavity which communicates with the sphenoidal sinus, and the margins of which are serrated for articulation with the vertical part of the sphenoidal turbinated bone. The internal or ethmoidal surface is directed inwards, upwards and forwards, and articulates with the lateral mass of the ethmoid bone. In some cases, the cellular cavity above-mentioned opens on this surface of the bone, it then communicates with the posterior ethmoidal cells. More rarely it opens on both surfaces, and then communicates with the posterior ethmoidal cells, and the sphenoidal sinus. The non-articular or free surfaces of the orbital process are the superior or orbital, directed upwards and outwards, of a triangular form, concave, smooth, articulating with the superior maxillary bone, and forming the back part of the floor of the orbit. The external or zygomatic surface, directed outwards, backwards and downwards, is of an oblong form, smooth, and forms part of the zygomatic fossa. This surface is separated from the orbital by a smooth rounded border, which enters into the formation of the sphen-maxillary fissure.

The Sphenoidal Process of the palate bone is a thin compressed plate, much smaller than the orbital, and directed upwards and inwards. It presents three surfaces and two borders. The superior surface, the smallest of the three, articulates with the horizontal part of the sphenoidal turbinated bone; it presents a groove which contributes to the formation of the pterygo-palatine canal. The internal surface is concave, and forms part of the outer wall of the nasal fossa. The external surface is divided into two parts, an articular, and a non-articular portion; the non-articular portion is smooth and free, forming part of the zygomatic fossa, whilst behind is a rough surface for articulation with the inner surface of the pterygoid process of the sphenoid. The anterior border forms the posterior boundary of the sphenopalatine foramen. The posterior border, serrated at the expense of the outer table, articulates with the internal surface of the pterygoid process.

The orbital and sphenoidal processes are separated from one another by a deep
notch, which is converted into a foramen, the sphenopalatine, by articulation with the sphenoidal turbinated bone. Sometimes the two processes are united above, and form between them a complete foramen, or the notch is crossed by one or more spicula of bone, so as to form two or more foramina. In the articulated skull, this foramen opens into the back part of the outer wall of the superior meatus, and transmits the sphenopalatine vessels and nerves.

Development. From a single centre, which makes its appearance at the angle of junction of the two plates of the bone. From this point ossification spreads; inwards, to the horizontal plate; downwards, into the tuberosity; and upwards, into the vertical plate. In the fovea, the horizontal plate is much longer than the vertical; and even after it is fully ossified, the whole bone is remarkable for its shortness.

Articulations. With seven bones; the sphenoid, ethmoid, superior maxillary, inferior turbinated, vomer, opposite palate, and sphenoidal turbinated.

Attachment of Muscles. The Tensor palati, Azygus uvulae, Internal and External pterygoid.

The Inferior Turbinated Bones.

The Inferior Turbinated bones are situated one on each side of the outer wall of the nasal fossa. Each bone consists of a layer of thin 'spongy' bone, curled upon itself like a scroll, hence its name 'turbinated,' and extending horizontally across the outer wall of the nasal fossa, immediately below the orifice of the antrum. Each bone presents two surfaces, two borders, and two extremities.

The internal surface (fig. 45) is convex, perforated by numerous apertures, and traversed by longitudinal grooves and canals for the lodgment of arteries and veins. In the recent state it is covered by the lining membrane of the nose. The external surface is concave (fig. 46), and forms part of the inferior meatus. Its upper border is thin, irregular, and connected to various bones along the outer wall of the nose. It may be divided into three portions; of these, the anterior articulates with the inferior turbinated crest of the superior maxillary bone; the posterior with the inferior turbinated crest of the palate bone; the middle portion of the superior border presents three well marked processes, which vary much in their size and form. Of these the anterior and smallest, is situated at the junction of the anterior fourth with the posterior three-fourths of the bone; it is small and pointed, and is called the lachrymal process, for it articulates with the anterior inferior angle of the lachrymal bone, and by its margins, with the groove on the back of the nasal process of the superior maxillary, and thus assists in forming the lachrymal canal. At the junction of the two middle fourths of the bone, but encroaching on the latter, a broad thin plate, the ethmoidal process, ascends to join the uniform process of the ethmoid; from the lower border of this process, a thin lamina of bone curves downwards and outwards, hooking over the lower edge of the orifice of the antrum, which it narrows below; it is called the maxillary process, and fixes the bone firmly on to the outer wall of the nasal fossa. The inferior border is free, thick and cellular in structure, more especially in the centre of the bone. Both extremities are
more or less narrow and pointed. If the bone is held so that its outer concave surface is directed backwards (i.e., towards the holder), and its superior border, from which the lachrymal and ethmoidal processes project, upwards, the lachrymal process will be directed to the side to which the bone belongs.

Development. By a single centre which makes its appearance about the middle of fetal life.

Articulations. With four bones; one of the cranium, the ethmoid, and three of the face, the superior maxillary, lachrymal and palate.

No muscles are attached to this bone.

The Vomer

The Vomer (fig. 47.) is a single bone, situated vertically at the back part of the nasal fossæ, and forming part of the septum of the nose. It is thin, somewhat like a ploughshare in form, but it varies in different individuals, being frequently bent to one or the other side; it presents for examination two surfaces and four borders. The lateral surfaces are smooth, marked with small furrows for the lodgment of blood-vessels, and by a groove on each side, sometimes a canal, the naso-palatine, which runs obliquely downwards and forwards to the intermaxillary suture between the two anterior palatine canals; it transmits the naso-palatine nerve. The superior border, the thickest, presents a deep groove, bounded on each side by a horizontal projecting ala of bone; the groove receives the rostrum of the sphenoid, whilst the alæ are overlapped and retained by laminae which project from the under surface of the body of the sphenoid at the base of the pterygoid processes. At the anterior part of the groove a fissure is left for the transmission of blood-vessels to the substance of the bone. The inferior border, the longest, is broad and uneven in front, where it articulates with the two superior maxillary bones; thin and sharp behind where it joins with the palate bones. The upper half of the anterior border usually presents two laminae of bone, which receive between them the perpendicular plate of the ethmoid, the lower half consisting of a single rough edge, also occasionally channelled, which is united to the triangular cartilage of the nose. The posterior border is free, concave, and separates the nasal fossæ from one another behind. It is thick and bifid above, thin below.

Development. The vomer at an early period consists of two laminae united below, but separated above by a very considerable interval. Ossification commences in it at about the same period as in the vertebrae.

Articulations. With six bones; two of the cranium, the sphenoid and ethmoid; and four of the face, the two superior maxillary, the two palatine bones, and with the cartilage of the septum.

The vomer has no muscles attached to it.

The Inferior Maxillary Bone.

The Inferior Maxillary Bone, the largest and strongest bone of the face, serves for the reception of the inferior teeth. It consists of a curved horizontal portion, the body, and of two perpendicular portions, the rami, which join the former nearly at right angles behind.

The Horizontal portion, or body (fig. 48), is convex in its general outline, and curved somewhat like a horse-shoe. It presents for examination two surfaces
and two borders. The External Surface is convex from side to side, concave from above downwards. In the median line is a well marked vertical ridge, the symphysis; it extends from the upper to the lower border of the bone, and indicates

48.—Inferior Maxillary Bone. Outer Surface. Side View.

The point of junction of the two pieces of which the bone is composed at an early period of life. The lower part of the ridge terminates in a prominent triangular prominence, the mental process. On either side of the symphysis, just below the roots of the incisor teeth, is a depression, the incisive fossa, for the attachment of the Levator menti; and still more externally, a foramen, the mental foramen, for the passage of the mental nerve and artery. This foramen is placed just below the root of the second bicuspoid tooth. Running outwards from the base of the mental process on each side, is a well marked ridge, the external oblique line. This ridge is at first nearly horizontal, but afterwards inclines upwards and backwards, and is continuous with the anterior border of the ramus; it affords attachment to the Depressor labii inferioris and Depressor anguli oris, below it, to the Platysma myoides.

The Internal Surface (fig.49) is concave from side to side, convex from above downwards. In the middle line is an indistinct linear depression, corresponding to the symphysis externally; on either side of this depression, just below its centre, are four prominent tubercles, placed in pairs, two above and two below; they are called the genial tubercles, and afford attachment, the upper pair to the Genio-hyoglossi muscles, the lower pair to the Genio-hyodei muscles. Sometimes the tubercles on each side are blended into one, or they all unite into an irregular eminence of bone, or nothing but an irregularity may be seen on the surface of the bone at this part. On either side of the genial tubercles is an oval depression, the sublingual fossa, for lodging the sublingual gland; and beneath it a rough depression on each side, which gives attachment to the anterior belly of the Digastric muscle. At the back part of the sublingual fossa, the internal oblique line (mylo-hyoidian) commences; it is faintly marked at its commencement, but becomes more distinct as it passes upwards and outwards, and is especially prominent opposite the two last molar teeth; it divides the lateral surface of the bone into two portions, and affords attachment throughout its whole extent to the Mylo-hyoid muscle, the Superior constrictor being attached above its posterior extremity, nearer the alveolar margin. The portion of bone above this ridge is smooth, and covered by the mucous membrane of the mouth; whilst that below it presents an
oblong depression, wider behind than in front, the submaxillary fossa, for the lodgment of the submaxillary gland. The **superior** or alveolar border is wider, and its margins thicker behind than in front. It is hollowed into numerous cavities, for the reception of the teeth; these are sixteen in number, and vary in depth and size according to the teeth which they contain. At an early period of life, before the eruption of the teeth, the alveolar process is proportionally larger and deeper than in the adult, and the chief part of the body is above the oblique line. In adult life the base of the bone attains its maximum of development. In old age, on the contrary, after the loss of the teeth, the alveolar process becomes absorbed, and the chief part of the body is that which exists below the oblique line. At this period, the dental canal and mental foramen are situated close to the upper border of the bone. The **inferior border**, longer than the superior, and thicker in front than behind, is rounded; it presents a shallow groove, just where the body joins the ramus, over which the facial artery turns.

The **Perpendicular Portions**, or **Rami**, are of a quadrilateral form, and differ in their direction at various periods of life. In the fetus, they are almost parallel with the body; in youth they are oblique; in manhood they are nearly vertical, joining the body at almost a right angle. In old age, after the loss of the teeth, they again decline and assume an oblique direction. Each ramus presents for examination two surfaces, four borders, and two processes. The **external surface** is flat, marked with ridges, and gives attachment throughout nearly the whole of its extent to the Masseter muscle. The **internal surface** presents about its centre the oblique aperture of the inferior dental canal, for the passage of the inferior dental vessels and nerve. The margins of this opening are irregular, and present in front a prominent ridge, surmounted by a sharp spine, which gives attachment to the internal lateral ligament of the lower jaw; and at its lower and back part is seen a notch leading to a groove, which runs obliquely downwards to the posterior extremity of the submaxillary fossa; this groove is the mylo-hyoid, and lodges the mylo-hyoid vessels and nerve; behind the groove is a rough surface, for the insertion of the Internal pterygoid muscle. The inferior dental canal descends obliquely downwards and forwards in the substance of the ramus, and then horizontally forwards in the body; it is here placed under the alveoli, with which it communicates by small openings. On arriving at the incisor teeth, it
turns back to communicate with the mental foramen, giving off two small canals, which run forward, to be lost in the cancellous tissue of the bone beneath the incisor teeth. This canal, in the posterior two-thirds of the bone, runs nearest the internal surface of the jaw; and in the anterior third, nearer its external surface. Its walls are composed of compact tissue at either extremity, cancellous in the centre. It contains the inferior dental vessels and nerve, from which branches are distributed to the teeth through the small apertures at the bases of the alveoli. The superior border is thin, and presents two processes, separated by a deep concavity, the sigmoid notch. Of these processes, the anterior is the coronoid, the posterior the condyloid.

The Coronoid Process is a thin, flattened, triangular eminence of bone, which varies in length in different subjects. Its external surface is smooth, and affords attachment to the masseter and temporal muscles. Its internal surface gives attachment to the temporal muscle, and presents the commencement of a longitudinal ridge, which is continued to the posterior part of the alveolar process. In front of this ridge is a deep groove, continued below on to the outer side of the alveolar process; this ridge and part of the groove afford attachment above to the Temporal, below to the Buccinator muscle.

The Condyloid Process, shorter but thicker than the coronoid, consists of two portions; the condyle, and the constricted portion which supports the condyle, the neck. The condyle is of an oval form, its long axis being transverse, and placed in such a manner that its outer end is a little more forward and a little higher than its inner. It is convex from before backwards, and from side to side, the articular surface extending further on the posterior than on the anterior surface. The neck of the condyle is flattened from before backwards. Its posterior surface is convex; its anterior is hollowed out on its inner side by a depression (the pterygoid fossa), for the attachment of the External pterygoid. The lower border of the ramus is thick, straight, and continuous with the body of the bone. At its junction with the posterior border is the angle of the jaw, which is somewhat everted, rough on each side for the attachment of the masseter externally, and the internal pterygoid internally, and, between them, serving for the attachment of the stylo-maxillary ligament. The anterior border is thin above, thicker below, and continuous with the external oblique line. The posterior border is thick, smooth, and rounded, covered by the parotid gland.

The Sigmoid Notch, separating the two processes, is a deep semilunar depression, crossed by the masseteric artery and nerve.

Development. This bone is formed at such an early period of life, before, indeed, any other bone excepting the clavicle, that it has been found impossible at present to determine its earliest condition. It appears probable, however, that it is developed by two centres, one for each lateral half, the two segments meeting at the symphysis, where they become united. Additional centres have also been described for the coronoid process, the condyle, the angle, and the thin plate of bone, which forms the inner side of the alveolus. At birth it consists of two lateral halves. These join at the symphysis at the end of the first year; but a trace of separation at their upper part is seen at the commencement of the second year.

Articulations. With the glenoid fossa of the two temporal bones.

Attachment of Muscles. By its external surface, commencing at the symphysis, and proceeding backwards; Levator menti, Depressor labii inferioris, Depressor anguli oris, Platysma myoides, Buccinator, Masseter. By its internal surface, commencing at the same point; Genio-hyo-glossus, Genio-hyoides, Mylo-hyoides, Digastric, Superior constrictor, Temporal, Internal pterygoid, External pterygoid.

ARTICULATIONS OF THE CRANIAL BONES.

The bones of the cranium and face, are connected to each other by means of sutures. The Cranial Sutures may be divided into three sets: 1. Those of the vertex of the skull. 2. Those at the side of the skull. 3. Those at the base.
The sutures at the vertex of the skull are three, the sagittal, coronal, and lambdoid.

The Sagittal Suture (sagitta, an arrow) is formed by the junction of the two parietal bones, and extends from the middle of the frontal bone, backwards to the superior angle of the occipital. In childhood, and occasionally in the adult, when the two halves of the frontal bone are not united, it is continued forwards to the root of the nose. This suture sometimes presents, near its posterior extremity, the parietal foramen on each side; and in front, where it joins the coronal suture, a space is occasionally left, which encloses a large Wormian bone.

The Coronal Suture extends transversely across the vertex of the skull, and connects the frontal with the parietal bones. It commences at the extremity of the great wing of the sphenoid on one side, and terminates at the same point on the opposite side. The dentations of this suture are more marked at the sides than at the summit, and are so constructed that the frontal rests on the parietal above, whilst laterally the parietal supports the frontal.

The Lambdoid Suture, so called from its resemblance to the Greek letter λ, connects the occipital with the parietal bones. It commences on each side at the angle of the mastoid portion of the temporal bone, and inclines upwards to the end of the sagittal suture. The dentations of this suture are very deep and distinct, and are often interrupted by several small Wormian bones.

The sutures at the side of the skull are also three in number; the sphenoparietal, squamo-parietal, and masto-parietal. They are subdivisions of a single suture, formed between the lower border of the parietal, and the temporal and sphenoid bones, and extending from the lower end of the lambdoid suture behind, to the lower end of the coronal suture in front.

The Sphenoparietal is very short, and formed by the tip of the great wing of the sphenoid, and the anterior inferior angle of the parietal bone.

The Squamo-parietal, or squamous suture, is arched. It is formed by the squamous portion of the temporal bone overlapping the middle division of the lower border of the parietal.

The Masto-parietal is a short suture, deeply dentated, formed by the posterior inferior angle of the parietal, and the superior border of the mastoid portion of the temporal.

The sutures at the base of the skull are the basilar in the centre, and on each side, the petro-occipital, the masto-occipital, the petro-sphenoidal, and the squamo-sphenoidal.

The Basilar Suture is formed by the junction of the basilar surface of the occipital bone with the posterior surface of the body of the sphenoid. At an early period of life a thin plate of cartilage exists between these bones, but in the adult they become inseparably united. Between the outer extremity of the basilar suture, and the termination of the lambdoid, an irregular suture exists which is subdivided into two portions. The inner portion, formed by the union of the petrous part of the temporal, with the occipital bone, is termed the petro-occipital. The outer portion, formed by the junction of the mastoid part of the temporal with the occipital, is called the masto-occipital. Between the bones forming the petro-occipital suture, a thin plate of cartilage exists; in the masto-occipital is occasionally found the opening of the mastoid foramen. Between the outer extremity of the basilar suture and the sphenoparietal, an irregular suture may be seen formed by the union of the sphenoid with the temporal bone. The inner and smaller portion of this suture is termed the petro-sphenoidal; it is formed between the petrous portion of the temporal, and the great wing of the sphenoid; the outer portion, of greater length, and arched, is formed between the squamous portion of the temporal and the great wing of the sphenoid, it is called the squamo-sphenoidal.

The cranial bones are connected with those of the face, and the facial with each other, by numerous sutures, which, though distinctly marked, have received no special names. The only remaining suture deserving especial consideration is the
transverse. This extends across the upper part of the face, and is formed by the junction of the frontal with the facial bones; it extends from the external angular process of one side, to the same point on the opposite side, and connects the frontal with the malar, the sphenoid, the ethmoid, the lacrimal, the superior maxillary, and the nasal bones on each side.

**The Skull.**

The Skull, formed by the union of the several cranial and facial bones already described, when considered as a whole, is divisible into five regions; a superior region or vertex, an inferior region or base, two lateral regions, and an anterior region, the face.

The Superior Region, or vertex, presents two surfaces, and external and an internal. The **External Surface** is bounded in front by the nasal eminences, and superciliary ridges; behind, by the occipital protuberance and superior curved lines of the occipital bone, laterally, by an imaginary line extending from the outer end of the superior curved line, along the temporal ridge, to the external angular process of the frontal. This surface includes the vertical portion of the frontal, the greater part of the parietal, and the superior third of the occipital bone; it is smooth, convex, of an elongated oval form, crossed transversely by the coronal suture, and from before backwards by the sagittal, which terminates behind in the lambdoid. From before backwards may be seen the frontal eminences and remains of the suture connecting the two lateral halves of the frontal bone; on each side of the sagittal suture is the parietal foramen and parietal eminence, and still more posteriorly the smooth convex surface of the occipital bone.

The **Internal Surface** of the vertex is concave, presents eminences and depressions for the convolutions of the brain, and numerous furrows for the lodgment of branches of the meningeal arteries. Along the middle line of this surface is a longitudinal groove, narrow in front, where it terminates in the frontal crest, broader behind; it lodges the superior longitudinal sinus, and its margins afford attachment to the falx cerebri. On either side of it are several depressions for the Pacchionian bodies, and at its back part, the internal openings of the parietal foramina. This surface is also crossed in front by the coronal suture; from before backwards, by the sagittal; behind, by the lambdoid.

**Base of the Skull.**

The **Inferior Region**, or base of the skull presents two surfaces, an internal or cerebral, and an external or basilar.

The **Internal, or Cerebral Surface** (fig. 50.), is divisible into three parts, or fosse, called the anterior, middle, and posterior fossa of the cranium.

The **Anterior Fossa** is formed by the orbital plate of the frontal, the cribiform plate of the ethmoid, the ethmoidal process and lesser wing of the sphenoid. It is the most elevated of the three fosse, convex on each side where it corresponds to the roof of the orbits, concave in the median line in the situation of the cribiform plate of the ethmoid. It is traversed by three sutures, the ethmoido-frontal, ethmo-sphenoidal, and fronto-sphenoidal, and lodges the anterior lobes of the cerebrum. It presents in the median line from before backwards, the commencement of the groove for the superior longitudinal sinus, and crest for the attachment of the falx cerebri; the foramen cecum, this aperture is formed by the frontal and crista galli of the ethmoid, and if pervious, transmits a small vein from the nose to the superior longitudinal sinus. Behind the foramen cecum is the crista galli, the posterior margin of which affords attachment to the falx cerebri. On either side of the crista galli is the olfactory groove, which supports the bulb of the olfactory nerves, perforated by the three sets of orifices which give passage to its filaments; and in front by a slit-like opening, which transmits the nasal branch of the ophthalmic nerve. On each side are the internal openings of the anterior and posterior ethmoidal foramina, the former, situated about the middle of its outer margin, transmitting the nasal nerve, which runs in a groove along its surface, to the slit-
like opening above mentioned; whilst the latter, the posterior ethmoidal foramen, opens at the back part of this margin under cover of a projecting lamina of the

50.—Base of Skull. Inner or Cerebral Surface.

sphenoid, it transmits the posterior ethmoidal artery and vein to the posterior ethmoidal cells. Further back in the middle line is the ethmoidal spine, bounded behind by an elevated ridge, separating a longitudinal groove on each side which
support the olfactory nerves. The anterior fossa presents laterally eminences and depressions for the convolutions of the brain, and grooves for the lodgment of the anterior meningeal arteries.

The Middle Fossa, somewhat deeper than the preceding, is narrow in the middle, and becomes wider as it expands laterally. It is bounded in front by the posterior margin of the lesser wing of the sphenoid, the anterior clinoid process, and the anterior margin of the optic groove; behind, by the petrous portion of the temporal, and basilar suture; externally, by the squamous portion of the temporal, and anterior inferior angle of the parietal bone, and is divided into two lateral parts by the sella Turcica. It is traversed by four sutures, the squamous, sphenoparietal, sphenomiddle, and petro-sphenoidal.

In the middle line, from before backwards, is the optic groove, which supports the optic commissure, terminating on each side in the optic foramen, for the passage of the optic nerve and ophthalmic artery, behind is seen the olivary process, and laterally the anterior clinoid processes, which afford attachment to the folds of the dura mater, which form the cavernous sinus. In the centre of the middle fossa is the sella Turcica, a deep depression, which lodges the pituitary gland, bounded in front by a small eminence on either side, the middle clinoid process, and behind by a broad square plate of bone, surmounted at each superior angle by a tubercle, the posterior clinoid process; beneath the latter process is a groove, for the lodgment of the sixth nerve. On each side of the sella Turcica is the cavernous groove; it is broad, shallow, and curved somewhat like the italic letter $\phi$; it commences behind at the foramen lacerum medium, and terminates on the inner side of the anterior clinoid process. This groove lodges the cavernous sinus, the internal carotid artery, and the orbital nerves. The sides of the middle fossa are of considerable depth; they present eminences and depressions for the middle lobes of the brain, and grooves for lodging the branches of the middle meningeal artery; these commence on the outer side of the foramen spinosum, and consist of two large branches, an anterior and a posterior; the former passing upwards and forwards to the anterior inferior angle of the parietal bone, the latter passing upwards and backwards. The following foramina may also be seen from before backwards. Most anteriorly is the foramen lacerum anterius, or sphenoidal fissure, formed above by the lesser wing of the sphenoid; below, by the greater wing; internally, by the body of the sphenoid; and completed externally by the orbital plate of the frontal bone. It transmits the third, fourth, the three branches of the ophthalmic division of the fifth, the sixth nerve, and the ophthalmic vein. Behind the inner extremity of the sphenoidal fissure is the foramen rotundum, for the passage of the second division of the fifth or superior maxillary nerve; still more posteriorly is seen a small orifice, the foramen Vesalii; this opening is situated between the foramen rotundum and ovale, a little internal to both; it varies in size in different individuals, and transmits a small vein. It opens below in the pterygoid fossa, just at the outer side of the scaphoid depression. Posteriorly and externally is the foramen ovale, which transmits the third division of the fifth or inferior maxillary nerve, the small meningeal artery, and the small petrosal nerve. On the outer side of the foramen ovale is the foramen spinosum, for the passage of the middle meningeal artery; and on the inner side of the foramen ovale, the foramen lacerum medium. This aperture in the recent state is filled up with cartilage. On the anterior surface of the petrous portion of the temporal bone is seen from without inwards, the eminence caused by the projection of the superior semicircular canal, the groove leading to the hiatus Fallopi, for the transmission of the petrosal branch of the Vidian nerve; beneath it, the smaller groove, for the passage of the smaller petrosal nerve; and near the apex of the bone, the depression for the semilunar ganglion, and the orifice of the carotid canal, for the passage of the internal carotid artery and carotid plexus of nerves.

The Posterior Fossa, deeply concave, is the largest of the three, and situated on a lower level than either of the preceding. It is formed by the occipital, the petrous and mastoid portions of the temporal, and the posterior inferior angle of
the parietal bones; is crossed by three sutures, the petro-occipital, masto-occipital, and masto-parietal; and lodges the cerebellum, pons varolii, and medulla oblongata. It is separated from the middle fossa in the median line by the basilar suture, and on each side by the superior border of the petrous portion of the temporal bone. This serves for the attachment of the tentorium cerebelli, is grooved externally for the superior petrosal sinus, and at its inner extremity presents a notch, upon which rests the fifth nerve. Its circumference is bounded posteriorly by the groove for the lateral sinus. In the centre of this fossa is the foramen magnum, bounded on either side by a rough tubercle, which gives attachment to the odontoid ligaments; and a little above these are seen the internal openings of the anterior condyloid foramina. In front of the foramen magnum is the basilar process, grooved for the support of the medulla oblongata and pons varolii, and articulating on each side with the petrous portion of the temporal bone, forming the petro-occipital suture, the anterior half of which is grooved for the inferior petrosal sinus, the posterior half being encroached upon by the foramen lacerum posterior, or jugular foramen. This foramen is partially subdivided into two parts; the posterior and larger division transmits the internal jugular vein, the anterior the eighth pair of nerves. Above the jugular foramen is the internal auditory foramen, for the auditory and facial nerves and auditory artery; behind and external to this is the slit-like opening leading into the aqueductus vestibuli; whilst between these two latter, and near the superior border of the petrous portion, is a small triangular depression, which lodges a process of the dura mater, and occasionally transmits a small vein into the substance of the bone. Behind the foramen magnum are the inferior occipital fosse, which lodge the lateral lobes of the cerebellum, separated from one another by the internal occipital crest, which serves for the attachment of the falx cerebri, and lodges the occipital sinuses. These fosse are surmounted, above, by the deep transverse grooves for the lodgment of the lateral sinuses, that on the right side being usually larger than the left. These channels, in their passage outwards, groove the occipital bone, the posterior inferior angle of the parietal, the mastoid portion of the temporal, and the occipital just behind the jugular foramen, at the back part of which they terminate. Where this sinus grooves the mastoid part of the temporal bone, the orifice of the mastoid foramen may be seen; and just previous to its termination it has opening into it the posterior condyloid foramen.

The External Surface of the base of the Skull (fig. 51) is extremely irregular. It is bounded in front by the incisor teeth in the upper jaws; behind, by the superior curved lines of the occipital bone; and laterally, by the lower border of the malar bone, the zygomatic arch, and an imaginary line, extending from the zygoma to the mastoid process and extremity of the superior curved line of the occipit. It is formed by the palate processes of the two superior maxillary and palatal bones, the vomer, the pterygoid, under surface of the great wing, spinous process and part of the body of the sphenoid, the under surface of the squamous, mastoid, and petrous portions of the temporal, and occipital bones. The anterior part of the base of the skull is raised above the level of the rest of this surface (when the skull is turned over for the purpose of examination), surrounded by the alveolar process, which is thicker behind than in front, and excavated by sixteen depressions for lodging the teeth of the upper jaw; they vary in depth and size according to the teeth they contain. Immediately behind the incisor teeth is the anterior palatine fossa or canal. At the bottom of this fossa may usually be seen four apertures, two placed laterally, which open above, one in the floor of each nostril, and transmit the anterior palatine vessels, and two in the median line of the intermaxillary suture, one in front of the other, the most anterior one transmitting the left, and the posterior one (the larger) the right naso-palatine nerve. These two latter canals are sometimes wanting, or they may join to form a single one, or one of them may open into one of the lateral canals above referred to. The palatine vault is concave, uneven, perforated by numerous nutritious foramina, marked by depressions for the palatal glands, and crossed by a
crucial suture, which indicates the point of junction of the four bones of which it is composed. One or two small foramina, seen in the alveolar margin behind

51.—Base of Skull. External Surface.
the incisor teeth, occasionally seen in the adult, almost constant in young subjects, are called the incisive foramina; they transmit nerves and vessels to the incisor teeth. At each posterior angle is the posterior palatine foramen, for the transmission of the posterior palatine vessels and anterior palatine nerve, and running forwards and inwards from it a groove, which lodges the same vessels and nerve. Behind the posterior palatine foramen is the tuberosity of the palate bone, perforated by one or more accessory posterior palatine canals, and marked by the commencement of a ridge, which runs transversely inwards, and serves for the attachment of the tendinous expansion of the tensor palatini muscle. Projecting backwards from the centre of the posterior border of the hard palate is the posterior nasal spine, for the attachment of the Azygos uvula. Behind and above the hard palate is the posterior aperture of the nares, divided into two parts by the vomer, bounded above by the body of the sphenoid, below by the horizontal plate of the palate bone, and laterally by the pterygoid processes of the sphenoid. Each aperture measures about an inch in the vertical, and half an inch in the transverse direction. At the base of the vomer may be seen the expanded ala of this bone, receiving between them the rostrum of the sphenoid. Near the lateral margins of the vomer, at the root of the pterygoid process, are the pterygo-palatine canals. The pterygoid process, which bounds the posterior nares on each side, presents near its base the pterygoid or Vidian canal, for the Vidian nerve and artery. Each process consists of two plates, which bifurcate at the extremity to receive the tuberosity of the palate bone, and are separated behind by the pterygoid fossa, which lodges the Internal pterygoid muscle. The internal plate is long and narrow, presenting on the outer side of its base the scaphoid fossa, for the origin of the Tensor palatini muscle, and at its extremity the hamular process, around which the tendon of this muscle turns. The external pterygoid plate is broad, forms the inner boundary of the zygomatic fossa, and affords attachment to the External pterygoid muscle.

Behind the nasal fossa in the middle line is the basilar surface of the occipital bone, presenting in its centre the pharyngeal spine for the attachment of the Superior constrictor muscle of the pharynx, with depressions on each side for the insertion of the Rectus anticus major and minor. At the base of the external pterygoid plate is the foramen ovale; behind this, the foramen spinosum, and the prominent spinous process of the sphenoid, which gives attachment to the internal lateral ligament of the lower jaw and the Laxator tympani muscle. External to the spinous process is the glenoid fossa, divided into two parts by the Glaserian fissure, the anterior portion being concave, smooth, bounded in front by the eminentia articularis, and serving for the articulation of the condyle of the lower jaw; the posterior portion rough, bounded behind by the vaginal process, and serving for the reception of part of the parotid gland. Emerging from between the laminae of the vaginal process is the styloid process; and at the base of this process is the stylo-mastoid foramen, for the exit of the facial nerve, and entrance of the stylo-mastoid artery. External to the stylo-mastoid foramen is the auricular fissure for the auricular branch of the pneumogastric, bounded behind by the mastoid process. Upon the inner side of this process is a deep groove, the digastric fossa; and a little more internally, the occipital groove, for the occipital artery. At the base of the internal pterygoid plate is a large and somewhat triangular aperture, the foramen lacerum medium, bounded in front by the great wing of the sphenoid, behind by the apex of the petrous portion of the temporal bone, and internally by the body of the sphenoid and basilar process of the occipital bone; it presents in front the posterior orifice of the Vidian canal, behind the aperture of the carotid canal. This opening is filled up in the recent subject by a fibro-cartilaginous substance; across its upper or cerebral aspect passes the internal carotid artery and Vidian nerve. External to this aperture, the petro-sphenoidal suture is observed, at the outer termination of which is seen the orifice of the canal for the Eustachian tube, and that for the Tensor tympani muscle. Behind this suture is seen the under surface of the petrous portion of the temporal bone, presenting,
from within outwards, the quadrilateral rough surface, part of which affords attachment to the Levator palati and Tensor tympani muscles; behind this surface are the orifices of the carotid canal and the aqueductus cochlea, the former transmitting the internal carotid artery and the ascending branches of the superior cervical ganglion of the sympathetic, the latter serving for the passage of a small artery and vein to the cochlea. Behind the carotid canal is a very large irregular aperture, the jugular fossa, formed in front by the petrous portion of the temporal, and behind by the occipital; it is generally larger on the right than on the left side, and is perforated at the bottom by an irregular aperture; it is divided into two parts by a ridge of bone, which projects usually from the temporal; the anterior, or smaller portion, transmitting the three divisions of the eighth pair of nerves; the posterior, transmitting the internal jugular vein and the two ascending meningeal vessels, from the occipital and ascending pharyngeal arteries. On the ridge of bone dividing the carotid canal from the jugular fossa, is the small foramen for the transmission of the tympanic nerve; and on the outer wall of the jugular foramen, near the root of the styloid process, is the small aperture for the transmission of Arnold's nerve. Behind the basilar surface of the occipital bone is the foramen magnum, bounded on each side by the condyles, rough internally for the attachment of the alar ligaments, and presenting externally a rough surface, the jugular process, which serves for the attachment of the Rectus lateralis. On either side of each condyle anteriorly is the anterior condylid fossa, perforated by the anterior condylid foramina, for the passage of the lingual nerve. Behind each condyle are the posterior condylid fosses, perforated on one or both sides by the posterior condylid foramina, for the transmission of a vein to the lateral sinus. Behind the foramen magnum is the external occipital crest, terminating above at the external occipital tuberosity, whilst on each side are seen the superior and inferior curved lines; these, as well as the surfaces of the bone between them, being rough for the attachment of numerous muscles.

LATERAL REGIONS OF THE SKULL.

The Lateral Regions of the Skull are somewhat of a triangular form, their base being formed by a line extending from the external angular process of the frontal bone along the temporal ridge backwards to the outer extremity of the superior curved line of the occiput; and the sides being formed by two lines, the one drawn downwards and backwards from the external angular process of the frontal bone to the angle of the lower jaw, the other from the angle of the jaw upwards and backwards to the extremity of the superior curved line. This region is divisible into three portions, temporal, mastoid, and zygomatic.

THE TEMPORAL FOSSE.

The Temporal Portion, or fossa, is bounded above and behind by the temporal ridge, which extends from the external angular process of the frontal upwards and backwards across the frontal and parietal bones, curving downwards behind to terminate at the root of the zygomatic process. In front, it is bounded by the frontal, malar, and great wing of the sphenoid: externally, by the zygomatic arch, formed conjointly by the malar and temporal bones; below, it is separated from the zygomatic fossa by the pterygoid ridge, seen on the under surface of the great wing of the sphenoid. This fossa is formed by five bones, part of the frontal, great wing of the sphenoid, parietal, squamous portion of the temporal, and malar bones, and is traversed by five sutures, the transverse facial, coronal, sphenoparietal, squamos-parietal, and squamos-sphenoidal. It is deeply concave in front, convex behind, traversed by numerous grooves for lodging the branches of the deep temporal arteries, and filled by the temporal muscle.

The Mastoid Portion is bounded in front by the anterior horizontal root of the zygoma; above, by a line which corresponds with the posterior root of the zygoma and the masto-parietal suture; behind and inferiorly, by the masto-occipital suture. It is formed by the mastoid and part of the squamous portion of the temporal bone;
its surface is convex and rough for the attachment of muscles, and presents, from behind forwards, the mastoid foramen, below the mastoid process. In front of the mastoid process is the external auditory meatus, surrounded by the auditory process. Anterior to the meatus is the Glenoid fossa, bounded in front by the tubercle of the zygoma, behind by the auditory process, and above by the middle root of the zygoma, which terminates at the Glaserian fissure.

**The Zygomatic Fossae.**

The Zygomatic fossæ, are two irregular-shaped cavities, situated one on each side of the head, below, and on the inner side of the zygoma; bounded in front by the tuberosity of the superior maxillary bone and the ridge which descends from its malar process; behind, by the posterior border of the pterygoid process; above, by the pterygoid ridge on the under surface of the great wing of the sphenoid and squamous portion of the temporal; below, by the alveolar border of the superior maxilla; internally, by the external pterygoid plate; and externally, by the zygomatic arch and ramus of the jaw. It contains the lower part of the Temporal, the External, and Internal pterygoid muscles, the internal maxillary artery, the inferior maxillary nerve, and their branches. At its upper and inner part may be observed two fissures, the spheno-maxillary and pterygo-maxillary.

The Spheno-maxillary fissure, horizontal in direction, opens into the outer and back part of the orbit. It is formed above by the lower border of the orbital surface of the great wing of the sphenoid; below, by the posterior rounded border of the superior maxilla and a small part of the palate bone; externally, by a small part of the malar bone; internally, it joins at right angles with the pterygo-maxillary fissure. This fissure opens a communication from the orbit into three fossæ, the temporal, zygomatic, and spheno-maxillary; it transmits the superior maxillary nerve, infra-orbital artery, and ascending branches from Meckel's ganglion.

The Pterygo-maxillary fissure is vertical, and descends at right angles from the inner extremity of the preceding; it is a triangular interval, formed by the divergence of the superior maxillary bone from the pterygoid process of the sphenoid. It serves to connect the spheno-maxillary fossa with the zygomatic, and transmits branches of the internal maxillary artery.

**The Spheno-maxillary Fossa.**

The Spheno-maxillary fossa is a small triangular space situated at the angle of junction of the spheno-maxillary and pterygo-maxillary fissures, and placed beneath the apex of the orbit. It is formed above by a small part of the under surface of the body of the sphenoid; in front, by the superior maxillary bone; behind, by the pterygoid process of the sphenoid; internally by the vertical plate of the palate; externally, it communicates with the spheno-maxillary fissure. This fossa has three fissures terminating in it, the sphenoidal, spheno-maxillary, and pterygo-maxillary; it communicates with three fossæ, the orbital, nasal, and zygomatic, and with the cavity of the cranium, and has opening into it five foramina. Of these there are three on the posterior wall, the foramen rotundum above, the Vidian below and internal, and still more inferior and internal, the pterygo-palatine. On the inner wall is the sphen- palatine foramen by which it communicates with the nasal fossa, and below, the superior orifice of the posterior palatine canal, besides occasionally the orifices of two or three accessory posterior palatine canals.

**Anterior Region of the Skull.** (Fig. 52.)

The Anterior Region of the Skull, which forms the face, is of an oval form, presents an irregular surface, and is excavated for the reception of the two principal organs of sense, the eye and the nose. It is bounded above by the nasal eminences and margins of the orbit; below, by the prominence of the chin; on each side, by the malar bone, and anterior margin of the ramus of the jaw. In the median line are seen from above downwards, the nasal eminences, which indicate
the situation of the frontal sinuses; diverging outwards from them, the super-
ciliary ridges which support the eyebrows. Beneath the nasal eminences is the arch of the nose, formed by the nasal bones, and the nasal process of the superior maxillary. The nasal arch is convex from side to side, concave from above downwards, presenting in the median line the inter-nasal suture, formed between the nasal bones, laterally the naso-maxillary suture, formed between the nasal and the nasal process of the superior maxillary bones, both these sutures terminating above in that part of the transverse suture which connects the nasal bones and nasal processes of the superior maxillary with the frontal. Below the nose is seen the heart-shaped opening of the anterior nares, the narrow end upwards, and broad below; it presents laterally the thin sharp margins which serve for the attachment of the lateral cartilages of the nose, and in the middle line below, a prominent process, the anterior nasal spine, bounded by two deep notches. Below this is the intermaxillary suture, and on each side of it the incisive fossa. Beneath this fossa is the alveolar process of the upper and lower jaw, containing the incisive teeth, and at the lower part of the median line, the symphysis of the chin, the mental eminence, and the incisive fossa of the lower jaw.

Proceeding from above downwards, on each side are the supra-orbital ridges, terminating externally in the external angular process at its junction with the malar, and internally in the internal angular process; towards the inner third of this ridge is the supra-orbital notch or foramen, for the passage of the supra-orbital vessels and nerve, and at its inner side a slight depression for the attachment
of the cartilaginous pulley of the superior oblique muscle. Beneath the supra-orbital ridges are the openings of the orbits, bounded externally by the orbital ridge of the malar bone; below, by the orbital ridge formed by the malar, superior maxillary, and lachrymal bones; internally, by the nasal process of the superior maxillary, and the internal angular process of the frontal bone. On the outer side of the orbit, is the quadrilateral anterior surface of the malar bone, perforated by one or two small malar foramina. Below the inferior margin of the orbit, is the infra-orbital foramen, the termination of the infra-orbital canal, and beneath this, the canine fossa, which gives attachment to the Levator anguli oris; bounded below by the alveolar processes, containing the teeth of the upper and lower jaw. Beneath the alveolar arch of the lower jaw is the mental foramen for the passage of the mental nerve and artery, the external oblique line, and at the lower border of the bone, at the point of junction of the body with the ramus, a shallow groove for the passage of the facial artery.

The Orbits.

The Orbits (fig. 52) are two quadrilateral hollow cones, situated at the upper and anterior part of the face, their bases being directed forwards and outwards, and their apices backwards and inwards. Each orbit is formed of seven bones, the frontal, sphenoid, ethmoid, superior maxillary, malar, lachrymal and palate; but three of these, the frontal, ethmoid and sphenoid, enter into the formation of both orbits, so that the two cavities are formed of eleven bones only. Each cavity presents for examination, a roof, a floor, an inner and an outer wall, a circumference or base, and an apex. The Roof is concave, directed downwards and forwards, and formed in front by the orbital plate of the frontal; behind, by the lesser wing of the sphenoid. This surface presents internally the depression for the fibro-cartilaginous pulley of the superior oblique muscle; externally, the depression for the lachrymal gland, and posteriorly, the suture connecting the frontal and lesser wing of the sphenoid.

The Floor is nearly flat, and of less extent than the roof; it is formed chiefly by the orbital process of the superior maxillary; in front, to a small extent, by the orbital process of the malar, and behind, by the orbital surface of the palate. This surface presents at its anterior and internal part, just external to the lachrymal canal, a depression for the attachment of the tendon of origin of the inferior oblique muscle; externally, the suture between the malar and superior maxillary bones; near its middle, the infra-orbital groove; and posteriorly, the suture between the maxillary and palate bones.

The Inner Wall is flattened, and formed from before backwards by the nasal process of the superior maxillary, the lachrymal, os planum of the ethmoid, and a small part of the body of the sphenoid. This surface presents the lachrymal groove, and crest of the lachrymal bone, and the sutures connecting the ethmoid, in front, with the lachrymal, behind, with the sphenoid.

The Outer Wall is formed in front by the orbital process of the malar bone; behind, by the orbital plate of the sphenoid. On it are seen the orifices of one or two malar canals, and the suture connecting the sphenoid and malar bones.

Angles. The superior external angle is formed by the junction of the upper and outer walls; it presents from before backwards, the sutures connecting the frontal with the malar in front, and with the orbital plate of the sphenoid behind; quite posteriorly is the foramen lacerum anterius, or sphenoidal fissure, which transmits the third, fourth, ophthalmic division of the fifth, and sixth nerves, and the ophthalmic vein. The superior internal angle is formed by the junction of the upper and inner wall, and presents the suture connecting the frontal with the lachrymal in front, and with the ethmoid behind. This suture is perforated by two foramina, the anterior and posterior ethmoidal, the former transmitting the anterior ethmoidal artery and nasal nerve, the latter the posterior ethmoidal artery and vein. The inferior external angle, formed by the junction of the outer wall and floor, presents the sphen-maxillary fissure, which transmits the infra-orbital vessels and nerve, and the ascending branches from the spheno-palatine
ganglion. The *inferior internal angle* is formed by the union of the lachrymal and os planum of the ethmoid, with the superior maxillary and palate bones. The *circumference*, or base, of the orbit, quadrilateral in form, is bounded above by the supra-orbital arch; below, by the anterior border of the orbital plate of the malar, superior maxillary, and lachrymal bones; externally, by the external angular process of the frontal and malar bone; internally, by the internal angular process of the frontal and nasal process of the superior maxillary. The circumference is marked by three sutures, the fronto-maxillary internally, the fronto-malar externally, and the malar-maxillary below; it contributes to the formation of the lachrymal groove, and presents above, the supra-orbital notch (or foramen), for the passage of the supra-orbital artery, veins, and nerve. The *apex*, situated at the back of the orbit, corresponds to the optic foramen, a short circular canal, which transmits the optic nerve and ophthalmic artery. It will thus be seen that there are *nine* openings communicating with each orbit, viz., the optic, foramen lacerum anterius, spheno-maxillary fissure, supra-orbital foramen, infra-orbital canal, anterior and posterior ethmoidal foramina, malar foramina, and lachrymal canal.

**The Nasal Fossae.**

The *Nasal Fossae* are two large irregular cavities, situated in the middle line of the face, separated from each other by a thin vertical septum, and extending from the base of the cranium to the roof of the mouth. They communicate by two large apertures, the anterior nares, with the front of the face, and with the pharynx behind by the two posterior nares. These fossae are much narrower above than below, and in the middle than at the anterior or posterior openings: their depth, which is considerable, is much greater in the middle than at either extremity. Each nasal fossa communicates with four sinuses, the frontal in front, the sphenoidal behind, and the maxillary and ethmoidal on either side. Each fossa also communicates with four cavities: with the orbit by the lachrymal canal, with the mouth by the anterior palatine canal, with the cranium by the olfactory foramina, and with the sphenoidal fossa by the sphenoidal foramen; and they occasionally communicate with each other by an aperture in the septum. The bones entering into their formation are fourteen in number: three of the cranium, the frontal, sphenoid, and ethmoid, and all the bones of the face excepting the malar and lower jaw. Each cavity has four walls, a roof, a floor, an inner, and an outer wall.

The *upper wall*, or roof (fig. 53), is long, narrow, and concave from before backwards; it is formed in front by the nasal bones and nasal spine of the frontal, which are directed downwards and forwards; in the middle, by the cribriform lamella of the ethmoid, which is horizontal; and behind, by the under surface of the body of the sphenoid, and sphenoidal turbinate bones, which are directed downwards and backwards. This surface presents, from before backwards, the internal aspect of the nasal bones; on their outer side, the suture formed between the nasal, with the nasal process of the superior maxillary; on their inner side, the elevated crest which receives the nasal spine of the frontal and the perpendicular plate of the ethmoid, and articulates with its fellow of the opposite side; whilst the surface of the bones is perforated by a few small vascular apertures, and presents the longitudinal groove for the nasal nerve: further back is the transverse suture, connecting the frontal with the nasal in front, and the ethmoid behind, the olfactory foramina on the under surface of the cribriform plate, and the suture between it and the sphenoid behind: quite posteriorly are seen the sphenoidal turbinate bones, the orifice of the sphenoidal sinuses, and the articulation of the ala of the vomer with the under surface of the body of the sphenoid.

The *floor* is flattened from before backwards, concave from side to side, and wider in the middle than at either extremity. It is formed in front by the palate process of the superior maxillary; behind, by the palate process of the palate bone. This surface presents, from before backwards, the anterior nasal spine; behind this, the upper orifice of the anterior palatine canal; internally, the ele-
vated crest which articulates with the vomer; and behind, the suture between the palate and superior maxillary bones, and the posterior nasal spine.

53.—Roof, Floor, and Outer Wall of Nasal Fossa.

The inner wall, or septum (fig. 54), is a thin vertical septum, which separates the nasal fossae from one another; it is occasionally perforated, so that they communicate, and is frequently deflected considerably to one side. It is formed, in front, by the crest of the nasal bones and nasal spine of the frontal; in the middle, by the perpendicular lamella of the ethmoid; behind, by the vomer and rostrum of the sphenoid; below, by the crest of the superior maxillary and palate bones. It presents, in front, a large triangular notch, which receives the triangular cartilage of the nose; above, the lower orifices of the olfactory canals; and behind, the guttural edge of the vomer. Its surface is marked by numerous vascular and nervous canals, and traversed by sutures connecting the bones of which it is formed.

The outer wall is formed, in front, by the nasal process of the superior maxillary and lacrimal bones; in the middle, by the ethmoid and inner surface of the superior maxillary and inferior turbinated bones; behind, by the vertical plate of the palate bone. This surface presents three irregular longitudinal passages, or meatuses, formed between three horizontal plates of bone that spring from it; they are termed the superior, middle, and inferior meatuses of the nose. The superior meatus, the smallest of the three, is situated at the upper and back part of each nasal fossa, occupying the posterior third of the outer wall. It is situated between the superior and middle turbinated bones, and has opening into it two foramina, the sphenopalatine, at the back part of its outer wall, the posterior ethmoidal cells, at the front part of the upper wall. The opening of the sphenoidal sinuses is usually at the upper and back part of the nasal fossa, immediately behind the superior turbinated bone. The middle meatus, situated between the middle and inferior turbinated bones, occupies the posterior two-thirds of the outer wall of each nasal fossa. It presents two apertures. In front is the orifice of the infundibulum, by which the middle meatus communicates with the anterior ethmoidal cells, and
through these with the frontal sinuses. At the centre of the outer wall is the orifice of the antrum, which varies somewhat as to its exact position in different skulls. The inferior meatus, the largest of the three, is the space between the inferior turbinate bone and the floor of the nasal fossa. It extends along the entire length of the outer wall of the nose, is broader in front than behind, and presents anteriorly the lower orifice of the lachrymal canal.

54.—Inner Wall of Nasal Fossa, or Septum of Nose.

Os Hyoides.

The Hyoid bone is named from its resemblance to the Greek Upsilon; it is also called the lingual bone, from supporting the tongue, and giving attachment to its numerous muscles. It is a bony arch, shaped like a horse-shoe, and consisting of five segments, a central portion or body, two greater cornua, and two lesser cornua.

The Body forms the central part of the bone, is of a quadrilateral form, its anterior surface (fig. 55) convex, directed forwards and upwards, and divided into two parts by a vertical ridge, which descends along the median line, and is crossed at right angles by a horizontal ridge, so that this surface is divided into four muscular depressions. At the point of meeting of these two lines is a prominent elevation, the tubercle. The portion above the horizontal ridge is directed upwards, and is sometimes described as the superior border. The anterior surface gives attachment to the Genio-hyoid in the greater part of its extent; above, to the Genio-hyo-glossus; below, to the Mylo-hyoid, Stylo-hyoid, and aponeurosis of the Digastric; and between these to part of the Hyo-glossus. The posterior surface is smooth, concave, directed backwards and downwards, and separated from the epiglottis by the thyro-hyoid membrane, and by a quantity of loose areolar tissue. The superior border is rounded, and
gives attachment to the thyro-hyoid membrane, and part of the Genio-hyo-glossi muscles. The inferior border gives attachment in front to the Sterno-hyoid, behind to part of the Thyro-hyoid, and to the Omo-hyoid at its junction with the great cornu. The lateral surfaces are small, oval, convex facets, covered with cartilage for articulation with the greater cornua.

The Greater Cornua project backwards from the lateral surfaces of the body, they are flattened from above downwards, diminish in size from before backwards, and terminate posteriorly in a tubercle for the attachment of the thyro-hyoid ligament. Their outer surface gives attachment to the Hyo-glossus; their upper border, to the Middle constrictor of the pharynx; their lower border, to part of the Thyro-hyoid muscle.

The Lesser Cornua are two small conical shaped eminences, attached by their bases to the angles of junction between the body and greater cornua, and giving attachment by their apices to the stylo-hyoid ligaments. In youth the cornua are connected to the body by cartilaginous surfaces and held together by ligaments; in middle life, the body and greater cornua usually become joined; and in old age all the segments are united together, forming a single bone.

Development. By five centres; one for the body and one for each cornu. Ossification commences in the body and greater cornua towards the end of fetal life, those for the cornua first appearing. Ossification of the lesser cornua commences some months after birth.


THE THORAX.

The Thorax or chest is an osseo-cartilaginous cage, intended to contain and protect the principal organs of respiration and circulation. It is the largest of the three cavities connected with the spine, and is formed by the sternum and costal cartilages in front, the twelve ribs on each side, and the bodies of the dorsal vertebrae behind.

THE STERNUM.

The Sternum (figs. 56, 57) is a flat narrow bone, situated in the median line of the front of the chest, and consisting in the adult of three portions. Its form resembles an ancient sword: the upper piece representing the handle, is termed the manubrium, the middle and largest piece which represents the chief part of the blade, is termed the gladiolus, and the inferior piece like the point of the sword, is termed the ensiform or xiphoid appendix. In its natural position, its direction is oblique, its anterior surface looking upwards and forwards, its posterior downwards and backwards. It is flattened in front, concave behind, broad above, becoming narrowed at the point where the first and second pieces are connected, after which it again widens a little, and is pointed at its extremity.

The First Piece of the sternum or Manubrium, is of a somewhat triangular form, broad and thick above, narrowed below at its junction with the middle piece. Its anterior surface convex from side to side, concave from above downwards, is smooth and affords attachment on each side to the Pectoralis major and sternal origin of the Sterno-cleido-mastoid muscle. In well marked bones, ridges limiting the attachment of these muscles are very distinct. Its posterior surface, concave and smooth, affords attachment on each side to the Sterno-hyoid and Sterno-thyroid muscles. The superior border, the thickest, presents at its centre the interclavicular notch, and on each side an oval articular surface, directed upwards backwards and outwards, for articulation with the sternal end of the clavicle. The inferior border presents an oval rough surface, covered in the recent state with a thin layer of cartilage, for articulation with the second portion of the bone. The lateral borders are marked superiorly by an articular depression for the first costal carti-
56.—Sternum and Costal Cartilages. Anterior Surface.

57.—Posterior Surface of Sternum.
lage, and below by a half facet, which, with a similar facet on the upper angle of the middle portion of the bone, forms a notch for the reception of the costal cartilage of the second rib. These articular surfaces are separated by a curved edge which slopes from above downwards and inwards.

The Second Piece of the sternum, or gladiolus, considerably longer, narrower, and thinner than the superior, is broader below than above. Its anterior surface is nearly flat, directed upwards and forwards, and marked by three transverse lines which cross the bone opposite the third, fourth, and fifth articular depressions. These lines indicate the point of union of the four separate pieces of which this part of the bone consists at an early period of life. At the junction of the third and fourth pieces, is occasionally seen an orifice, the sternal foramen; it varies in size and form in different individuals, and pierces the bone from before backwards. This surface affords attachment on each side to the sternal origin of the Pectoralis major. The posterior surface, slightly concave, is also marked by three transverse lines; but they are less distinct than those on the anterior surface; this surface affords attachment below, on each side, to the Triangularis sterni muscle, and occasionally presents the posterior opening of the sternal foramen. The superior border is marked by an oval surface for articulation with the manubrium. The inferior border is narrow and articulates with the ensiform appendix. Each lateral border presents five articular depressions; the first, at each superior angle, is a half facet for the lower half of the cartilage of the second rib, the three succeeding depressions receive the cartilages of the third, fourth, and fifth ribs, whilst each inferior angle presents a half facet for the upper half of the cartilage of the seventh rib. These depressions are separated by a series of curved inter-articular notches, which diminish in length from above downwards.

The Third Piece of the sternum, the ensiform or xiphoïd appendix, is the smallest of the three; it is thin and elongated in form, cartilaginous in structure in youth, but more or less ossified at its upper part in the adult. Its anterior surface affords attachment to the costo-xiphoïd ligaments. Its posterior surface, to some of the fibres of the Diaphragm and Triangularis sterni muscles. Its lateral borders, to the aponeurosis of the abdominal muscles. Above, it is continuous with the lower end of the gladiolus; below, by its pointed extremity, it gives attachment to the linea alba, and at each superior angle presents a half facet for the lower half of the cartilage of the seventh rib. This portion of the sternum is very various in appearance, being sometimes pointed, broad and thin, sometimes bifid, or perforated by a round hole, occasionally curved, or deflected considerably to one or the other side.

Structure. This bone is composed of a considerable amount of loose spongy tissue within, covered externally with a very thin layer of compact tissue.

Development. The sternum, including the ensiform appendix, is developed by six centres. One for the first piece or manubrium, four for the second piece or gladiolus, and one for the ensiform appendix. The sternum is entirely cartilaginous up to the middle of foetal life, and when ossification takes place, the osseous granules are deposited in the middle of the intervals between the articular depressions for the costal cartilages, in the following order (fig. 58). In the first piece, between the fifth and sixth months; in the second and third, between the sixth and seventh; in the fourth piece, at the ninth month; in the fifth, within the first year, or between the first and second years after birth; and in the ensiform appen-
dix, between the second and the seventeenth or eighteenth years, by a single centre which makes its appearance at the upper part, and proceeds gradually downwards. To these may be added the occasional existence, as described by Breschet, of two small epi-sternal centres, which make their appearance one on each side of the interclavicular notch. It occasionally happens that some of these divisions are formed from more than one centre, the number and position of which vary (fig. 60). Thus the first piece may have two, three, or even six centres; the second piece has seldom more than one; the third, fourth, and fifth pieces, are often formed from two centres placed laterally, the irregular union of which will serve to explain the occasional occurrence of the sternal foramen (fig. 61), or of the vertical fissure which occasionally intersects this part of the bone. Union of these various parts commences from below, and proceeds upwards, taking place in the following order (fig. 59). The fifth piece is joined to the fourth soon after puberty; the fourth to the third, between the twentieth and twenty-fifth years; the third to the second, between the thirty-fifth and fortieth years; the second is rarely joined to the first except in very advanced age.

Articulations. With the clavicles, and seven costal cartilages on each side.

Attachment of Muscles. The Pectoralis major, Sterno-cleido-mastoid, Sterno-hyoid, Sterno-thyroid, Triangularis sterni, aponeurosis of the Obliquus externus, Obliquus internus, and Transversalis muscles, Rector and Diaphragm.

The Ribs.

The Ribs are elastic arches of bone, which form the chief part of the thoracic walls. They are twelve in number on each side; but this number may be increased by the development of a cervical or lumbar rib, or may be diminished to eleven. The first seven are connected behind with the spine, and in front with the sternum,
through the intervention of the costal cartilages, they are called **vertebro-sternal**, or **true ribs**. The remaining five are **false ribs**; of these the first three, being connected behind with the spine, and in front with the costal cartilages, are called the **vertebro-costal ribs**; the last two are connected with the vertebrae only, being free at their anterior extremities, they are termed **vertebral** or **floating ribs**. The ribs vary in their direction, the upper ones being placed nearly at right angles with the spine; the lower ones are placed obliquely, so that the anterior extremity is lower than the posterior. The extent of obliquity reaches its maximum at the ninth rib, gradually decreasing from that point towards the twelfth. The ribs are situated one beneath the other in such a manner that spaces are left between them; these are called **intercostal spaces**. Their length corresponds to the length of the ribs, their breadth is more considerable in front than behind, and between the upper than between the lower ribs. The ribs increase in length from the first to the eighth, when they again diminish to the twelfth. In breadth they decrease from above downwards; in each rib the greatest breadth is at the sternal extremity.

**Common characters of the Ribs** (fig. 62).

Take a rib from the middle of the series in order to study its common characters. Each rib presents two extremities, a posterior or vertebral, an anterior or sternal, and an intervening portion, the body or shaft. The **posterior or vertebral extremity**, presents for examination a head, neck, and tuberosity.

The **head** (fig. 63) is marked by a kidney-shaped articular surface, divided by a horizontal ridge into two facets for articulation with the costal cavity formed by the junction of the bodies of two contiguous dorsal vertebrae; the upper facet is small, the inferior one of large size; the ridge separating them, serves for the attachment of the inter-articular ligament.

The **neck** is that flattened portion of the rib which extends outwards from the head; it is about an inch long, and rests upon the transverse process of the inferior of the two vertebrae with which the head articulates. Its **anterior surface** is flat and smooth, its **posterior** rough, for the attachment of the middle costo-transverse ligament. Of its two borders, the **superior** presents a rough crest for the attach-
ment of the anterior costo-transverse ligament; its inferior border is rounded. On the outer surface of the neck, just where it joins the shaft, is an eminence, the tuberosity; it consists of two portions, an articular and a non-articular. The articular portion, the most internal and inferior of the two, presents a small oval surface directed downwards, backwards and inwards, for articulation with the extremity of the transverse process of the vertebra below it. The non-articular portion is a rough elevation, which affords attachment to the posterior costo-transverse ligament.

63.—Vertebral Extremity of a Rib. External Surface.

The shaft presents two surfaces, an external and an internal; and two borders, a superior and an inferior. The external surface is convex, and marked for the attachment of muscles. At its posterior part, a little in front of the tuberosity, is seen a prominent line, directed obliquely from above, downwards and outwards; this gives attachment to a tendon of the Sacro-lumbalis muscle, and is called the angle. At this point, the rib is bent upon itself in two directions. If the rib is laid upon its lower border, it will be seen that the anterior portion of the shaft, as far as the angle, rests upon this surface, while the vertebral end of the bone, beyond the angle, is bent inwards and at the same time tilted upwards. The distance between the angle and the tuberosity increases gradually from the second to the tenth rib. This portion of bone is rounded, rough, and irregular, and serves for the attachment of the Longissimus dorsi. The portion of bone between the angle and sternal extremity is also slightly twisted upon its own axis, the external surface looking downwards behind the angle, a little upwards in front of it. This surface presents, towards its sternal extremity, an oblique line, the anterior angle. The internal surface is concave, smooth, and presents the orifices of two or three nutrient foramina, the course of which is directly backwards towards the vertebral extremity. This surface looks a little upwards, behind the angle; a little downwards, in front of it. The superior border, thick and rounded, is marked by an external and an internal lip, more distinct behind than in front; they serve for the attachment of the External and Internal intercostal muscles. The inferior border, thin and sharp, has attached the External intercostal muscle. This border is marked on its inner side by a deep groove which commences at the tuberosity and gradually becomes lost at the junction of the anterior with the middle third of the bone. At the back part of the bone, this groove belongs to the inferior border; but just in front of the angle, where it is deepest and broadest, it corresponds to the internal surface; it lodges the intercostal vessels and nerve. Its superior edge is rounded and continued back as far as the vertebral extremity; it serves for the attachment of the Internal intercostal muscle. Its inferior edge corresponds to the lower margin of the rib, and gives attachment to the External intercostal. The anterior or sternal extremity, is flattened, and presents a porous oval concave depression, into which the costal cartilage is received.

Peculiar Ribs.

The peculiar ribs which require especial consideration, are five in number, viz., the first, second, tenth, eleventh and twelfth.

The first rib (fig.64) is one of the shortest and the most curved of all the ribs; it is broad, flat, and placed horizontally at the upper part of the thorax, its surfaces looking upwards and downwards; and its borders, inwards and outwards. The
head is of small size, rounded, and presents only a single articular facet for articulation with the body of the first dorsal vertebra. The neck is narrow and rounded. The tuberosity, thick and prominent, rests on the outer border. There is no angle, and it is not twisted on its axis. The upper surface of the

Peculiar Ribs.

shaft is marked towards its anterior part by two shallow depressions, separated from one another by a ridge, which becomes more prominent towards the internal border, where it terminates in a tubercle; this tubercle and ridge serve for the attachment of the Scalenus anticus muscle, the groove in front of it transmitting the subclavian vein; that behind it, the subclavian artery. The inferior surface is smooth, and destitute of the groove observed on the other ribs. The outer
border is convex, thick, and rounded. The inner, concave, thin, and sharp, and marked about its centre by the tubercle before mentioned. The anterior extremity is larger and thicker than any of the other ribs.

The second rib (fig. 65) is much longer than the first, but bears a very considerable resemblance to it in the direction of its curvature. The non-articular portion of the tuberosity is occasionally only slightly marked. The angle is slight, and situated close to the tuberosity, and the rib is not twisted, so that both ends touch any plane surface upon which it may be laid. The shaft is not horizontal, like that of the first rib; its external surface, which is convex, looking upwards and a little outwards; it presents near the middle a rough eminence for the attachment of part of the first, and the second serration of the serratus magnus. The inner surface smooth and concave, is directed downwards and a little inwards; it presents a short groove towards its posterior part.

The tenth rib (fig. 66) has only a single articular surface on its head.

The eleventh and twelfth ribs (figs. 67 and 68) have each a single articular surface on the head, which is of rather large size; they have no neck or tuberosity, and are pointed at the extremity. The eleventh has a slight angle and a shallow groove on the lower border. The twelfth has neither, and is much shorter than the eleventh.

Structure. The ribs consist of a quantity of cancellous tissue, enclosed in a thin compact layer.

Development. Each rib, with the exception of the last two, is developed by three centres, one for the shaft, one for the head, and one for the tubercle. The last two have only two centres, that for the tubercle being wanting. Ossification commences in the body of the ribs at a very early period, before its appearance in the vertebra. The epiphysis of the head, which is of a slightly angular shape, and that for the tubercle, of a lenticular form, make their appearance between the sixteenth and twentieth years, and do not become united to the rest of the bone until about the twenty-fifth year.

Attachment of Muscles. The Intercostals, Scalenus anticus, Scalenus medius, Scalenus posticus, Pectoralis minor, Serratus magnus, Obliquus externus, Transversalis, Quadratus lumborum, Diaphragm, Latissimus dorsi, Serratus posticus superior, Serratus posticus inferior, Sacro-lumbalis, Musculus accessorius ad sacro-lumbalem, Longissimus dorsi, Cervicais ascendens, Levatores costarum.

The Costal Cartilages.

The Costal Cartilages (fig. 56) are white elastic structures, which serve to prolong the ribs forward to the front of the chest, and contribute very materially to the elasticity of this cavity. The seven first are connected with the sternum, the three next with the lower border of the cartilage of the preceding rib. The cartilages of the two last ribs, which have pointed extremities, float freely in the parietes of the abdomen. Like the ribs, the costal cartilages vary in their length, breadth, and direction. They increase in length from the first to the seventh, and gradually diminish to the last. They diminish in breadth, as well as the intervals between them, from the first to the last. They are broad at their attachment to the ribs, and taper towards their sternal extremities, excepting the two first, which are of the same breadth throughout, and the sixth, seventh, and eighth, which are enlarged where their margins are in contact. In direction they also vary; the first descends a little, the second is horizontal, the third ascends slightly, whilst all the rest follow the course of the ribs for a short extent, and then ascend to the sternum or preceding cartilage. Each costal cartilage presents two surfaces, two borders, and two extremities. The anterior surface is convex, and looks forwards and upwards; that of the first gives attachment to the costo-clavicular ligament; that of the first, second, third, fourth, fifth, and sixth at their sternal ends to the Pectoralis major. The others are covered, and give partial attachment to some of the great flat muscles of the abdomen. The posterior surface is concave, and directed backwards and downwards, the six or seven inferior ones affording attachment...
to the Transversalis and Diaphragm muscles. Of the two borders, the superior is concave, the inferior, convex; they afford attachment to the Intercostal muscles, the upper border of the sixth giving attachment to the Pectoralis major muscle. The contiguous borders also of the sixth, seventh, and eighth, and sometimes the ninth and tenth costal cartilages present smooth oblong surfaces at the points where they articulate. Of the two extremities, the outer one is continuous with the osseous tissue of the rib to which it belongs. The inner extremity of the first is continuous with the sternum; the six next have rounded extremities, which are received into shallow concavities on the lateral margins of the sternum. The inner extremities of the eighth, ninth and tenth costal cartilages are pointed, and lie in contact with the cartilage above. Those of the eleventh and twelfth are free and pointed.

In the male, the first costal cartilage becomes more or less ossified in the adult, and is often connected to the sternum by bone. Ossification of the remaining cartilages also occurs to a variable extent after the middle of life, those of the true ribs being first ossified. In the female, the process of ossification does not take place until old age. The costal cartilages are most elastic in youth, those of the false ribs being more so than the true. In old age they become of a deep yellow colour.

Attachment of Muscles. The Subclavius, Sternal-thyroid, Pectoralis major, Internal oblique, Transversalis, Rectus, Diaphragm, Triangularis sterni, Internal and External intercostals.

THE PELVIS.

The Pelvis is composed of four bones. The two Ossa Innominata, which bound it in front and at the sides, and the Sacrum and Coccyx, which complete it behind.

The Os INNOMINATUM.

The Os Innominatum, so called from bearing no resemblance to any known object, is a large irregular-shaped bone, which, with its fellow of the opposite side, forms the sides and anterior wall of the pelvic cavity. In young subjects, it consists of three separate parts, which meet and form the large cup-like cavity, situated near the middle of the outer side of the bone; and, although in the adult these have become united, it is usual to describe the bone as divisible into three portions, the ilium, the ischium, and the pubes.

The Ilium is the superior broad and expanded portion which runs upwards from the upper and back part of the acetabulum, and forms the prominence of the hip.

The ischium is the inferior and strongest portion of the bone; it proceeds downwards from the acetabulum, expands into a large tuberosity, and then curving upwards, forms with the descending ramus of the pubes a large aperture, the obturator foramen.

The pubes is that portion which runs horizontally inwards from the inner side of the acetabulum for about two inches, then makes a sudden bend, and descends to the same extent: it forms the front of the pelvis, and supports the external organs of generation.

The Ilium presents for examination two surfaces, an external and an internal, a crest, and two borders, an anterior and a posterior. External Surface or Dorsum of the Ilium (fig. 69). The back part of this surface is directed backwards, downwards, and outwards; its front part forwards, downwards and outwards. It is smooth, convex in front, deeply concave behind; bounded above by the crest, below by the upper border of the acetabulum, in front and behind by the anterior and posterior borders. This surface is crossed in an arched direction by three semicircular lines, the superior, middle, and inferior curved lines. The superior curved line, the shortest of the three, commences at the crest, about two inches in front of its posterior extremity; it is at first distinctly marked, but as it passes downwards and outwards to the back part of the great sacro-sciatic notch, where it terminates, it becomes less marked, and is often altogether lost. The rough surface
included between this line and the crest, affords attachment to part of the Gluteus maximus above, a few fibres of the Pyriformis below. The middle curved line, the longest of the three, commences at the crest, about an inch behind its anterior extremity, and, taking a curved direction downwards and backwards, terminates at the upper part of the great sacro-sciatic notch. The space between the middle, the superior curved lines, and the crest, is concave, and affords attachment to the Gluteus medius muscle. Near the central part of this line may often be observed the orifice of a nutritious foramen. The inferior curved line, the least distinct of the three, commences in front at the upper part of the anterior inferior spinous process, and taking a curved direction backwards and downwards, terminates at the anterior part of the great sacro-sciatic notch. The surface of bone included between the middle and inferior curved lines, is concave from above downwards, convex from before backwards, and affords attachment to
the Gluteus minimus muscle. Beneath the inferior curved line, and corresponding to the upper part of the acetabulum, is a smooth eminence (sometimes a depression), to which is attached the reflected tendon of the Rectus femoris muscle.

The Internal Surface (fig. 70) of the ilium is bounded above by the crest,

70.—Right Os Inominatum. Internal Surface.

below by a prominent line, the linea-ileo pectinea, and before and behind by the anterior and posterior borders. It presents anteriorly a large smooth concave surface called the internal iliac fossa, or venter of the ilium; it lodges the Iliacus muscle, and presents at its lower part the orifice of a nutritious canal. Behind the iliac fossa is a rough surface, divided into two portions, a superior and an inferior. The inferior, or auricular portion, so called from its resemblance to the external ear, is coated with cartilage in the recent state, and articulates with a similar shaped surface on the side of the sacrum. The superior portion is concave and rough for the attachment of the posterior sacro-iliac ligaments.

The crest of the ilium is convex in its general outline and sinuously curved, being bent inwards anteriorly, outwards posteriorly. It is longer in the female
than in the male, very thick behind, and thinner at the centre than at the extremities. It terminates at either end in a prominent eminence, the anterior superior, and posterior superior spinous process. The surface of the crest is broad, and divided into an external lip, an internal lip, and an intermediate space. To the external lip is attached the Tensor vaginae femoris, Obliquus externus abdominis, and Latissimus dorsi, and by its whole length the fascia lata; to the interspace between the lips, the Internal oblique; to the internal lip, the Transversalis, Quadratus lumborum, and Erector spinae.

The anterior border of the ilium is concave. It presents two projections separated by a notch. Of these, the uppermost, formed by the junction of the crest and anterior border, is called the anterior superior spinous process of the ilium, the outer border of which gives attachment to the fascia lata, and the origin of the Tensor vaginae femoris, its inner border, to the Iliacus internus, whilst its extremity affords attachment to Poupart's ligament and the origin of the Sartorius. Beneath this eminence, is a notch which gives attachment to the Sartorius muscle, and across which passes the external cutaneous nerve. Below the notch is the anterior inferior spinous process, which terminates in the upper lip of the acetabulum; it gives attachment to the straight tendon of the Rectus femoris muscle. On the inner side of the anterior inferior spinous process, is a broad shallow groove, over which passes the Iliacus muscle. The posterior border, shorter than the anterior, also presents two projections separated by a notch, the posterior superior, and the posterior inferior spinous processes. The former corresponds with that portion of the posterior surface of the ilium, which serves for the attachment of the sacro-iliac ligaments, the latter, to the auricular portion which articulates with the sacrum. Below the posterior inferior spinous process, is a deep notch, the great sacro-sciatic.

The Ischium forms the inferior and posterior part of the os innominatum. It is divisible into a thick and solid portion, the body, and a thin ascending part, the ramus. The body, somewhat triangular in form, presents three surfaces, an external, internal, and posterior, and three borders. The external surface corresponds to that portion of the acetabulum formed by the ischium; it is smooth and concave above, and forms a little more than two-fifths of that cavity; its outer margin is bounded by a prominent rim or lip, to which the cotyloid-fibro-cartilage is attached. Below the acetabulum, between it and the tuberosity, is a deep groove, along which the tendon of the Obturator externus muscle runs, as it passes outwards to be inserted into the digital fossa of the femur. The internal surface is smooth, concave, and forms the lateral boundary of the true pelvic cavity; it is broad above, and separated from the venter of the ilium by the iliopectineal, narrow below, its posterior border being encroached upon a little below its centre, by the spine of the ischium, above and below which are the greater and lesser sacro-sciatic notches; in front it presents a sharp margin, which forms the outer boundary of the obturator foramen. This surface is perforated by two or three large vascular foramina, and affords attachment to part of the Obturator internus muscle.

The posterior surface is quadrilateral in form, broad and smooth above, narrow below where it becomes continuous with the tuberosity; it is limited in front by the margin of the acetabulum, behind by the front part of the great sacro-sciatic notch. This surface supports the Pyriformis, the two Gemelli, and the Obturator internus muscles, in their passage outwards to the great trochanter. The body of the ischium presents three borders, posterior, inferior, and internal. The posterior border presents, a little below the centre, a thin and pointed triangular eminence, the spine of the ischium, more or less elongated in different subjects. Its external surface gives attachment to the Gemellus superior, its internal surface to the Coccygeus and Levator ani, whilst to the pointed extremity is connected the lesser sacro-sciatic ligament. Above the spine is a notch of large size, the great sacro-sciatic, converted into a foramen by the lesser sacro-sciatic ligament; it transmits the Pyriformis muscle, the gluteal vessels and nerve
passing out above this muscle, the sciatic, and internal pudic vessels and nerve, and a small nerve to the Obturator internus muscle below it. Below the spine is a smaller notch, the lesser sacro-sciatic; it is smooth, coated with cartilage in the recent state, the surface of which presents numerous markings corresponding to the subdivisions of the tendon of the Obturator internus which winds over it. It is converted into a foramen by the sacro-sciatic ligaments, and transmits the tendon of the Obturator internus, the nerve which supplies this muscle, and the pudic vessels and nerve. The inferior border is thick and broad: at its point of junction with the posterior, is a large rough eminence upon which the body rests in sitting: it is called the tuberosity of the ischium. The internal border is thin, and forms the outer circumference of the obturator foramen.

The tuberosity, situated at the junction of the posterior and inferior borders, presents for examination an external lip, an internal lip, and an intermediate space. The external lip gives attachment to the Quadratus femoris and part of the Adductor magnus muscles. The inner lip is bounded by a sharp ridge for the attachment of a falciform prolongation of the great sacro-sciatic ligament, presents a groove on the inner side of this for the lodgment of the internal pudic vessels and nerve, and more anteriorly has attached the Transversus perinei, Erector penis, and Compressor urethrae muscles. The intermediate surface presents four distinct impressions. Two of these seen at the front part of the tuberosity are rough, elongated, and separated from each other by a prominent ridge: the outer one gives attachment to the Adductor magnus; the inner one to the great sacro-sciatic ligament. Two situated at the back part are smooth, larger in size and separated by an oblique ridge: from the upper and outer arises the Semi-membranosus; from the lower and inner, the Biceps and Semi-tendinosus. The most superior part of the tuberosity gives attachment to the Gemellus inferior.

The ramus is the thin flattened part of the ischium, which ascends from the tuberosity upwards and inwards, and joins the ramus of the pubes, their point of junction being indicated in the adult by a rough eminence. Its outer surface is rough for the attachment of the Obturator externus muscle. Its inner surface forms part of the anterior wall of the pelvis. Its inner border is thick, rough, slightly everted, forms part of the outlet of the pelvis, and serves for the attachment of the crus-penis. Its outer border is thin and sharp, and forms part of the inner margin of the obturator foramen.

The Pubes forms the anterior part of the os innominatum; it is divisible into a horizontal ramus or body, and a perpendicular ramus.

The body, or horizontal ramus, presents for examination two extremities, an outer and an inner, and four surfaces. The outer extremity, the thickest part of the bone, forms one-fifth of the cavity of the acetabulum: it presents above, a rough eminence, the ilio-pubic, which serves to indicate the point of junction of the ilium and pubes. The inner extremity of the body of the bone is the symphyseis; it is oval, covered by eight or nine transverse ridges, or a series of nipple-like processes arranged in rows, separated by grooves; they serve for the attachment of the intercartilacular fibro-cartilage, placed between it and the opposite bone. Its upper surface, triangular in form, wider externally than internally, is bounded behind by a sharp ridge, the pectineal line, or linea-ilio-pectinea, which, running outwards, marks the brim of the true pelvis. The surface of bone in front of the pubic portion of the linea-ilio-pectinea, serves for the attachment of the Pectineus muscle. This ridge terminates internally at a tuberence, which projects forwards, and is called the spine of the pubes. The portion of bone included between the spine and inner extremity of the pubes is called the crest; it serves for the attachment of the Rectus, Pyramidalis, and conjoined tendon of the Internal oblique and Transversalis. The point of junction of the crest with the symphyseis is called the angle of the pubes.

The inferior surface presents externally a broad and deep oblique groove, for the passage of the obturator vessels and nerve; and internally a sharp margin,
which forms part of the circumference of the obturator foramen. Its external surface is flat and compressed, and serves for the attachment of muscles. Its internal surface, convex from above downwards, concave from side to side, is smooth, and forms part of the anterior wall of the pelvis. The descending ramus of the pubes passes outwards and downwards, becoming thinner and narrower as it descends, and joins with the ramus of the ischium. Its external surface is rough, for the attachment of muscles. Its inner surface, smooth, and forms part of the anterior wall of the pelvis. The descending ramus of the pubes passes outwards and downwards, becoming thinner and narrower as it descends, and joins with the ramus of the ischium. Its external surface is rough, for the attachment of muscles. Its inner surface, smooth.

The cotyloid cavity or acetabulum, is a deep cup-shaped hemispherical depression; formed internally by the pubes, above by the ilium, behind and below by the ischium, a little less than two-fifths being formed by the ilium, a little more than two-fifths by the ischium, and the remaining fifth by the pubes. It is bounded by a prominent uneven rim, which is thick and strong above, and serves for the attachment of a fibro-cartilaginous structure, which contracts its orifice and deepens the surface for articulation. It presents on its inner side a deep notch, the cotyloid notch, which transmits the nutrient vessels into the interior of the joint, and is continuous with a deep circular depression at the bottom of the cavity: this depression is perforated by numerous apertures, lodges a mass of fat, and its margins serve for the attachment of the ligamentum teres. The notch is converted, in the natural state, into a foramen by a dense ligamentous band which passes across it. Through this foramen the nutrient vessels and nerves enter the joint.

The obturator or thyroid foramen is a large aperture, situated between the ischium and pubes. In the male it is large, of an oval form, its longest diameter being obliquely from above downwards; in the female smaller, and more triangu-
lar. It is bounded by a thin uneven margin, to which a strong membrane is attached; and presents at its upper and outer part a deep groove, which runs from the pelvis obliquely forwards, inwards, and downwards. It is converted into a foramen by the obturator membrane, and transmits the obturator vessels and nerve.

Structure. This bone consists of much cancellous tissue, especially where it is thick, enclosed between two layers of thick and dense compact tissue. In the thinner parts of the bone, as at the bottom of the acetabulum, and centre of the iliac fossa, it is usually semi-transparent, and composed entirely of compact tissue.

Development (fig. 71). By eight centres: three primary— one for the ilium, one for the ischium, and one for the pubes; and five secondary— one for the crest of the ilium its whole length, one for the anterior inferior spinous process (said to occur more frequently in the male than the female), one for the tuberosity of the ischium, one for the symphysis pubis (more frequent in the female than the male), and one for the Y-shaped piece at the bottom of the acetabulum. These various centres appear in the following order: First, in the ilium, at the lower part of the bone, immediately above the sciatic notch, at about the same period that the development of the vertebrae commences. Secondly, in the body of the ischium, at about the third month of foetal life. Thirdly, in the body of the pubes, between the fourth and fifth months. At birth, these centres are quite separate; the crest, the bottom of the acetabulum, and the rami of the ischium and pubes, being still cartilaginous. At about the sixth year, the rami of the pubes and ischium are almost completely ossified. About the thirteenth or fourteenth year, the three divisions of the bone have extended their growth into the bottom of the acetabulum, being separated from each other by a Y-shaped portion of cartilage, which now presents traces of ossification. The ilium and ischium then become joined, and lastly the pubes, through the intervention of the portion above mentioned. At about the age of puberty, ossific matter appears in each of the remaining portions, and they become joined to the rest of the bone about the twenty-fifth year.

Articulations. With its fellow of the opposite side, the sacrum and femur.

Attachment of Muscles. Ilium. To the outer lip of the crest, the Tensor vaginae femoris, Obliquus externus abdominis, and Latissimus dorsi; to the internal lip, the Transversalis, Quadratus lumborum, and Erector spinae; to the interspace between the lips, the Obliquus internus. To the outer surface of the ilium, the Gluteus maximus, Gluteus medius, Gluteus minimus, reflected tendon of Rectus, portion of Pyriformis; to the internal surface, the Iliacus; to the anterior border, the Sartorius and straight tendon of the Rectus. To the ischium. Its outer surface, the Obturator externus; internal surface, Obturator internus and Levator ani. To the spine. The Gemellus superior, Levator ani, and Coccygeus. To the tuberosity, the Biceps, Semi-tendinosus, Semi-membranosus, Quadratus femoris, Adductor magnus, Gemellus inferior, Transversus perinae, Erector penis. To the pubis, the Obliquus externus, Obliquus internus, Transversalis, Rectus, Pyramidalis, Psoa parvus, Pectineus, Adductor longus, Adductor brevis, Gracilis, Obturator externus and internus, Levator ani, Compressor urethrae, and occasionally a few fibres of the Accelerator urinae.

The Pelvis.

The pelvis is stronger and more massively constructed than either of the other osseous cavities already considered; it is connected to the lower end of the spine, which it supports, and transmits its weight to the lower extremities, upon which it rests. It is composed of four bones—the two ossa innominatae, which bound it on either side and in front; and the sacrum and coccyx, which complete it behind.

The pelvis is divided by a prominent line, the linea ileo pectinea, into a false and true pelvis.

The false pelvis is all that expanded portion of the pelvic cavity which is situated above the linea ileo pectinea. It is bounded on each side by the ossa ili;
in front it is incomplete, presenting a wide interval between the anterior superior spinous processes of the ilia on either side, filled up in the recent state by the parietes of the abdomen; behind, in the middle line, is a deep notch. This broad shallow cavity is admirably adapted to support the intestines, and to transmit part of their weight to the anterior wall of the abdomen.

The **true pelvis** is all that part of the pelvic cavity which is situated beneath the linea ileo pectinea. It is smaller than the false pelvis, but its walls are more perfect. For convenience of description, it may be divided into a superior circumference or inlet, an inferior circumference or outlet, and a cavity.

The **superior circumference** forms the margin or brim of the pelvis, the included space being called the **inlet**. It is formed by the linea ileo pectinea, completed in front by the spine and crest of the pubes, and behind by the anterior margin of the base of the sacrum and sacro-vertebral angle.

The **inlet** of the pelvis is somewhat cordate in form, obtusely pointed in front, diverging on either side, and encroached upon behind by the projection forwards of the promontory of the sacrum. It has three principal diameters: antero-posterior (sacro-pubic), transverse, and oblique. The antero-posterior extends from the sacro-vertebral angle to the symphysis pubis; its average measurement is four inches. The transverse extends across the greatest width of the pelvis, from the middle of the brim on one side, to the same point on the opposite; its average measurement is five inches. The oblique extends from the margin of the pelvis corresponding to the ileo pectineal eminence on one side, to the sacro-iliac symphysis on the opposite side; its average measurement is also five inches.

The **cavity** of the true pelvis is bounded in front by the symphysis pubis; behind, by the concavity of the sacrum and coccyx, which, curving forwards above and below, contracts the inlet and outlet of the canal; and laterally it is bounded by a broad, smooth, quadrangular plate of bone, corresponding to the inner surface of the body of the ischium. This cavity is shallow in front, measuring at the symphysis an inch and a half in depth, three inches and a half in the middle, and four inches and a half posteriorly. From this description, it will be seen that the cavity of the pelvis is a short, curved canal, considerably deeper on its posterior than on its anterior wall, and broader in the middle than at either extremity, from the projection forwards of the sacro-coccygeal column above and below. This cavity contains, in the recent subject, the rectum, bladder, and part of the organs of generation. The rectum is placed at the back of the pelvis, and corresponds to the curve of the sacro-coccygeal column, the bladder in front, behind the symphysis pubis. In the female, the uterus and vagina occupy the interval between these parts.

The **lower circumference** of the pelvis is very irregular, and forms what is called the **outlet**. It is bounded by three prominent eminences: one posterior, formed by the point of the coccyx; and one on each side, the tuberosities of the ischia. These eminences are separated by three notches; one in front, the **pubic arch**, formed by the convergence of the rami of the ischia and pubes on each side. The other notches, one on each side, are formed by the sacrum and coccyx behind, the ischium in front, and the ilium above: these are called the greater and lesser sacro-sciatic notches; in the natural state they are converted into foramina by the lesser and greater sacro-sciatic ligaments.

The diameters of the outlet of the pelvis are two, antero-posterior and transverse. The **antero-posterior** extends from the tip of the coccyx to the lower part of the symphysis pubis; and the **transverse** from the posterior part of one ischiatric tuberosity, to the same point on the opposite side: the average measurement of both is four inches. The antero-posterior diameter varies with the length of the coccyx, and is capable of increase or diminution, on account of the mobility of this bone.

**Position of the Pelvis.** In the erect posture, the pelvis is placed obliquely with regard to the trunk of the body; the pelvic surface of the symphysis pubis looking upwards and backwards, the concavity of the sacrum and coccyx looking down-
wards and forwards. The base of the sacrum, in well-formed female bodies, being nearly four inches above the upper border of the symphysis pubis, and the apex of the coccyx a little more than half an inch above its lower border. This obliquity is much greater in the foetus, and at an early period of life, than in the adult.

**Aces of the Pelvis.** The plane of the inlet of the true pelvis will be represented by a line drawn from the base of the sacrum to the upper margin of the symphysis pubis. A line carried at right angles with this at its middle, would correspond at one extremity with the umbilicus, and by the other with the middle of the coccyx; the axis of the inlet is therefore directed downwards and backwards. The axis of the outlet produced upwards, would touch the base of the sacrum; and is therefore directed downwards and forwards. The axis of the cavity is curved like the cavity itself; this curve corresponds to the concavity of the sacrum and coccyx, the extremities being indicated by the central points of the inlet and outlet.

**Differences between the Male and Female Pelvis.** In the male, the bones are heavier, stronger, and more solid, and the muscular impressions and eminences on their surfaces more strongly marked. It is altogether more massive in its general form; its cavity is deeper and narrower, and its apertures small. In the female, the bones are lighter and more delicate, the muscular impressions on its surface only slightly marked, and the pelvis generally is less massive in structure. The iliac fossae are large, and the ilia widely expanded; hence the great prominence of the hips. The cavity is shallow, but capacious, being very broad both in the antero-posterior and transverse diameters; the inlet and outlet are also large. The obturator foramen is triangular; the tuberosities of the ischium are widely separated; the sacrum is wider and less curved; the symphysis pubis not so deep; and the arch of the pubis is greater, and its edges more everted.

In the foetus, and for several years after birth, the cavity of the pelvis is small; the viscera peculiar to this cavity in the adult, being situated in the lower part of the abdomen.

**THE UPPER EXTREMITY.**

The Upper Extremity consists of four parts — the shoulder, the arm, the forearm, and the hand. The **shoulder** consists of two bones, the clavicle and the scapula.

**The Clavicle.**

The Clavicle (clavis, a 'key'), or collar-bone, is a long bone, curved somewhat like the italic letter $f$, and placed horizontally at the upper and lateral part of the thorax, immediately above the first rib. It articulates internally with the upper border of the sternum, and with the acromion process of the scapula by its outer extremity; serving to sustain the upper extremity in the various positions which it assumes, whilst at the same time it allows it great latitude of motion. The horizontal plane of the clavicle is nearly straight; but in the vertical plane it presents a double curvature, the convexity being in front at the sternal end, and behind at the scapular end. Its inner two-thirds are of a triangular prismatic form, and extend, in the natural position of the bone, from the sternum to the coracoid process of the scapula; the outer fourth being flattened from above downwards, and extending from the coracoid process to the acromion. It presents for examination two surfaces, two borders, and two extremities.

The **superior surface** (fig. 72), for the inner three-fourths of its extent, is narrow, smooth, of equal diameter throughout, and presents near the sternal end impressions for the attachment of the Sterno-mastoid muscle behind, the Pectoralis major in front. Its outer fourth is broad, flat, uneven, perforated by numerous foramina, and covered by the fibres of the Deltoid and Trapezius muscles, which encroach upon it considerably in front and behind.

The **inferior surface** (fig. 73) is also narrow for the inner three-fourths of its extent, broader and more flattened externally. Commencing at the sternal extre-
CLAVICLE.

mity, may be seen a small facet for articulation with the cartilage of the first rib, continuous with the articular surface at the sternal end of the bone. External to this a rough impression, the rhomboid, for the attachment of the costo-clavicular

72.—Left Clavicle. Superior Surface.

73.—Left Clavicle. Inferior Surface.

(rhomboid) ligament. The middle third of this surface is occupied by a longitudinal groove, the subclavian groove, broader externally than internally; it gives attachment to the Subclavius muscle, and by its anterior margin to the strong aponeurosis which encloses it; internally is a rough surface, the limit of the attachment of the Pectoralis major below. At the junction of the prismatic with the flattened portion of the bone, at its posterior border, may be seen a rough eminence, the tubercle of the clavicle. This, in the natural position of the bone, surmounts the coracoid process of the scapula, and affords attachment to the conoid ligament. From this tubercle an oblique line passes forwards and outwards on the under surface of the acromial extremity. It is called the oblique line of the clavicle, and affords attachment to the trapezoid ligament.

The anterior border is broad and convex for its sternal half, and presents a rough impression for the attachment of the Pectoralis major muscle. Its outer half is a narrow, concave margin, serving for the attachment of the Deltoid: a small interval is usually left between the attachments of these muscles, where this border is smooth, receiving no muscular fibres. This is the narrowest part of the clavicle, and hence the most common seat of fracture.

The posterior border is broad and deeply concave for the inner two-thirds of its extent, affording attachment internally by a small extent of surface, to the Sterno-hyoid; convex, narrow, and irregular in its outer third, for the attachment of the Trapezius. This border corresponds to the subclavian vessels and brachial plexus of nerves, and presents, towards its centre, the foramen for the nutritious artery of the bone.

The internal or sternal end of the clavicle is directed inwards, and a little downwards and forwards; it presents a large triangular facet, concave from before backwards, convex from above downwards, which articulates with the sternum through the intervention of an inter-articular fibro-cartilage; the circumference of the articular surface is rough, for the attachment of numerous ligaments.
The outer extremity, directed forwards and outwards, presents a small oval facet, for articulation with the acromion process of the scapula.

Peculiarities of this Bone in the Sexes and in Individuals. In the female, the clavicle is less curved, smoother, longer, and more slender than in the male. In those persons who perform considerable manual labour, which brings into constant action the muscles connected with this bone, it acquires considerable bulk, becomes shorter, more curved, its ridges for muscular attachment become prominently marked, and its sternal end of a prismatic or quadrangular form.

Structure. The shaft as well as the extremities consists of cancellous tissue, invested in a compact layer much thicker in the centre than at either end. The clavicle is highly elastic, by reason of its curves. From the experiments of Mr. Ward, it has been shewn that it possesses sufficient longitudinal elastic force to raise its own weight nearly two feet on a level surface; and sufficient transverse elastic force, opposite the centre of its anterior convexity, to raise its own weight about a foot. This extent of elastic power must serve to moderate very considerably the effect of concussions received upon the point of the shoulder.

Development. By two centres: one for the shaft, and one for the sternal end of the bone. The centre for the shaft appears very early, before any other bone; the second centre makes its appearance about the eighteenth or twentieth year, and unites with the rest of the bone a few years after.

Articulations. With the sternum, scapula, and cartilage of the first rib.

Attachment of Muscles. The Sterno cleido-mastoid, Trapezius, Pectoralis major, Deltoid, Subclavius, and Sterno-hyoid.

The Scapula.

The Scapula is a large flat bone, triangular in shape, which forms the back part of the shoulder. It is situated at the posterior aspect and side of the thorax, between the first and seventh ribs, and presents for examination two surfaces, three borders, and three angles.

The anterior surface, or venter (fig. 74), presents a broad concavity, the subscapular fossa. It is marked, in the posterior two thirds, by several oblique ridges, which pass from behind obliquely forwards and upwards, the anterior third being smooth. The oblique ridges above-mentioned, give attachment to the tendinous intersections, and the surfaces between them, to the fleshy fibres of the Subscapularis muscle. The anterior third of the fossa, which is smooth, is covered by, but does not afford attachment to, the fibres of this muscle. This surface is separated from the posterior border, by a smooth triangular margin at the superior and inferior angles, and in the interval between these, by a narrow margin which is often deficient. This marginal surface affords attachment throughout its entire extent to the Serratus magnus muscle. The subscapular fossa presents a transverse depression at its upper part, called the subscapular angle; it is in this situation that the fossa is deepest, and consequently the thickest part of the Subscapularis muscle lies in a line parallel with the glenoid cavity, and must consequently operate most effectively on the humerus which is contained in it.

The posterior surface, or dorsum (fig. 75) is convex from above downwards, alternately convex and concave from side to side. It is subdivided unequally into two parts by the spine; that portion above the spine is called the supra spinous fossa, and that below it, the infra spinous fossa.

The supra spinous fossa, the smaller of the two, is concave, smooth, and broader towards the vertebral than at the humeral extremity. It affords attachment by its inner two-thirds to the fibres of the Supra spinatus muscle.

The infra spinous fossa is much larger than the preceding; towards its inner side a shallow concavity is seen at its upper part; its centre presents a prominent convexity, whilst towards the axillary border is a deep groove, which runs from the upper towards the lower part. The inner three-fourths of this surface affords attachment to the Infra-spinatus muscle; the outer fourth is only covered by it, without giving origin to its fibres. This surface is separated from the axillary
border by an elevated ridge, which runs from the lower part of the glenoid cavity, downwards and backwards to the posterior border, about an inch above the inferior angle. This ridge serves for the attachment of a strong aponeurosis, which separates the Infra-spinatus from the two Teres muscles. The surface of bone between this line and the axillary border is narrow for the upper two-thirds of its extent, and traversed near its centre by a groove for the passage of the dorsalis capula artery; it affords attachment to the Teres minor. Its lower third presents a broader, somewhat triangular surface, which gives origin to the Teres major, and over which glides the Latissimus dorsi muscle; sometimes this muscle takes origin by a few fibres from this part. The broad and narrow portions of bone above alluded to are separated by an oblique line, which runs from the axillary border, downwards and backwards; to it is attached the aponeurosis separating the two Teres muscles from each other.

The Spine is a prominent plate of bone, which crosses obliquely the inner three-fourths of the dorsum of the scapula at its upper part, and separates
the supra from the infra spinous fossa: it commences at the vertebral border by a smooth triangular surface, over which the trapezius glides, separated by a bursa; and, gradually becoming more elevated as it passes forwards, terminates in the acromion process which overhangs the shoulder joint. The spine is triangular and flattened from above downwards, its apex corresponding to the posterior border, its base, which is directed outwards, to the neck of the scapula. It presents two surfaces and three borders. Its superior surface is concave, assists in forming the supra-spinous fossa, and affords attachment to part of the Supra-spinatus muscle. Its inferior surface forms part of the infra-spinous fossa, gives origin to part of the Infra-spinatus muscle, and presents near its centre the orifice of a nutritious canal. Of the three borders, the anterior is attached to the dorsum of the bone; the posterior, or crest of the spine, is broad, and presents two lips, and an intervening
rough interval. To the superior lip is attached the Trapezius, to the extent shown in the figure. A very rough prominence is generally seen occupying that portion of the spine which receives the insertion of the middle and inferior fibres of this muscle. To the inferior lip, its whole length, is attached the Deltoid. The interval between them is also partly covered by the fibres of these muscles. The external border, the shortest of the three, is slightly concave, its edges thick and round, continuous above with the under surface of the acromion process, below with the neck of the scapula. The narrow portion of bone external to this border, serves to connect the supra and infra spinous fossae.

The Acromion process, so called from forming the summit of the shoulder joint (ακροπόρος, a summit; ἀκρος, the shoulder), is a large, and somewhat triangular process, flattened from behind forwards, directed at first a little outwards, and then curving forwards and upwards, so as to overhang the glenoid cavity. Its upper surface directed upwards, backwards, and outwards, is convex, rough, and partly covered by some of the fibres of origin of the Deltoid. Its under surface is smooth and concave. Its outer border, which is thick and irregular, affords attachment to the Deltoid muscle. Its inner margin, shorter than the outer, is concave, gives attachment to a portion of the Trapezius muscle, and presents about its centre a small oval surface, for articulation with the scapular end of the clavicle. Its apex, formed at the point of meeting of these two borders in front, is thin, and has attached to it the coraco-acromion ligament.

Of the three borders or costae of the scapula, the superior is the shortest and thinnest; it is concave, terminating at its inner extremity at the superior angle, at its outer extremity at the coracoid process. At its outer part is a deep semicircular notch, formed partly by the base of the coracoid process. This notch is converted into a foramen by the transverse ligament, and serves for the passage of the supra scapular nerve. The adjacent margin of the superior border affords attachment to the Omo-hyoid muscle. The external, or axillary border, is the thickest of the three. It commences above at the lower margin of the glenoid cavity, and inclines obliquely downwards and backwards to the inferior angle. Immediately below the glenoid cavity, is a rough depression about an inch in length, which affords attachment to the long head of the Triceps muscle; to this succeeds a longitudinal groove which extends as far as its lower third, and affords origin to part of the Subscapularis muscle. The inferior third of this border which is thin and sharp, serves for the attachment of a few fibres of the Teres major behind, and of the Subscapularis in front. The internal, or vertebral border, also named the base, is the longest of the three, and extends from the superior to the inferior angle of the bone. It is convex, intermediate in thickness between the superior and the external, and that portion of it above the spine bent considerably outwards, so as to form an obtuse angle with the lower part. This border presents an anterior lip, a posterior lip, and an intermediate space. The anterior lip affords attachment to the Serratus magnus; the posterior lip, to the Supra-spinatus above the spine, the Infra-spinatus below; the interval between the two lips, to the Levator anguli scapulae above the triangular surface at the commencement of the spine, the Rhomboideus minor, to the edge of that surface; the Rhomboideus major being attached by means of a fibrous arch, connected above to the lower part of the triangular surface at the base of the spine, and below to the lower part of the posterior border.

Of the three angles, the superior, formed by the junction of the superior and internal borders, is thin, smooth, rounded, somewhat inclined outwards, and gives attachment to a few fibres of the Levator anguli scapulae muscle. The inferior angle thick and rough, is formed by the union of the vertebral and axillary borders, its outer surface affording attachment to the Teres major, and occasionally a few fibres of the Latissimus dorsi. The anterior angle is the thickest part of the bone, and forms what is called the head of the scapula. The head presents a shallow, pyriform, articular surface, the glenoid cavity (γλενίδα, a superficial cavity; αὐδός, like); its longest diameter is from above downwards, and its
direction outwards and forwards. It is broader below than above; at its apex is attached the long tendon of the Biceps muscle. It is covered with cartilage in the recent state; and its margins, slightly raised, give attachment to a fibro-cartilaginous structure, the glenoid ligament, by which its cavity is deepened. The neck of the scapula is the slightly depressed surface which surrounds the head, it is more distinct on the posterior than on the anterior surface, and below than above. In the latter situation, it has, arising from it, a thick prominence, the coracoid process.

The Coracoid process, so called from its fancied resemblance to a crow's beak (κοπατ, a crow; είδος, like), is a thick curved process of bone, which arises by a broad base from the upper part of the neck of the scapula; it ascends at first upwards and inwards, then becoming smaller, it changes its direction and passes forwards and outwards. The ascending portion, flattened from before backwards, presents in front a smooth concave surface, over which passes the sub-scapularis muscle. The horizontal portion is flattened from above downwards; its upper surface is convex and irregular; its under surface is smooth; its anterior border is rough, and gives attachment to the Pectoralis minor, its posterior also rough to the coraco-acromion ligament, while the apex is embraced by the conjoined tendon of origin of the short head of the Biceps and Coraco-brachialis muscles. At the inner side of the root of the coracoid process is a rough depression for the attachment of the conoid ligament, and running from it obliquely forwards and outwards on the upper surface of the horizontal portion, an elevated ridge for the attachment of the trapezoid ligament.

Structure. In the head, processes, and all the thickened parts of the bone, it is cellular in structure, of a dense compact tissue in the rest of its extent. The

76.—Plan of the Development of the Scapula. By Seven Centres.

Epipyses (except one for the Coracoid process) appear at fifteen to seventeen years, and unite at twenty-two to twenty-five years.
centre and upper part of the dorsum, but especially the former, is usually so thin as to be semi-transparent; occasionally the bone is found wanting in this situation, and the adjacent muscles come into contact.

Development (fig. 76). By seven centres; one for the body, two for the coracoid process, two for the acromion, one for the posterior border, and one for the inferior angle.

That for the body makes its first appearance at about the same period that osseous matter is deposited in the vertebræ, and forms the chief part of the bone. At birth, all the other centres are cartilaginous. About the first year after birth, osseous deposition occurs in the middle of the coracoid process; which usually becomes joined with the rest of the bone at the time when the other centres make their appearance. Between the fifteenth and seventeenth years, osseous matter is deposited in the remaining centres in quick succession, and in the following order: first, near the base of the acromion, and in the upper part of the coracoid process, the latter appearing in the form of a broad scale; secondly, in the inferior angle and contiguous part of the posterior border; thirdly, near the extremity of the acromion; fourthly, in the posterior border. The acromion process, besides being formed of two separate nuclei, has its base formed by an extension into it of the centre of ossification which belongs to the spine, the extent of which varies in different cases. The two separate nuclei unite, and then join with the extension carried in from the spine. These various epiphyses become united to the bone between the ages of twenty-two and twenty-five years.

Articulations. With the humerus and clavicle.

Attachment of Muscles. To the anterior surface, the Subscapularis; posterior surface, Supra-spinatus, Infra-spinatus; spine, Trapezius, Deltoid; superior border, Omo-hyoid; vertebral border, Serratus magnus, Levator anguli scapulae, Rhomboideus minor and Major; axillary border, Triceps, Teres minor, Teres major; glenoid cavity; long head of the Biceps, coracoid process; short head of Biceps, Coraco-brachialis, Pectoralis minor; and to the inferior angle occasionally a few fibres of the Latissimus dorsi.

The Humerus.

The Humerus is the longest and largest bone of the upper extremity; it presents for examination a shaft and two extremities.

The Superior Extremity is the largest part of the bone; it presents a rounded head, a constriction around the base of the head, the neck, and two other eminences, the greater and lesser tuberosities (fig. 77).

The head, nearly hemispherical in form, is directed inwards, upwards, and a little backwards; its surface is smooth, coated with cartilage in the recent state, and articulates with the glenoid cavity of the scapula. The circumference of its articular surface is slightly constricted, and is termed the anatomical neck, in contradistinction to the constriction which exists below the tuberosities, and is called the surgical neck, from its being the seat of the accident called by surgeons, 'fracture of the neck of the humerus.'

The neck, which is obliquely directed, forming an obtuse angle with the shaft, is more distinctly marked in the lower half of its circumference, than in the upper half, where it presents a narrow groove, separating the head from the tuberosities. Its circumference affords attachment to the capsular ligament, and is perforated by numerous vascular foramina.

The greater tuberosity is situated on the outer side of the head and lesser tuberosity. Its superior surface is rounded and marked by three flat facets, separated by two slight ridges, the most anterior giving attachment to the tendon of the Supra-spinatus; the middle, to the Infra-spinatus; the posterior, to the Teres minor. The external surface of the great tuberosity is convex, rough, and continuous with the outer side of the shaft.

The lesser tuberosity is more prominent, although smaller than the greater; it is situated in front of the head, and is directed inwards and forwards. Its
OSTEOMETRY.

77.—Left Humerus. Anterior View.
summit presents a prominent facet for the insertion of the tendon of the Subscapularis muscle. These two tuberosities are separated from one another by a deep groove, the bicipital groove, so called from its lodging the long tendon of the Biceps muscle. It commences above between the two tuberosities, passes obliquely downwards and a little inwards, and terminates at the junction of the upper with the middle third of the bone. It is deep and narrow at its commencement, and becomes shallow and a little broader as it descends. In the recent state it is covered with a thin layer of cartilage, lined by a prolongation of the synovial membrane of the shoulder joint, and receives part of the tendon of insertion of the Latissimus dorsi about its centre.

The Shaft of the humerus is almost cylindrical in the upper half of its extent; prismatic and flattened below, it presents three borders and three surfaces for examination.

The external border runs from the back part of the greater tuberosity to the external condyle, and separates the external from the posterior surface. It is rounded and indistinctly marked in its upper half, and serves for the attachment of the external head of the triceps muscle; its centre is traversed by a broad but shallow oblique depression, the musculo-spiral groove; its lower part is marked by a prominent rough margin, a little curved from behind forwards, which presents an anterior lip for the attachment of the Supinator longus above, the Extensor carpi radialis longior below, a posterior lip for the Triceps, and an interstice for the attachment of the external intermuscular aponeurosis.

The internal border extends from the lesser tuberosity above to the internal condyle below. Its upper third is marked by a prominent ridge, forming the inner lip of the bicipital groove, and giving attachment from above downwards to the tendons of the Latissimus dorsi, Teres major, and part of the origin of the inner head of the Triceps. About its centre is a rough ridge for the attachment of the Coraco-brachialis, and just below this is seen the entrance of the nutritious canal directed downwards. Its inferior third is raised into a slight ridge, which becomes very prominent below; it presents an anterior lip for the attachment of the Brachialis anticus, a posterior lip for the internal head of the Triceps, and an intermediate space for the internal intermuscular aponeurosis.

The anterior border runs from the front of the great tuberosity above, to the coronoid depression below, separating the internal from the external surface. Its upper part is very prominent and rough, forms the outer lip of the bicipital groove, and serves for the attachment of the tendon of the Pectoralis major. About its centre is seen the rough deltoid impression; below, it is smooth and rounded, affording attachment to the Brachialis anticus.

The external surface is directed outwards above, where it is smooth, rounded, and covered by the Deltoid muscle; forwards below, where it is slightly concave from above downwards, and gives origin to part of the Brachialis anticus muscle. About the middle of this surface, is seen a rough triangular impression for the insertion of the Deltoid muscle, and below it the musculo-spiral groove, directed obliquely from behind, forwards and downwards; it transmits the musculo-spiral nerve and superior profunda artery.

The internal surface, less extensive than the external, is directed forwards above, inwards and forwards below: at its upper part it is narrow, and forms the bicipital groove. The middle part of this surface is slightly rough for the attachment of the Coraco-brachialis; its lower part is smooth, concave, and gives attachment to the Brachialis anticus muscle.

The posterior surface (fig. 78) appears somewhat twisted, so that its superior part is directed a little inwards, its inferior part backwards and a little outwards. Nearly the whole of this surface is covered by the external and internal heads of the triceps, the former being attached to its upper and outer part, the latter to its inner and back part, their origin being separated by the musculo-spiral groove.

The Lower Extremity is flattened from before backwards, and curved slightly forwards; it terminates below in a broad articular surface, which is divided into
two parts by a shallow groove; on either side of the articulate surface are the external and internal condyles. The articular surface extends a little lower than the condyles, and is curved slightly forwards, so as to occupy the more anterior part of the bone; its greatest breadth is in the transverse diameter, and it is obliquely directed, so that its inner extremity occupies a lower level than the outer. The outer portion of this articular surface presents a smooth rounded eminence, which has received the name of the lesser or radial head of the humerus; it articulates with the cup-shaped depression on the head of the radius, is limited to the front and lower part of the bone, and does not extend as far back as the other portion of the articular surface. On the inner side of this eminence is a shallow groove, in which is received the inner margin of the cup-like cavity of the head of the radius. The inner or trochlear portion of the articular surface presents a deep depression between two well-marked borders. This surface is curved from before backwards, concave from side to side, and occupies the anterior lower and posterior part of the bone. The external border, less prominent than the internal, corresponds to the interval between the radius and ulnar. The internal border is thicker, more prominent, and, consequently, of greater length than the external. The grooved portion of the articular surface fits accurately within the greater sigmoid cavity of the ulna; it is broader and deeper on the posterior than on the anterior aspect of the bone, and is directed obliquely from behind forwards, and from without inwards. Immediately above the back part of the trochlear surface, is a deep triangular depression, the olecranon depression, in which is received the summit of the olecranon process in extension of the fore-arm. Above the front part of the trochlear surface, is seen a smaller depression, the coronoid depression; it receives the coronoid process of the ulna during flexion of the fore-arm. These fossæ are separated from one another by a thin lamina of bone, which is sometimes perforated; their margins afford attachment to the anterior and posterior ligaments of the elbow joint, and they are lined in the recent state by the synovial membrane of this articulation. Above the front part of the radial tuberosity, is seen a slight depression which receives the
anterior border of the head of the radius when the fore-arm is strongly flexed. The external condyle is a small tubercular eminence, less prominent than the internal, curved a little forwards, and giving attachment to the external lateral ligament of the elbow joint, and to a tendon common to the origin of some of the extensor and supinator muscles. The internal condyle, larger and more prominent than the external, is directed a little backwards, it gives attachment to the internal lateral ligament, and to a tendon common to the origin of some of the flexor muscles of the fore-arm. These eminences are directly continuous above with the external and internal borders.

Structure. The extremities consist of cancellous tissue, covered with a thin compact layer; the shaft is composed of a cylinder of compact tissue, thicker at the centre than at the extremities, and hollowed out by a large medullary canal.

Development. By seven centres (fig. 79); one for the shaft, one for the head, one for the greater tuberosity, one for the radial, and one for the trochlear portion of the articular surface, and one for each condyle. The centre for the shaft appears very early, soon after ossification has commenced in the cavicle, and soon extends towards the extremities. At birth, it is ossified nearly in its whole length, the extremities remaining cartilaginous. Between the first and second years, ossification commences in the head of the bone, and between the second and third years the centre for the tuberosities marks its appearance usually by a single ossific point, but sometimes, according to Beclard, by one for each tuberosity, that for the lesser being small, and not appearing until after the fourth year. By the fifth year, the centres for the head and tuberosities have enlarged and become joined, so as to form a single large epiphysis.

The lower end of the humerus is developed in the following manner: At the end of the second year, ossification commences in the radial portion of the articular surface, and from this point extends inwards, so as to form the chief part of the articular end of the bone, the centre for the inner part of the articular surface not appearing until about the age of twelve. Ossification commences in the internal condyle about the fifth year, and in the external one not until between the age of thirteen or fourteen. About sixteen or seventeen years, the outer condyle and both portions of the articular surface (having already joined) unite with the shaft; at eighteen years, the inner condyle becomes joined, whilst the upper epiphysis, although the first formed, is not joined until about the twentieth year.

Articulations. With the glenoid cavity of the scapula, and with the ulna and radius.

Attachment of Muscles. To the greater tuberosity, the Supra-spinatus, Infraspinatus, and Teres minor; to the lesser tuberosity, the Subscapularis; to the anterior bicipital ridge, the Pectoralis major; to the posterior bicipital ridge and groove, the Latissimus dorsi and Teres major; to the shaft, the Deltoid, Coraco-brachialis, Brachialis anticus, External and Internal heads of the Triceps; to the internal
condyle, the Pronator radii teres, and common tendon of the Flexor carpi radialis, Palmaris longus, Flexor digitorum sublimis, and Flexor carpi ulnaris; to the external condyloid ridge, the Supinator longus, and Extensor carpi radialis longior; to the external condyle, the common tendon of the Extensor carpi radialis brevior, Extensor communis digitorum, Extensor minimi digitii, and Extensor carpi ulnaris, the Anconeus, and Supinator brevis.

The Fore-arm is that portion of the upper extremity, situated between the elbow and wrist. It is composed of two bones, the Ulna and Radius.

The Ulna.  (fig. 80, 81) is a long bone, prismatic in form, placed at the inner side of the fore-arm, parallel with the radius, being the largest and longest of the two. Its upper extremity, of great thickness and strength, forms a large part of the articulation of the elbow joint; it gradually tapers as it descends, its inferior extremity being very small, and excluded from the wrist joint by the interposition of an interarticular fibro-cartilage. It is divisible into a shaft and two extremities.

The Upper Extremity, the strongest part of the bone, presents for examination two large curved processes, the Olecranon process and the Coronoid process, and two concave articular cavities, the greater and lesser Sigmoid cavities.

The Olecranon Process is a large thick curved eminence, situated at the upper and back part of the ulna. It rises somewhat higher than the coronoid, is contracted where it joins the shaft, and curved forwards at the summit so as to present a prominent tip. Its posterior surface, directed backwards, is of a triangular form, smooth, subcutaneous, and covered by a bursa. Its superior surface, directed upwards, is of a quadrilateral form, marked behind by a rough surface for the attachment of the Triceps muscle, and in front, near the margin, by a slight transverse groove for the attachment of part of the posterior ligament of the elbow joint. Its anterior surface is smooth, concave, covered with cartilage in the recent state, and forms the upper and back part of the great sigmoid cavity. The lateral borders present a continuation of the same groove that was seen on the margin of the superior surface, they serve for the attachment of ligaments, viz., the back part of the internal lateral ligament internally; the posterior ligament externally. The Olecranon process, in its structure as well as in its position and use, resembles the Patella in the lower limb, and, like it, sometimes exists as a separate piece, not united to the rest of the bone.

The Coronoid Process (κορωνη, a crow's beak; ειδός) is a rough triangular eminence of bone which projects horizontally forwards from the upper and front part of the ulna, forming the lower part of the great sigmoid cavity. Its base is continuous with the shaft. Its apex, pointed, slightly curved upwards, is received into the coronoid depression of the humerus in flexion of the fore-arm. Its superior surface is smooth, concave, and forms the lower part of the great sigmoid cavity. The inferior surface is concave, directed downwards and forwards and marked internally by a rough impression for the insertion of the Brachialis anticus. At the junction of this surface with the body, is a rough eminence, the tubercle of the ulna, for the attachment of the oblique ligament. Its outer surface presents a narrow, oblong, articular depression, the lesser sigmoid cavity. The inner surface, by its prominent free margin, serves for the attachment of the front part of the internal lateral ligament. At the front part of this surface is a small rounded eminence for the attachment of one head of the Flexor digitorum sublimis. Behind the eminence, a depression for part of the origin of the Flexor profundus digitorum, and descending from it a ridge, lost below on the inner border of the shaft, which gives attachment to one head of the Pronator radii teres.

The Greater Sigmoid Cavity (αιξια, ειδός, form), so called from its resemblance to the Greek letter Σ, is a semi-lunar depression of large size, situated between the olecranon and coronoid processes, and serving for articulation with the trochlear surface of the humerus. About the middle of either lateral border of this cavity
is a notch, which contracts it somewhat, and serves to indicate the junction of the two processes of which it is formed. The cavity is concave from above downwards, and divided into two lateral parts by a smooth elevated ridge, which runs from the summit of the olecranon to the tip of the coronoid process. Of these two portions, the internal is the largest, and slightly concave transversely; the external the smallest, being nearly plane from side to side.

The Lesser Sigmoid Cavity is a narrow, oblong, articular depression, placed on the outer side of the coronoid process, and serving for articulation with the head of the radius. It is concave from before backwards; and its extremities, which are prominent, serve for the attachment of the orbicular ligament.

The Shaft is prismatic in form at its upper part, and curved from behind forwards, and from within outwards, so as to be convex behind and externally; its central part is quite straight; its lower part rounded, smooth, and bent a little outwards; it tapers gradually from above downwards, and presents for examination three borders and three surfaces.

The anterior border commences above at the prominent inner angle of the coronoid process, and terminates below in front of the styloid process. It is well marked above, smooth and rounded in the middle of its extent, and affords attachment to the Flexor profundus digitorum, sharp and prominent in its lower fourth, for the attachment of the Pronator quadratus. It separates the anterior from the internal surface.

The posterior border commences above at the apex of the triangular surface at the back part of the olecranon, and terminates below at the back part of the styloid process; it is well marked in the upper three-fourths, and gives attachment to an aponeurosis common to the Flexor carpi ulnaris, the Extensor carpi ulnaris, and the Flexor profundus digitorum muscles; its lower fourth is smooth and rounded. This border separates the internal from the posterior surface.

The external border commences above by two lines, which converge one from each extremity of the lesser sigmoid cavity, enclosing between them a triangular space for the attachment of part of the Supinator brevis, and terminates below at the middle of the articular surface for the radius. Its two middle-fourths are very prominent, and serve for the attachment of the interosseous membrane; its lower fourth is smooth and rounded. This border separates the anterior from the posterior surface.

The anterior surface, much broader above than below, is concave in the upper three-fourths of its extent, and affords attachment to the Flexor profundus digitorum. Its lower fourth, also concave, to the Pronator quadratus. The lower fourth is separated from the remaining portion of the bone by a prominent ridge, directed obliquely from above downwards and inwards; this ridge marks the extent of attachment of the Pronator above. At the junction of the upper with the middle third of the bone is the nutritious canal, directed obliquely upwards and inwards.

The posterior surface, directed backwards and outwards, is broad and concave above, somewhat narrower and convex in the middle of its course, narrow, smooth, and rounded below. It presents above an oblique ridge, which runs from the posterior extremity of the lesser sigmoid cavity, downwards to the posterior border, marking off a small triangular surface above it for the insertion of the Anconeus muscle, whilst the ridge itself affords attachment to the Supinator brevis. The surface of bone below this is subdivided by a longitudinal ridge into two parts, the internal part is smooth, concave, and gives origin (occasionally is merely covered by) the Extensor carpi ulnaris. The external portion, wider and rougher, gives attachment from above downwards to part of the Supinator brevis, the Extensor ossis metacarpi pollicis, Extensor secundii internodi pollicis, and Extensor indicis muscles.

The internal surface is broad and concave above, narrow and convex below. It gives attachment by its upper three-fourths to the Flexor profundus digitorum muscle; its lower fourth is subcutaneous.

The Lower Extremity of the ulna is of small size, and excluded from the articulation of the wrist joint. It presents for examination two eminences; the outer
81.—Bones of the Left Forearm. Posterior Surface.
and larger is a rounded articular eminence, termed the head of the ulna. The inner, narrower and more projecting, is a non-articular eminence, the styloid process. The head presents an articular facet, part of which, of an oval form, is directed downwards, and plays on the surface of the triangular fibro-cartilage, which separates this bone from the wrist joint; the remaining portion, directed outwards, is narrow, convex, and received into the sigmoid cavity of the radius. The styloid process projects from the inner and back part of the bone, and descends a little lower than the head, terminating in a rounded summit, which affords attachment to the internal lateral ligament of the wrist. The head is separated from the styloid process below and in front, by a depression for the attachment of the triangular inter-articular fibro-cartilage; behind, by a shallow groove for the passage of the tendon of the Extensor carpi ulnaris.

Structure. Similar to that of the other long bones.

Development. By three centres; one for the shaft, one for the inferior extremity, and one for the olecranon (fig. 82). The centre for the shaft appears a short time after the radius, and soon extends through the greater part of the bone. At birth, the ends are cartilaginous. About the fourth year, a separate osseous nucleus appears in the middle of the head, which soon extends into the styloid process. About the tenth year, ossific matter appears in the upper cartilaginous end of the bone near its extremity, the chief part of the olecranon being formed from an extension of the shaft of the bone into it. At about the sixteenth year, the upper epiphysis becomes joined, and at about the twentieth the inferior one.

Articulations. With the humerus and radius.

Attachment of Muscles. To the olecranon; the Triceps, Anconeus, and one head of the Flexor carpi ulnaris. To the coronoid process; the Brachialis anticus, Pronator radii teres, Flexor sublimis digitorum, and Flexor profundus digitorum. To the shaft; the Flexor profundus digitorum, Pronator quadratus, Flexor carpi ulnaris, Extensor carpi ulnaris, Anconeus, Supinator brevis, Extensor ossis metacarpi pollicis, Extensor secundi inter-nodii pollicis, and Extensor indicis.

The Radius.

The Radius is situated on the outer side of the fore-arm, lying parallel with the ulna, which exceeds it in length and size. Its upper end is small, and forms only a small part of the elbow-joint; but its lower end is large, and forms the chief part of the wrist. It is one of the long bones, having a prismatic form, slightly curved longitudinally, and presenting for examination a shaft and two extremities.

The Upper Extremity presents a head, neck, and tuberosity. The head is of a cylindrical form, depressed on its upper surface into a shallow cup, which receives the radial or lesser head of the humerus. Around the circumference of the head is a smooth articular surface, coated with cartilage in the recent state, broad internally where it articulates with the lesser sigmoid cavity of the ulna, narrow in the rest of its circumference, to play in the orbicular ligament. The head is supported on a round, smooth, and constricted portion of bone, called the neck, which presents, behind, a slight ridge, for the attachment
of part of the Supinator brevis. Beneath the neck, at the inner and front aspect of the bone, is a rough eminence, the tuberosity. Its surface is divided into two parts by a vertical line—a posterior rough portion, for the insertion of the tendon of the Biceps muscle; and an anterior smooth portion, on which a bursa is interposed between the tendon and the bone.

The Shaft of the bone is prismatic in form, narrower above than below, and slightly curved, so as to be convex outwards. It presents three surfaces, separated by three borders.

The anterior border extends from the lower part of the tuberosity above, to the anterior part of the base of the styloid process below. It separates the anterior from the external surface. Its upper third is very prominent; and, from its oblique direction downwards and outwards, has received the name of the oblique line of the radius. It affords attachment, externally, to the Supinator brevis; internally, to the Flexor longus pollicis, and between these to the Flexor digitorum sublimis. The middle third of the anterior border is indistinct and rounded. Its lower fourth is sharp, prominent, affords attachment to the Pronator quadratus, and terminates in a small tubercle, into which is inserted the tendon of the Supinator longus.

The posterior border commences above, at the back part of the neck of the radius, and terminates below, at the posterior part of the base of the styloid process; it separates the posterior from the external surface. It is indistinct above and below, but well marked in the middle third of the bone.

The internal or interosseous border commences above, at the back part of the tuberosity, where it is rounded and indistinct, becomes sharp and prominent as it descends, and at its lower part bifurcates into two ridges, which descend to the anterior and posterior margins of the sigmoid cavity. This border separates the anterior from the posterior surface, and has the interosseous membrane attached to it throughout the greater part of its extent.

The anterior surface is narrow and concave for its upper two-thirds, and gives attachment to the Flexor longus pollicis muscle; below, it is broad and flat, its lower fourth giving attachment to the Pronator quadratus. At the junction of the upper and middle thirds of this surface is the nutritive foramen, which is directed obliquely upwards.

The posterior surface is rounded, convex, and smooth in the upper third of its extent, and covered by the Supinator brevis muscle. Its middle third is broad, slightly concave, and gives attachment to the Extensor ossis metacarpi pollicis above, the Extensor primi internodi pollicis below. Its lower third is broad, convex, and covered by the tendons of the muscles which subsequently run in the grooves on the lower end of the bone.

The external surface is rounded and convex throughout its entire extent. Its upper third gives attachment to the Supinator brevis muscle. About its centre is seen a rough ridge, for the insertion of the Pronator radii teres muscle. Its lower part is narrow, and covered by the tendons of the Extensor ossis metacarpi, and Extensor primi internodi pollicis muscles.

The Lower Extremity of the radius is large, of quadrilateral form, and provided with two articular surfaces, one at the extremity, and one at the inner side of the bone; it presents, also, three borders, an anterior, posterior, and external. The articular surface at the extremity of the bone is of triangular form, concave, smooth, and divided by a slight ridge into two parts. Of these, the external is large, of a triangular form, and articulates with the scaphoid bone; the inner, smaller and quadrilateral, articulates with the semi-lunar. The articular surface at the inner side of the bone is called the sigmoid cavity of the radius; it is narrow, concave, smooth, and articulates with the head of the ulna.

Its anterior border, rough and irregular, affords attachment to the anterior ligament of the wrist-joint. Its external border is prolonged obliquely downwards upon the margin of a strong conical projection, the styloid process, which gives attachment by its base to the tendon of the Supinator longus, and by its apex to the external lateral ligament of the wrist-joint. The outer surface of
this process is marked by two grooves, which run obliquely downwards and forwards, and are separated from one another by an elevated ridge. The most anterior one gives passage to the tendon of the Extensor ossis metacarpi pollicis, the posterior one to the tendon of the Extensor primi internodii pollicis. Its posterior border is convex, affords attachment to the posterior ligament of the wrist, and is marked by three grooves. The most external is broad, but shallow, and subdivided into two by a slightly elevated ridge. The external groove transmits the tendon of the Extensor carpi radialis longior, the inner one the tendon of the Extensor carpi radialis brevior. Near the centre of the bone is a deep, but narrow, groove, directed obliquely from above downwards and outwards; it transmits the tendon of the Extensor secundii internodii pollicis. Internally is a broad groove, for the passage of the tendons of the Extensor communis digitorum, and that of the Extensor indicis; the tendon of the Extensor minimi digiti passing through the groove at its point of articulation with the ulna.

Development (fig. 83). By three centres: one for the shaft, and one for each extremity. That for the shaft, makes its appearance near the centre of the bone, soon after the development of the humerus commences. At birth, the shaft is ossified; but the ends of the bone are cartilaginous. About the end of the second year, ossification commences in the lower epiphysis; and about the fifth year, in the upper one. At the age of puberty, the upper epiphysis becomes joined to the shaft; the lower epiphysis becoming united about the twentieth year.

Articulations. With four bones; the humerus, ulna, scaphoid, and semi-lunar.

Attachment of Muscles. To the tuberosity, the Biceps; to the oblique ridge, the Supinator brevis, Flexor digitorum sublimis, and Flexor longus pollicis; to the shaft (its anterior surface), the Flexor longus pollicis and Pronator quadratus, (its posterior surface) the Extensor ossis metacarpi pollicis, and Extensor primi internodii pollicis; to the outer surface, the Pronator radii teres; and to the styloid process, the Supinator longus.

THE HAND.

The Hand is subdivided into three segments, the Carpus or wrist, the Metacarpus or palm, and the Phalanges or fingers.

CARPUS.

The bones of the Carpus, eight in number, are arranged in two horizontal rows. Those of the upper row, enumerated from the radial to the ulnar side, are the scaphoid, semi-lunar, cuneiform, and pisiform; those of the lower row, enumerated in the same order, are the trapezium, trapezoid, magnum, and unciform.

COMMON CHARACTERS OF THE CARPAL BONES.

Each bone (excepting the pisiform) presents six surfaces. Of these, the anterior or palmar, and the posterior or dorsal, are rough, for ligamentous attach-
ment, the dorsal surface being generally the broadest of the two. The superior and inferior are articular, the superior generally convex, the inferior concave; and the internal and external are also articular when in contact with contiguous bones, otherwise rough and tubercular. Their structure in all is similar, consisting within of a loose cancellous tissue enclosed in a thin layer of compact tissue. Each bone is also developed from a single centre of ossification.

**Bones of the Upper Row.** (Figs. 84, 85.)

The Scaphoid is the largest bone of the first row. It has received its name from its fancied resemblance to a boat, being broad at one end, and narrowed like a prow at the opposite. It is situated at the superior and external part of the carpus, its direction being from above downwards, outwards, and forwards. Its superior surface is convex, smooth, of triangular shape, and articulates with the lower end of the radius. Its inferior surface, directed downwards, outwards, and backwards, is smooth, convex, also triangular, and divided by a slight ridge into two parts, the external of which articulates with the trapezium, the inner with the trapezoid. Its posterior or dorsal surface presents a narrow, rough groove, which runs the entire breadth of the bone, and serves for the attachment of ligaments. The anterior or palmar surface is concave above, and elevated at its lower and outer part into a prominent rounded tubercle, which projects forwards from the front of the carpus, and gives attachment to the anterior annular ligament of the wrist. The external surface is rough and narrow, and gives attachment to the external lateral ligament of the wrist. The internal surface presents two articular facets: of these, the superior or smaller one is flattened, of semilunar form, and articulates with the semi-lunar; the inferior or larger is concave, forming, with the semi-lunar bone, a concavity for the head of the os magnum.

To ascertain to which hand this bone belongs, hold the convex radial articular surface upwards, and the dorsal surface backwards; the prominent tubercle will be directed to the side to which the bone belongs.

**Articulations.** With five bones; the radius above, trapezium and trapezoid below, os magnum and semi-lunar internally.

The Semi-lunar bone may be distinguished by its deep concavity and crescentic outline. It is situated in the centre of the upper range of the carpus, between the scaphoid and cuneiform. Its superior surface, convex, smooth, and quadrilateral in form, articulates with the radius. Its inferior surface is deeply concave, and of greater extent from before backwards, than transversely; it articulates with the head of the os magnum, and by a long narrow facet (separated by a ridge from the general surface) with the unciniform bone. Its anterior or palmar and posterior or dorsal surfaces are rough, for the attachment of ligaments, the former being the broader, and of somewhat rounded form. The external surface presents a narrow, flattened, semi-lunar facet, for articulation with the scaphoid. The internal surface is marked by a smooth, quadrilateral facet, for articulation with the cuneiform.

To ascertain to which hand this bone belongs, hold it with the dorsal surface upwards, and the convex articular surface backwards; the quadrilateral articular facet will then point to the side to which the bone belongs.

**Articulations.** With five bones: the radius above, os magnum and unciniform below, scaphoid and cuneiform on either side.

The Cuneiform (Os Pyramidal), may be distinguished by its pyramidal shape, and from having an oval-shaped, isolated facet, for articulation with the pisiform bone. It is situated at the upper and inner side of the carpus. The superior surface presents an internal, rough, non-articular portion; and an external or articular portion, which is convex, smooth, and separated from the lower end of the ulna by the inter-articular fibro-cartilage of the wrist. The inferior surface, directed outwards, is concave, sinuously curved, and smooth, for articulation with the unciniform. Its posterior or dorsal surface is rough, for the attachment of ligaments. Its anterior or palmar surface presents, at its inner side, an
Oval-shaped facet, for articulation with the pisiform; and is rough externally, for ligamentous attachment. Its external surface, the base of the pyramid, is marked

§4.—Bones of the Left Hand. Dorsal Surface.

by a flat, quadrilateral, smooth facet, for articulation with the semi-lunar. The internal surface, the summit of the pyramid, is pointed and roughened, for the attachment of the internal lateral ligament of the wrist.
To ascertain to which hand this bone belongs, hold it so that the base is directed backwards, and the articular facet for the pisiform bone upwards; the concave articular facet will point to the side to which the bone belongs.

Articulations. With three bones: the semi-lunar externally, the pisiform in front, the unciform below, and with the triangular inter-articular fibro-cartilage which separates it from the lower end of the ulna.

The Pisiform bone may be known by its small size, and from its presenting a single articular facet. It is situated at the anterior and inner side of the carpus, is nearly circular in form, and presents on its posterior surface a smooth, oval facet, for articulation with the cuneiform bone. This facet approaches the superior, but not the inferior, border of the bone. Its anterior or palmar surface is rounded and rough, and gives attachment to the anterior annular ligament. The outer and inner surfaces are also rough, the former being convex, the other usually concave.

To ascertain to which hand it belongs, hold the bone with its posterior or articular facet downwards, and the non-articular portion of the same surface backwards; the inner concave surface will then point to the side to which the bone belongs.

Articulations. With one bone, the cuneiform.

Attachment of Muscles. To two: the Flexor carpi ulnaris, and Abductor minimi digiti; and to the anterior annular ligament.

Bones of the Lower Row. (Figs. 84, 85.)

The Trapezium is of very irregular form. It may be distinguished by a deep groove, for the tendon of the Flexor carpi radialis muscle. It is situated at the external and inferior part of the carpus, between the scaphoid and first metacarpal bone. The superior surface, concave and smooth, is directed upwards and inwards, and articulates with the scaphoid. Its inferior surface, directed downwards and outwards, is oval, concave from side to side, convex from before backwards, so as to form a saddle-shaped surface, for articulation with the base of the first metacarpal bone. The anterior or palmar surface is narrow and rough. At its upper part is a deep groove, running from above obliquely downwards and inwards; it transmits the tendon of the Flexor carpi radialis, and is bounded externally by a prominent ridge, the oblique ridge of the trapezium. This surface gives attachment to the Abductor pollicis, Flexor ossis metacarpi, and Flexor brevis pollicis muscles; and the anterior annular ligament. The posterior or dorsal surface is rough, and the external surface also broad and rough, for the attachment of ligaments. The internal surface presents two articular facets; the upper one, large and concave, articulates with the trapezoid; the lower one, narrow and flattened, with the base of the second metacarpal bone.

To ascertain to which hand it belongs, hold the bone with the grooved palmar surface upwards, and the external, broad, non-articular surface backwards; the saddle-shaped surface will then be directed to the side to which the bone belongs.

Articulations. With four bones: the scaphoid above, the trapezoid and second metacarpal bones internally, the first metacarpal below.

Attachment of Muscles. Abductor pollicis, Flexor ossis metacarpi, part of the Flexor brevis pollicis, and the anterior annular ligament.

The Trapezoid is the smallest bone in the second row. It may be known by its wedge-shaped form; its broad end occupying the dorsal, its narrow end the palmar surface of the hand. Its superior surface, quadrilateral in form, smooth and slightly concave, articulates with the scaphoid. The inferior surface articulates with the upper end of the second metacarpal bone; it is convex from side to side, concave from before backwards, and subdivided, by an elevated ridge, into two unequal lateral facets. The posterior or dorsal, and anterior or palmar surfaces are rough, for the attachment of ligaments; the former being the larger of the two. The external surface, convex and smooth, articulates with the
trapezium. The internal surface is concave and smooth below, for articulation with the os magnum, rough above, for the attachment of an interosseous ligament.

To ascertain to which side this bone belongs, let the broad dorsal surface be held upwards, and its inferior concavo-convex surface forwards; the internal concave surface will then point to the side to which the bone belongs.

Articulations. With four bones; the scaphoid above, second metacarpal bone below, trapezium externally, os magnum internally.
Attachment of Muscles. Part of the Flexor brevis pollicis.

The Os Magnum is the largest bone of the carpus, and occupies the centre of the wrist. It presents, above, a rounded portion or head, which is received into the concavity formed by the scaphoid and semi-lunar bones; a constricted portion or neck; and, below, the body. Its superior surface is rounded, smooth, and articulates with the semi-lunar. Its inferior surface is divided, by two ridges, into three facets, for articulation with the second, third, and fourth metacarpal bones; that for the third (the middle facet) being the largest of the three. The posterior or dorsal surface is broad and rough, and the anterior or palmar narrow, rounded, but also rough, for the attachment of ligaments. The external surface articulates with the trapezoid by a small facet at its anterior inferior angle, behind which is a rough depression, for the attachment of an interosseous ligament. Above this is a deep and rough groove, which forms part of the neck, and serves for the attachment of ligaments, bounded superiorly by a smooth, convex surface, for articulation with the scaphoid. The internal surface articulates with the unciform by a smooth, concave, oblong facet, which occupies its posterior and superior parts; rough in front, for the attachment of an interosseous ligament.

To ascertain to which hand this bone belongs, the rounded head should be held upwards, and the broad dorsal surface forwards; the internal concave articular surface will point to its appropriate side.

Articulations. With seven bones: the scaphoid and semi-lunar above; the second, third, and fourth metacarpal below; the trapezoid on the radial side; and the unciform on the ulnar side.

Attachment of Muscles. Part of the Flexor brevis pollicis.

The Unciform bone may be readily distinguished by its wedge-shaped form, and the hook-like process that projects from its palmar surface. It is situated at the inner and lower angle of the carpus, with its base downwards, resting on the two inner metacarpal bones, and its apex directed upwards and outwards. Its superior surface, the apex of the wedge, is narrow, convex, smooth, and articulates with the semi-lunar. Its inferior surface articulates with the fourth and fifth metacarpal bones, the concave surface for each being separated by a ridge, which runs from before backwards. The posterior or dorsal surface is triangular and rough, for ligamentous attachment. The anterior or palmar surface presents at its lower and inner side a curved, hook-like process of bone, the unciniform process, directed from the palmar surface forwards and outwards. It gives attachment, by its apex, to the annular ligament; by its inner surface, to the Flexor brevis minimi digitii, and the Flexor ossis metacarpi minimi digitii; and is grooved on its outer side, for the passage of the Flexor tendons into the palm of the hand. This is one of the four eminences on the front of the carpus, to which the anterior annular ligament is attached; the others being the pisiform internally, the oblique ridge of the trapezium and the tuberosity of the scaphoid externally. The internal surface articulates with the cuneiform by an oblong surface, cut obliquely from above backwards and inwards. Its external surface articulates with the os magnum by its upper and posterior part, the remaining portion being rough, for the attachment of ligaments.

To ascertain to which hand it belongs, hold the apex of the bone upwards, and the broad dorsal surface backwards; the concavity of the unciniform process will be directed to the side to which the bone belongs.

Articulations. With five bones: the semi-lunar above, the fourth and fifth metacarpal below, the cuneiform internally, the os magnum externally.

Attachment of Muscles. To two: the Flexor brevis minimi digitii, the Flexor ossis metacarpi minimi digitii; and to the anterior annular ligament.

The Metacarpus.

The Metacarpal bones are five in number; they are long cylindrical bones, presenting for examination a shaft and two extremities.
Common Characters of the Metacarpal Bones.

The shaft is prismoid in form, and curved longitudinally, so as to be convex in the longitudinal direction behind, concave in front. It presents three surfaces; two lateral, and one posterior. The lateral surfaces are concave, for the attachment of the Interossei muscles, and separated from one another by a prominent line. The posterior or dorsal surface is triangular, smooth, and flattened below, and covered, in the recent state, by the tendons of the Extensor muscles. In its upper half, it is divided by a ridge into two narrow lateral depressions, for the attachment of the Dorsal interossei muscles. This ridge bifurcates a little above the centre of the bone, and its branches run to the small tubercles on each side of the digital extremity.

The carpal extremity, or base, is of a cuboidal form, and broader behind than in front: it articulates, above, with the carpus; and on each side with the adjoining metacarpal bones; its dorsal and palmar surfaces being rough, for the attachment of tendons and ligaments.

The digital extremity, or head, presents an oblong surface, flattened at each side, for articulation with the first phalanx; it is broader and extends farther forwards in front than behind; and longer in the antero-posterior, than in the transverse diameter. On either side of the head is a deep depression, surmounted by a tubercle, for the attachment of the lateral ligament of the metacarpo-phalangeal joint. The posterior surface, broad and flat, supports the Extensor tendons; and the anterior surface presents a median groove, bounded on each side by a tubercle, for the passage of the Flexor tendons.

Peculiar Metacarpal Bones.

The metacarpal bone of the thumb is shorter and wider than the rest, diverges to a greater degree from the carpus, and its palmar surface is directed inwards towards the palm. The shaft is flattened and broad on its dorsal aspect, and does not present the bifurcated ridge peculiar to the other metacarpal bones; concave from before backwards on its palmar surface. The carpal extremity, or base, presents a concavo-convex surface, for articulation with the trapezium, and has no lateral facets. The digital extremity is less convex than that of the other metacarpal bones, broader from side to side than from before backwards, and terminates anteriorly in a small articular eminence on each side, over which play two sesamoid bones.

The metacarpal bone of the index finger is the longest, and its base the largest of the other four. Its carpal extremity is prolonged upwards and inwards; and its dorsal and palmar surfaces are rough, for the attachment of tendons and ligaments. It presents four articular facets: one at the end of the bone, which has an angular depression for articulation with the trapezoid; on the radial side, a flat quadrilateral facet, for articulation with the trapezium; its ulnar side being prolonged upwards and inwards, to articulate above with the os magnum, internally with the third metacarpal bone.

The metacarpal bone of the middle finger is a little less in size than the preceding; it presents a pyramidal eminence on the radial side of its base (dorsal aspect), which extends upwards behind the os magnum. The carpal-articular facet is concave behind, flat and horizontal in front, and corresponds to the os magnum. On the radial side is a smooth, concave facet, for articulation with the second metacarpal bone; and on the ulnar side two small oval facets, for articulation with the third metacarpal.

The metacarpal bone of the ring-finger is shorter and smaller than the preceding, and its base small and quadrilateral; its carpal surface presenting two facets, for articulation with the unciform and os magnum. On the radial side are two oval facets, for articulation with the third metacarpal bone; and on the ulnar side a single concave facet, for the fifth metacarpal.
The metacarpal bone of the little finger may be distinguished by the concavo-convex form of its carpal surface, for articulation with the unciform, and from having only one lateral articular facet, which corresponds with the fourth metacarpal bone. On its ulnar side, is a prominent tubercle for the insertion of the tendon of the Extensor carpi ulnaris. The dorsal surface of the shaft is marked by an oblique ridge, which extends from near the inner side of the upper extremity, to the outer side of the lower. The outer division of this surface serves for the attachment of the fourth Dorsal interosseous muscle; the inner division is smooth, and covered by the Extensor tendons of the little finger.

Articulations. The first, with the trapezium; the second, with the trapezium, trapezoides, os magnum, and third metacarpal bones; the third, with the os magnum, and second and fourth metacarpal bones; the fourth, with the os magnum, unciform, and third and fifth metacarpal bones; and the fifth, with the unciform and fourth metacarpal.

Attachment of Muscles. To the metacarpal bone of the thumb, three: the Flexor ossis metacarpi pollicis, Extensor ossis metacarpi pollicis, and first Dorsal interosseous. To the second metacarpal bone, five: the Flexor carpi radialis, Extensor carpi radialis longior, first and second Dorsal interosseous, and first Palmar interosseous. To the third, five: the Extensor carpi radialis brevior, Flexor brevis pollicis, Adductor pollicis, and second and third Dorsal interosseous. To the fourth, three: the third and fourth Dorsal interosseous and second Palmar. To the fifth, four: the Extensor carpi ulnaris, Flexor carpi ulnaris, Flexor ossis metacarpi minimi digiti, and third Dorsal interosseous.

Phalanges.

The Phalanges are the bones of the fingers; they are fourteen in number, three for each finger and two for the thumb. They are long bones, and present for examination a shaft, and two extremities. The shaft tapers from above downwards, is convex posteriorly, concave in front from above downwards, flat from side to side, and marked laterally by rough ridges, which give attachment to the fibrous sheaths of the Flexor tendons. The metacarpal extremity or base, in the first row, presents an oval concave articular surface, broader from side to side, than from before backwards; and the same extremity in the other two rows, a double concavity separated by a longitudinal median ridge, extending from before backwards. The digital extremities are smaller than the others, and terminate, in the first and second row, in two small lateral condyles, separated by a slight groove, the articular surface being prolonged farther forwards on the palmar, than on the dorsal surface, especially in the first row.

The Ungual phalanges are convex on their dorsal, flat on their palmar surfaces, they are recognised by their small size, and from their ungual extremity presenting, on its palmar aspect, a roughened elevated surface of a horse-shoe form, which serves to support the sensitive pulp of the finger.

Articulations. The first row with the metacarpal bones, and the second row of phalanges; the second row, with the first and third; the third, with the second row.

Attachment of Muscles. To the base of the first phalanx of the thumb, four muscles: the Extensor primi internodii pollicis, Flexor brevis pollicis, Abductor pollicis, Adductor pollicis. To the second phalanx, two: the Flexor longus pollicis, and the Extensor secundi internodii. To the base of the first phalanx of the index finger, the first Dorsal and the first Palmar interosseous; to that of the middle finger, the second and third Dorsal interosseous; to the ring finger, the fourth Dorsal and the second Palmar interosseous; and to that of the little finger, the third Palmar interosseous, the Flexor brevis minimi digiti, and Abductor minimi digiti. To the second phalanges, the Flexor sublimis digitorum, Extensor communis digitorum; and, in addition, the Extensor indicis, to the index finger; the Extensor minimi digiti, to the little finger. To the third phalanges, the Flexor profundus digitorum and Extensor communis digitorum.
Development of the Hand.

The Carpal bones are each developed by a single centre; at birth they are all cartilaginous. Ossification proceeds in the following order (fig. 86); in the os magnum and unciform an ossific point appears during the first year, the former preceding the latter; in the cuneiform, at the third year; in the trapezium and semilunar, at the fifth year, the former preceding the latter; in the scaphoid, at the sixth year; in the trapezoid, during the eighth year; and in the pisiform, about the twelfth year.

86.—Plan of the Development of the Hand.

The Metacarpal bones are developed each by two centres: one for the shaft, and one for the digital extremity, for the four inner metacarpal bones; one for the shaft and one for the base, for the metacarpal bone of the thumb, which, in this respect, resembles the phalanges. Ossification commences in the centre of the shaft about the sixth week, and gradually proceeds to either end of the bone; about the third year the digital extremity of the four inner metacarpal bones and the base of the first metacarpal, commence to ossify, and they unite about the twentieth year.

The Phalanges are each developed by two centres: one for the shaft and one for the base. Ossification commences in the shaft, in all three rows, at about the sixth week, and gradually involves the whole of the bone excepting the upper extremity. Ossification of the base commences in the first row between the third and fourth years, and a year later in those of the second and third row. The two centres become united between the eighteenth and twentieth years.
THE LOWER EXTREMITY.

The Lower Extremities, two in number, are connected with the inferior part of the trunk. They are divided into three parts, the thigh, the leg, and the foot, which correspond to the arm, the forearm, and hand in the upper extremity.

The thigh is formed of a single bone, the femur.

THE FEMUR.

The Femur is the longest, largest, and heaviest bone in the skeleton, and almost perfectly cylindrical in the greater part of its extent. In the erect position of the body it is not vertical, but presents a general curvature in the longitudinal direction, which renders the bone convex in front and slightly concave behind; it also gradually inclines from above downwards and inwards, approaching its fellow towards its lower part, but separated from it above by a very considerable interval which corresponds to the entire breadth of the pelvis. The degree of this inclination varies in different persons, and is greater in the female than in the male. The femur, like other long bones, is divisible into a shaft and two extremities.

The Upper Extremity presents for examination a head, neck, and the greater and lesser trochanters.

The head, which is globular, and forms rather more than a hemisphere, is directed upwards, inwards, and a little forwards, the greater part of its convexity being above and in front. Its surface is smooth, coated with cartilage in the recent state, and presents a little behind and below its centre a rough depression, for the attachment of the ligamentum teres. The neck is a flattened pyramidal process of bone, which connects the head with the shaft. It varies in length and obliquity at various periods of life, and under different circumstances. In the adult male, it forms an obtuse angle with the shaft, being directed upwards, inwards, and a little forwards. In the female, it approaches more nearly a right angle. Occasionally, in very old subjects, and more especially in those greatly debilitated, its direction becomes horizontal, so that the head sinks below the level of the trochanter, and its length diminishes
to such a degree, that the head becomes almost contiguous with the shaft. The neck, is flattened from before backwards, contracted in the middle, and broader at its outer extremity, where it is connected with the shaft, than at its summit, where it is attached to the head. It is much broader in the vertical than in the anterior posterior diameter, on account of the greater amount of resistance required in sustaining the weight of the trunk. Its anterior surface, narrower than the posterior, is perforated by numerous vascular foramina. Its posterior surface is smooth, broader, and more concave than the anterior, and receives towards its outer side the attachment of the capsular ligament of the hip. Its superior border is short and thick, bounded externally by the great trochanter; and its surface perforated by large foramina. Its inferior border, long and narrow, curves a little backwards, to terminate at the lesser trochanter.

The Greater Trochanter is a large irregular quadrilateral eminence, situated at the outer side of the neck, at its junction with the upper part of the shaft. It is directed a little outwards and backwards, and rises less high than the head. It presents for examination two surfaces and four borders.

Its external surface, quadrilateral in form, is broad, rough, convex, and marked by a prominent diagonal line, which extends from the posterior superior to the anterior inferior angle: this line serves for the attachment of the tendon of the Gluteus medius. Above the line is a triangular surface, sometimes rough for part of the tendon of the same muscle, sometimes smooth for the interposition of a bursa between that tendon and the bone. Below and behind the diagonal line is a smooth triangular surface, over which the tendon of the Gluteus maximus muscle plays, a bursa being interposed. The internal surface is of much less extent than the external, and presents at its base a deep depression, the digital or trochanteric fossa, for the attachment of the tendon of the Obturator externus muscle.

The superior border is free; it is thick and irregular, and marked by impressions for the attachment of the Pyriformis behind, the Obturator internus and Gemelli in front. The inferior border is placed at the point of junction of the trochanter with the outer surface of the shaft; it is rough, prominent, slightly curved, and gives attachment to the upper part of the Vastus externus muscle. The anterior border is prominent, somewhat irregular, as well as the surface of bone immediately below it; it affords attachment by its outer part to the Gluteus minimus. The posterior border is very prominent, and appears as a free rounded edge, which forms the back part of the digital fossa.

The Lesser Trochanter is a conical eminence, which varies in size in different subjects; it is situated at the lower and back part of the base of the neck. Its base is triangular, and connected with the adjacent parts of the bone by three well-marked borders: of these the superior is continuous with the lower border of the neck; the posterior, with the posterior intertrochanteric line; and the inferior with the middle bifurcation of the linea aspera. Its summit, which is directed inwards and backwards, is rough, and gives insertion to the tendon of the Psoas magnus. The Iliacus is inserted into the shaft below the lesser trochanter, between the Vastus internus in front, and the Pectineus behind. A well marked prominence, but of variable size, situated at the upper and front part of the neck, at its junction with the great trochanter, is called the tubercle of the femur; it is the point of meeting of three muscles, the Gluteus minimus externally, the Vastus externus below, and the tendon of the Obturator internus and Gemelli above. Running obliquely downwards and inwards from the tubercle is the spiral line of the femur, or anterior intertrochanteric line; it winds around the inner side of the shaft, below the lesser trochanter, and terminates in the linea aspera, about two inches below this eminence. Its upper half is rough, and affords attachment to the capsular ligament of the hip joint; its lower half is less prominent and gives attachment to the upper part of the Vastus internus. The posterior inter-trochanteric line is very prominent, and runs from the summit of the great trochanter downwards and inwards to the upper and back part of the lesser trochanter. Its upper half forms the posterior border of the great trochanter. A
well-marked eminence commences about the centre of the posterior inter-trochanteric line, and passes vertically downwards for about two inches along the back part of the shaft; it is called the \textit{linea quadrati}, and gives attachment to the Quadratus femoris, and a few fibres of the Adductor magnus muscles.

The \textit{Shaft}, almost perfectly cylindrical in form, is a little broader above than in the centre, and somewhat flattened from before backwards below. It is curved from before backwards, smooth and convex in front, and strengthened behind by a prominent longitudinal ridge, the \textit{linea aspera}. It presents for examination three borders separating three surfaces. Of the three borders, one, the \textit{linea aspera}, is posterior, the other two are placed laterally.

The \textit{linea aspera} (fig. 88) is a prominent longitudinal ridge or crest, presenting on the middle third of the bone an external lip, an internal lip, and a rough intermediate space. A little above the centre of the shaft, this crest divides into three lines; the most external one becomes very rough, and is continued almost vertically upwards to the base of the great trochanter; the middle one, the least distinct, is continued to the base of the trochanter minor; and the internal one is lost above in the spiral line of the femur. Below, the \textit{linea aspera} divides into two bifurcations, which enclose between them a triangular space (the popliteal space), upon which rests the popliteal artery. Of these two bifurcations, the outer branch is the most prominent, and descends to the summit of the outer condyle. The inner branch is less marked, presents a broad and shallow groove for the passage of the femoral artery, and terminates at a small tubercle at the summit of the internal condyle.

To the inner lip of the \textit{linea aspera}, its whole length, is attached the Vastus internus; and to the whole length of the outer lip the Vastus externus. The Adductor magnus is also attached to the whole length of the \textit{linea aspera}, being connected with the outer lip above, and the inner lip below. Between the Vastus externus and the Adductor magnus are attached two muscles, viz., the Gluteus maximus above, and the short head of the
Biceps below. Between the Adductor magnus and the Vastus internus four muscles are attached: the Iliaca and Pectineus above (the latter to the middle division of the upper bifurcation); below these, the Adductor brevis and Adductor longus. The linea aspera is perforated a little below its centre by the nutritious canal, which is directed obliquely from below upwards.

The two lateral borders of the femur are only very slightly marked, the external extending from the anterior inferior angle of the great trochanter to the anterior extremity of the external condyle; the internal passes from the spiral line, at a point opposite the trochanter minor, to the anterior extremity of the internal condyle. The internal border marks the limit of attachment of the Crucæus muscle internally.

The anterior surface includes that portion of the shaft which is situated between the two lateral borders. It is smooth, convex, broader above and below than in the centre, slightly twisted, so that its upper part is directed forwards and a little outwards, its lower part forwards and a little inwards. The upper three-fourths of this surface serve for the attachment of the Crucæus; the lower fourth is separated from this muscle by the intervention of the synovial membrane of the knee-joint, and affords attachment to the Sub-crucæus to a small extent. The external surface includes the portion of bone between the external border and the outer lip of the linea aspera; it is continuous above with the outer surface of the great trochanter, below with the outer surface of the external condyle: to its upper three-fourths is attached the outer portion of the Crucæus muscle. The internal surface includes the portion of bone between the internal border and the inner lip of the linea aspera; it is continuous above with the lower border of the neck, below with the inner side of the internal condyle: it is covered by the Vastus internus muscle.

The Lower Extremity, larger than the upper, is of a cuboid form, flattened from before backwards, and divided by an interval presenting a smooth depression in front, and a notch of considerable size behind, into two large eminences, the condyles. The interval is called the inter-condyloid notch. The external condyle is the most prominent anteriorly, and is the broadest both in the antero-posterior and transverse diameters. The internal condyle is the narrowest, longest, and most prominent internally. This difference in the length of the two condyles depends upon the obliquity of the thigh-bones, in consequence of their separation above at the articulation with the pelvis. If the femur is held in this oblique position, the surfaces of the two condyles will be seen to be nearly horizontal. The two condyles are joined together anteriorly, and form a smooth trochlear surface, the external border of which is more prominent, and ascends higher than the internal one. This surface articulates with the patella. It presents a median groove, which extends downwards and backwards to the intercondyloid notch; and two lateral convexities, of which the external is the broader, more prominent, and prolonged farther upwards upon the front of the outer condyle. The inter-condyloid notch lodges the crucial ligaments; it is bounded laterally by the opposed surfaces of the two condyles, and in front by the lower end of the shaft.

Outer Condyle. The outer surface of the external condyle presents, a little behind its centre, an eminence, the outer tuberosity; it is less convex and prominent than the inner tuberosity, and gives attachment to the external lateral ligament of the knee. Immediately beneath it is a groove, which commences at a depression a little behind the centre of the lower border of this surface: the depression is for the tendon of origin of the Popliteus muscle; the groove in which this tendon is contained is smooth, covered with cartilage in the recent state, and runs upwards and backwards to the posterior extremity of the condyle. The inner surface of the outer condyle forms one of the lateral boundaries of the inter-condyloid notch, and gives attachment, by its posterior part, to the anterior crucial ligament. The inferior surface is convex, smooth, and broader than that of the internal condyle. The posterior extremity is convex and smooth; just
above the articular surface is a depression, for the tendon of the outer head of the Gastrocnemius.

*Inner Condyle.* The *inner surface* of the inner condyle presents a convex eminence, the *inner tuberosity*, rough, for the attachment of the internal lateral ligament. Above this tuberosity, at the termination of the inner bifurcation of the linea aspera, is a tubercle, for the insertion of the tendon of the Adductor magnus; and behind and beneath the tubercle a depression, for the tendon of the inner head of the Gastrocnemius. The *outer side* of the inner condyle forms one of the lateral boundaries of the inter-condyloid notch, and gives attachment, by its anterior part, to the posterior cruciate ligament. Its *inferior or articular surface* is convex, and presents a less extensive surface than the external condyle.

*Structure.* Like that of the other cylindrical bones, the linea aspera is composed of a very dense, ivory-like, compact tissue.

*Articulations.* With three bones; the os innominatum, tibia, and patella.

*Development* (fig. 89). The femur is developed by five centres; one for the shaft, one for each extremity, and one for each trochanter. Of all the long bones, it is the first to show traces of ossification: this first commences in the shaft, at about the fifth week of foetal life, the centres of ossification in the epiphyses appearing in the following order. First, in the lower end of the bone, at the ninth month of foetal life; from this the condyles and tuberosities are formed; in the head, at the end of the first year after birth; in the great trochanter, during the fourth year; and in the lesser trochanter, between the thirteenth and fourteenth. The order in which the epiphyses are joined to the shaft, is the direct reverse of their appearance; their junction does not commence until after puberty, the lesser trochanter being first joined, then the greater, then the head, and, lastly, the inferior extremity (the first in which ossification commenced), which is not united until the twentieth year.

*Attachment of Muscles.* To the great trochanter, the Gluteus medius, Gluteus minimus, Pyriformis, Obturator internus, Obturator externus, Gemellus superior, Gemellus inferior, and Quadratus femoris. To the lesser trochanter, the Psoas magnus, and the Iliacus below it. To the shaft, its posterior surface, the Vastus externus, Gluteus maximus, short head of the Biceps, Vastus internus, Adductor magnus, Pectineus, Adductor brevis, and Adductor longus; to its anterior surface, the Cruræus and Sub-cruræus. To the condyles, the Gastrocnemius, Plantaris, and Popliteus.

**THE LEG.**

The Leg consists of three bones: the Patella, a large sesamoid bone, placed in front of the knee, analogous to the olecranon process of the ulna; and the Tibia and Fibula.
The Patella. (Figs. 90, 91).

The *Patella* is a small, flat, triangular bone, situated at the anterior part of the knee-joint. It resembles the sesamoid bones, from being developed in the tendon of the Quadriceps extensor; but, in relation with the tibia, it may be regarded as analogous to the olecranon process of the ulna, which occasionally exists as a separate piece, connected to the shaft of that bone by a continuation of the tendon of the Triceps muscle. It presents an anterior and posterior surface, three borders, a base, and an apex.

The anterior surface is convex, perforated by small apertures, for the passage of nutrient vessels, and marked by numerous rough, longitudinal striae. This surface is covered, in the recent state, by an expansion from the tendon of the Quadriceps extensor, separated from the integument by a synovial bursa, and gives attachment below to the ligamentum patellae. The posterior surface presents a smooth, oval-shaped, articular surface, covered with cartilage in the recent state, and divided into two facets by a vertical ridge, which descends from the superior towards the inferior angle of the bone. The ridge corresponds to the groove on the trochlear surface of the femur, and the two facets to the articular surfaces of the two condyles; the outer facet, for articulation with the outer condyle, being the broader and deeper, serves to indicate the leg to which the bone belongs. This surface presents, inferiorly, a rough, convex, non-articular depression, the lower half of which gives attachment to the ligamentum patellae; the upper half being separated from the head of the tibia by adipose tissue.

Its superior and lateral borders give attachment to the tendon of the Quadriceps extensor; to the superior border, that portion of the tendon which is derived from the Rectus and Crurae muscles; and to the lateral borders, the portion derived from the external and internal Vasti muscles.

The base, or superior border, is thick, directed upwards, and cut obliquely at the expense of its outer surface; it receives the attachment, as already mentioned, of part of the Quadriceps extensor tendon.

The apex is pointed, and gives attachment to the ligamentum patellae.

**Structure.** It consists of loose cancellous tissue, covered by a thin compact lamina.

**Development.** By a single centre, which makes its appearance, according to Beclard, about the third year. In two instances, I have seen this bone cartilaginous throughout, at a much later period (six years). More rarely, the bone is developed by two centres, placed side by side.

**Articulations.** With the two condyles of the femur.

**Attachment of Muscles.** Four muscles are attached to the patella, viz., the Rectus, Crurae, Vastus internus, and Vastus externus. The tendons of these muscles joined at their insertion, constitute the Quadriceps extensor crus.

The Tibia. (Figs. 92, 93)

The Tibia (figs. 92, 93) is situated at the anterior and inner side of the leg, and, excepting the femur, is the longest and largest bone in the skeleton. It is prismatic in form, expanded above, where it enters into formation with the knee joint, and more slightly below. In the male, its direction is vertical, and parallel with
the bone of the opposite side, but in the female it has a slight oblique direction downwards and outwards, to compensate for the oblique direction of the femur inwards. It presents for examination a shaft and two extremities.

The Superior Extremity, or head, is large and expanded on each side into two lateral eminences, the tuberosities. Superiorly, the tuberosities present two smooth concave surfaces, which articulate with the condyles of the femur; the internal articular surface is longer than the external, oval from before backwards, to articulate with the internal condyle; the external one being broader, flatter, and more circular, to articulate with the external condyle. Between the two articular surfaces, and nearer the posterior than the anterior aspect of the bone, is an eminence, the spinous process of the tibia, surmounted by a prominent tubercle on each side, which give attachment to the extremities of the semilunar fibro-cartilages; and in front and behind the spinous process, a rough depression for the attachment of the anterior and posterior crucial ligaments and the semilunar cartilages. Anteriorly the tuberosities are continuous with one another, presenting a large and somewhat flattened triangular surface, broad above, and perforated by large vascular foramina, narrow below, where it terminates in a prominent oblong elevation of large size, the tubercle of the tibia; the lower half of this tubercle is rough, for the attachment of the ligamentum patellae; the upper half is a smooth facet corresponding, in the recent state, with a bursa which separates this ligament from the bone. Posteriorly, the tuberosities are separated from each other above by a shallow depression, the popliteal notch, which gives attach-
ment to the posterior crucial ligament. The posterior surface of the inner tuberosity presents a deep transverse groove, for the insertion of the tendon of the Semi-membranosus; and the posterior surface of the outer one, a flat articular facet, nearly circular in form, directed downwards, backwards, and outwards, for articulation with the fibula. The lateral surfaces are convex and rough, the internal one, the most prominent, gives attachment below to the internal lateral ligament.

The Shaft of the tibia is of a triangular prismoid form, broad above, gradually decreasing in size to the commencement of its lower fourth, its most slender part, and then enlarges again towards its lower extremity. It presents for examination three surfaces and three borders.

The anterior border, the most prominent of the three, is called the crest of the tibia, or in popular language, the shin; it commences above at the tubercle, and terminates below at the anterior margin of the inner malleolus. This border is very prominent in the upper two-thirds of its extent, smooth and rounded below. It presents a very flexuous course, being curved outwards above, and inwards below; it gives attachment to the deep fascia of the leg.

The internal border is smooth and rounded above and below, but more prominent in the centre; it commences at the back part of the inner tuberosity, and terminates at the posterior border of the internal malleolus; its upper third gives attachment to the internal lateral ligament of the knee, and to some fibres of the Popliteus muscle; its middle third, to some fibres of the Soleus and Flexor longus digitorum muscles.

The external border is thin and prominent, especially its central part, and gives attachment to the interosseous membrane; it commences above in front of the fibular articular facet, and bifurcates below, forming the boundaries of a triangular rough surface, for the attachment of the inferior interosseous ligament, connecting the tibia and fibula.

The internal surface is smooth, convex, and broader above than below; its upper third, directed forwards and inwards, is covered by the aponeurosis derived from the tendon of the Sartorius, and by the tendons of the Gracilis and Semi-tendinosus, all of which are inserted nearly as far forwards, as the anterior border; in the rest of its extent it is sub-cutaneous.

The external surface is narrower than the internal, its upper two-thirds present a shallow groove for the attachment of the Tibialis anticus muscle; its lower third is smooth, convex, curves gradually forwards to the anterior part of the bone, and is covered from within outwards by the tendons of the following muscles: Tibialis anticus, Extensor proprius pollicis, Extensor longus digitorum, Peroneus tertius.

The posterior surface (fig. 93) presents at its upper part a prominent ridge, the oblique line of the tibia, which extends from the back part of the articular facet for the fibula, obliquely downwards, to the internal border, at the junction of its upper and middle thirds. It marks the limit for the insertion of the Popliteus muscle, and serves for the attachment of the popliteal fascia, and part of the Soleus, Flexor longus digitorum, and Tibialis posticus muscles; the triangular concave surface, above, and to the inner side of this line, gives attachment to the Popliteus muscle. The middle third of the posterior surface is divided by a vertical ridge into two lateral halves; the ridge is well marked at its commencement at the oblique line, but becomes gradually indistinct below; the inner and broadest half gives attachment to the Flexor longus digitorum, the outer and narrowest, to part of the Tibialis posticus. The remaining part of the bone is covered by the Tibialis posticus, Flexor longus digitorum, and Flexor longus pollicis muscles. Immediately below the oblique line is the medullary foramen, which is directed obliquely downwards.

The Lower Extremity, much smaller than the upper, is somewhat quadrilateral in form, and prolonged downwards, on its inner side, into a strong process, the internal malleolus. The inferior surface of the bone presents a quadrilateral smooth surface, for articulation with the astragalus; narrow internally, where it becomes continuous with the articular surface of the inner malleolus, broader
externally, and traversed from before backwards by a slight elevation, separating two lateral depressions. The anterior surface is smooth and rounded above, and covered by the tendons of the Extensor muscles of the toes; its lower margin presents a rough transverse depression, for the attachment of the anterior ligament of the ankle joint. The posterior surface presents a superficial groove directed obliquely downwards and inwards, continuous with a similar groove on the posterior extremity of the astragalus, it serves for the passage of the tendon of the Flexor longus pollicis. The external surface presents a triangular rough depression, the lower part of which, in some bones, is smooth, covered with cartilage in the recent state and articulates with the fibula, the remaining part is rough for the attachment of the inferior interosseous ligament, which connects it with the fibula. This surface is bounded by two prominent ridges, continuous above with the interosseous ridge; they afford attachment to the anterior and posterior tibio-fibular ligaments. The internal surface is prolonged downwards to form a strong pyramidal-shaped process, flattened from without inwards, the inner malleolus; its inner surface is convex and subcutaneous. Its outer surface, smooth and slightly concave, deepens the articular surface for the astragalus. Its anterior border is rough, for the attachment of ligamentous fibres. Its posterior border presents a broad and deep groove, directed obliquely downwards and inwards; it is occasionally double, and transmits the tendons of the Tibialis posticus and Flexor longus digitorum muscles. Its summit is marked by a rough depression behind, for the attachment of the internal lateral ligament of the ankle joint.
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Structure. Like that of the other long bones.

Development. By three centres (fig. 94): one for the shaft, and one for each extremity. Ossification commences in the centre of the shaft about the same time as in the femur, the fifth week, and gradually extends towards either extremity. The centre for the upper epiphysis appears at birth; it is flattened in form, and has a thin tongue-shaped process in front, which forms the tubercle. That for the lower epiphysis appears in the second year. The lower epiphysis joins the shaft about the twentieth year, and the upper one about the twenty-fifth year. Two additional centres occasionally exist, one for the tongue-shaped process of the upper epiphysis, the tubercle, and one for the inner malleolus.

Articulations. With three bones: the femur, fibula, and astragalus.

Attachment of Muscles. To the inner tuberosity, the Semi-membranosus. To the outer tuberosity, the Tibialis anticus and Extensor longus digitorum: to the shaft; its internal surface, the Sartorius, Gracilis, and Semi-tendinosus; to its external surface, the Tibialis anticus: to its posterior surface, the Poplitiens, Solens, Flexor longus digitorum, and Tibialis posticus: to the tubercle, the ligamentum patellae.

The Fibula.

The Fibula (fig. 92, 93) is situated at the outer side of the leg. It is the smaller of the two bones, and, in proportion to its length, the most slender of all the long bones; it is placed nearly parallel with the tibia, its lower extremity inclining a little forwards, so as to be on a plane anterior to that of the upper end. It presents for examination a shaft and two extremities.

The Superior Extremity or Head, is of an irregular rounded form, presenting above a flattened articular facet, directed upwards and inwards, for articulation with a corresponding facet on the external tuberosity of the tibia. On the outer side is a thick and rough prominence, continued behind into a pointed eminence, the styloid process, which projects upwards from the posterior part of the head. The prominence above mentioned gives attachment to the tendon of the Biceps muscle, and to the long external lateral ligament of the knee, the ligament dividing this tendon into two parts. The summit of the styloid process gives attachment to the short external lateral ligament. The remaining part of the circumference of the head is rough, for the attachment, in front, of the anterior superior tibio-fibular ligament, and the upper and anterior part of the Peroneus longus; and behind, to the posterior superior tibio-fibular ligament, and the upper fibres of the outer head of the Solens muscle.

The Lower Extremity, called the malleolus externus, is of a pyramidal form, somewhat flattened from without inwards, and is longer, and descends lower than the internal malleolus. Its external surface is convex, sub-cutaneous, and continuous with a triangular (also sub-cutaneous) surface on the outer side of the shaft. The internal surface presents in front a smooth triangular facet, broader above than below, convex from above downwards, which articulates with a corresponding
surface on the outer side of the astragalus. Behind and beneath the articular
surface is a rough depression, which gives attachment to the posterior fasciculus of
the external lateral ligament of the ankle. Its anterior border is thick and rough,
and marked below by a depression for the attachment of the anterior fasciculus of
the external lateral ligament. The posterior border is broad and marked by a
shallow groove, for the passage of the tendons of the Peroneus longus and brevis
muscles. Its summit is rounded, and gives attachment to the middle fasciculus of
the external lateral ligament.

The Shaft presents three surfaces, and three borders. The anterior border
commences in front of the head, runs vertically downwards to a little below the
middle of the bone, and then curving a little outwards, bifurcates below into two
lines, which bound the triangular sub-cutaneous surface immediately above the outer
side of the malleolus externus. It gives attachment to an inter-muscular septum,
which separates the muscles on the anterior surface from those on the external.

The internal border or interosseous ridge, is situated close to the inner
side of the preceding, it runs nearly parallel with it in the upper third of its
extent, but diverges from it so as to include a broader space in the lower two-
thirds. It commences above just beneath the head of the bone (sometimes it is quite
indistinct for about an inch below the head), and terminates below at the apex of a
rough triangular surface immediately above the articular facet of the external mal-
elolus. It serves for the attachment of the interosseous membrane, and separates
the extensor muscles in front, from the flexor muscles behind. The portion of bone
included between the anterior and interosseous lines, forms the anterior surface.

The posterior border is sharp and prominent; it commences above at the base of
the styloid process, and terminates below in the posterior border of the outer mal-
elolus. It is directed outwards above, backwards in the middle of its course,
backwards and a little inwards below, and gives attachment to an aponeurosis
which separates the muscles on the outer from those on the inner surface of the shaft.
The portion of bone included between this line and the interosseous ridge, forms
the internal surface. Its upper three-fourths are subdivided into two parts, an
anterior and a posterior, by a very prominent ridge, the oblique line of the tibia,
which commences above at the inner side of the head, and terminates by being
continuous with the interosseous ridge at the lower fourth of the bone. It attaches
an aponeurosis which separates the Tibialis posticus from the Soleus above, and
the Flexor longus pollicis below. This ridge sometimes ceases just before
approaching the interosseous ridge.

The anterior surface is the interval between the anterior and interosseous lines.
It is extremely narrow and flat in the upper third of its extent; broader and grooved
longitudinally in its lower third; it serves for the attachment of three muscles, the
Extensor longus digitorum, Peroneus tertius, and Extensor longus pollicis.

The external surface, much broader than the preceding, is directed outwards in
the upper two-thirds of its course, backwards in the lower third, where it is con-
tinuous with the posterior border of the external malleolus. This surface is com-
pletely occupied by the Peroneus longus and brevis muscles.

The internal surface is the interval between the interosseous ridge and the
posterior border, and occupies nearly two-thirds of the circumference of the bone.
Its upper three-fourths are divided into an anterior and a posterior portion by a
very prominent ridge already mentioned, the oblique line of the fibula. The
anterior portion is directed inwards, and is grooved for the attachment of the
Tibialis posticus muscle. The posterior portion is continuous below with the
rough triangular surface above the articular facet of the outer malleolus; it is
directed backwards above, backwards and inwards at its middle, directly inwards
below. Its upper fourth is rough, for the attachment of the Soleus muscle; its
lower part presents a triangular rough surface, connected to the tibia by a strong
interosseous ligament, and between these two points, the entire surface is covered
by the fibres of origin of the Flexor longus pollicis muscle. At about the middle
of this surface is the nutritious foramen, which is directed downwards.
In order to distinguish the side to which the bone belongs, hold it with the lower extremity downwards, and the broad groove for the Peronei tendons backwards, towards the holder, the triangular sub-cutaneous surface will then be directed to the side to which the bone belongs.

Articulations. With two bones; the tibia and astragalus.

Development. By three centres (fig. 95); one for the shaft, and one for each extremity. Ossification commences in the shaft about the sixth week of foetal life, a little later than in the tibia, and extends gradually towards the extremities. At birth both ends are cartilaginous. Ossification commences in the lower end in the second year, and in the upper one about the fourth year. The lower epiphysis, the first in which ossification commences, becomes united to the shaft about the twentieth year, contrary to the law which appears to prevail with regard to the junction of the epiphyses with the shaft; the upper one is joined about the twenty-fifth year.

Attachment of Muscles. To the head, the Biceps, Solens, and Peroneus longus: to the shaft, its anterior surface, the Extensor longus digitorum, Peroneus tertius, and Extensor longus pollicis; to the internal surface, the Soleus, Tibialis posterior, and Flexor longus pollicis: to the external surface, the Peroneus longus and brevis.

THE FOOT.

The Foot (fig. 96, 97) is the terminal part of the inferior extremity; it serves to support the body in the erect posture, and as an important instrument of locomotion. It consists of three divisions: the Tarsus, Metatarsus, and Phalanges.

THE TARSUS.

The bones of the Tarsus are seven in number; viz., the calcaneum, or os calcis, astragalus, cuboid, scaphoid, internal, middle, and external, cuneiform bones. These bones may be conveniently arranged into two lateral rows. The outer row, remarkable for its great solidity and strength, forms the basis of support to the foot; it consists of two bones, the os calcis and cuboid. The inner row, which contributes chiefly to its elasticity, is formed by the astragalus, scaphoid, and three cuneiform bones.

THE CALCANEUM.

The Calcaneum, or Os Calcis, is the largest bone of the tarsus. It is irregularly cuboidal in form, and situated at the lower and back part of the foot. It presents for examination six surfaces; superior, inferior, external, internal, anterior, and posterior.

The superior surface is formed behind, of the upper edge of that process of the os calcis which projects backwards to form the heel. This process varies in length in different individuals; it is convex from side to side, concave from before backwards, and corresponds above to a mass of adipose substance placed in front of the tendo Achillis. In the middle of this surface are two (sometimes three) articular facets, separated by a broad shallow groove, directed obliquely forwards and outwards, and rough for the attachment of the interosseous ligament connecting the astragalus and os calcis. Of these two articular surfaces, the
96.—Bones of the Right Foot. Dorsal Surface.
external is the larger, and situated upon the body of the bone; it is of an oblong form, broader behind than in front, and convex from before backwards. The internal articular surface is supported on a projecting process of bone, called the lesser process of the calcaneum (sustentaculum tali); it is of an oblong form, concave longitudinally, and sometimes subdivided into two, which differ in size and shape. More anteriorly is seen the upper surface of the greater process, marked by a rough depression for the attachment of numerous ligaments, and the tendon of origin of the Extensor brevis digitorum muscle.

The inferior surface is narrow, rough, uneven, broader behind than in front, and convex from side to side; it is bounded posteriorly by two tuberosities, separated by a rough depression: the external, small, prominent, and rounded, gives attachment to part of the Abductor minimi digiti; the internal, broader and larger, for the support of the heel, gives attachment, by its prominent inner margin, to the Abductor pollicis, and in front to the Flexor brevis digitorum muscles, and the depression between the tubercles to the Abductor minimi digiti, and plantar fascia. The rough surface in front of these tubercles gives attachment to the long plantar ligament; and to a prominent tubercle nearer the anterior part of the bone, as well as to the transverse groove in front, is attached the short plantar ligament.

The external surface is subcutaneous, and presents near its centre a tubercle, for the attachment of the middle fasciculus of the external lateral ligament. Behind the tubercle is a broad smooth surface, giving attachment, at its upper and anterior part, to the external astragalo-calcanean ligament; and in front a narrow surface marked by two oblique grooves, separated by an elevated ridge: the superior groove transmits the tendon of the Peroneus brevis; the inferior, the tendon of the Peroneus longus; the intervening ridge gives attachment to a prolongation from the external annular ligament.

The internal surface presents a deep concavity, directed obliquely downwards and forwards, for the transmission of the plantar vessels and nerves and Flexor tendons into the sole of the foot; it affords attachment to part of the Flexor accessorius muscle. This surface presents in front an eminence of bone, the lesser process, which projects horizontally inwards from the upper and front part of this surface. This process is concave above, and supports the anterior articular surface of the astragalus; below, it is convex, and grooved for the tendon of the Flexor longus pollicis. Its free margin is rough, for the attachment of ligaments.

The anterior surface, of a somewhat triangular form, is smooth, concavo-convex, and articulates with the cuboid. It is surmounted, on its outer side, by a rough prominence, which forms an important guide to the surgeon in the performance of Chopart's operation.

The posterior surface is rough, prominent, convex, and wider below than above. Its lower part is rough, for the attachment of the tendon Achillis; its upper part smooth, coated with cartilage, and corresponds to a bursa which separates this tendon from the bone.

Articulations. With two bones: the astragalus and cuboid.

Attachment of Muscles. Part of the Tibialis posticus, the tendon Achillis, Plantaris, Abductor pollicis, Abductor minimi digiti, Flexor brevis digitorum, Flexor accessorius, and Extensor brevis digitorum.

The Cuboid.

The Cuboid bone is placed on the outer side of the foot, immediately in front of the os calcis. It is of a pyramidal shape, its base being directed upwards and inwards, its apex downwards and outwards. It may always be known from all the other tarsal bones, by the existence of a deep groove on its under surface, for the tendon of the Peroneus longus muscle. It presents for examination six surfaces; three articular, and three non-articular: the non-articular surfaces are the superior, inferior, and external.
The superior or dorsal surface, directed upwards and outwards, is rough, for the attachment of numerous ligaments. The inferior or plantar surface presents in front a deep groove, which runs obliquely from without, forwards and inwards; it lodges the tendon of the Peroneus longus, and is bounded behind by a prominent ridge, terminating externally in an eminence, the tuberosity of the cuboid, the surface of which presents a convex facet, for articulation with the sesamoid bone of the tendon contained in the groove. The ridge and surface of bone behind it are rough, for the attachment of the long and short plantar ligaments. The external surface, the smallest and narrowest of the three, presents a deep notch, formed by the commencement of the peroneal groove.

The articular surfaces are the posterior, anterior, and internal. The posterior is a smooth, triangular, concavo-convex surface, for articulation with the anterior surface of the os calcis. The anterior, of smaller size, but also irregularly triangular, is divided by a vertical ridge into two facets; the inner quadrilateral in form, to articulate with the fourth metatarsal bone; the outer larger and more triangular, for articulation with the fifth metatarsal. The internal surface is broad, rough, irregularly quadrilateral, presenting at its middle and upper part a small oval facet, for articulation with the external cuneiform bone; and behind this (occasionally) a smaller facet, for articulation with the scaphoid; it is rough in the rest of its extent, for the attachment of strong interosseous ligaments.

To ascertain to which foot it belongs, hold the bone so that its under surface, marked by the peroneal groove, looks downwards, and the large concavo-convex articular surface backwards, towards the holder; the small non-articular surface marked by the commencement of the peroneal groove, will point to the side to which the bone belongs.

Articulations. With four bones: the os calcis, external cuneiform, and the fourth and fifth metatarsal bones, occasionally with the scaphoid.

Attachment of Muscles. Part of the Flexor brevis pollicis.

The Astragalus.

The Astragalus (fig. 96), next to the os calcis, is the largest of the tarsal bones. It is placed at the middle and upper part of the tarsus, supporting the tibia above, articulating with the malleoli on either side, resting below upon the os calcis, and joined in front to the scaphoid. This bone may easily be recognised by its large rounded head, the broad articular facet on its upper convex surface, and by the two articular facets separated by a deep groove on its under concave surface. It presents six surfaces for examination.

The superior surface presents, behind, a broad smooth trochlear surface, for articulation with the tibia; it is broader in front than behind, convex from before backwards, slightly concave from side to side. In front of the trochlea is the upper surface of the neck of the astragalus, rough for the attachment of ligaments. The inferior surface presents two articular facets separated by a deep groove. The groove runs obliquely forwards and outwards, becoming gradually broader and deeper in front: it corresponds with a similar groove upon the upper surface of the os calcis, and forms, when articulated with that bone, a canal, filled up in the recent state by the calcaneo-astragaloid interosseous ligament. Of the two articular facets, the posterior is the larger, of an oblong form, and deeply concave from side to side; the anterior, although nearly of equal length, is narrower, of an elongated oval form, convex from side to side, and often subdivided into two by an elevated ridge; the posterior articulates with the lesser process of the os calcis; the anterior, with the upper surface of the calcaneo-scaphoid ligament. The internal surface presents at its upper part a pear-shaped articular facet for the inner malleolus, continuous above with the trochlear surface; below the articular surface is a rough depression, for the attachment of the deep portion of the internal lateral ligament. The external surface presents a large triangular facet, concave from above downwards, for articulation with the external malleolus; it is con-
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97.—Bones of the Right Foot. Plantar Surface.
TARSUS.

Continuous above with the trochlear surface: in front is a deep rough margin, for the attachment of the anterior fasciculus of the external lateral ligament. The anterior surface, convex and rounded, forms the head of the astragalus; it is smooth, of an oval form, and directed obliquely inwards and downwards; it is continuous below with that part of the anterior facet on the under surface which rests upon the calcaneo-scaphoid ligament. The head is surrounded by a constricted portion, the neck of the astragalus. The posterior surface is narrow, and traversed by a groove, which runs obliquely downwards and inwards, and transmits the tendon of the Flexor longus pollicis.

To ascertain to which foot it belongs, hold the bone with the broad articular surface upwards, and the rounded head forwards; the lateral triangular articular surface for the external malleolus will then point to the side to which the bone belongs.

Articulations. With four bones; tibia, fibula, os calcis, and scaphoid.

The Scaphoid or Navicular bone, so called from its fancied resemblance to a boat, is situated at the inner side of the tarsus, between the astragalus behind and the three cuneiform bones in front. This bone may be distinguished by its boat-like form, being concave behind, convex, and subdivided into three facets in front.

The anterior surface, of an oblong form, is convex from side to side, and subdivided by two ridges into three facets, for articulation with the three cuneiform bones. The posterior surface is oval, concave, broader externally than internally, and articulates with the rounded head of the astragalus. The superior surface is convex from side to side, and rough for the attachment of ligaments. The inferior, somewhat concave, irregular, and also rough for the attachment of ligaments. The internal surface presents a rounded tubercular eminence, the tuberosity of the scaphoid, which gives attachment to part of the tendon of the Tibialis posticus. The external surface is broad, rough, and irregular, for the attachment of ligamentous fibres, and occasionally presents a small facet for articulation with the cuboid bone.

To ascertain to which foot it belongs, hold the bone with the concave articular surface backwards, and the broad dorsal surface upwards; the broad external surface will point to the side to which the bone belongs.

Articulations. With four bones; astragalus and three cuneiform; occasionally also with the cuboid.

Attachment of Muscles. Part of the Tibialis posticus.

The Cuneiform Bones have received their name from their wedge-like form. They form the most anterior row of the inner division of the tarsus, being placed between the scaphoid behind, the three innermost metatarsal bones in front, and the cuboid externally. They are called the first, second, and third, counting from the inner to the outer side of the foot, and from their position, internal, middle, and external.

The Internal Cuneiform.

The Internal Cuneiform is the largest of the three. It is situated at the inner side of the foot, between the scaphoid behind and the base of the first metatarsal in front. It may be distinguished by its large size, as compared with the other two, and from its more irregular wedge-like form. It presents for examination six surfaces.

The internal surface is subcutaneous, and forms part of the inner border of the foot; it is broad, quadrilateral, and presents at its anterior inferior angle a smooth oval facet, over which the tendon of the Tibialis anticus muscle glides; rough in the rest of its extent, for the attachment of ligaments. The external surface is concave, presenting, along its superior and posterior borders, a narrow surface for articulation with the middle cuneiform behind, and second metatarsal bone in
front; in the rest of its extent, it is rough for the attachment of ligaments, and prominent below, where it forms part of the tuberosity. The anterior surface, reniform in shape, articulates with the metatarsal bone of the great toe. The posterior surface is triangular, concave, and articulates with the innermost and largest of the three facets on the anterior surface of the scaphoid. The inferior or plantar surface is rough, and presents a prominent tuberosity at its back part for the attachment of part of the tendon of the Tibialis posticus. It also gives attachment in front of this to part of the tendon of the Tibialis anticus. The superior surface is the narrow pointed end of the wedge, which is directed upwards and outwards; it is rough for the attachment of ligaments.

To ascertain to which side it belongs, hold the bone so that its superior narrow edge looks upwards, and the long articular surface forwards; the external surface marked by its vertical and horizontal articular facets will point to the side to which it belongs.

Articulations. With four bones; scaphoid, middle cuneiform, and first and second metatarsal bones.

Attachment of Muscles. The Tibialis anticus and posticus.

The Middle Cuneiform. The Middle Cuneiform, the smallest of the three, is of very regular wedge-like form; the broad extremity being placed upwards, the narrow end downwards. It is situated between the other two bones of the same name, and corresponds to the scaphoid behind, and the second metatarsal in front.

The anterior surface, triangular in form, and narrower than the posterior, articulates with the base of the second metatarsal bone. The posterior surface, also triangular, articulates with the scaphoid. The internal surface presents an articular facet, running along the superior and posterior borders, for articulation with the internal cuneiform, and is rough below for the attachment of ligaments. The external surface presents posteriorly a smooth facet for articulation with the external cuneiform bone. The superior surface forms the base of the wedge; it is quadrilateral, broader behind than in front, and rough for the attachment of ligaments. The inferior surface, pointed and tubercular, is also rough for ligamentous attachment.

To ascertain to which foot the bone belongs, hold its superior or dorsal surface upwards, the broadest edge being towards the holder, and the smooth facet (limited to the posterior border) will point to the side to which it belongs.

Articulations. With four bones; scaphoid, internal and external cuneiform, and second metatarsal bone.

The External Cuneiform. The External Cuneiform, intermediate in size between the two preceding, is of a very regular wedge-like form, the broad extremity being placed upwards, the narrow end downwards. It occupies the centre of the front row of the tarsus between the middle cuneiform internally, the cuboid externally, the scaphoid behind, and the third metatarsal in front. It has six surfaces for examination.

The anterior surface triangular in form, articulates with the third metatarsal bone. The posterior surface articulates with the most external facet of the scaphoid, and is rough below for the attachment of ligamentous fibres. The internal surface presents two articular facets separated by a rough depression; the anterior one, situated at the superior angle of the bone, articulates with the outer side of the base of the second metatarsal bone; the posterior one skirts the posterior border, and articulates with the middle cuneiform; the rough depression between the two gives attachment to an interosseous ligament. The external surface also presents two articular facets, separated by a rough non-articular surface; the anterior facet, situated at the superior corner of the bone, is small, and articulates with the inner side of the base of the fourth metatarsal; the posterior, and larger one, articulates
with the cuboid; the rough non-articular surface serves for the attachment of an
interosseous ligament. The three facets for articulation with the three metatarsal
bones are continuous with one another, and covered by a prolongation of the same
cartilage; the facets for articulation with the middle cuneiform and scaphoid are
also continuous, but that for articulation with the cuboid is usually separate and
independent. The superior or dorsal surface, of an oblong form, is rough for the
attachment of ligaments. The inferior or plantar surface is an obtuse rounded
margin, and serves for the attachment of part of the tendon of the Tibialis posticus,
some of the fibres of origin of the Flexor brevis pollicis, and ligaments.

To ascertain to which side it belongs, hold the bone with the broad dorsal sur-
face upwards, the prolonged edge backwards; the separate articular facet for the
cuboid will point to the proper side.

Articulations. With six bones: the scaphoid, middle cuneiform, cuboid, and
second, third, and fourth metatarsal bones.

Attachment of Muscles. Part of Tibialis posticus, and Flexor brevis pollicis.

The Metatarsal Bones.

The Metatarsal bones are five in number; they are long bones, and subdivided
into a shaft, and two extremities.

The Shaft is prismoid in form, tapers gradually from the tarsal to the phala-
geal extremity, and is slightly curved longitudinally, so as to be concave below,
slightly convex above.

The Posterior Extremity, or Base, is wedge-shaped, articulating by its terminal
surface with the tarsal bones, and by its lateral surfaces with the contiguous bones;
its dorsal and plantar surfaces being rough, for the attachment of ligaments.

The Anterior Extremity, or Head, presents a terminal rounded articular sur-
face, oblong from above downwards, and extending further backwards below than
above. Its sides are flattened, and present a depression, surmounted by a tuber-
cle, for ligamentous attachment. Its under surface is grooved in the middle line,
for the passage of the Flexor tendon, and marked on each side by an articular
eminence continuous with the terminal articular surface.

Peculiar Metatarsal Bones.

The First is remarkable for its great size, but is the shortest of all the meta-
tarsal bones. The shaft is strong, and of well-marked prismoid form. The
posterior extremity presents no lateral articular facets; its terminal articular sur-
face is of large size, of semi-lunar form, and its circumference grooved for the
tarsometatarsal ligaments; its inferior angle presents a rough oval prominence,
for the insertion of the tendon of the Peroneus longus. The head is of large size;
on its plantar surface are two grooved facets, over which glide sesamoid bones,
separated by a smooth elevated ridge.

The Second is the longest and largest of the remaining metatarsal bones; its
posterior extremity being prolonged backwards, into the recess formed between
the three cuneiform bones. Its tarsal extremity is broad above, narrow and rough
below. It presents four articular surfaces: one behind, of a triangular form, for
articulation with the middle cuneiform; one at the upper part of its internal
lateral surface, for articulation with the internal cuneiform; and two on its
external lateral surface, a superior and an inferior, separated by a rough depres-
sion. Each articular surface is divided by a vertical ridge into two parts; the
anterior segment of each facet articulates with the third metatarsal; the two pos-
terior (sometimes continuous) with the external cuneiform.

The Third articulates behind, by means of a triangular smooth surface, with
the external cuneiform; on its inner side, by two facets, with the second meta-
tarsal; and on its outer side, by a single facet, with the third metatarsal. This
facet is of circular form, and situated at the upper angle of the base.
The Fourth is smaller in size than the preceding; its tarsal extremity presents a terminal quadrilateral surface, for articulation with the cuboid; a smooth facet on the inner side, divided by a ridge into an anterior portion for articulation with the third metatarsal, and a posterior portion for articulation with the external cuneiform; on the outer side a single facet, for articulation with the fifth metatarsal.

The Fifth is recognised by the tubercular eminence on the outer side of its base; it articulates behind, by a triangular surface cut obliquely from without inwards, with the cuboid, and internally with the fourth metatarsal.

Articulations. Each bone articulates with the tarsal bones by one extremity, and by the other with the first row of phalanges. The number of tarsal bones with which each metatarsal articulates, is one for the first, three for the second, one for the third, two for the fourth, and one for the fifth.

Attachment of Muscles. To the first metatarsal bone, three: part of the Tibialis anticus, Peroneus longus, and First dorsal interosseus. To the second, three: the Adductor pollicis, and First and Second dorsal interosseous. To the third, four: the Adductor pollicis, Second and Third dorsal interosseous, and First plantar. To the fourth, four: the Adductor pollicis, Third and Fourth dorsal, and Second plantar interosseous. To the fifth, five: the Peroneus brevis, Peroneus tertius, Flexor brevis minimi digiti, Fourth dorsal, and Third plantar interosseous.

Phalanges.

The Phalanges of the foot, both in number and general arrangement, resemble those in the hand; there being two in the great toe, and three in each of the other toes.

The phalanges of the first row resemble closely those of the hand. The shaft is compressed from side to side, convex above, concave below. The posterior extremity is concave; and the anterior extremity presents a trochlear-articular surface, for articulation with the second phalanges.

The phalanges of the second row are remarkably small and short, but rather broader than those of the first row.

The ungual phalanges in form resemble those of the fingers; but they are smaller, flattened from above downwards, presenting a broad base for articulation with the second row, and an expanded extremity for the support of the nail and end of the toe.

Articulations. The first row with the metatarsal bones, and second phalanges; the second of the great toe with the first phalanx, and of the other toes with the first and third phalanges; the third with the second row.


Development of the Foot. (Fig. 98.)

The Tarsal bones are each developed by a single centre, excepting the os calcis, which has an epiphysis for its posterior extremity. The centres make their appearance in the following order: in the os calcis, at the sixth month of foetal life; in the astragali, about the seventh month; in the cuboid, at the ninth month; external cuneiform, during the first year; internal cuneiform, in the third year; middle cuneiform, in the fourth year. The epiphysis for the posterior
sesamoid bones. 131

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tuberosity of the os calcis appears at the tenth year, and unites with the rest of the bone soon after puberty.

The Metatarsal bones are each developed by two centres: one for the shaft, and one for the digital extremity in the four outer metatarsal; one for the shaft, and one for the base in the metatarsal bone of the great toe. Ossification

98.—Plan of the Development of the Foot.

commences in the centre of the shaft about the seventh week, and extends towards either extremity, and in the digital epiphyses about the third year; they become joined between the eighteenth and twentieth years.

The Phalanges are developed by two centres for each bone: one for the shaft, and one for the metatarsal extremity.

sesamoid bones.

These are small rounded masses, cartilaginous in early life, osseous in the adult, which are developed in those tendons which exert a certain amount of pressure upon the parts over which they glide. It is said that they are more commonly found in the male than in the female, and in persons of an active muscular habit than in those that are weak and debilitated. They are invested throughout their whole surface by the fibrous tissue of the tendon in which they are found, excepting upon that side which lies in contact with the part over which they play, where they present a free articular facet. They may be divided into
two kinds: those which glide over the articular surfaces of joints; those which play over the cartilaginous facets found on the surfaces of certain bones.

The sesamoid bones of the joints are, in the lower extremity, the patella (already described), which is developed in the tendon of the Quadriceps extensor. Two small sesamoid bones are found opposite the metatarso-phalangeal joint of the great toe in each foot, in the tendons of the Flexor brevis pollicis, and occasionally one in the metatarso-phalangeal joints of the second toe, the little toe, and, still more rarely, in the third and fourth toes.

In the upper extremity, there are two on the palmar surface, opposite the metacarpo-phalangeal joint in the thumb, developed in the tendons of the Flexor brevis pollicis. Occasionally one or two opposite the metacarpo-phalangeal articulations of the fore and little fingers, and, still more rarely, one opposite the same joints of the third and fourth fingers.

Those found in tendons which glide over certain bones occupy the following situations. One in the tendon of the Peroneus longus, where it glides through the groove in the cuboid bone. One appears late in life in the tendon of the Tibialis anticus, opposite the smooth facet on the internal cuneiform bone. One in the tendon of the Tibialis posticus, opposite the inner side of the astragalus. One in the outer head of the Gastrocnemius, behind the outer condyle of the femur; and one in the Psoas and Iliacus, where they glide over the body of the pubes. Occasionally in the tendon of the Biceps, opposite the tuberosity of the radius; in the tendon of the Gluteus maximus, as it passes over the great trochanter; and in the tendons which wind around the inner and outer malleoli.
The Articulations.

The various bones of which the Skeleton consists are connected together at different parts of their surfaces, and such connection is designated by the name of Joint or Articulation. If the joint is immovable, as between the cranial bones, their adjacent margins are applied in almost close contact, a thin layer of fibrous membrane only being interposed; but in the moveable joints, the bones forming the articulation are generally expanded for greater convenience of mutual connexion, covered by an elastic structure, called cartilage, held together by strong bands, or capsules, of fibrous tissue, called ligament, and lined throughout by a membrane, the synovial membrane, which secretes a fluid which lubricates the various parts of which the joint is formed, so that the structures which enter into the formation of a joint are bone, cartilage, fibro-cartilage, ligament, and synovial membrane.

Bone constitutes the fundamental element of all the joints. In the long bones the extremities are the parts which form the articulations; they are generally somewhat enlarged and expanded, consisting of loose spongy cancellous tissue, with a thin coating of compact substance, which forms their articular surface, and is called the articular lamella. In the flat bones, the articulations usually take place at the edges; and in the short bones, by various parts of their surface.

Cartilage is a firm, opaque, blueish-white substance, highly elastic, extremely flexible, and possessed of considerable cohesive power. That form of cartilage which enters into the formation of the joints is called articular cartilage; it forms a thin incrustation upon the articular extremities, or surfaces, of bones, and is admirably adapted, by its elastic property, to break the force of concussions, and afford perfect ease and freedom of movement between the bones. Where it covers the rounded ends of bones, as the extremities of the femur and humerus, it is thick at the centre, and becomes gradually thinner towards the circumference: an opposite arrangement exists where it lines the corresponding cavities. On the articular surfaces of the short bones, as the carpus and tarsus, the cartilage is disposed in a layer of uniform thickness throughout. The attached surface of articular cartilage is closely adapted to the articular lamella; the free surface is smooth, polished, and covered in the fetus by an extremely thin prolongation of synovial membrane, which, however, at a later period of life, cannot be demonstrated. Articular cartilage in the adult does not contain blood-vessels; its nutrition being derived from the vessels of the synovial membrane which skirt the circumference of the cartilage, and from those of the adjacent bone, which are, however, separated from direct contact with the cartilage by means of the articular lamella. Mr. Toynbee has shown, that the minute vessels as they approach the articular lamella dilate, and forming arches, return into the cancellous tissue of the bone. The vessels of the synovial membrane advance forwards with it upon the circumference of the cartilage for a very short distance, and then return in loops; they are only found on the parts not subjected to pressure. In the fetus, and also in certain diseased conditions of the joints, the vessels advance for some distance upon the cartilage. Lymphatic vessels and nerves have not, as yet, been traced in its substance.

Fibro-cartilage is also employed in the construction of the joints, contributing to their strength and elasticity. This consists of a mixture of white fibrous and cartilaginous tissues in various proportions; it is to the first of these two constituents that its strength and toughness is chiefly owing and to the latter its elasticity. The fibro-cartilages admit of arrangement into four groups, inter-articular, inter-osseous, circumferential, and stratiform.

The Inter-articular fibro-cartilages (menisci) are flattened fibro-cartilaginous plates, of a round, oval, or sickle-like form, interposed between the articular sur-
faces of certain joints. They are free on both surfaces, thinner toward their
centre than at their circumference, and held in position by their extremities being
connected to the surrounding ligaments. The synovial membrane of the joint is
prolonged over them a short distance from their attached margin. They are found in
the temporomaxillary, sterno-clavicular, acromio-clavicular, wrist and knee
joints.

The Inter-osseous fibro-cartilages are interposed between the bony surfaces of
those joints which admit of only slight mobility, as between the bodies of the
vertebræ and the synapsis of the pubes; they exist in the form of discs, inti-
mately adherent to the opposed surfaces, being composed of concentric rings of
fibrous tissue, with cartilaginous laminae interposed, the former tissue predomin-
ating towards the circumference, the latter towards the centre.

The Circumferential fibro-cartilages consist of a rim of fibro-cartilage, which
surrounds the margins of some of the articular cavities, as the cotyloid cavity of
the hip, and the glenoid cavity of the shoulder; they serve to deepen the articular
surface and protect the edges of the bone.

The Stratiform fibro-cartilages are those which form a thin layer in the osseous
grooves, through which the tendons of certain muscles glide.

Ligaments are found in nearly all the moveable articulations; they consist of
bands of various forms, serving to connect together the articular extremities of
bones, and composed mainly of bundles of white fibrous tissue, placed parallel with,
or closely interlaced with, one another, and presenting a white, shining, silvery
aspect. Ligament is pliant and flexible, so as to allow of the most perfect freedom
of movement, but strong, tough, and inextensible, so as not readily to yield under the
most severely applied force; it is, consequently, admirably adapted to serve as the
connecting medium between the bones. There, are some ligaments which consist
entirely of yellow elastic tissue, as the ligamenta subflava, which connect together
the adjacent arches of the vertebrae.

Synovial Membrane is a thin, delicate membrane, which invests the arti-
cular extremities of the bones, and is then reflected on the inner surface of the
various ligaments which connect the articulating surfaces. It resembles the serous
membrane in being a shut sac, but differs in the nature of its secretion, which is
thick, viscid, and glairy, like the white of egg; and hence termed synovia. The
synovial membranes found in the body admit of subdivision into three kinds, articular, bursal, and vaginal.

The Articular Synovial Membranes are found in all the freely moveable
(diarthrodial) joints. In the fetus, this membrane may be traced over the entire
surface of the cartilages; but in the adult it is wanting, excepting at their circum-
ference, upon which it encroaches for a short distance: it then invests the inner
surface of the capsular or other ligaments enclosing the joint, and is reflected over
the surface of any tendons passing through its cavity, as the tendon of the Popli-
tea in the knee, and the tendon of the Biceps in the shoulder. In some joints, the
synovial membrane is thrown into numerous folds, which project forward into
the cavity. These folds consist of a reduplication of the synovial membrane, some
of them containing fat, and, more rarely, isolated cartilage-cells; the free borders
of the longer processes being subdivided into vascular fringe-like processes, the
vessels of which have a convoluted arrangement. They are especially distinct in
the knee, where they are known as the mucous andalar ligaments, and were
described by Clopton Havers as mucilaginous glands, and as the source of the
synovial secretion, a view lately revived by Mr. Rainey, who finds them in the
bursal and vaginal, as well as in the articular synovial membranes.

The Bursal Synovial Membranes (Bursæ mucose) are found interposed be-
tween surfaces which move upon each other, producing friction, as in the gliding
of a tendon, or of the integument over projecting bony surfaces. They are small
shut sacs, connected by arcular tissue with the adjacent parts, and secreting a
fluid in their interior analogous to synovia. The bursæ admit of a subdivision
into two kinds, subcutaneous and deep-seated. The subcutaneous are found in
various situations, as between the integument and front of the patella, over the olecranon, the malleoli, and other prominent parts. The deep seated are more numerous, and usually found interposed between muscles or their tendons as they play over projecting bony surfaces, as between the Glutei muscles and surface of the great trochanter. Where one of these exists in the neighbourhood of a joint, it usually communicates with the cavity of the synovial membrane, as is generally the case with the bursa between the tendon of the Psoas and Iliacus, and the capsular ligament of the hip, or the one interposed between the under surface of the Subscapularis and the neck of the scapula.

The Vaginal Synovial Membranes (synovial sheaths) serve to facilitate the gliding of tendons in the osseo-fibrous canals through which they pass. The membrane is here arranged in the form of a sheath, one layer of which adheres to the wall of the canal, and the other is reflected upon the outer surface of the contained tendon; the space between the two free surfaces of the membrane, being partially filled with synovia. These sheaths are chiefly found surrounding the tendons of the Flexor and Extensor muscles of the fingers and toes, as they pass through the osseo-fibrous canals in the hand or foot.

Synovia is a transparent, yellowish-white, or slightly reddish fluid, viscid like the white of egg, having an alkaline reaction, and slightly saline taste. It consists, according to Frerichs, in the ox, of 94.85 water, 0.56 mucus and epithelium, 0.07 fat, 3.51 albumen and extractive matter, and 0.99 salts.

The Articulations are divided into three classes: Synarthrosis, or immovable; Amphiarthrosis, or mixed; and Diarthrosis, or moveable.

I. Synarthrosis. Immoveable Articulations.

Synarthrosis (συν, with, ἀρθρον, a joint), or Immoveable Joints, include all those articulations in which the surfaces of the bones are in almost direct contact, not separated by an intervening synovial cavity, and immovably connected with each other, as between the bones of the cranium and face, excepting the lower jaw. The varieties of synarthrosis are three in number: Sutura, Schindylesis, Gomphosis.

Sutura (a seam). Where the articulating surfaces are connected by a series of processes and indentations interlocked together, it is termed sutura vera; of which there are three varieties: sutura dentata, serrata, and limboa. The surfaces of the bones are not in direct contact, being separated by a layer of membrane continuous externally with the pericranium, internally with the dura mater. The sutura dentata (dens, a tooth) is so called from the tooth-like form of the projecting articular processes, as in the suture between the parietal bones. In the sutura serrata (serra, a saw), the edges of the two bones forming the articulation are serrated like the teeth of a fine saw, as between the two portions of the frontal bone. In the sutura limboa (limbus, a selvage), besides the dentated processes, there is a certain degree of bevelling of the articular surfaces, so that the bones overlap one another, as in the suture between the parietal and occipital bones. Where the articulation is formed by roughened surfaces placed in apposition with one another, it is termed the false sutura, sutura notha, of which there are two kinds: the sutura squamosa (squama, a scale), formed by the overlapping of two contiguous bones by broad bevelled margins, as in the temporoparietal suture; and the sutura harmonia (ἀρμονία, to adapt), where there is simple apposition of two contiguous rough bony surfaces, as in the articulation between the two superior maxillary bones, or of the palate processes of the palate bones with each other. The sutures present a great tendency to obliteration as age advances, the intervening fibrous-tissue becoming ossified. The frontal suture seldom exists after puberty; and it rarely happens that all the others are distinct in a skull beyond the age of fifty.

Schindylesis (σχίνδυλης, a fissure) is that form of articulation in which a thin plate of bone is received into a cleft or fissure formed by the separation of two laminae of another, as in the articulation of the rostrum of the sphenoid, and descending plate of the ethmoid with the vomer, or in the reception of the latter in the fissure between the superior maxillary and palate bones.
ARTICULATIONS.

Gomphosis (γομφός, a nail) is an articulation formed by the insertion of a conical process into a socket, as a nail is driven into a board; and is illustrated in the articulation of the teeth in the alveoli of the maxillary bones.


Amphiarthrosis (αμφί 'on all sides,' ἀρθρόν 'a joint'), or Mixed Articulation. In this form of articulation, the contiguous osseous surfaces are connected together by broad flattened discs of fibro-cartilage, which adhere to the ends of both bones, as in the articulation between the bodies of the vertebrae, and first two pieces of the sternum; or the articulating surfaces are covered with fibro-cartilage, lined by a partial synovial membrane, and connected together by external ligaments, as in the sacro-iliac and pubic symphysis; both these forms being capable of limited motion in every direction. The former resemble the synarthrodial joints in the continuity of their surfaces, and absence of synovial sac; the latter, the diarthrodial. These joints occasionally become obliterated in old age: this is frequently the case in the inter-pubic articulation, and occasionally in the intervertebral and sacro-iliac.


Diarthrosis (δια 'through,' ἀρθρόν 'a joint'). This form of articulation includes the greater number of the joints in the body, mobility being their distinguishing character. They are formed by the approximation of two contiguous bony surfaces, covered with cartilage, connected by ligaments, and having a synovial sac interposed. The varieties of joints in this class, have been determined by the kind of motion permitted in each; they are four in number: Arthrodia, Enarthrosis, Ginglymus, Diarthrosis Rotatorius.

Arthrodia is that form of joint which admits of a gliding movement; it is formed by the approximation of plane surfaces, or one slightly concave, the other slightly convex; the amount of motion between them being limited by the ligaments, or osseous processes, surrounding the articulation; as in the articular processes of the vertebrae, temporomaxillary, sterno and acromio-clavicular, inferior radio-ulnar, carpal, carpo-metacarpal, superior tibio-fibular, tarsal, and tarso-metatarsal articulations.

Enarthrosis is that form of joint which is capable of motion in all directions. It is formed by the reception of a globular head into a deep cup-like cavity (hence the name 'ball and socket'), the parts being kept in apposition by a capsular ligament strengthened by accessory ligamentous bands, and the contiguous cartilaginous surfaces having a synovial sac interposed. Examples of this form of articulation are found in the hip and shoulder-joints.

Ginglymus, Hinge-joint (γωγγλωμος, a hinge). In this form of joint, the articular surfaces are moulded to each other in such a manner, as to permit motion only in one direction, forwards and backwards, the extent of motion at the same time being considerable. The articular surfaces are connected together by strong lateral ligaments, which form their chief bond of union. The most perfect forms of ginglymi are the elbow and ankle; the knee is less perfect, as it allows a slight degree of rotation in certain positions of the limb: there are also the metatarso-phalangeal and phalangeal joints in the lower extremity, metacarpo-phalangeal and phalangeal joints in the upper extremity.

Diarthrosis rotatorius (Lateral Ginglymus). Where the mobility is limited to rotation, the joint is formed by a pivot-like process turning within a ring, or the ring on the pivot, the ring being formed partly of bone, partly of ligament. In the articulation of the odontoid process of the axis with the atlas, the ring is formed in front by the anterior arch of the atlas; behind, by the transverse ligament; here the ring rotates around the odontoid process. In the superior radio-ulnar articulation, the ring is formed partly by the lesser sigmoid cavity of the ulna; in the rest of its extent, by the orbicular ligament; here, the neck of the radius rotates within the ring.
Subdivision into Three Classes.

Subjoined, in a tabular form, are the names, distinctive characters, and examples of the different kinds of articulations.

Dentata, having tooth-like processes.

Inter-parietal suture.

Serrata, having serrated edges, like the teeth of a saw.

Inter-frontal suture.

Limboa, having bevelled margins, and dentated processes.

Occipito-parietal suture.

Dentata, having tooth-like processes.

Inter-parietal suture.

Serrata, having serrated edges, like the teeth of a saw.

Inter-frontal suture.

Limboa, having bevelled margins, and dentated processes.

Occipito-parietal suture.

Sutura vera (true) articulate by indented borders.

Sutura notha (false) articulate by rough surfaces.

Synarthrosis, or immovable joint.
Surfaces separated by fibrous membrane, no intervening synovial cavity, and immovable connected with each other.
Example: bones of cranium and face (except lower jaw).

Schindylesis. Articulation formed by the reception of a thin plate of bone into a fissure of another.
Rostrum of sphenoid with vomer.

Gomphosis. An articulation formed by the insertion of a conical process into a socket.
Tooth in socket.

1. Surfaces connected by fibro-cartilage, not separated by synovial membrane, and having limited motion. Bodies of vertebrae.
2. Surfaces connected by fibro-cartilage, lined by a partial synovial membrane. Sacro-iliae and pubic symphyses.

Amphiarthrosis, Mixed Articulation.

Arthrodi. Gliding joint; articulation by plane surfaces, which glide upon each other. As in sterno and acromioclavicular articulations.

Enarthrosis. Ball and socket joint; capable of motion in all directions. Articulation by a globular head received into a cup-like cavity. As in hip and shoulder joints.

Ginglymus. Hinge joint; motion limited to one direction, forwards and backwards. Articular surfaces fitted together so as to permit of movement in one plane. As in the elbow, ankle, and knee.

Diarthrosis rotatorius. Articulation by a pivot process turning within a ring, or ring around a pivot. As in superior radio-ulnar articulation, and atlo-axoid joint.
ARTICULATIONS.

The Kinds of Movement admitted in Joints.

The movements admissible in joints may be divided into four kinds; gliding, angular movement, circumscription, and rotation.

Gliding movement is the most simple kind of motion that can take place in a joint, one surface gliding over another. This kind of movement is common to all moveable joints; but in some, as in the articulations of the carpus and tarsus, is the only motion permitted. This motion is not confined to plane surfaces, but may exist between any two contiguously contiguous surfaces, of whatever form, limited by the ligaments which enclose the articulation.

Angular movement occurs only between the long bones, and may take place in four directions, forwards or backwards, constituting flexion and extension, or inwards and outwards, which constitutes abstraction and adduction. Flexion and extension is confined to the strictly ginglymoid or hinge joints. Abduction and adduction, combined with flexion and extension, are met with only in the most moveable joints; as in the hip, shoulder, and thumb, and partially in the wrist and ankle.

Circumduction is that limited degree of motion which takes place between the head of a bone and its articular cavity, whilst the extremity and sides of a limb are made to circumscribe a conical space, the base of which corresponds with the inferior extremity of the limb, the apex to the articular cavity; and is best seen in the shoulder and hip joints.

Rotation is the movement of a bone upon its own axis, the bone retaining the same relative situation with respect to the adjacent parts; as in the articulation between the atlas and axis, where the odontoid process serves as a pivot around which the atlas turns; or in the rotation of the radius against the humerus, and also in the hip and shoulder.

The articulations may be arranged into those of the trunk, those of the upper extremity, and those of the lower extremity.

ARTICULATIONS OF THE TRUNK.

These may be divided into the following groups viz.:

1. Of the vertebral column.
2. Of the atlas with the axis.
3. Of the atlas with the occipital bone.
4. Of the axis with the occipital bone.
5. Of the lower jaw.
6. Of the ribs with the vertebrae.
7. Of the cartilages of the ribs with the sternum, and with each other.
8. Of the sternum.
9. Of the vertebral column with the pelvis.
10. Of the pelvis.

1. Articulations of the Vertebral Column.

The different segments of the vertebral column are connected together by ligaments, which admit of the same arrangement as the vertebrae themselves. They may be divided into five sets. 1. Those connecting the bodies of the vertebrae. 2. Those connecting the laminae. 3. Those connecting the articular processes. 4. The ligaments connecting the spinous processes. 5. Those of the transverse processes.

The articulation of the bodies of the vertebrae with each other, form a series of amphiarthrodial joints; whilst those between the articular processes form a series of arthrodial joints.

I. The Ligaments of the Bodies are


The Anterior Common Ligament (fig. 107) is a broad and strong band of ligamentous fibres, which extends along the front surface of the bodies of the vertebrae, from the axis to the sacrum. It is broader below than above, and thicker in the dorsal than in the cervical or lumbar regions. It is attached, above, to the body of the axis by a pointed process, which is connected with the tendon of origin of the Longus colli muscle; and, as it descends, is somewhat broader opposite the centre.
of the body of each vertebra, than opposite the intervertebral substance. It consists of dense longitudinal fibres, which are intimately adherent to the intervertebral substance and prominent margins of the vertebrae; but less closely with the centre of the bodies. In this situation the fibres are exceedingly thick, and serve to fill up the concavities on their front surface, and to make the anterior surface of the spine more even. This ligament is composed of several layers of fibres, which vary in their length, but are closely interlaced with each other. The most super-

99.—Vertical Section of two Vertebrae and their Ligaments, from the Lumbar Region.
different parts of the spine. In shape they accurately correspond with the surfaces of the bodies between which they are placed, being oval in the cervical and lumbar regions, circular in the dorsal. Their size is greatest in the lumbar region. In thickness they vary not only in the different regions of the spine, but in different parts of the same region: thus, they are uniformly thick in the lumbar region; thickest in front in the cervical and lumbar regions which are convex forwards, and behind, to a slight extent, in the dorsal region. They thus contribute, in a great measure, to the curvatures of the spine in the neck and loins; whilst the concavity of the dorsal region is chiefly due to the shape of the bodies of the vertebrae. The intervertebral discs form about one-fourth of the spinal column, exclusive of the first two vertebrae; they are not equally distributed, however, between the various bones; the dorsal portion of the spine having, in proportion to its length, a much smaller quantity than in the cervical and lumbar regions, which necessarily gives to the latter parts greater pliancy and freedom of movement. The intervertebral discs are adherent, by their surfaces, to the adjacent parts of the bodies of the vertebrae; and by their circumference are closely connected in front to the anterior, and behind to the posterior common ligament; whilst in the dorsal region they are connected laterally to the heads of those ribs which articulate with two vertebrae, by means of the inter-articular ligament; they consequently form part of the articular cavities in which the heads of these bones are received.

The intervertebral substance is composed, at its circumference, of laminae of fibrous tissue and fibro-cartilage; and at its centre of a soft, elastic, pulpy matter. The laminae are arranged concentrically one within the other, with their edges turned towards the corresponding surfaces of the vertebrae, and consist of alternate plates of fibrous tissue and fibro-cartilage. These plates are not quite vertical in their direction, those near the circumference being curved outwards and closely approximated; whilst those nearest the centre curve in the opposite direction, and are somewhat more widely separated. The fibres of which each plate is composed, are directed, for the most part, obliquely from above downwards; the fibres of an adjacent plate have an exactly opposite arrangement, varying in their direction in every layer; whilst in some few they are horizontal. This laminar arrangement belongs to about the outer half of each disc, the central part being occupied by a soft, pulpy, highly elastic substance, of a yellowish colour, which rises up considerably above the surrounding level, when the disc is divided horizontally. This substance presents no concentric arrangement, and consists of white fibrous tissue, having interspersed cells of variable shape and size. The pulpy matter is separated from immediate contact with the vertebrae, by the interposition of thin plates of cartilage.

2. LIGAMENTS CONNECTING THE LAMINAE.

Ligamenta Subflava.

The Ligamenta Subflava are interposed between the laminae of the vertebrae, from the axis to the sacrum. They are most distinct when seen from the inner surface of the spine; when viewed from the outer surface, they appear short, being overlapped by the laminae. Each ligament consists of two lateral portions, which commence on each side at the root of either articular process, and pass backwards to the point where the laminae converge to form the spinous process, where their margins are thickest, and separated by a slight interval, filled up with arcular tissue. These ligaments consist of yellow elastic tissue, the fibres of which, almost perpendicular in direction, are attached to the anterior surface of the margin of the lamina above, and to the posterior surface, as well as to the margin of the lamina below. In the cervical region, they are thin in texture, but very broad and long; they become thicker in the dorsal region; and in the lumbar acquire very considerable thickness. Their highly elastic property serves to preserve the upright posture, and to counteract the efforts of the Flexor muscles of the spine. These ligaments do not exist between the occiput and atlas, or between the atlas and axis.
3. Ligaments connecting the Articular Processes.

Capsular. Synovial Membranes.

The Capsular Ligaments are thin and loose bags of ligamentous fibre attached to the contiguous margins of the articulating processes of each vertebra, through the greater part of their circumference, and completed internally by the ligamenta subflava. They are longer and more loose in the cervical than in the dorsal or lumbar regions. The capsular ligaments are lined on their inner surface by a delicate synovial membrane.

4. Ligaments connecting the Spinous Processes.

Inter-spinous. Supra-spinous.

The Inter-spinous Ligaments, thin and membranous, are interposed between the spinous processes in the dorsal and lumbar regions. Each ligament extends from the root to the summit of each spinous process, and connects together their adjacent margins. They are narrow and elongated in the dorsal region, broader, quadrilateral in form, and thicker in the lumbar region.

The Supra-spinous Ligament is a strong fibrous cord, which connects together the apices of the spinous processes from the seventh cervical to the spine of the sacrum. It is thicker and broader in the lumbar than in the dorsal region, and intimately blended, in both situations, with the neighbouring aponeuroses. The most superficial fibres of this ligament connect three or four vertebrae; those deeper seated pass between two or three vertebrae; whilst the deepest connect the contiguous extremities of neighbouring vertebrae.

5. Ligaments connecting the Transverse Processes.

Inter-transverse.

The Inter-transverse Ligaments consist of a few thin scattered fibres, interposed between the transverse processes. They are generally wanting in the cervical region; in the dorsal, they are rounded cords; in the lumbar region, thin and membranous.

The two upper vertebrae, the Atlas and Axis, are connected together by ligaments distinct from those by which the rest are united.


The articulation of the anterior arch of the atlas with the odontoid process forms a lateral ginglymoid joint, whilst that between the articulating processes of the two bones forms a double arthrodia. The ligaments of this articulation are the

Two Anterior Atlo-Axoid. Transverse.
Posterior Atlo-Axoid. Two Capsular.
Four Synovial Membranes.

Of the Two Anterior Atlo-Axoid Ligaments (fig. 100), the most superficial is a rounded cord, situated in the middle line, attached, above, to the tubercle on the anterior arch of the atlas; below, to the base of the odontoid process and body of the axis. The deeper ligament is a membranous layer, attached, above, to the lower border of the anterior arch of the atlas; below, to the base of the odontoid process and body of the axis. These ligaments are in relation, in front, with the Recti antici majores.

The Posterior Atlo-Axoid Ligament (fig. 101) is a broad and thin membranous layer, attached, above, to the lower border of the posterior arch of the atlas; below, to the upper edge of the laminae of the axis. This ligament supplies the place of the ligamenta subflava, and is in relation, behind, with the Inferior oblique muscles.
The Transverse Ligament (figs. 102, 103) is a thick and strong ligamentous band, which arches across the ring of the atlas, and serves to retain the odontoid process in firm connection with its anterior arch. This ligament is flattened from before backwards, broader and thicker in the middle than at either extremity, and firmly
attached on each side of the atlas to a small tubercle on the inner surface of each of its lateral masses. As it crosses the odontoid process, a small fasciculus is derived from its upper and lower borders; the former, passing upwards to be inserted into the basi-
silar process of the occipital bone; the latter, downwards, to be attached to the root of the odontoid process: hence this ligament has received the name of cruci-
form. The transverse ligament divides the ring of the atlas into two unequal parts: of these, the poste-
rior and larger serves for the transmission of the cord and its membranes; the anterior and smaller serving to retain the odontoid process in its position. The lower border of the space formed between the atlas and transverse ligament being smaller than the upper (on account of the transverse ligament embracing firmly the narrow neck of the odontoid process), while the central part of the odontoid process is larger than its base; this process is still retained in firm connection with the anterior arch when all the other liga-
ments have been divided.

The Capsular Ligaments are two thin and loose capsules, connecting the articular surfaces of the atlas and axis, the fibres being strongest on the anterior and external part of the articulation.

There are four Synovial Membranes in this articulation. One lining the inner surface of each of the capsular ligaments: one between the anterior surface of the odontoid process and anterior arch of the atlas: and one between the poste-
rior surface of the odontoid process and the transverse ligament. This synovial membrane often communicates with those between the condyles of the occipital bone and the articular surfaces of the atlas.

Actions. This joint is capable of great mobility, and allows the rotation of the atlas, and, with it, of the cranium upon the axis, the extent of rotation being limited by means of the odontoid ligaments.

Articulation of the Spine with the Cranium.

The ligaments connecting the spine with the cranium may be divided into two sets: Those connecting the occipital bone with the atlas; Those connecting the occipital bone with the axis.

3. Articulation of the Atlas with the Occipital Bone.

This articulation is a double arthrodia. Its ligaments are the

Two Anterior Occipito-Atloid.
Posterior Occipito-Atloid.
Two Lateral Occipito-Atloid.
Two Capsular and Synovial Membranes.

Of the Two Anterior Ligaments (fig. 100), the most superficial is a strong, narrow, rounded cord, attached, above, to the basilar process of the occiput; below, to the tubercle on the anterior arch of the atlas: the deeper ligament is a broad and thin membranous layer, which passes between the anterior margin of the foramen magnum above, and the whole length of the upper border of the anterior arch of the atlas below. This ligament is in relation, in front, with the Recti antici

minores; behind, with the odontoid ligaments.
The **Posterior Occipito-Atlod Ligament** (fig. 101) is a very broad but thin membranous lamina, intimately blended with the dura mater. It is connected, above, to the posterior margin of the foramen magnum; below, to the central part of the upper border of the posterior arch of the atlas. This ligament is incomplete at each side, and forms, with the superior intervertebral notches, an opening for the passage of the vertebral artery and sub-occipital nerve. It is in relation, behind, with the Recti postici minores and Obliqui superiores; in front, with the dura mater of the spinal canal, to which it is intimately adherent.

The **Lateral Ligaments** are strong bands of fibres, directed obliquely upwards and inwards, attached, above, to the jugular process of the occipital bone; below, to the base of the transverse process of the atlas.

The **Capsular Ligaments** surround the condyles of the occipital bone, and connect them with the articular surfaces of the atlas; they consist of thin and loose capsules, which enclose the synovial membrane of this articulation. The synovial membranes between the occipital bone and atlas communicate occasionally with that between the posterior surface of the odontoid process and transverse ligament.

**Actions.** The movements permitted in this joint are flexion and extension, which give rise to the ordinary forward or backward nodding of the head, besides slight lateral motion to one or the other side. When either of these actions is carried beyond a slight extent, the whole of the cervical portion of the spine assists in its production.

### 4. Articulation of the Axis with the Occipital Bone.

#### Occipito-Axoid.

To expose these ligaments, the spinal canal should be laid open by removing the posterior arch of the atlas, the laminae and spinous process of the axis, and that portion of the occipital bone behind the foramen magnum, as seen in fig. 103.

The **Occipito-Axoid Ligament** (Apparatus ligamentosus colli) is situated at the

![Diagram of Articulations](image-url)
upper part of the front surface of the spinal canal. It is an exceedingly broad and strong ligamentous band, which covers the odontoid process and its ligaments, and appears to be a prolongation upwards of the posterior common ligament of the spine. It is attached, below, to the posterior surface of the body of the axis, and becoming broader and expanded as it ascends, is inserted into the basilar groove of the occipital bone, in front of the foramen magnum.

**Relations.** By its anterior surface, it is intimately connected with the transverse ligament; by its posterior surface, with the dura mater. By dividing this ligament transversely across, and turning its ends aside, the transverse and odontoid ligaments are exposed.

The Odontoid or Check Ligaments are strong rounded fibrous cords, which arise on either side of the apex of the odontoid process, and passing obliquely upwards and outwards, are inserted into the rough depressions on the inner side of the condyles of the occipital bone. In the triangular interval left between these ligaments and the margin of the foramen magnum, a third strong ligamentous band (ligamentum suspensorium) may be seen, which passes almost perpendicularly from the apex of the odontoid process to the anterior margin of the foramen, being intimately blended with the anterior occipito-atloid ligament.

**Actions.** The odontoid ligaments serve to limit the extent to which rotation of the cranium may be carried; hence they have received the name of check ligaments.

5. Temporo-Maxillary Articulation.

This articulation is a double arthrodia. The parts entering into its formation are, on each side, the anterior part of the glenoid cavity of the temporal bone and the eminentia articularis above; with the condyle of the lower jaw below. The ligaments are the following.

- External Lateral. Capsular.
- Internal Lateral. Inter-articular Fibro-cartilage.
- Stylo-maxillary. Two Synovial Membranes.

104.—Temporo-Maxillary Articulation. External View.
The *External Lateral Ligament* (fig. 104) is a short, thin, and narrow fasciculus, attached above to the outer surface of the zygoma and to the rough tubercle on its lower border; below, to the outer surface and posterior border of the neck of the lower jaw. This ligament is a little broader above than below; its fibres are placed parallel with one another, and directed obliquely downwards and backwards. Externally, it is covered by the parotid gland and by the integument. Internally, it is in relation with the inter-articular fibro-cartilage and the synovial membranes.

The *Internal Lateral Ligament* (fig. 105) is a long, thin, and loose band, attached above by its narrow extremity to the spinous process of the sphenoid bone, and becoming broader as it descends, is inserted into the inner margin of the dental foramen. Its outer surface is in relation above with the External pterygoid muscle; lower down it is separated from the neck of the condyle by the internal maxillary artery; and still more inferiorly the inferior dental vessels and nerve separate it from the ramus of the jaw. Internally it is in relation with the Internal pterygoid.

The *Stylo-maxillary Ligament* is a thin aponeurotic cord, which extends from near the apex of the styloid process of the temporal bone, to the angle and posterior border of the ramus of the lower jaw, between the Masseter and Internal pterygoid muscles. This ligament separates the parotid from the sub-maxillary gland, and has attached to its inner side part of the fibres of origin of the Stylo-glossus muscle. Although usually clasped among the ligaments of the jaw, it can only be considered as an accessory in the articulation.

The *Capsular Ligament* consists of a thin and loose ligamentous capsule, attached above to the circumference of the glenoid cavity and the articular surface immediately in front; below, to the neck of the condyle of the lower jaw. It consists of a few thin scattered fibres, and can hardly be considered as a distinct ligament; it is thickest at the back part of the articulation.

The *Inter-articular Fibro-cartilage* (fig. 106) is a thin plate of a transversely oval form, placed horizontally between the condyle of the jaw and the glenoid cavity. Its upper surface is concave from before backwards, and a little convex transversely, to accommodate itself to the form of the glenoid cavity. Its under surface, where it is in contact with the condyle, is concave. Its circumference is connected externally to the external lateral ligament; internally, to the capsular ligament; and in front to the tendon of the External pterygoid muscle. It is thicker at its circumference, especially behind, than at its centre, where it is sometimes perforated. The fibres of which it is composed have a concentric arrangement, more apparent at the circumference than at the centre. Its surfaces are smooth, and divide the joint into two cavities, each of which is furnished with
COSTO-VERTEBRAL.

a separate synovial membrane. When the fibro-cartilage is perforated, the synovial membranes are continuous with one another.

The Synovial Membranes, two in number, are placed one above, and the other below the fibro-cartilage. The upper one, the larger and looser of the two, after lining the cartilage covering the glenoid cavity and eminentia articularis, is continued over the upper surface of the fibro-cartilage. The lower one is interposed between the under surface of the fibro-cartilage and the condyle of the jaw, being prolonged downwards a little further behind than in front.

Actions. The movements permitted in this articulation are very extensive. Thus the jaw may be depressed or elevated, or it may be carried forwards or backwards, or from side to side. It is by the alternation of these movements performed in succession, that a kind of rotatory movement of the lower jaw upon the upper takes place, which materially assists in the mastication of the food.

If the movement of depression is carried only to a slight extent, the condyles remain in the glenoid cavities, their anterior part descending only to a slight extent, but if depression is considerable, the condyles glide from the glenoid fossæ on to the eminentia articularis, carrying with them the inter-articular fibro-cartilages. When the jaw is elevated, the condyles and fibro-cartilages are carried backwards into their original position. When the jaw is carried forwards or backwards, a horizontal gliding movement of the fibro-cartilages and condyles upon the glenoid cavities takes place in the antero-posterior direction; whilst in the movement from side to side, this occurs in the lateral direction.

6. Articulation of the Ribs with the Vertebrae.

The articulation of the ribs with the vertebral column, may be divided into two sets. 1. Those which connect the heads of the ribs with the bodies of the vertebrae. 2. Those which connect the neck and tubercle of the ribs with the transverse processes.

I. Articulation between the Heads of the Ribs and the Bodies of the Vertebrae.

These form a series of angular ginglymoid joints, connected together by the following ligaments:—

Anterior Costo-vertebral or Stellate.
Capsular.
Inter-articular.
Two Synovial Membranes.

The Anterior Costo-vertebral or Stellate Ligament (fig. 107) connects the anterior part of the head of each rib, with the sides of the bodies of the vertebrae, and the intervening intervertebral disc. It consists of three flat bundles of ligamentous fibres, which radiate from the anterior part of the head of the rib. The superior fasciculus passes upwards to be connected with the body of the vertebra above; the inferior one descends to the body of the vertebra below; and the middle one, the smallest and least distinct, passes horizontally inwards to be attached to the intervertebral substance.
Relations. In front with the thoracic ganglia of the sympathetic, the pleura, and on the right side, the vena azygos major; behind, with the inter-articular ligament and synovial membranes.

In the first rib, which articulates with a single vertebra only, this ligament does not present a distinct division into three fasciculi; its superior fibres, however pass to be attached to the body of the last cervical vertebra, as well as to that of the vertebra with which the rib articulates. In the eleventh and twelfth ribs, which also articulate with a single vertebra, the same division does not exist, but the superior fibres of the ligament, in each case, are connected with the vertebra above, as well as that with which the ribs articulate.

The Capsular Ligament is a thin and loose ligamentous bag, which surrounds the joint between the head of the rib and the articular cavity formed by the junction of the vertebrae. It is very thin, firmly connected with the anterior ligament, and most distinct at the upper and lower parts of the articulation.

The Inter-articular Ligament is situated in the interior of the articulation. It consists of a short band of fibres, flattened from above downwards, attached by one extremity to the sharp crest on the head of the rib, and by the other to the inter-vertebral disc. It divides the joint into two cavities, which have no communication with one another, and are each lined by a separate synovial membrane. In the first, eleventh, and twelfth ribs, the inter-articular ligament does not exist, consequently there is but one synovial membrane.

Actions. The movements permitted in these articulations are limited to elevation, depression, and slightly forwards and backwards. This movement varies however, very much in its extent in different ribs. The first rib is almost entirely immovable, excepting in strong and violent inspirations. The movement of the second rib is also not very extensive. In the other ribs, their mobility increases successively to the two last, which are very moveable. The ribs are generally more moveable in the female than in the male.

2. Articulation between the Neck and Tubercle of the Ribs with the Transverse Processes.

The ligaments connecting these parts are—

Anterior Costo-Transverse.
Middle Costo-Transverse (Interosceous).
Posterior Costo-Transverse.
Capsular and Synovial Membrane.

The Anterior Costo-Transverse Ligament (fig. 108.) is a broad and strong
band of fibres, attached below to the sharp crest on the upper border of the neck of each rib, and passing obliquely upwards and outwards, to the lower border of the transverse process immediately above. It is broader below than above, broader and thinner between the lower ribs than between the upper, and more distinct in front than behind. This ligament is in relation, in front, with the intercostal vessels and nerves; behind, with the Longissimus dorsi. Its internal border completes an aperture formed between it and the articular processes, through which pass the posterior branches of the intercostal vessels and nerves. Its external border is continuous with a thin aponeurosis, which covers the External intercostal muscle.

The first and last ribs have no anterior costo-transverse ligament.

The Middle Costo-Transverse or Interosseous Ligament consists of short, but strong, fibres, which pass between the rough surface on the posterior part of the neck of each rib, and the anterior surface of the adjacent transverse process. In order fully to expose this ligament, a horizontal section should be made across the transverse process and corresponding part of the rib; or the rib may be forcibly separated from the transverse process, and its fibres torn asunder.

In the eleventh and twelfth ribs, this ligament is quite rudimentary.

The Posterior Costo-Transverse Ligament is a short, but thick and strong, fasciculus, which passes obliquely from the summit of the transverse process to the rough non-articular portion of the tubercle of the rib. This ligament is shorter and more oblique in the upper, than in the lower ribs. Those corresponding to the superior ribs ascend, and those of the inferior ones slightly descend.

In the eleventh and twelfth ribs, this ligament is wanting.

The articular portion of the tubercle of the rib, and adjacent transverse process, form an arthrodial joint, provided with a thin capsular ligament attached to the circumference of the articulating surfaces, and enclosing a small synovial membrane.

In the eleventh and twelfth ribs, this articulation is wanting.

Actions. The movement permitted in these joints, is limited to a slight gliding motion of the articular surfaces one upon the other.
7. Articulation of the Cartilages of the Ribs with the Sternum.

The articulation of the cartilages of the true ribs with the sternum are arthro-
dial joints. The ligaments connecting them are—

- Anterior Costo-Sternal.
- Posterior Costo-Sternal.
- Capsular.
- Synovial Membranes.

The Anterior Costo-Sternal Ligament (fig. 109) is a broad and thin membranous

109.—Costo-Sternal, Costo-Xiphoid, and Inter-costal Articulations. Anterior View.

The synovial cavities exposed by a vertical section of the Sternum & Cart

band that radiates from the inner extremity of the cartilages of the true ribs, to the
anterior surface of the sternum. It is composed of fasciculi, which pass in differ-