

Gray's Anatomy



Oliver Wendell Holmes.

Descriptive & Surgical

GRAY'S ANATOMY

DESCRIPTIVE AND SURGICAL.

BY

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THE DISSECTIONS

JOINTLY BY THE AUTHOR AND DR. CARTER.



LONDON:

JOHN W. PARKER AND SON, WEST STRAND.

1858.

ILLUSTRATED &
PUBLISHED BY
e-KİTAP PROJESİ & CHEAPEST BOOKS



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www.cheapestboooks.com

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Istanbul

ISBN:

978-625-6004-61-0

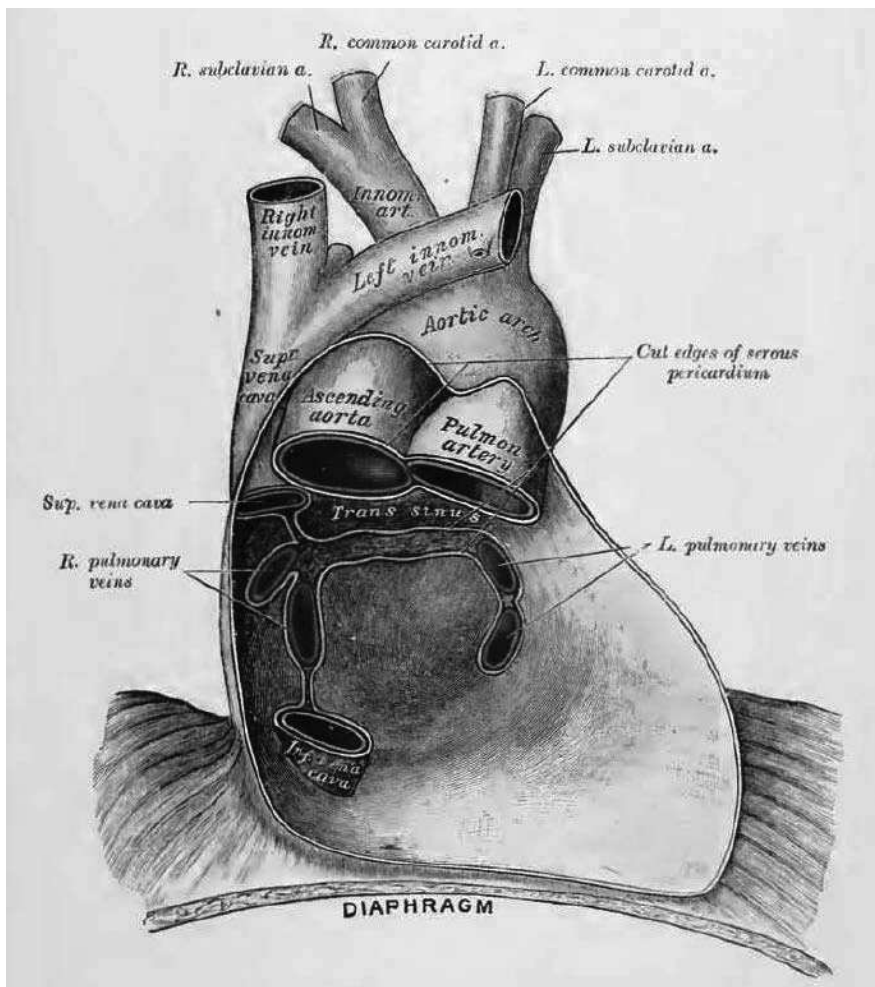
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GRAY's ANATOMY

DESCRIPTIVE & SURGICAL

1858 Edition



TO

SIR BENJAMIN COLLINS BRODIE, BART.,

F.R.S., D.C.L.,

SERJEANT-SURGEON TO THE QUEEN,

CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE,

THIS WORK IS DEDICATED,

IN ADMIRATION OF HIS GREAT TALENTS,

AND

IN REMEMBRANCE OF MANY ACTS OF KINDNESS

SHOWN TO THE AUTHOR,

FROM AN EARLY PERIOD OF HIS PROFESSIONAL CAREER.

PREFACE.

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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 Fasciæ. 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, shewing 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 herniæ, 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.

1

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 33·3 per cent.; the inorganic or earthy matter, *two-thirds*, or 66·7 per cent.: as is seen in the subjoined analysis by Berzelius:—

<i>Animal Matter,</i>	Gelatine and Blood-vessels	. 33'30
	Phosphate of Lime	. 51'04
<i>Inorganic</i>	Carbonate of Lime	. 11'30
or	Fluoride of Calcium	2'00
<i>Earthy Matter.</i>	Phosphate of Magnesia	. 1'16
	Soda and Chloride of Sodium	. 1'20

B

100'00

The proportion between these two constituents varies at different periods of life as is seen in the following table from Schreger:—

	Child	Adult	Old Age
<i>Animal matter</i> . . .	47·20 ...	20·18 ...	12·2
<i>Earthy matter</i> . . .	48·48 ...	74·84 ...	84·1

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-

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, lachrymal, vomer, scapula*, 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 *vertebræ, 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 nutritious 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 nutritious 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 epiphyseal 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—

Cranium	8
Ossicula auditûs	6
Face	14
Vertebral column (sacrum and coccyx included) .	26
Os hyoides, sternum, and ribs	26
Upper extremities	64
Lower extremities	62

206

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 *Vertebræ*.

The *Vertebræ* 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*.

$$\begin{array}{lcl} \text{True } \textit{Vertebræ}, 24 & \left\{ \begin{array}{l} 7 \text{ Cervical.} \\ 12 \text{ Dorsal.} \\ 5 \text{ Lumbar.} \end{array} \right. \\ \text{False } \textit{Vertebræ}, 9 & \left\{ \begin{array}{l} 5 \text{ Sacrum.} \\ 4 \text{ Coccyx.} \end{array} \right. \end{array}$$

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 *venæ basis vertebræ*.

The *Pedicles* project backwards, one on each side, from the upper part of the body of the *vertebræ*, 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.

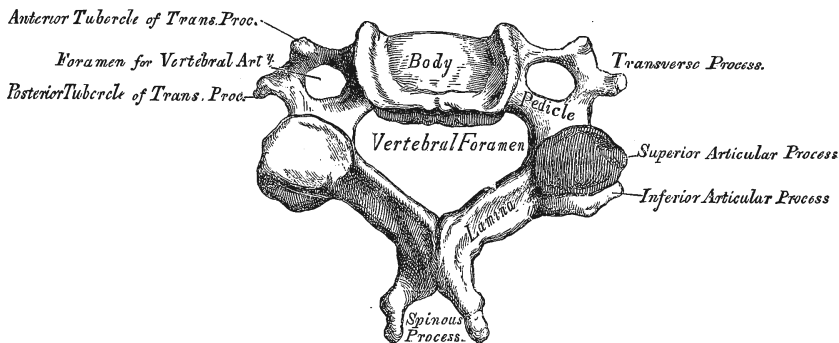
The *Articular Processes* are four in number; two superior, the smooth surfaces of which are directed more or less backwards; and two inferior, the articular surfaces of which look more or less forwards.

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

1.—A Cervical Vertebra.

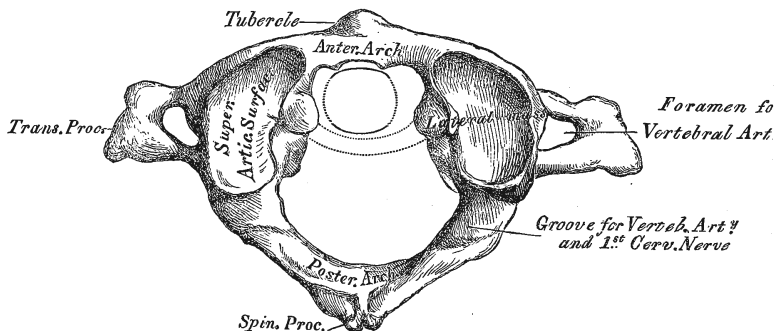


processes. The *articular processes* are oblique: the superior are of an oval form, flattened, and directed upwards and backwards; the inferior downwards and forwards.

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

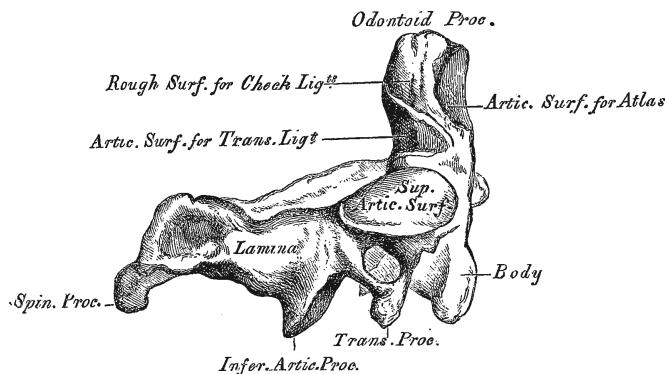
2.—1st Cervical Vertebra, or Atlas.



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 spiculæ. 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 vertebræ. 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 vertebræ. 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

3.—2nd Cervical Vertebra, or Axis.



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;

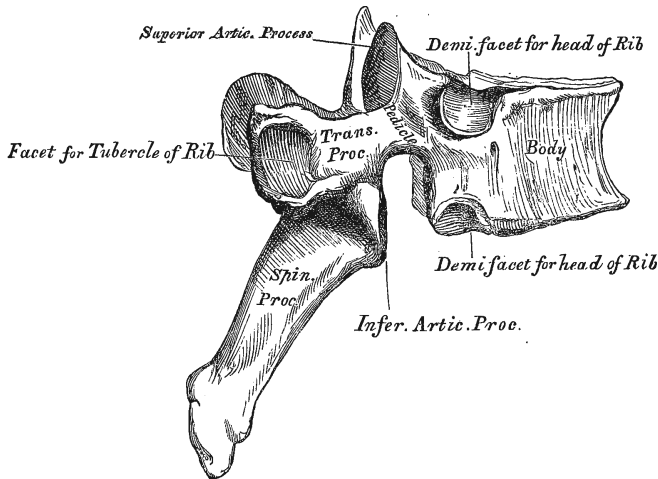
its anterior surface deeper than the posterior, presents a median longitudinal ridge, separating two lateral depressed surfaces for the attachment of the Longi colli muscles. The odontoid process presents two oval articulating surfaces: one in front, for articulation with the Atlas; another behind, for 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 vertebræ. The superior intervertebral notches are very shallow, and lie behind the articular processes; the inferior in front of them, as in the other cervical vertebræ. 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 nuchæ. 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 VERTEBRÆ.

The *Dorsal Vertebræ* (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.

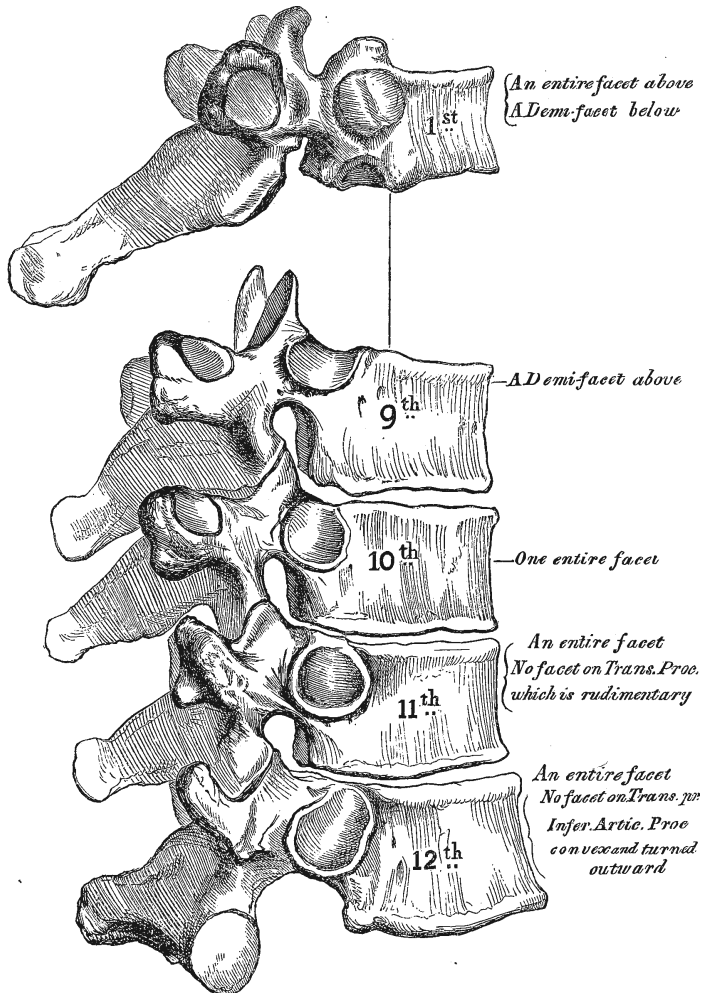


in the lateral direction, more particularly in the middle of the dorsal region, thicker behind than in front, flat above and below, deeply concave behind, and marked on each lateral surface, near the root of the pedicle, by two demi-facets, one above, the other below. These are covered with cartilage in the recent state; and, when

articulated with the adjoining vertebræ, 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 vertebræ are the *first, ninth, tenth, eleventh, and twelfth* (fig. 5).

5.—Peculiar Dorsal Vertebræ.



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

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.

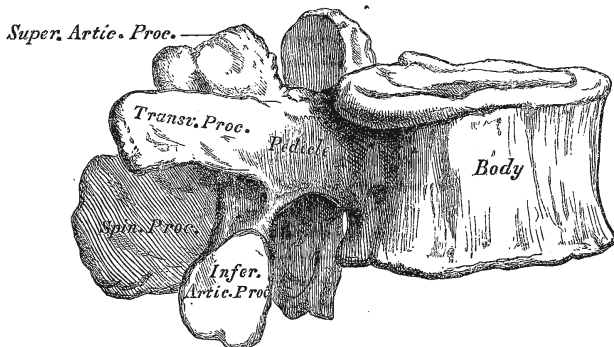
The *Twelfth Dorsal* has the same characters as the eleventh; but may be distinguished from it by the transverse processes being quite rudimentary, and the inferior articular surfaces being convex and turned outwards, like those of the lumbar vertebræ.

The smallest dorsal vertebra is the fourth. The vertebræ 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 VERTEBRÆ.

The Lumbar Vertebræ (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 Vertebra. 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

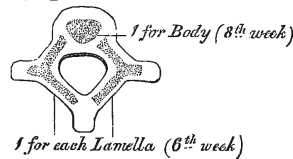
single large irregular or several small apertures at the posterior part of the body of each bone. The arch and processes projecting from it have, on the contrary, an exceedingly thick covering of compact tissue.

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.

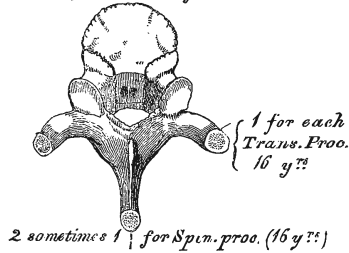
7.—Development of a Vertebra.

By 3 primary centres



8.

By 4 Secondary Centres



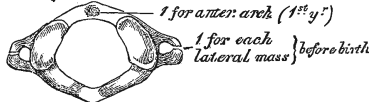
9.

By 2 additional plates



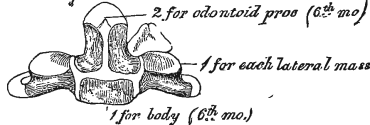
10.—Axis.

By 3 centres



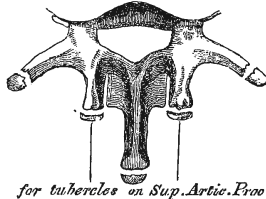
11.—Axis.

By 5 centres



12.—Lumbar Vertebra.

2 additional centres



Exceptional Cases.

The *Atlas* (fig. 10) is developed by *three* centres. One (sometimes two) for the anterior arch, and one for each lateral mass. The ossific 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 ossific nuclei make their first appearance in the lower dorsal vertebrae (about the ninth), the lumbar and first sacral are those in which these nuclei are largest at birth.

THE FALSE VERTEBRÆ.

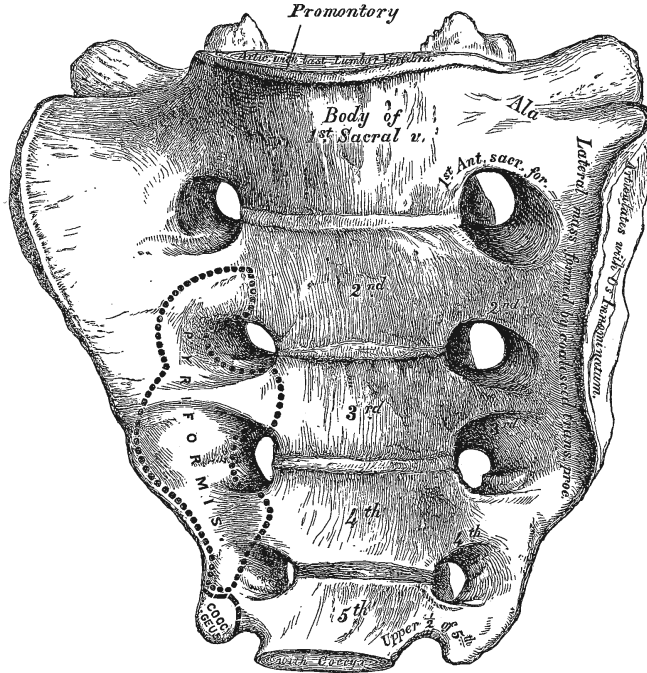
The False Vertebrae consist of nine pieces, which are united so as to form two bones, five entering into the formation of the sacrum, four the coccyx.

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 ossa 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.

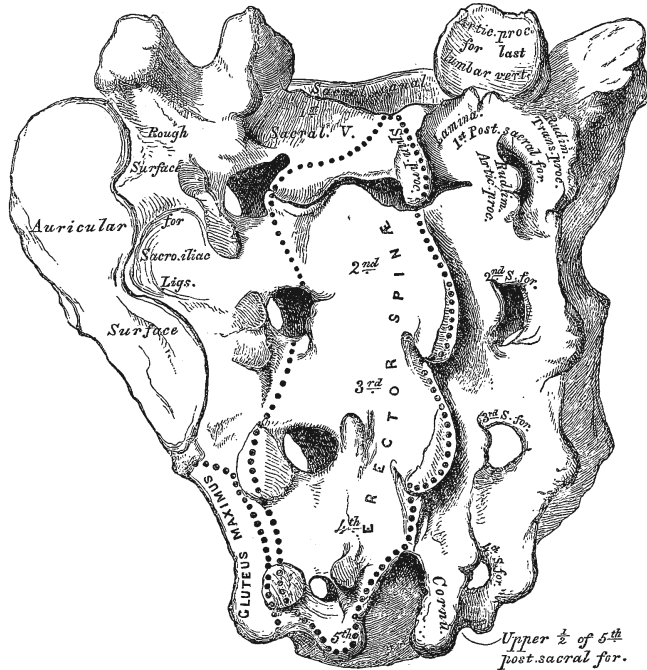


of the sacral vertebræ, traversed by four broad shallow grooves, which lodge the anterior sacral nerves as they pass outwards, the grooves being separated by prominent ridges of bone, which give attachment to the slips of the Pyriformis muscle.

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 *laminæ*, 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 laminæ 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 Spinæ.

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 is 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 *ala*

of the sacrum; they extend outwards, and are continuous on each side with the iliac fossæ.

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 vertebræ 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 vertebræ, 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 vertebræ, 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 vertebræ.

15.—Development of Sacrum.

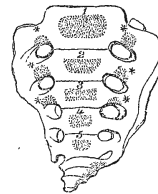
Formed by union of 5 Vertebræ.

2 characteristic points.

1st

*2 Additional centres
for the first 3 pieces **

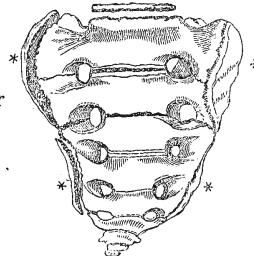
at birth



2nd

*2 Epiphysal laminae
for each lateral surface. **

at 25th y^r



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 epiphysal lamellæ; and one for each of the laminæ.

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

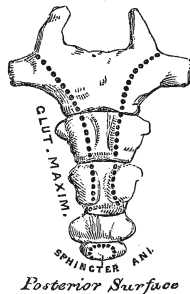
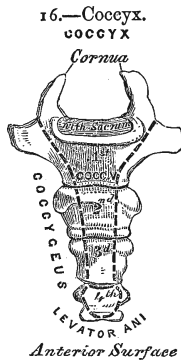
Period of Development. At about the eighth or ninth week of foetal life, ossification of the central part of the bodies of the three first vertebræ commences, and, at a somewhat later period, that of the two last. Between the sixth and eighth months, ossification of the lamellæ takes place; and at about the same period the characteristic osseous tubercles for the three first sacral vertebræ make their appearance. The lateral pieces join to form the arch, and are united to the bodies, first, in the lowest vertebræ. 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 epiphysal lamellæ 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.

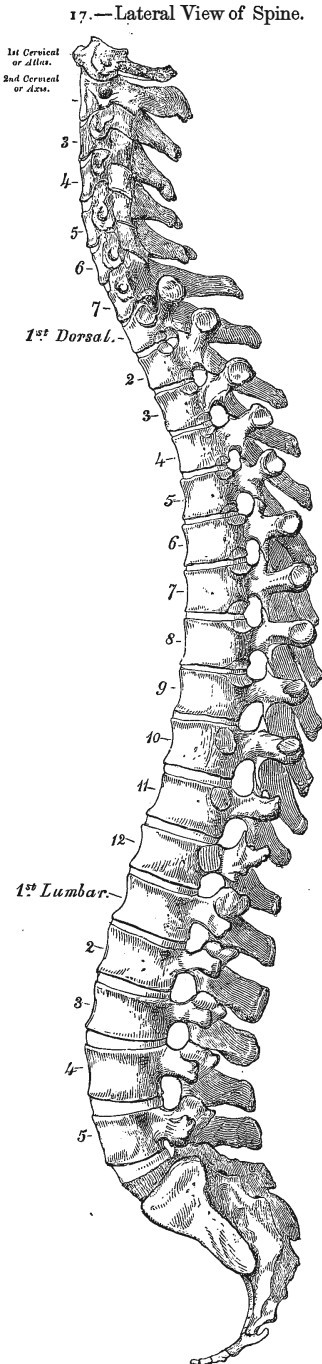
Attachment of Muscles. The Pyriformis and Coccygeus on either side, behind the Gluteus maximus and Erector Spinæ.

THE COCCYX.

The Coccyx (κόκκυξ, 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 vertebræ. 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 vertebræ. 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 vertebræ, 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 vertebræ from the second cervical to the last lumbar; the lower one by the false vertebræ, 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 vertebræ, 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 vertebræ, 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 vertebræ 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 vertebræ, 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 laminæ in the cervical and lumbar regions, where it is shallow, and by the laminæ 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 vertebræ, 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.

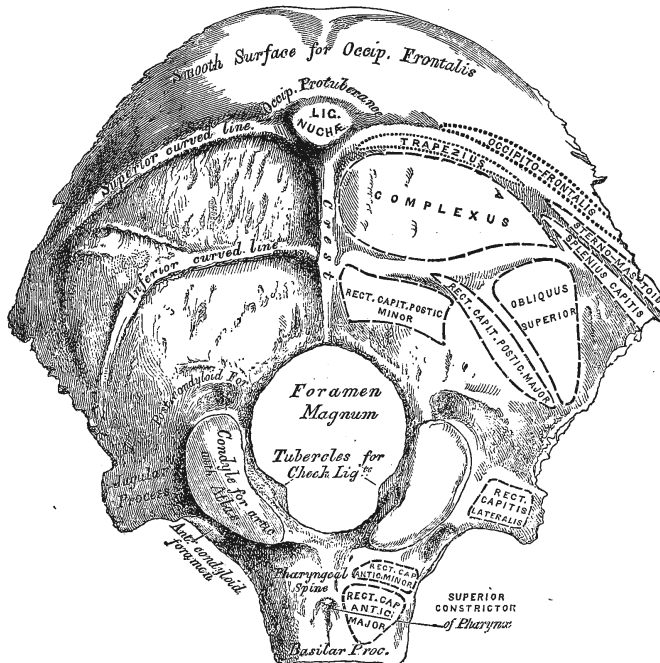
THE Skull is divided into two parts, the Cranium and the Face. The Cranium is composed of *eight* bones; viz., the *occipital*, *two parietal*, *frontal*, *two temporal*, *sphenoid*, and *ethmoid*. The Face is composed of *fourteen* bones; viz., the *two nasal*, *two superior maxillary*, *two lacrymal*,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

<i>Skull, 22 bones.</i>	{	<i>Cranium, 8 bones.</i>	{	Occipital.
				Two Parietal.
				Frontal.
				Two Temporal.
				Sphenoid.
				Ethmoid.
	{	<i>Face, 14 bones.</i>	{	Two Nasal.
				Two Superior Maxillary.
				Two Lachrymal.
				Two Malar.
				Two Palate.
				Two Inferior Turbinated.
				Vomer.
				Inferior Maxillary.

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.



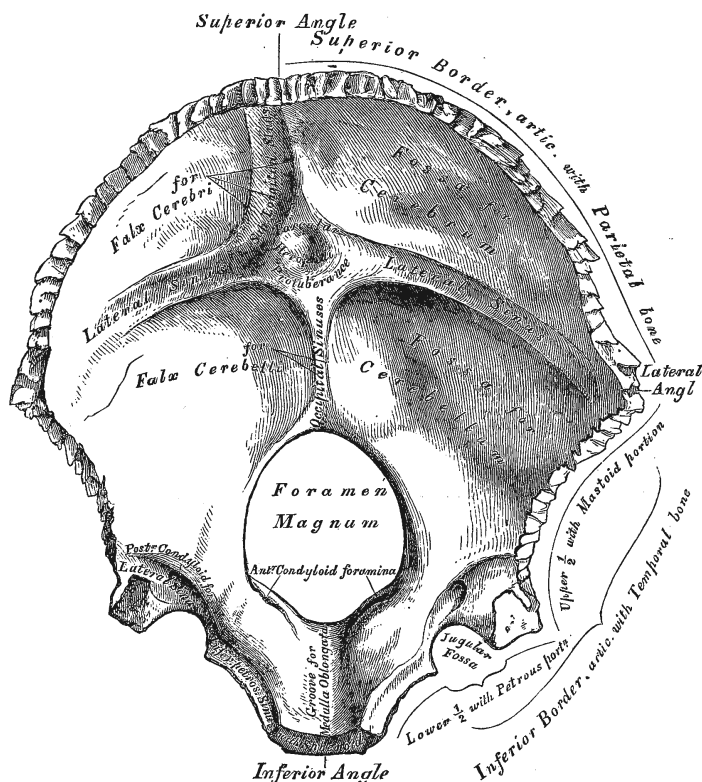
External Surface. Midway between the summit of the bone and the posterior margin of the foramen magnum is a prominent tubercle, the external occipital protuberance, for the attachment of the ligamentum nuchæ; and descending from it, as far as the foramen, a vertical ridge, the external occipital crest. 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-cleido mastoideus; 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 antici, major and minor.

The *Internal or Cerebral Surface* (fig. 19) is deeply concave. The occipital part is divided by a crucial ridge into four fossæ. 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:

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 condyloid foramina; the internal openings of the posterior condyloid 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

19.—Occipital Bone. Inner Surface.



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 fœtus 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*

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 posterius. This notch is often subdivided into two parts by a small process of bone.

Structure. The occipital bone consists of two compact laminæ, 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 fossæ it is thin, semi-transparent, and destitute of diploe.

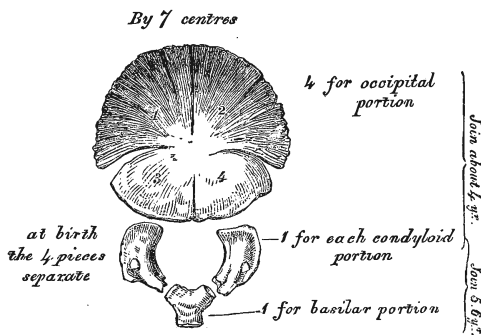
Development (fig 20). The occipital bone has *seven* centres of development; four for the posterior or occipital part, one for the basilar portion; and one for each condyloid portion.

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 condyloid 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 condyloid 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 Occipito-frontalis, 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.

20.—Development of Occipital Bone.



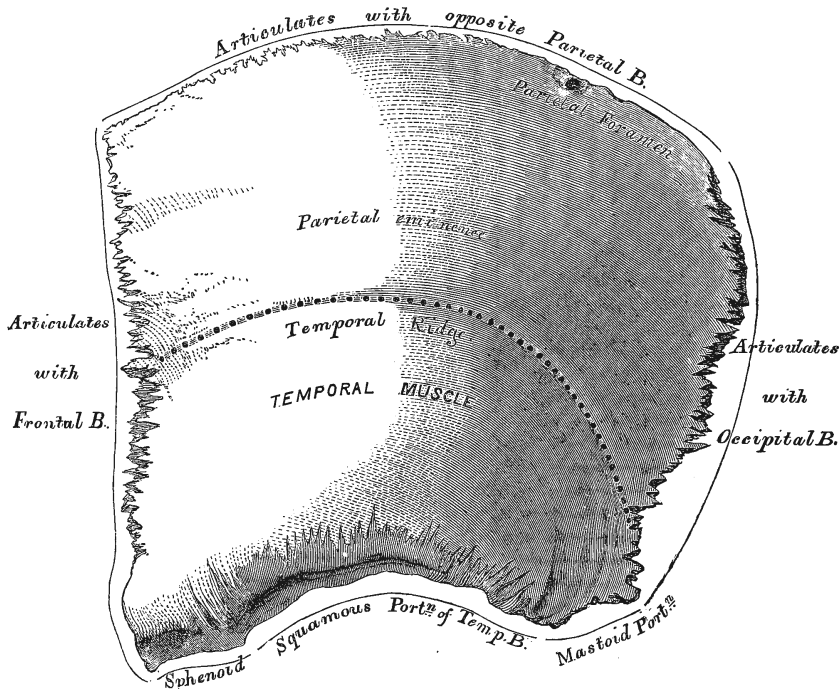
THE PARIETAL BONES.

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

21.—Left Parietal Bone. External Surface.



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.

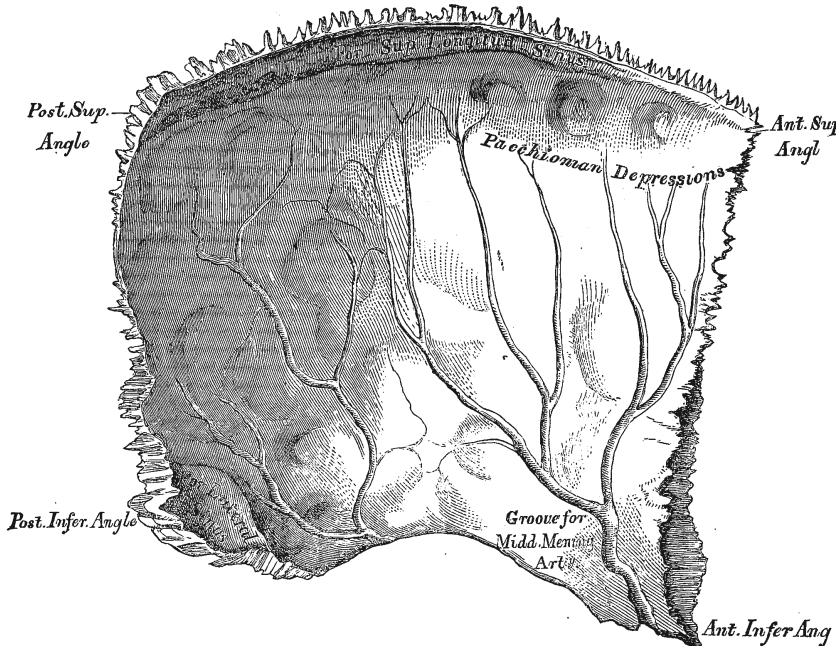
The *Internal Surface* (fig. 22), concave, presents numerous eminences and depressions for lodging the convolutions of the brain, and minute furrows for the ramifications of the meningeal arteries: these run upwards and backwards from deep grooves, which commence in the anterior inferior angle, and at 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 foetus 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

22.—Left Parietal Bone. Internal Surface.



artery. The *posterior superior angle* corresponds with the junction of the sagittal and lambdoid sutures. In the foetus 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 foetal life.

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

Attachment of Muscles. To one only, the Temporal.

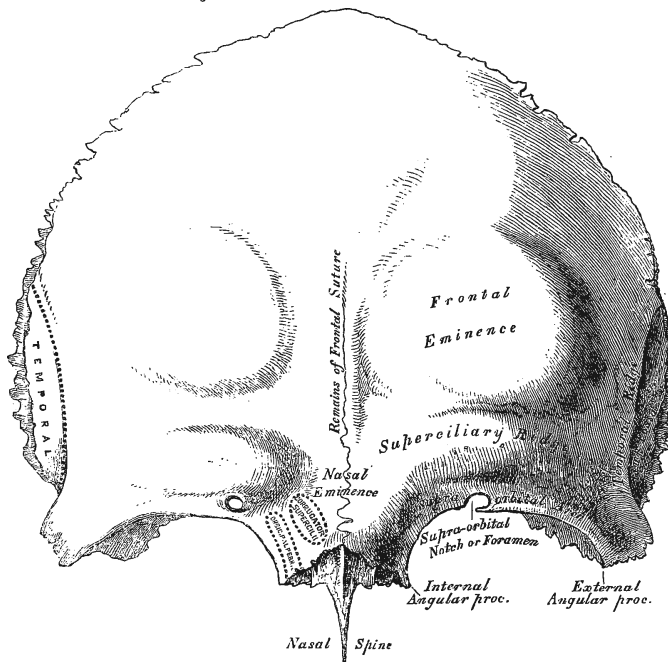
THE FRONTAL BONE.

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

23.—Frontal Bone. Outer Surface.



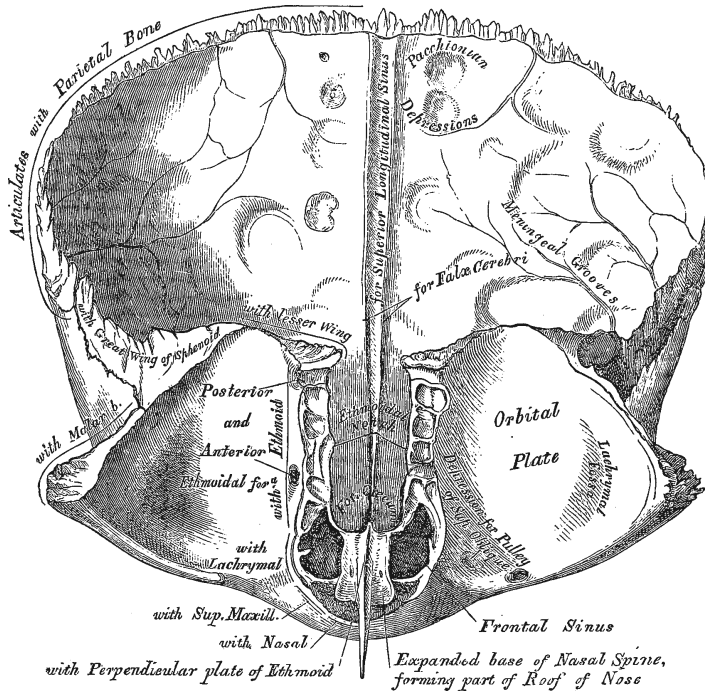
called the *supra-orbital notch* or *foramen*. It transmits the supra-orbital artery, veins, and nerve. The supra-orbital arch terminates externally in the external angular process, and internally in the internal angular process. The external angular is a strong prominent process, which articulates with 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 *nasal notch*, which articulates in the middle line with the nasal, and on either side with the nasal process of the superior maxillary bones.

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 cæcum*, which is generally completed be-

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 fossæ 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

24.—Frontal Bone. Inner Surface.



is quadrilateral; and filled up, when the bones are united, by the cribriform 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,

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.

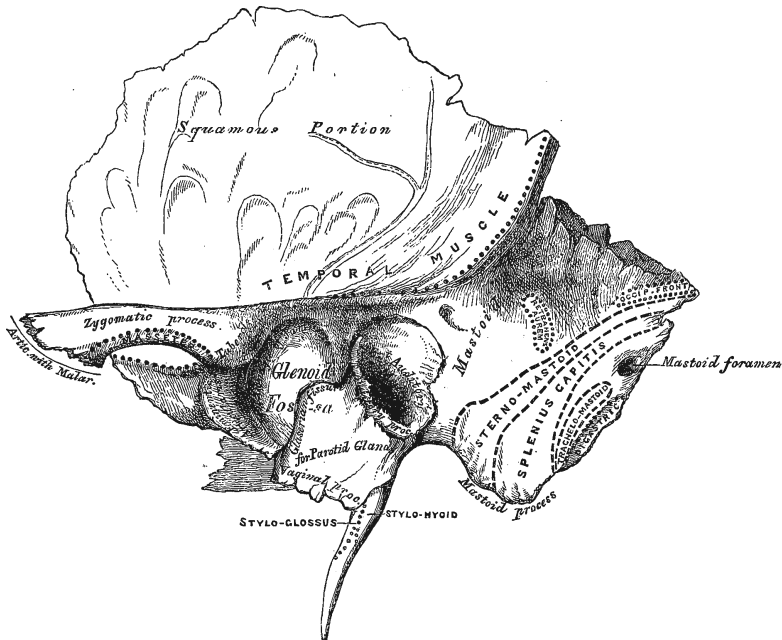
THE TEMPORAL BONES.

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 *eminencia 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

25.—Left Temporal Bone. Outer Surface.



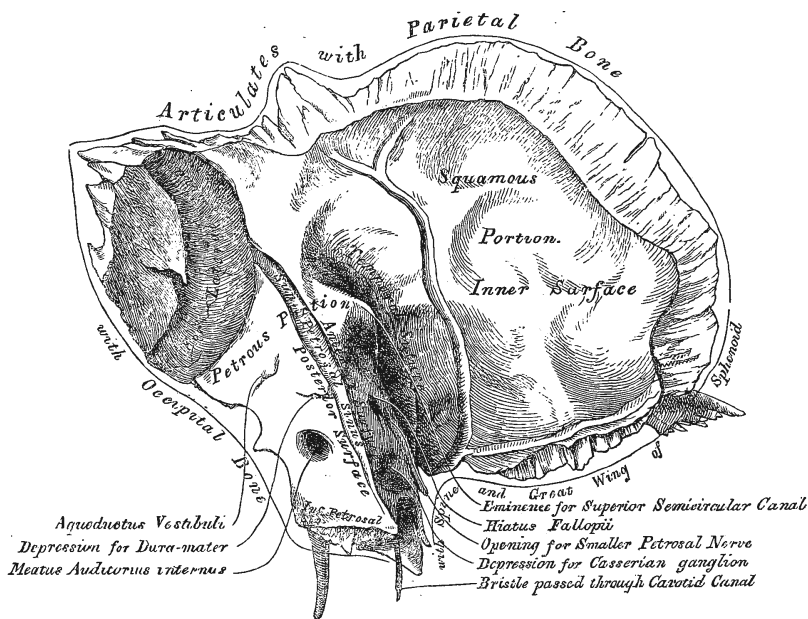
lodges the processus gracilis of the malleus, and transmits the laxator tympani muscle and the anterior tympanic artery. The chorda tympani nerve passes through a separate canal parallel to the Glaserian fissure, on the outer side of the Eustachian tube, in the retiring angle between the squamous and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

26.—Left Temporal Bone. Inner Surface.



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

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.

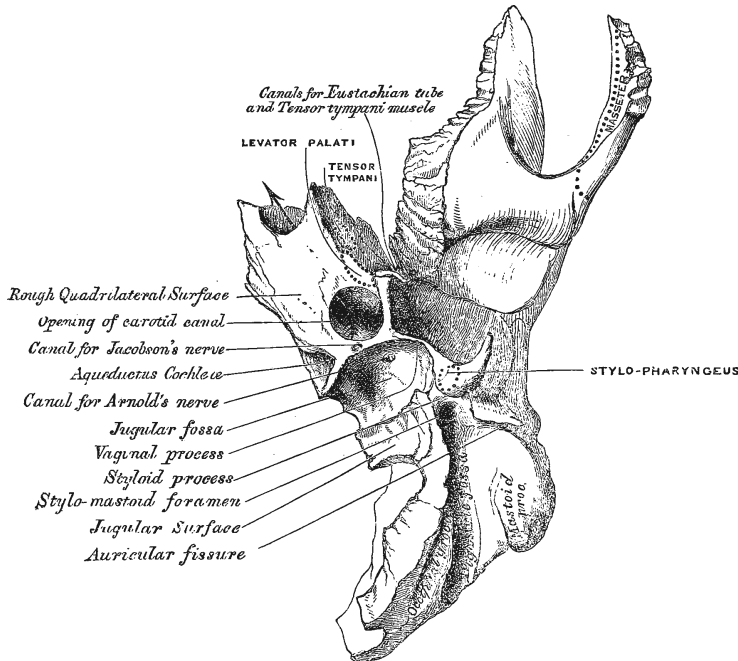
The *posterior surface* forms the front boundary of the posterior fossa of the skull, and is continuous with the inner surface of the mastoid portion of the bone. It presents three points for examination. 1. About its centre is a large orifice, the meatus auditorius internus. This aperture varies considerably 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 aquæductus 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 palati, 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 aquæductus 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 posterius. 5. A small foramen for the passage of Jacobson's nerve (the tympanic branch of the glosso-pharyngeal). 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 laminæ, 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 laminæ of which it is received, and directed downwards, forwards, and inwards. It affords attachment to three muscles, the Stylo-pharyngeus, Stylo-glossus, and Stylo-hyoideus, 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 aquæductus 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

27.—Petrus Portion. Inferior Surface.



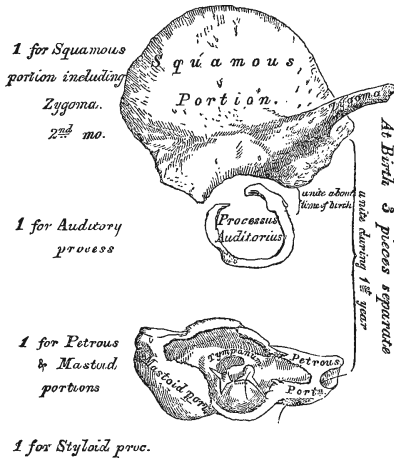
for the jugular fossa, which, with a similar notch on the occipital, forms the foramen lacerum posterius. A projecting eminence of bone occasionally stands out from the centre of the notch, and divides the foramen into two parts. The *anterior* border is divided into two parts, an outer, joined to the 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 vertebræ; 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

28.—Development of Temporal Bone.
By four Centres.



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 at 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 auditorius, the glenoid 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, Sterno-mastoid, Splenius capitis, Trachelo-mastoid, Digastricus and Retrahens aurem; to the styloid process, the Stylo-pharyngeus, Stylo-hyoideus and Stylo-glossus; and to the petrous portion, the Levator palati, Tensor tympani, and Stapedius.

THE SPHENOID BONE.

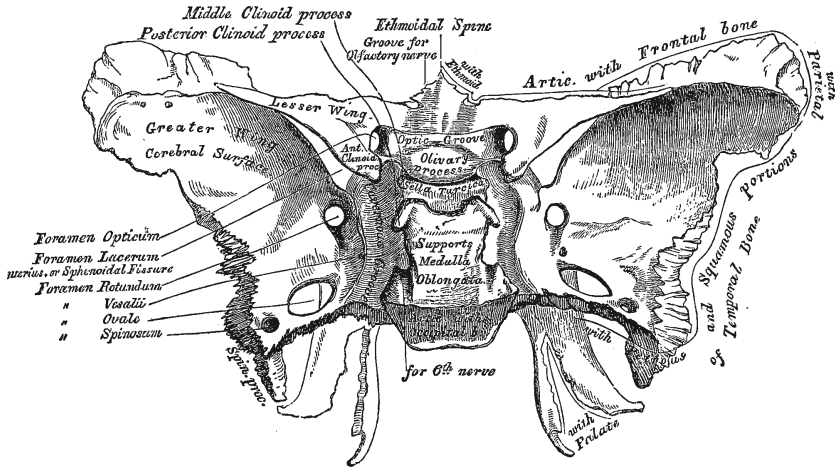
The Sphenoid ($\sigma\phi\eta\nu$, a 'wedge'; $\epsilon\acute{\iota}\delta\delta\varsigma$, 'like') is situated at the anterior part of the base of the skull, articulating with all the other cranial bones, which it binds firmly and solidly together. In its form it somewhat resembles a bat, with its wings 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

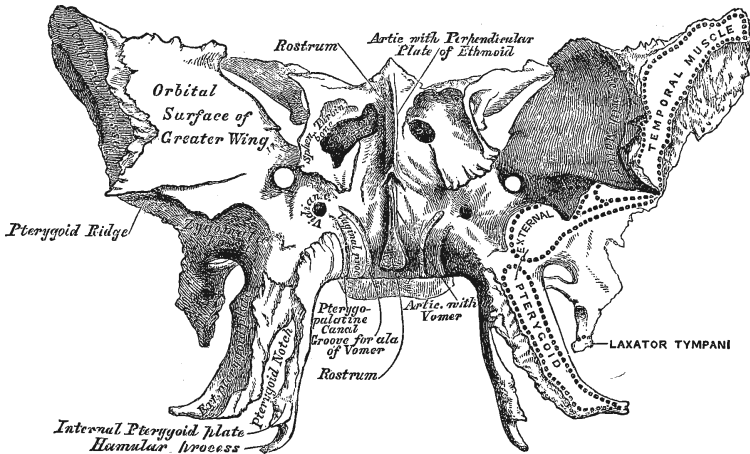
posterior clinoid processes, the size and form of which vary considerably in different individuals. The sides of this plate of bone are notched below, for the passage of the sixth pair of nerves; and behind, it presents a shallow depression, which slopes

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 *f*; 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 turbinated 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 ala 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.

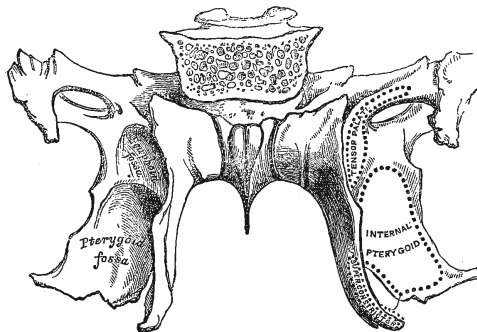
The *Greater Wings* are two strong processes of bone, which arise at the sides of the body, and are curved in a direction upwards, outwards, and backwards; being prolonged behind into a sharp-pointed extremity, called the *spinous process of the sphenoid*. Each wing presents three surfaces and a circumference. 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 Vesalii, 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 orbital 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 Ingrassias) 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

31.—Sphenoid Bone. Posterior Surface.



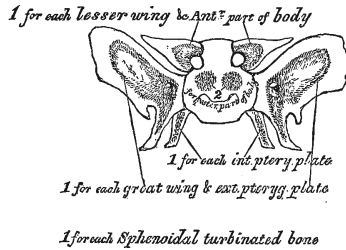
the pterygoid fossa, and gives attachment to the Internal pterygoid. The *internal pterygoid plate* is much narrower and longer, curving outwards at its extremity, into a hook-like process of bone, the hamular process, around which turns the tendon of the Tensor-palati muscle. At the base of this plate 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.

32.—Development of Sphenoid.
By Ten Centres.

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 turbinated 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 foetal 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 foetal 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 middle of foetal 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 foetal 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-tympani, Levator-palpebræ, 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.

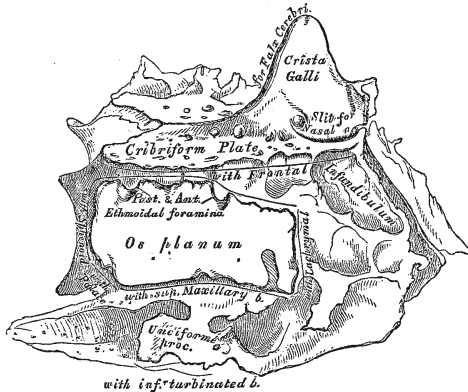
THE SPHENOIDAL SPONGY BONES.

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* (*ἠθμός*, 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.

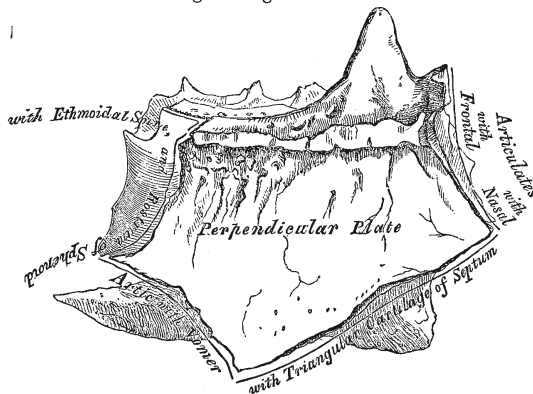
33.—Ethmoid Bone. Outer Surface (enlarged).



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 *crista 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 *alæ*, which are received into corresponding depressions in the frontal, completing the *foramen cæcum* behind. Its sides are smooth, and sometimes bulging, when it is found to enclose a small sinus. On each side of the *crista 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 *crista 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-

34.—Perpendicular Plate of Ethmoid (enlarged). Shewn by removing the Right Lateral Mass.



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 turbinated 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 turbinated 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 turbinated 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 *unciform 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 turbinated 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 foetal 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 cribriform 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 triquetra*, 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.

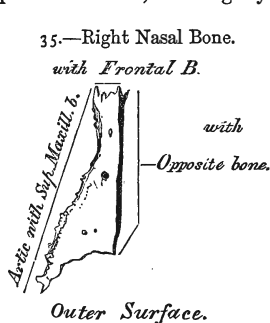
BONES OF THE FACE.

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

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

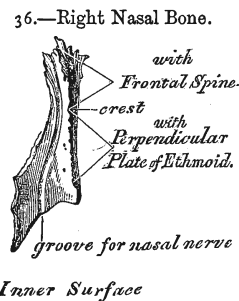
NASAL BONES.

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 trans-

mission of a small vein. Sometimes this foramen is absent on one or both sides, and occasionally the foramen cœcum 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 vertebræ.

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 fossæ, the zygomatic and speno-maxillary, and two fissures, the speno-maxillary, 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.

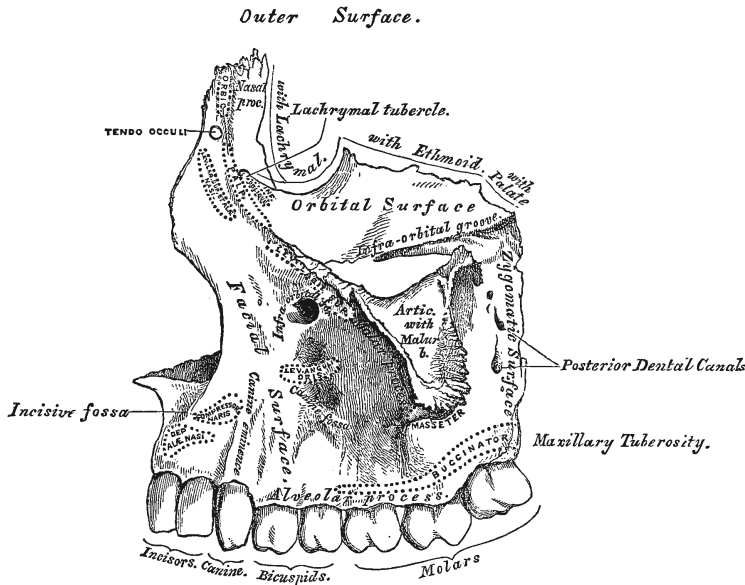
The *external or facial surface* (fig. 37) is directed forwards and outwards. In the median line of the bone, just above the incisor teeth, is a depression, the incisive or myrtiform fossa, which gives origin to the Depressor labii superioris alæque nasi. Above and a little external to it, the Compressor 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.

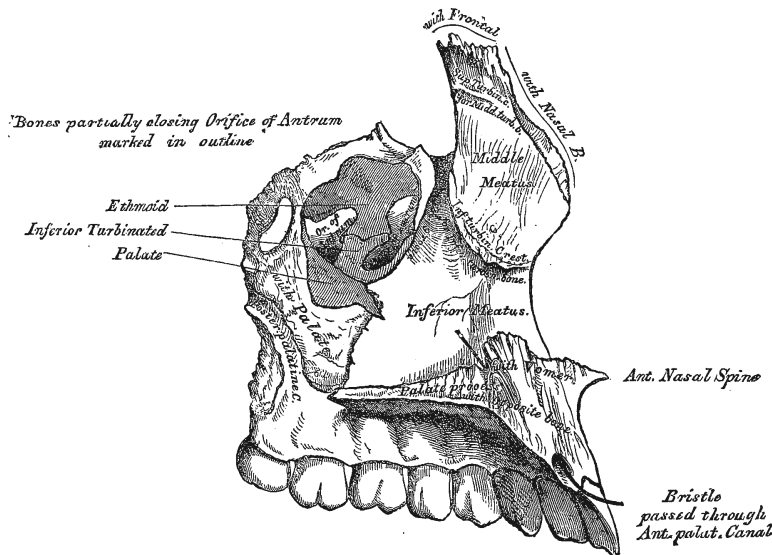


the malar process, and in front by part of the circumference of the orbit continuous, on the inner side, with the nasal, on the outer side, with the malar process. Along the middle line of this surface is a deep groove, the infra-orbital, for the passage of the infra-orbital nerve and artery. This groove 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 palatine 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-

mening 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 fossæ. The margins of this aperture are thin and ragged, and the aperture itself is much contracted 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 laminae 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

antrum, encroach upon the adjacent parts, pushing up the floor of the orbit and displacing the eyeball, projecting inward into the nose, protruding forwards on to the cheek, and making their way backwards into the zygomatic fossa, and downwards into the mouth.

The *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 *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 alæque 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 performance 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.

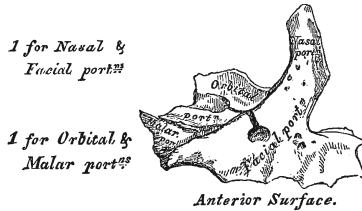
The *Alveolar Process* is the thickest part of the bone, broader behind than in front, and excavated into deep cavities for the reception of the teeth. These cavities are eight in number, and vary in size and depth according to the teeth they contain: those for the canine teeth being the deepest; those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

The *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 alveolar 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 lodgment of the palatine 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.

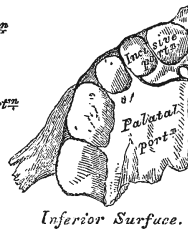
Development (fig. 39). This bone is formed at such an early period, and ossification proceeds in it with such rapidity, that it has been found impracticable

39.—Development of Superior Maxillary Bone.
By Four Centres.



1 for Incisive port^{ns}

1 for Palatal port^{ns}



at
Birth

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 foetal life.

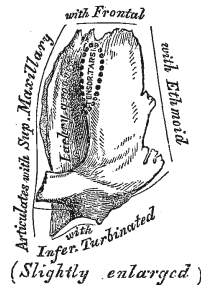
Articulations. With *nine* bones; two of the cranium—the frontal and ethmoid, and with seven of the face, viz., the nasal, malar, lachrymal, inferior turbinated, palate, vomer, and its fellow of the opposite side. Sometimes it articulates with the orbital plate of the sphenoid.

Attachment of Muscles. Orbicularis palpebrarum, Obliquus inferior oculi, Levator labii superioris alæque nasi, Levator labii superioris proprius, Levator angulioris, Compressor naris, Depressor alæ 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

40.—Left Lachrymal Bone.
External Surface.



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 turbinated bone, assisting in the formation of the lachrymal canal.

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

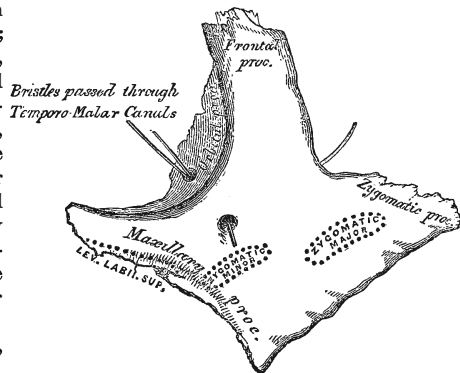
Articulations. With four bones; two of the cranium, the frontal and ethmoid, and two of the face, the superior maxillary and the inferior turbinated.

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 fossæ. 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.

41.—Left Malar Bone. Outer Surface.

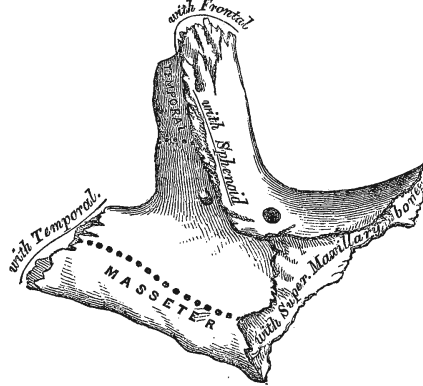


The internal surface (fig. 42), directed backwards and inwards, is concave, presenting internally a rough triangular surface, for articulation with the superior maxillary bone; and externally, a smooth concave surface, which forms the anterior boundary of the temporal fossa above, wider below, where 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*

42.—Left Malar Bone. Inner Surface.



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 *f*, 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 vertebræ 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 uvulæ. 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;

43.—Left Palate Bone. Internal View (enlarged).

