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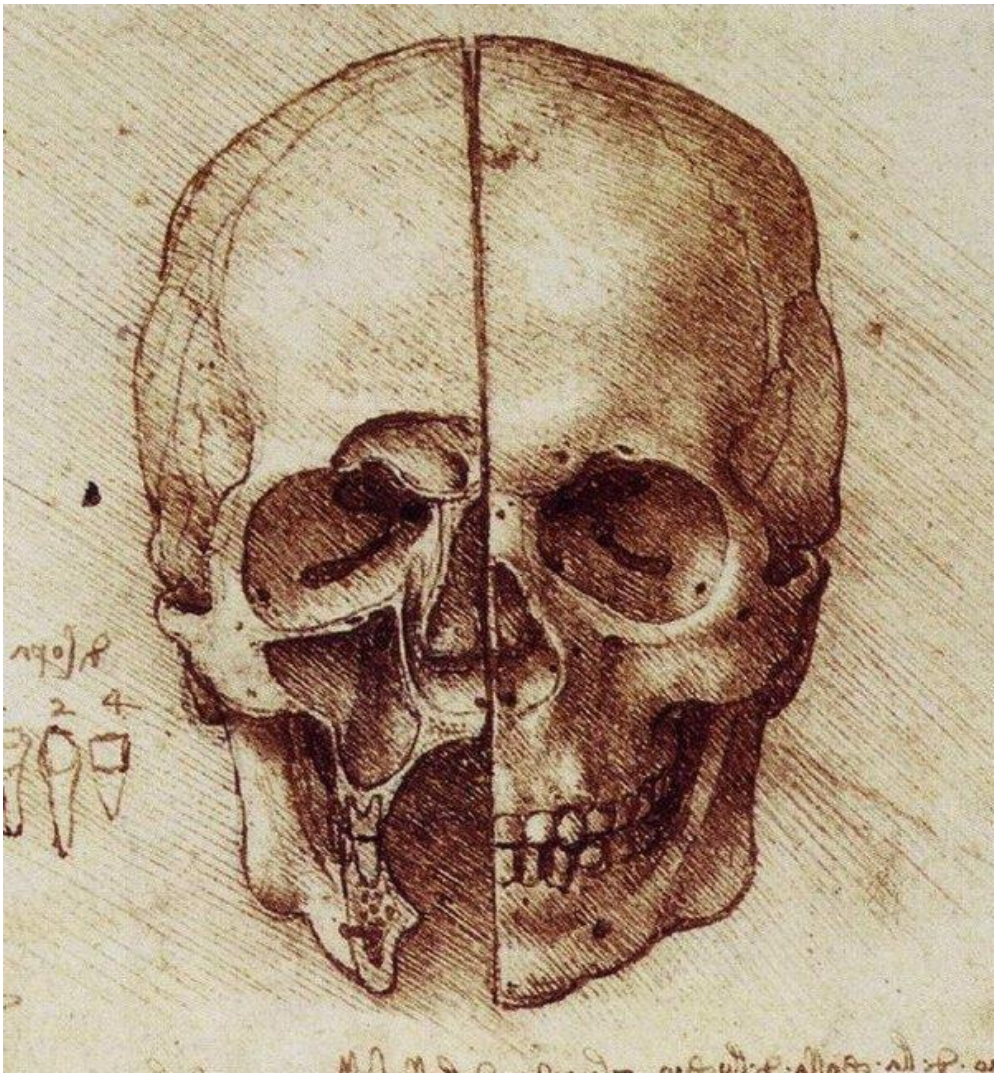

Study guide

Poltava 2020

MINISTRY OF PUBLIC HEALTH OF UKRAINE
UKRANIAN MEDICAL STOMATOLOGICAL ACADEMY

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This guide is intended for undergraduate, postgraduate students and continuing education of health care professionals in a variety of clinical disciplines (medicine, pediatrics, dentistry) as it includes the basic concepts of human anatomy of the skull in adults and newborns.

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PREFACE

Modern craniology successfully solves the fundamental problem of medicine, namely, the study of regularitis of structure of a human skull and clarifying the morphological and functional features of various forms. Due to the complexity of its structure, the skull is the placesora large number of anatomic variations, anomalies and dysplasias.

Facial bones are an important architectural part of the face, ensuring the perfection of its design fundamentals and uniqua individuality. Besides, they provide mechanical strength of the skull. By participating in the formation of cavities (orbit, nasal and oral), they are used for protection and normal functioning of the primary divisions of digestive, respiratory systems and sensory organs (sight, smell, taste). Fissures, foramens and channels which the cranial cavities have, allow the passage of the neurovascular bundles for the innervation of these organs. The structure of the maxilla and mandible and palatine bones represents the most pronounced signs of the evolution of the skull, characteristic of the skull of Homo sapiens and associated with the development of articulate speech, the development of the brain, the consumption of processed food.

The study of the skull bones, their connections and relationships with blood vessels and nerves is necessary to understand the features of rendering proper medical care in case of disruption of their normal functioning.

Skull lodges the brain, teeth and special senses like cochlear and vestibular apparatus, retina, olfactory mucous membrane, and taste buds. The weight of the brain is not felt as it is floating in the cerebrospinal fluid. Our personality, power of speech, attention, concentration, judgement, and intellect are because of the brain that we possess and its proper use, for our own good and for the good of the society as well.

The skeleton of the head is called the **skull**. It consists of several bones that are joined together to form the ***cranium***. The term skull also includes the

mandible or lower jaw, which is a separate bone. However, the two terms skull and cranium, are often used synonymously. The skullcap is formed by frontal, parietal, squamous temporal and a part of occipital bones, develop by intramembranous ossification, being a quicker one-stage process. The base of the skull in contrast ossifies by intracartilaginous ossification, which is a two-stage process (membrane-cartilage-bone).

The skull can be divided into two main parts:

1. The **neurocranium**, consists of the frontal, parietal, occipital, temporal, sphenoid and ethmoid bones. The ***calvaria* or *skullcap*** *(brain box)* is the upper convex part of the cranium, which encloses the brain.
2. The **facial skeleton, viscerocranium,** constitutes the rest of the skull and includes the mandible.

Bones of the neurocranium

The occipital bone.

The **occipital bone (os occipitale),** situated at the back and lower part of the cranium, is trapezoid in shape and curved on itself. It is pierced by a large oval aperture, the **foramen magnum,** through which the cranial cavity communicates with the vertebral canal.

The curved, expanded plate behind the foramen magnum is named the **squama;** the thick, somewhat quadrilateral piece in front of the foramen is called the **basilar part,** whilst on either side of the foramen is the **lateral portion.**

The Squama (squama occipitalis). The squama, situated above and behind the foramen magnum, is curved from above downward and from side to side.

Surfaces. The **external surface** is convex and presents midway between the summit of the bone and the foramen magnum; a prominence, the **external occipital protuberance.** Extending lateralward from this on either side are two

curved lines, one a little above the other. The upper, often faintly marked, is named the **highest nuchal line,** and to it, the galea aponeurotica is attached. The lower is termed the **superior nuchal line.** That part of the squama, which lies above the highest nuchal lines, is named the **planum occipitale,** and is covered by the occipital muscle; that below, termed the **planum nuchale** is rough and irregular for the attachment of several muscles. From the external occipital protuberance a ridge or crest, the **external occipital crest,** often faintly marked, descends to the foramen magnum, and affords attachment to the ligamentum nuchae; running from the middle of this line across either half of the nuchal plane is the **inferior nuchal line.**

Several muscles are attached to the outer surface of the squama, thus: the superior nuchal line gives origin to the Occipitalis and Trapezius, and insertion to the Sternocleidomastoideus and Splenius capitis: into the surface between the superior and inferior nuchal lines the Semispinalis capitis and the Obliquus capitis superior are inserted, while the inferior nuchal line and the area below it receive the insertions of the Recti capitis posteriores major and minor. The posterior atlantoccipital membrane is attached around the postero-lateral part of the foramen magnum, just outside the margin of the foramen.

The **internal surface** is deeply concave and divided into four fossae by a **cruciate eminence.** The upper two fossae are triangular and lodge the occipital lobes of the cerebrum; the lower two are quadrilateral and accommodate the hemispheres of the cerebellum. At the point of intersection of the four divisions of the cruciate eminence is the **internal occipital protuberance.** From this protuberance, the upper division of the cruciate eminence runs to the superior angle of the bone, and on one side of it (generally the right) is a deep groove, the **sagittal sulcus,** which lodges the hinder part of the superior sagittal sinus; to the margins of this sulcus, the falx cerebri is attached. The lower division of the cruciate eminence is prominent, and is named the internal occipital crest; it bifurcates near the foramen magnum and gives the falx cerebelli;

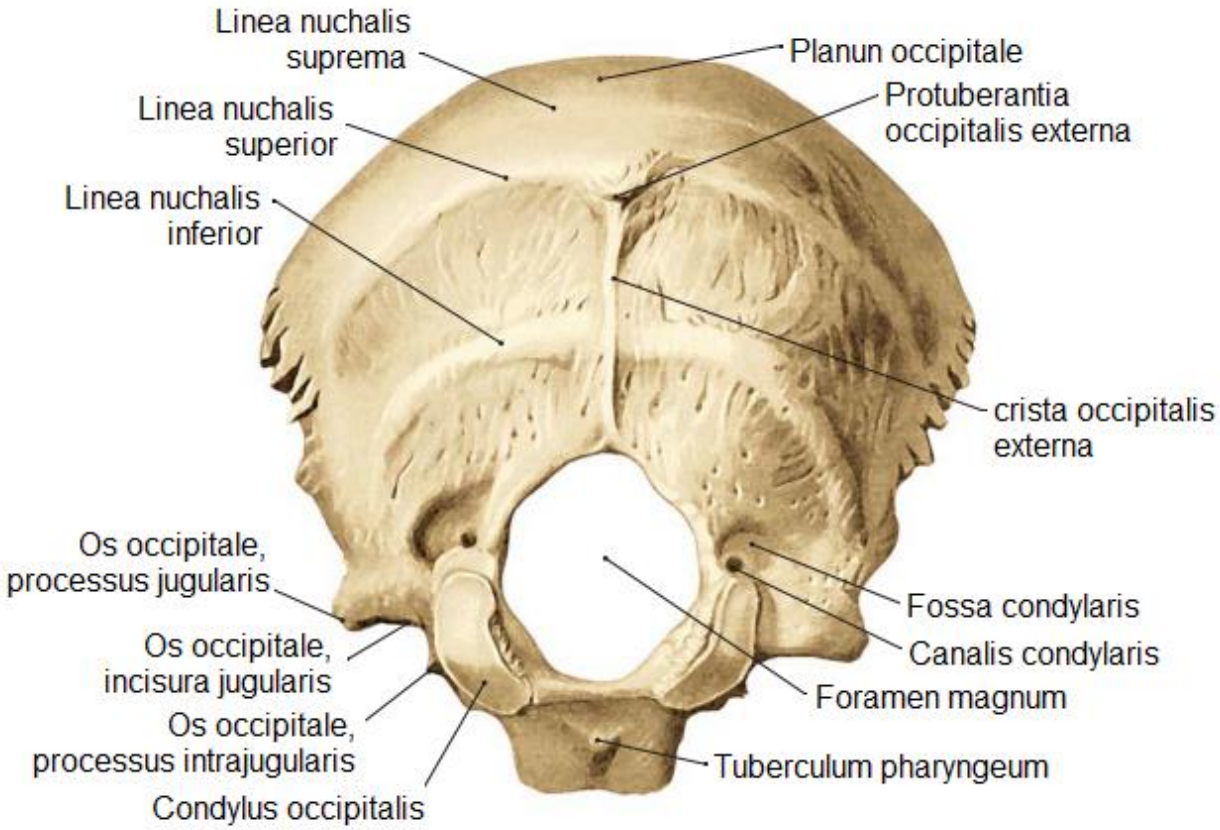


Fig. 1. **The occipital bone, posterior and inferior aspects**.

in the attached margin of this falx is the occipital sinus, which is sometimes duplicated. In the upper part of the internal occipital crest, a small depression is sometimes distinguishable; it is termed the **vermian fossa** since it is occupied by part of the vermis of the cerebellum. Transverse grooves, one on either side, extend from the internal occipital protuberance to the lateral angles of the bone; those grooves accommodate the transverse sinuses, and their prominent margins give attachment to the tentorium cerebelli. The groove on the right side is usually larger than that on the left, and is continuous with that for the superior sagittal sinus. Exceptions to this condition are, however, not infrequent; the left may be larger than the right or the two may be almost equal in size. The angle of union of the superior sagittal and transverse sinuses is named the **confluence of the sinuses**, and its position is indicated by a depression situated on one or other side of the protuberance.

Lateral Parts (pars lateralis). The lateral parts are situated at the sides of the foramen magnum; on their under surfaces are the **condyles** for articulation with the superior facets of the atlas. The condyles are oval, and their anterior extremities, directed forward and medialward, are closer together than their posterior, and encroach on the basilar portion of the bone; the posterior extremities extend back to the level of the middle of the foramen magnum. The articular surfaces of the condyles are convex from before backward and from side to side, and look downward and lateralward. To their margins are attached the capsules of the atlantooccipital articulations, and on the medial side of each is a rough impression or tubercle for the alar ligament.

At the base of either condyle, the bone is tunnelled by a short canal, the **hypoglossal canal** (*anterior condyloid foramen*). This begins on the cranial surface of the bone immediately above the foramen magnum, and is directed lateralward and forward above the condyle. It may be partially or completely divided into two by a spicule of bone; it gives exit to the hypoglossal or twelfth cranial nerve, and entrance to a meningeal branch of the ascending pharyngeal artery. Behind either condyle is a depression, the **condyloid fossa,** which receives the posterior margin of the superior facet of the atlas when the head is bent backward; the floor of this fossa is sometimes perforated by the **condyloid canal,** through which an emissary vein passes from the transverse sinus.

Extending lateralward from the posterior half of the condyle is a quadrilateral plate of bone, the **jugular process,** excavated in front by the **jugular notch,** which, in the articulated skull, forms the posterior part of the jugular foramen. The jugular notch may be divided into two by a bony spicule, the **intrajugular process,** which projects lateralward above the hypoglossal canal. The under surface of the jugular process is rough, and gives attachment to the Rectus capitis lateralis muscle and the lateral atlantooccipital ligament; from this surface an eminence, the paramastoid process, sometimes projects downward, and may be of sufficient length to reach and articulate with the

transverse process of the atlas. Laterally the jugular process presents a rough quadrilateral or triangular area, which is joined to the jugular surface of the temporal bone by a plate of cartilage; after the age of twenty-five, this plate tends to ossify.

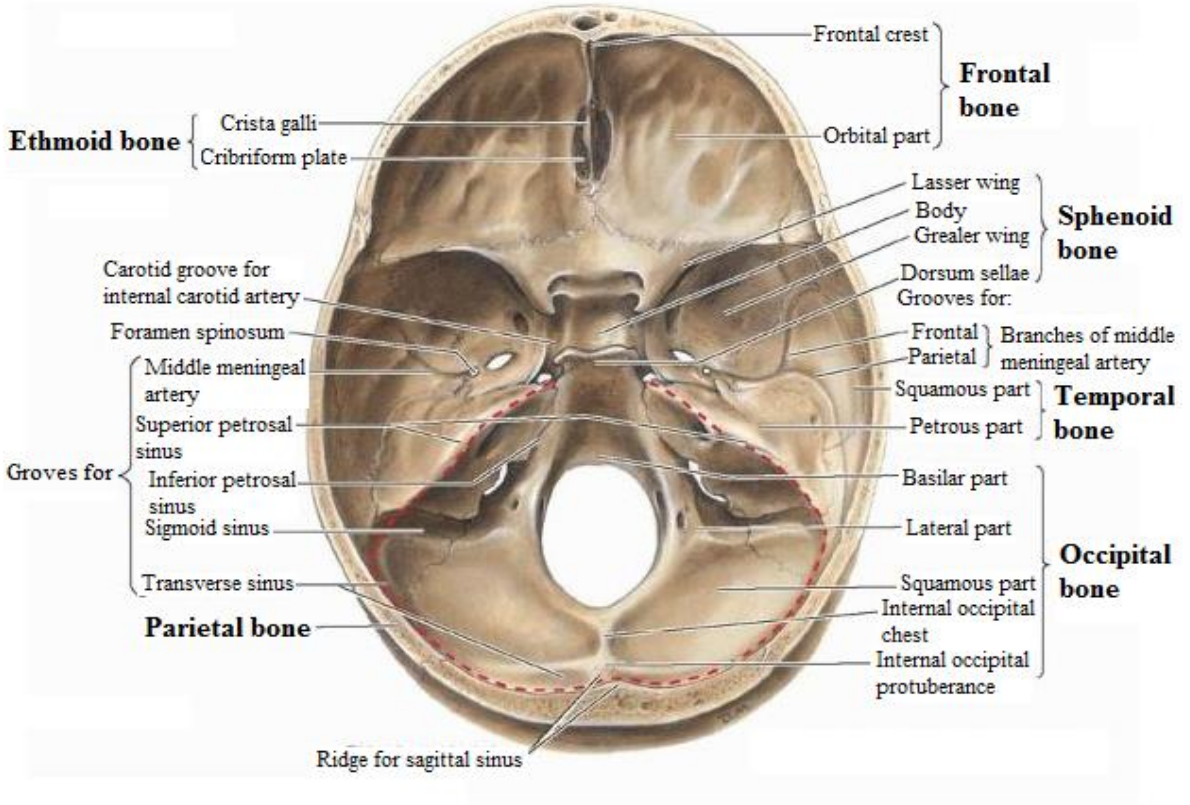


Fig 2. The occipital bone, anterior and superior aspects.

The **upper surface** of the lateral part presents an oval eminence, the **jugular tubercle,** which overlies the hypoglossal canal and is sometimes crossed by an oblique groove for the glossopharyngeal, vagus, and accessory nerves. On the upper surface of the jugular process is a deep groove, which curves medialward and forward and is continuous with the jugular notch. This groove lodges the terminal part of the transverse sinus, and opening into it, close to its medial margin, is the orifice of the condyloid canal.

Basilar Part (pars basilaris). The basilar part extends forward and upward from the foramen magnum, and presents *in front* an area more or less quadrilateral in outline. In the young skull, this area is rough and uneven, and is joined to the body of the sphenoid by a plate of cartilage. By the twenty-fifth

year, this cartilaginous plate is ossified, and the occipital and sphenoid form a continuous bone.

The parietal bone

The **parietal bones** (*os parietale*) form, by their union, the sides and roof of the cranium. Each bone is irregularly quadrilateral in form, and has two surfaces, four borders, and four angles.

Surfaces. The **external surface** is convex, smooth, and marked near the center by an eminence, the **parietal eminence** (*tuber parietale*), which indicates the point where ossification commenced. Crossing the middle of the bone in an arched direction are two curved lines, the **superior** and **inferior temporal lines;** the former gives attachment to the temporal fascia, and the latter indicates the upper limit of the muscular origin of the Temporalis. Above these lines the bone is covered by the galea aponeurotica; below them it forms part of the temporal fossa, and affords attachment to the Temporalis muscle. At the back part and close to the upper or sagittal border is the **parietal foramen,** which transmits a vein to the superior sagittal sinus, and sometimes a small branch of the occipital artery; it is not constantly present, and its size varies considerably.

The **internal surface** is concave; it presents depressions corresponding to the cerebral convolutions, and numerous furrows for the ramifications of the middle meningeal vessel; the latter run upward and backward from the sphenoidal angle, and from the central and posterior part of the squamous border. Along the upper margin is a shallow groove, which, together with that on the opposite parietal, forms a channel, the sagittal sulcus, for the superior sagittal sinus; the edges of the sulcus afford attachment to the falx cerebri. Near the groove are several depressions, best marked in the skulls of old persons, for the arachnoid granulations (Pacchionian bodies). In the groove is the internal opening of the parietal foramen when that aperture exists.

Borders. The **sagittal border,** the longest and thickest, is dentated and articulates with its fellow of the opposite side, forming the sagittal suture. The

squamous border 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 squama of the temporal; the posterior part is thick and serrated for articulation with the mastoid portion of the temporal. The **frontal border** is deeply serrated, and bevelled at the expense of the outer surface above and of the inner below; it articulates with the frontal bone, forming onehalf of the **coronal suture.** The **occipital border,** deeply denticulated, articulates with the occipital, forming one-half of the **lambdoidal suture.**

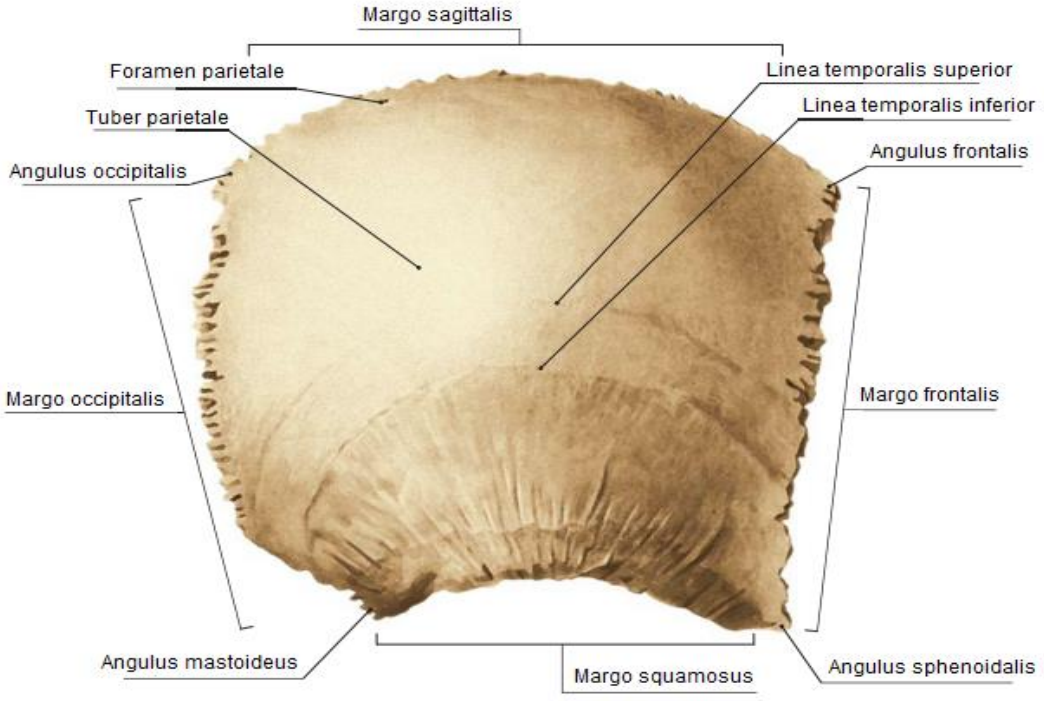


Fig. 3. The right parietal bone, external surface.

Angles. The **frontal angle** is practically a right angle, and corresponds with the point of meeting of the sagittal and coronal sutures; this point is named the **bregma;** in the fetal skull and for about a year and a half after birth this region is membranous, and is called the **anterior fontanelle.** The **sphenoidal angle,** thin and acute, is received into the interval between the frontal bone and the great wing of the sphenoid. Its inner surface is marked by a deep groove,

sometimes a canal, for the anterior divisions of the middle meningeal artery. The **occipital angle** is rounded and corresponds with the point of meeting of the sagittal and lambdoidal sutures — a point which is termed the **lambda;** in the fetus this part of the skull is membranous, and is called the **posterior fontanelle.** The **mastoid angle** is truncated; it articulates with the occipital bone and with the mastoid portion of the temporal, and presents on its inner surface a broad, shallow groove which lodges part of the transverse sinus. The point of meeting of this angle with the occipital and the mastoid part of the temporal is named the **asterion.**

The frontal bone

The frontal bone (*os frontale***)** resembles a cockle-shell in form, and consists of two portions — a **vertical** portion, the **squama,** corresponding with the region of the forehead; and an **orbital** or **horizontal** portion, which enters into the formation of the roofs of the orbital and nasal cavities.

Squama (squama frontalis). Surfaces. The **external surface** of this portion is convex and usually exhibits, in the lower part of the middle line, the remains of the **frontal** or **metopic suture;** in infancy, this suture divides the bone into two, a condition, which may persist throughout life. On either side of this suture, about three cm. above the supraorbital margin is a rounded elevation, the **frontal eminence** (*tuber frontale*). These eminences vary in size in different individuals, are occasionally unsymmetrical, and are especially prominent in young skulls; the surface of the bone above them is smooth, and covered by the galea aponeurotica. Below the frontal eminences, and separated from them by a shallow groove, are two arched elevations, the superciliary arches; these are prominent medially, and are joined to one another by a smooth elevation named the glabella. They are larger in the male than in the female, and their degree of prominence depends to some extent on the size of the frontal air sinuses; prominent ridges are, however, occasionally associated with small air sinuses. Beneath each superciliary arch is a curved and prominent margin, the

supraorbital margin, which forms the upper boundary of the base of the orbit, and separates the squama from the orbital portion of the bone.

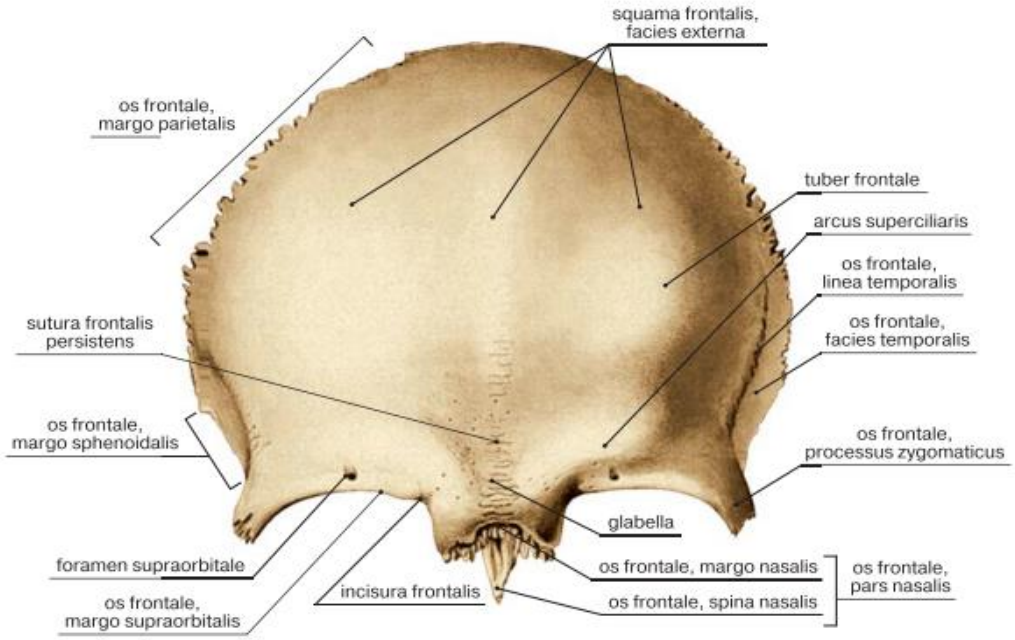


Fig. 4. The frontal bone, anterior aspect.

The lateral part of this margin is sharp and prominent, affording to the eye, in that situation, considerable protection from injury; the medial part is rounded. At the junction of its medial and intermediate thirds is a notch, sometimes converted into a foramen, the supraorbital notch or foramen, which transmits the supraorbital vessels and nerve. A small aperture in the upper part of the notch transmits a vein from the diploe to join the supraorbital vein. The supraorbital margin ends laterally in the zygomatic process, which is strong and prominent, and articulates with the zygomatic bone. Running upward and backward from this process is a well-marked line, the temporal line, which divides into the upper and lower temporal lines, continuous, in the articulated skull, with the corresponding lines on the parietal bone. The area below and behind the temporal line forms the anterior part of the temporal fossa, and gives origin to the Temporalis muscle. Between the supraorbital margins the squama projects downward to a level below that of the zygomatic processes; this portion is known as the nasal part and presents a rough, uneven interval, the nasal notch,

which articulates on either side of the middle line with the nasal bone, and laterally with the frontal process of the maxilla and with the lacrimal bone. The term nasion is applied to the middle of the frontonasal suture. From the center of the notch the nasal process projects downward and forward beneath the nasal bones and frontal processes of the maxillae, and supports the bridge of the nose. The nasal process ends below in a sharp spine, and on either side of this is a small grooved surface, which enters into the formation of the roof of the corresponding nasal cavity. The spine forms part of the septum of the nose, articulating in front with the crest of the nasal bones and behind with the perpendicular plate of the ethmoid bone.

The internal surface of the squama is concave and presents in the upper part of the middle line a vertical groove, the sagittal sulcus, the edges of which unite below to form a ridge, the frontal crest; the sulcus lodges the superior sagittal sinus, while its margins and the crest afford attachment to the falx cerebri. The crest ends below in a small notch, which is converted into a foramen, the foramen cecum, by articulation with the ethmoid bone. This foramen varies in size in different subjects, and is frequently impervious; when open, it transmits a vein from the nose to the superior sagittal sinus. On either side of the middle line the bone presents depressions for the convolutions of the brain, and numerous small furrows for the anterior branches of the middle meningeal vessels. Several small, irregular fossae may also be seen on either side of the sagittal sulcus, for the reception of the arachnoid granulations.

Orbital or Horizontal Part (pars orbitalis). This portion consists of two thin triangular plates, the orbital plates, which form the vaults of the orbits, and are separated from one another by a median gap, the ethmoidal notch.

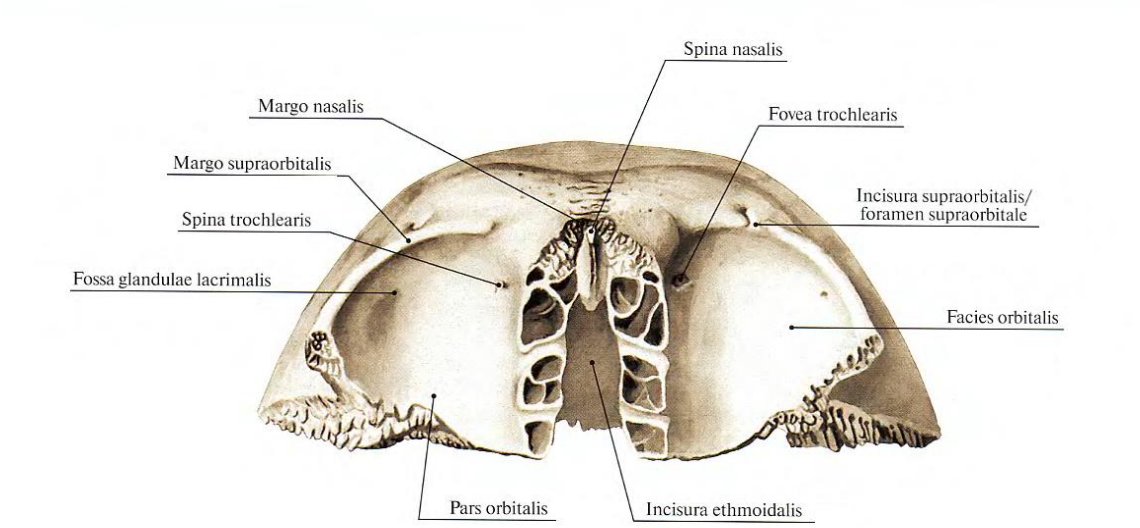


Fig. 5. The frontal bone, inferior aspect.

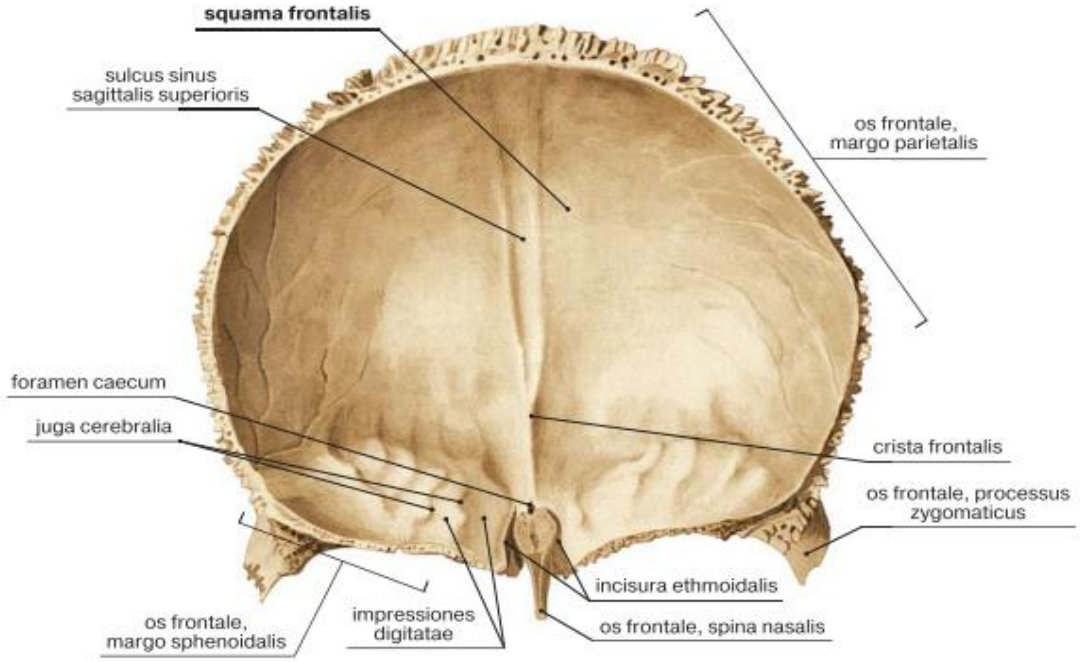


Fig. 6. The frontal bone, posterior aspect.

Surfaces. The inferior surface of each orbital plate is smooth and concave, and presents, laterally, under cover of the zygomatic process, a shallow depression, the lacrimal fossa, for the lacrimal gland; near the nasal part is a depression, the fovea trochlearis, or occasionally a small trochlear spine, for the attachment of the cartilaginous pulley of the Obliquus oculi superior.

The **superior surface** is convex, and marked by depressions for the convolutions of the frontal lobes of the brain, and faint grooves for the meningeal branches of the ethmoidal vessels.

The **ethmoidal notch** separates the two orbital plates; it is quadrilateral, and filled, in the articulated skull, by the cribriform plate of the ethmoid. The margins of the notch present several half-cells which, when united with corresponding half-cells on the upper surface of the ethmoid bone, complete the ethmoidal air cells. Two grooves cross these edges transversely; they are converted into the **anterior** and **posterior ethmoidal canals** by the ethmoid, and open on the medial wall of the orbit. The anterior canal transmits the nasociliary nerve and anterior ethmoidal vessels, the posterior — the posterior ethmoidal nerve and vessels.

In front of the ethmoidal notch, on either side of the frontal spine, are the openings of the **frontal air sinuses.** These are two irregular cavities, which extend backward, upward, and lateralward for a variable distance between the two tables of the skull; they are separated from one another by a thin bony septum, which often deviates to one or other side, with the result that the sinuses are rarely symmetrical. Absent at birth, they are usually fairly well-developed between the seventh and eighth years, but only reach their full size after puberty.

The sphenoid bone

The **sphenoid bone** (*os sphenoidale***)** is situated at the base of the skull in front of the temporal bone and basilar part of the occipital bone. It somewhat resembles a bat with its wings extended, and is divided into a median portion or body, two great and two small wings extending outward from the sides of the body, and two pterygoid processes which project from it below.

Body (corpus sphenoidale). The body, more or less cubical in shape, is hollowed out in its interior to form two large cavities, the **sphenoidal air sinuses,** which are separated from each other by a septum.

Surfaces. The superior surface of the body presents in front a prominent spine, the ethmoidal spine, for articulation with the cribriform plate of the ethmoid bone; behind this is a smooth surface slightly raised in the middle line, and grooved on either side for the olfactory lobes of the brain. This surface is bounded behind by a ridge, which forms the anterior border of a narrow, transverse groove, the **chiasmatic groove** (*optic groove*), above and behind which lies the optic chiasma; the groove ends on either side in the **optic canal,** which transmits the optic nerve and ophthalmic artery into the orbital cavity. Behind the chiasmatic groove is an elevation, the **tuberculum sellae;** and still more posteriorly, a deep

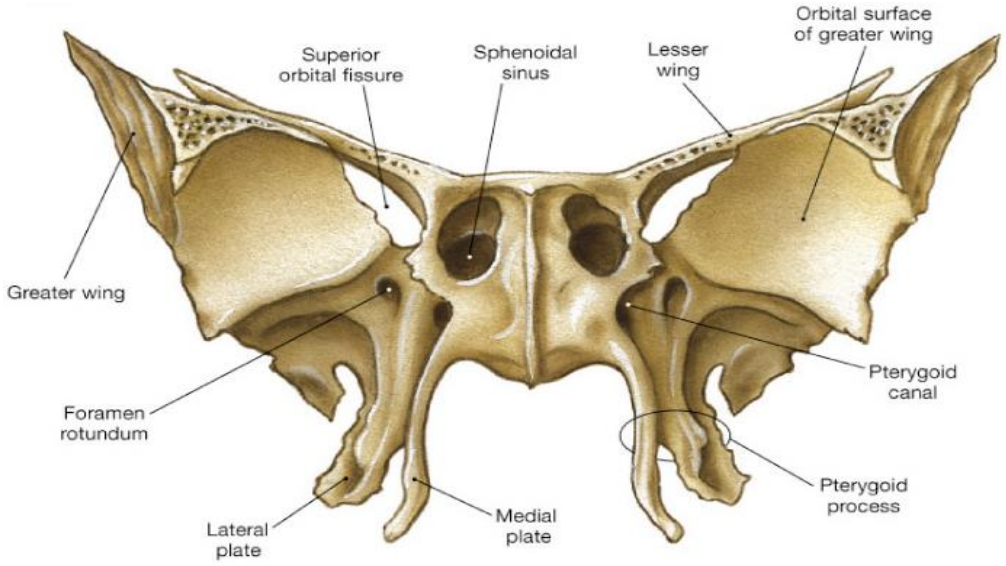


Fig. 7. The sphenoid bone. Anterior view.

depression, the **sella turcica,** the deepest part of which lodges the hypophysis cerebri and is known as the **fossa hypophysealis.** The anterior boundary of the sella turcica is completed by two small eminences, one on either side, called the **middle clinoid processes,** while the posterior boundary is formed by a square-shaped plate of bone, the **dorsum sellae,** ending at its superior angles in two tubercles, the **posterior clinoid processes,** the size and form of which vary considerably in different individuals. The posterior clinoid processes deepen the sella turcica, and give attachment to the tentorium cerebelli.

On either side of the dorsum sellae is a notch for the passage of the abducent nerve, and below the notch a sharp process, the petrosal process, which articulates with the apex of the petrous portion of the temporal bone, and forms the medial boundary of the foramen lacerum. Behind the dorsum sellae is a shallow depression, the clivus, which slopes obliquely backward, and is continuous with the groove on the basilar portion of the occipital bone; it supports the upper part of the pons.

The **lateral surfaces** of the body are united with the great wings and the medial pterygoid plates. Above the attachment of each great wing is a broad groove, curved something like the italic letter *f;* it lodges the internal carotid artery and the cavernous sinus, and is named the **carotid groove.** Along the posterior part of the lateral margin of this groove, in the angle between the body and great wing, is a ridge of bone, called the **lingula.**

The **posterior surface,** quadrilateral in form, is joined, during infancy and adolescence, to the basilar part of the occipital bone by a plate of cartilage. Between the eighteenth and twenty-fifth years this becomes ossified, ossification commencing above and extending downward.

The **anterior surface** of the body presents, in the middle line, a vertical crest, the sphenoidal crest, which articulates with the perpendicular plate of the ethmoid, and forms part of the septum of the nose. On either side of the crest is

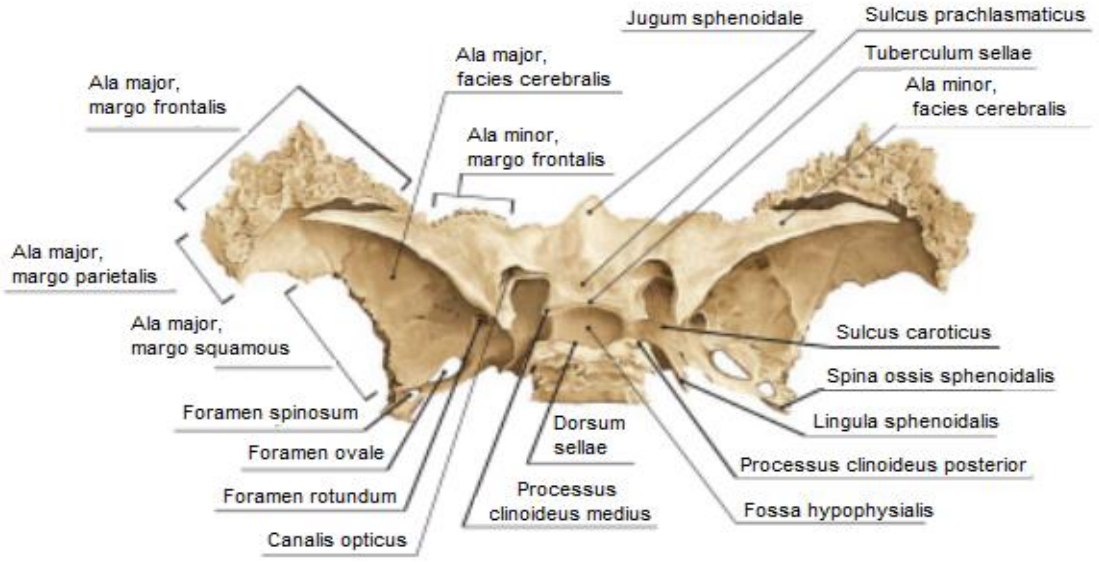


Fig. 8. The sphenoid bone, superior aspect.

an irregular opening leading into the corresponding sphenoidal air sinus. These sinuses are two large, irregular cavities hollowed out of the interior of the body of the bone, and separated from one another by a bony septum, which is commonly bent to one or the other side. They vary considerably in form and size, are seldom symmetrical, and are often partially subdivided by irregular bony laminae. Occasionally, they extend into the basilar part of the occipital nearly as far as the foramen magnum. They begin to be developed before birth, and are of a considerable size by the age of six. They are partially closed, in front and below, by two thin, curved plates of bone, the sphenoidal conchae, leaving in the articulated skull a round opening at the upper part of each sinus by which it communicates with the upper and back part of the nasal cavity and occasionally with the posterior ethmoidal air cells. The lower margin articulates with the orbital process of the palatine bone, the upper – with the orbital plate of the frontal bone.

The Great Wings (alae majores). The great wings, or **ali sphenoids,** are two strong processes of bone, which arise from the sides of the body, and are curved upward, lateralward, and backward; the posterior part of each projects as a triangular process which fits into the angle between the squama and the petrous portion of the temporal bone and presents at its apex a downwardly directed process, the **spina angularis** (*sphenoidal spine*).

Surfaces. The **superior** or **cerebral surface** of each great wing forms part of the middle fossa of the skull; it is deeply concave, and presents depressions for the convolutions of the temporal lobe of the brain. At its anterior and medial part is a circular aperture, the **foramen rotundum,** for the transmission of the maxillary nerve. Behind and lateral to this is the **foramen ovale,** for the transmission of the mandibular nerve, the accessory meningeal artery, and sometimes the lesser superficial petrosal nerve. Lastly, in the

posterior angle, near to and in front of the spine, is a short canal, sometimes double, the **foramen spinosum,** which transmits the middle meningeal vessels and a recurrent branch from the mandibular nerve.

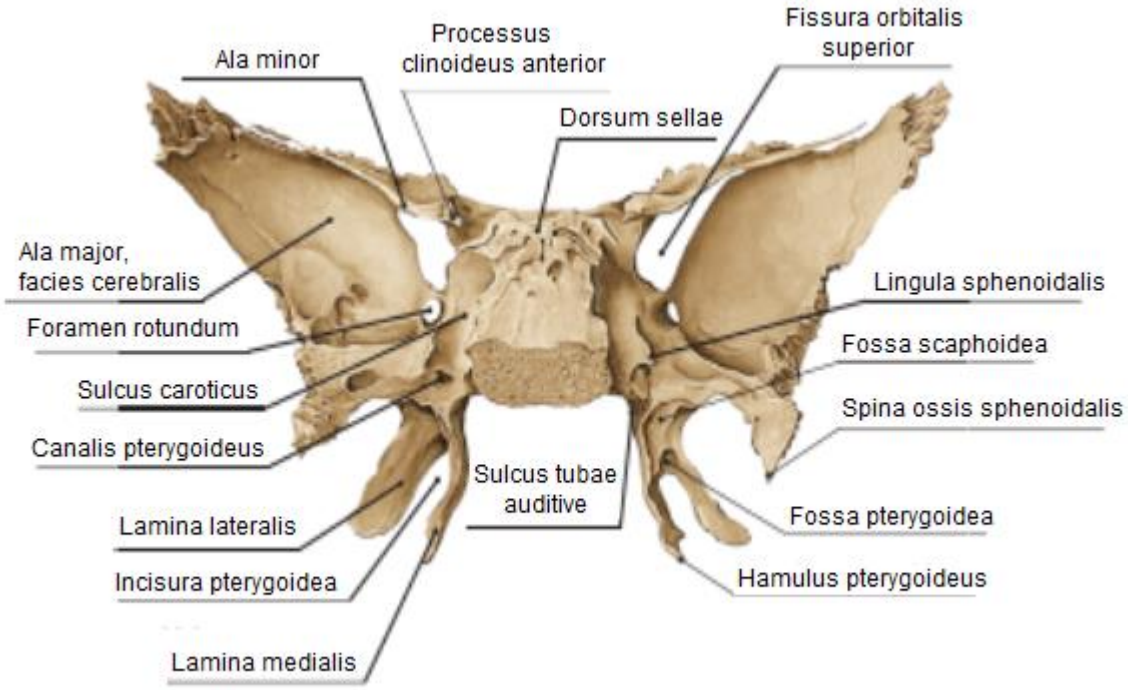


Fig. 9. The sphenoid bone, posterior aspect.

The **lateral surface** is convex, and divided by a transverse ridge, the **infratemporal crest,** into two portions. The superior or temporal portion, convex from above downward, concave from before backward, forms a part of the temporal fossa, and gives attachment to the Temporalis; the inferior or infratemporal, smaller in size and concave, enters into the formation of the infratemporal fossa, and, together with the infratemporal crest, affords attachment to the Pterygoideus lateralis. It is pierced by the foramen ovale and foramen spinosum, and at its posterior part is the spina angularis, which is frequently grooved on its medial surface for the chorda tympani nerve. To the spina angularis are attached the sphenomandibular ligament and the Tensor veli palatini. Medial to the anterior extremity of the infratemporal crest is a triangular process, which serves to increase the attachment of the Pterygoideus lateralis; extending downward and medialward from this process on to the front

part of the lateral pterygoid plate is a ridge, which forms the anterior limit of the infratemporal surface, and, in the articulated skull, the posterior boundary of the pterygomaxillary fissure.

The **orbital surface** of the great wing, smooth, and quadrilateral in shape, is directed forward and medialward and forms the posterior part of the lateral wall of the orbit. Its upper serrated edge articulates with the orbital plate of the frontal. Its inferior rounded border forms the postero-lateral boundary of the inferior orbital fissure. Its medial sharp margin forms the lower boundary of the superior orbital fissure and has projecting from about its center a little tubercle which gives attachment to the inferior head of the Rectus lateralis oculi; at the upper part of this margin is a notch for the transmission of a recurrent branch of the lacrimal artery. Its lateral margin is serrated and articulates with the zygomatic bone. Below the medial end of the superior orbital fissure is a grooved surface, which forms the posterior wall of the pterygopalatine fossa, and is pierced by the foramen rotundum.

The Small Wings (alae minor). The small wings or **orbito-sphenoids** are two thin triangular plates, which arise from the upper and anterior parts of the body, and, projecting lateralward, end in sharp points.

Borders. The **anterior border** is serrated for articulation with the frontal bone. The **posterior border,** smooth and rounded, is received into the lateral fissure of the brain; the medial end of this border forms the **anterior clinoid process,** which gives attachment to the tentorium cerebelli; it is sometimes joined to the middle clinoid process by a spicule of bone, and when this occurs the termination of the groove for the internal carotid artery is converted into a foramen (*carotico-clinoid*). The small wing is connected to the body by two roots, the upper thin and flat, the lower thick and triangular; between the two roots is the **optic foramen,** for the transmission of the optic nerve and ophthalmic artery.

Pterygoid processes (processus pterygoidei). The pterygoid processes, one on either side, descend perpendicularly from the regions where the body and great wings unite. Each process consists of a medial and a lateral plate, the upper parts of which are fused anteriorly; a vertical sulcus, the **pterygopalatine groove,** descends on the front of the line of fusion. The plates are separated below by an angular cleft, the **pterygoid fissure,** the margins of which are rough for articulation with the pyramidal process of the palatine bone. The two plates diverge behind and enclose between them a V-shaped fossa, the **pterygoid fossa,** which contains the Pterygoideus medialis and Tensor veli palatini. Above this fossa is a small, oval, shallow depression, the **scaphoid fossa,** which gives origin to the Tensor veli palatini. The anterior surface of the pterygoid process is broad and triangular near its root, where it forms the posterior wall of the pterygopalatine fossa and presents the anterior orifice of the pterygoid canal.

Lateral pterygoid plate. The **lateral pterygoid plate** is broad, thin, and everted; its **lateral surface** forms part of the medial wall of the infratemporal fossa, and gives attachment to the Pterygoideus externus; its **medial surface** forms part of the pterygoid fossa.

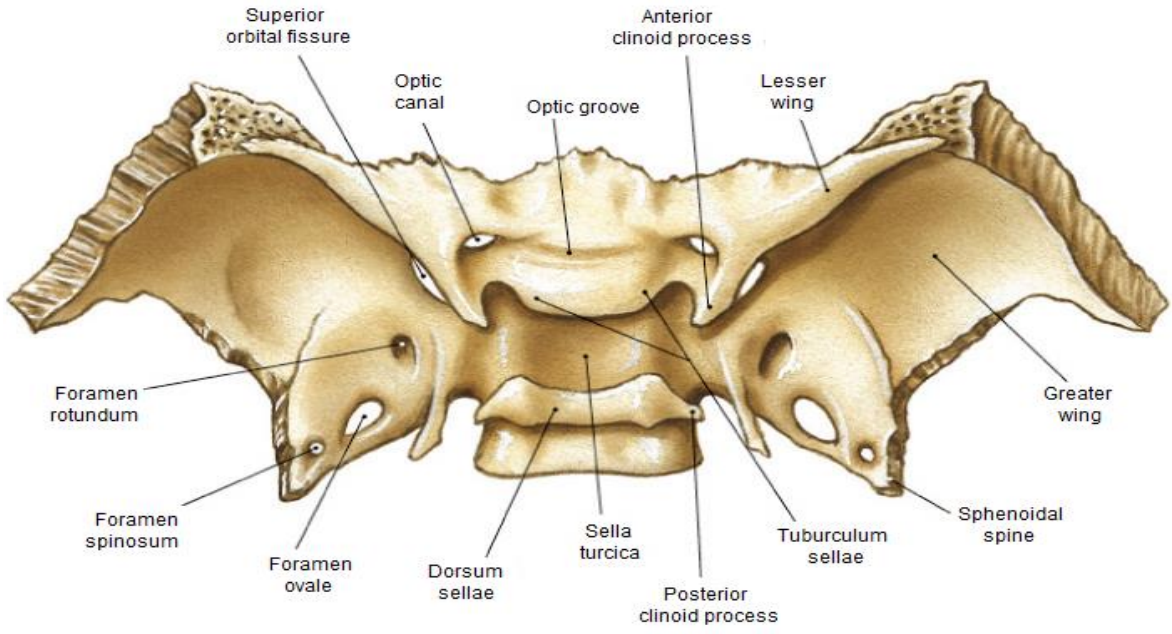


Fig. 10. The sphenoid bone, **posterior aspect**.

Medial pterygoid plate. The medial pterygoid plate is narrower and longer than the lateral; it curves lateralward at its lower extremity into a hook-like process, the **pterygoid hamulus,** around which the tendon of the Tensor veli palatini glides.

The **lateral surface** of this plate forms part of the pterygoid fossa, the **medial surface** constitutes the lateral boundary of the choana or posterior aperture of the corresponding nasal cavity. Superiorly the medial plate is prolonged on to the under surface of the body as a thin lamina, named the **vaginal process,** which articulates in front with the sphenoidal process of the palatine bone and behind with the ala of the vomer. The angular prominence between the posterior margin of the vaginal process and the medial border of the scaphoid fossa is named the **pterygoid tubercle,** and immediately above this is the posterior opening of the pterygoid canal. On the under surface of the vaginal process is a furrow, which is converted into a canal by the sphenoidal process of the palatine bone, for the transmission of the pharyngeal branch of the internal maxillary artery and the pharyngeal nerve from the sphenopalatine ganglion. The pharyngeal aponeurosis is attached to the entire length of the posterior edge of the medial plate, and the Constrictor pharyngis superior takes origin from its lower third. Projecting backward from near the middle of the posterior edge of this plate is an angular process, the **processus tubarius,** which supports the pharyngeal end of the auditory tube. The anterior margin of the plate articulates with the posterior border of the vertical part of the palatine bone.

The ethmoid bone

The ethmoid bone (*os ethmoidale*) is exceedingly light and spongy, and cubical in shape; it is situated at the anterior part of the base of the cranium, between the two orbits, at the roof of the nose, and contributes to each of these cavities. It consists of four parts: a **horizontal** or **cribriform plate,** forming part

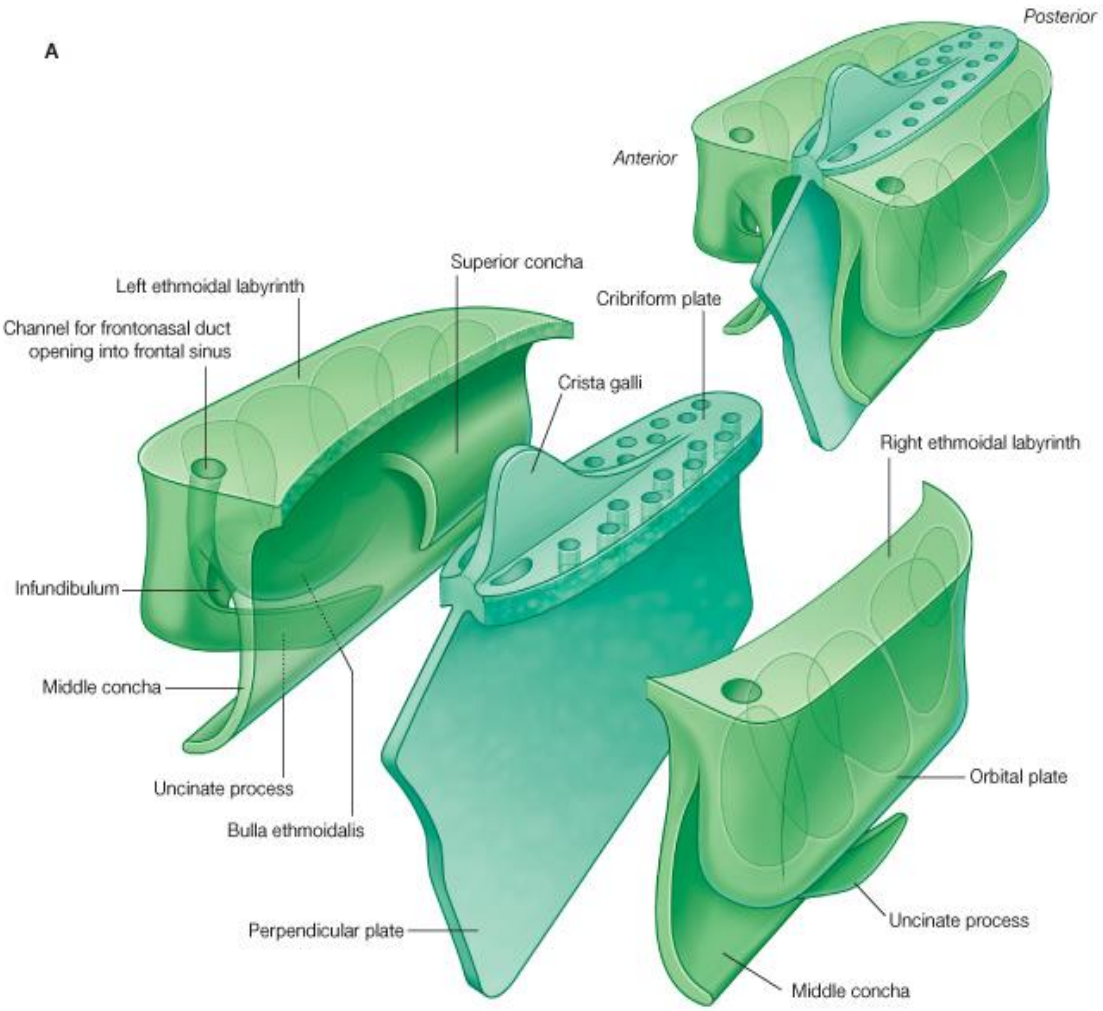
of the base of the cranium; a **perpendicular plate,** constituting part of the nasal septum; and two **lateral masses** or labyrinths.

Cribiform plate (lamina cribrosa; horizontal lamina). The cribriform plate is received into the ethmoidal notch of the frontal bone and roofs in the nasal cavities. Projecting upward from the middle line of this plate is a thick, smooth, triangular process, the **crista galli,** so called from its resemblance to a cock's comb. The long thin posterior border of the crista galli serves for the attachment of the falx cerebri. Its anterior border, short and thick, articulates with the frontal bone, and presents two small projecting **alae,** which are received into corresponding depressions in the frontal bone and complete the foramen cecum. Its sides are smooth, and sometimes bulging from the presence of a small air sinus in the interior. On either side of the crista galli, the cribriform plate is narrow and deeply grooved; it supports the olfactory bulb and is perforated by foramina for the passage of the olfactory nerves. The foramina in the middle of the groove are small and transmit the nerves to the roof of the nasal cavity; those at the medial and lateral parts of the groove are larger — the former transmit the nerves to the upper part of the nasal septum, the latter those to the superior nasal concha. At the front part of the cribriform plate, on either side of the crista galli, is a small fissure which is occupied by a process of dura mater. Lateral to this fissure is a notch or foramen, which transmits the nasociliary nerve; from this notch a groove extends backward to the anterior ethmoidal foramen.

Perpendicular plate (lamina perpendicularis; vertical plate). The perpendicular plate is a thin, flattened lamina, polygonal in form, which descends from the under surface of the cribriform plate, and assists in forming the septum of the nose; it is generally deflected a little to one or other side. The anterior border articulates with the spine of the frontal bone and the crest of the nasal bones. The posterior border articulates by its upper half with the sphenoidal crest, by its lower with the vomer. The inferior border is thicker than

the posterior, and serves for the attachment of the septal cartilage of the nose. The surfaces of the plate are smooth, except above, where numerous grooves and canals are seen; these lead from the medial foramina on the cribriform plate and lodge filaments of the olfactory nerves.

The **Labyrinth** or **Lateral Mass** (*labyrinthus ethmoidalis*) consists of a number of thin-walled cellular cavities, the **ethmoidal cells,** arranged in three groups, *anterior, middle,* and *posterior*, and interposed between two vertical plates of bone; the lateral plate forms part of the orbit, the medial, part of the corresponding nasal cavity. In the disarticulated bone, many of these cells are opened into, but when the bones are articulated, they are closed in at every part, except where they open into the nasal cavity.



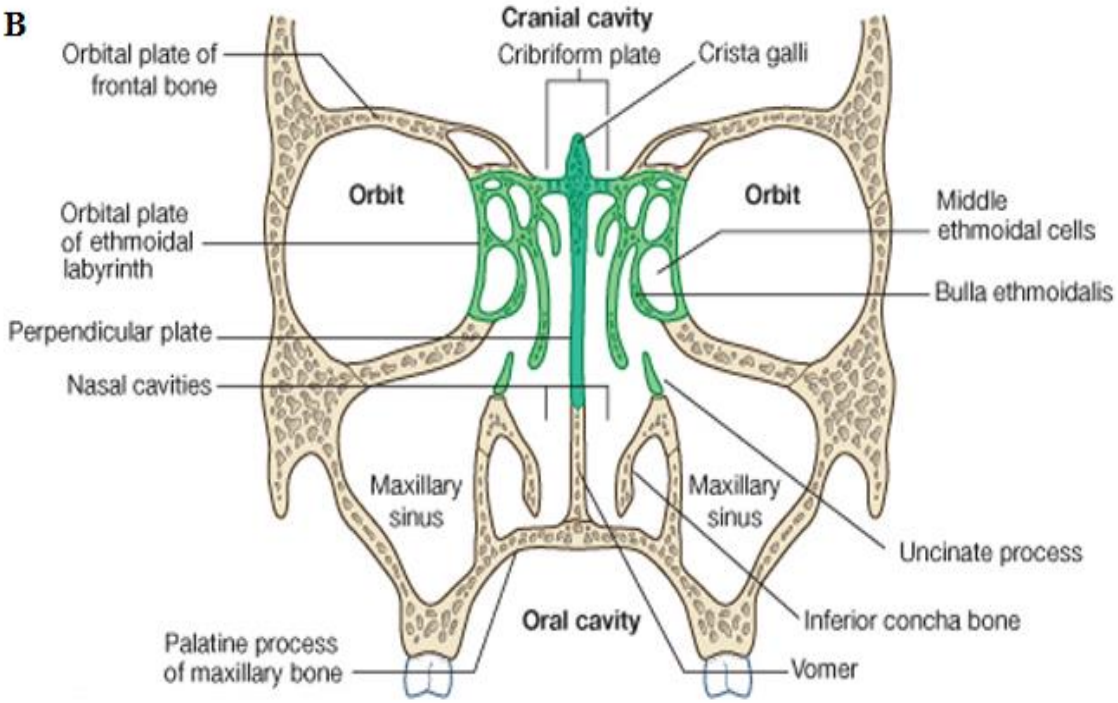


Fig. 11. The ethmoid bone. A. Overall shape. B. Coronal section through the skull.

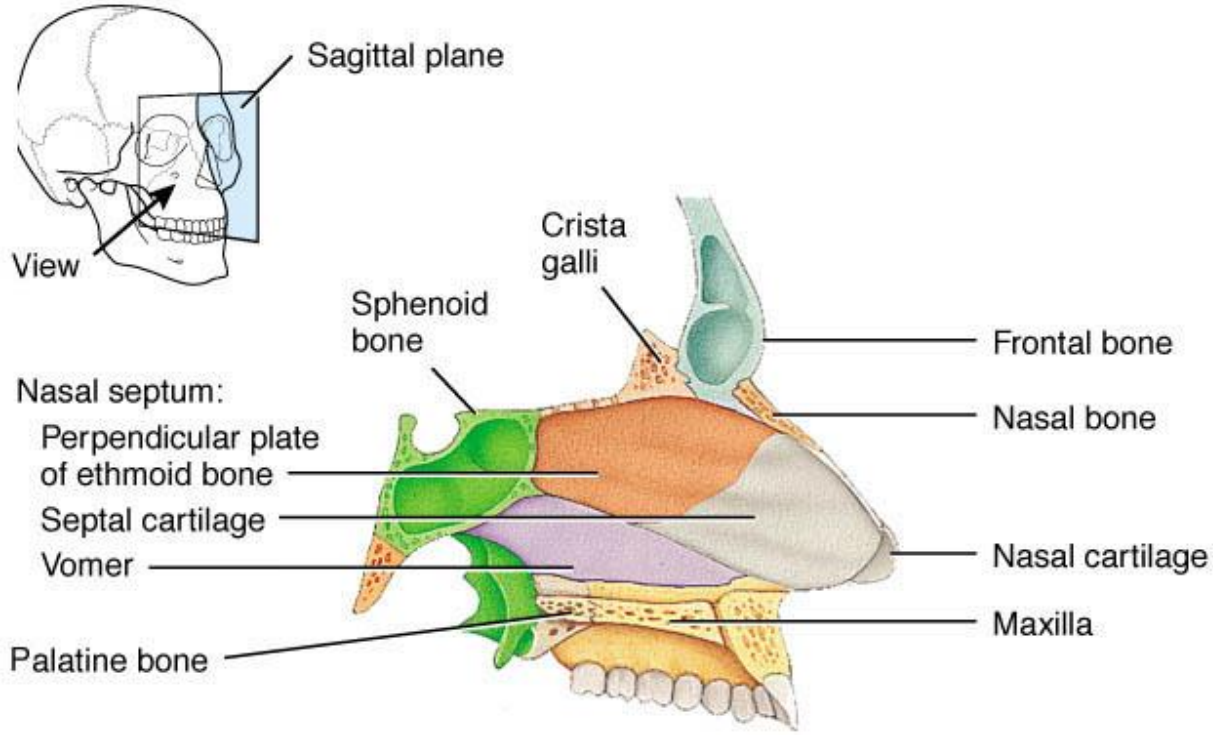


Fig. 12. The ethmoid bone, lateral aspect.

Surfaces. The **upper surface** of the labyrinth presents a number of half-broken cells, the walls of which are completed, in the articulated skull, by the

edges of the ethmoidal notch of the frontal bone. Crossing this surface are two grooves, converted into canals by articulation with the frontal; they are the **anterior** and **posterior ethmoidal canals,** and open on the inner wall of the orbit. The **posterior surface** presents large irregular cellular cavities, which are closed in by articulation with the sphenoidal concha and orbital process of the palatine bone. The **lateral surface** is formed of a thin, smooth, oblong plate, which covers in the middle and posterior ethmoidal cells and forms a large part of the medial wall of the orbit; it articulates above with the orbital plate of the frontal bone, below with the maxilla and orbital process of the palatine bone, in front with the lacrimal bone, and behind with the sphenoid.

In front of the plate are some broken air cells, which are overlapped and completed by the lacrimal bone and the frontal process of the maxilla. A curved lamina, the **uncinate process,** projects downward and backward from this part of the labyrinth; it forms a small part of the medial wall of the maxillary sinus, and articulates with the ethmoidal process of the inferior nasal concha.

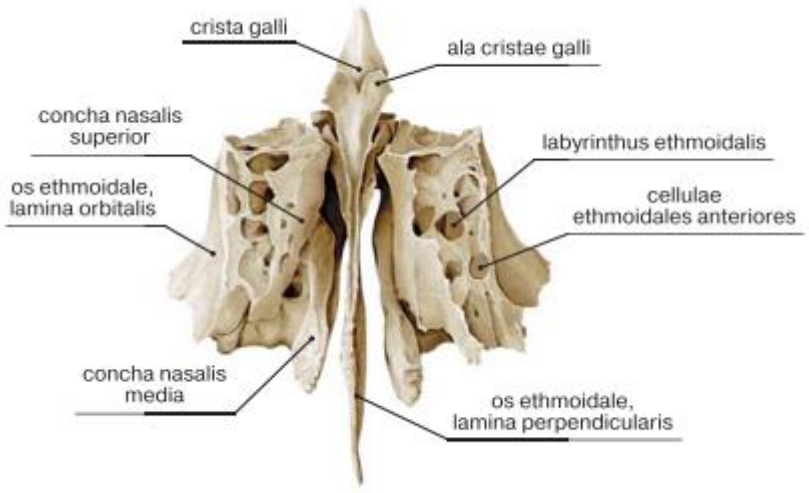


Fig. 13. The ethmoid bone, anterior aspect.

The **medial surface** of the labyrinth forms part of the lateral wall of the corresponding nasal cavity. It consists of a thin plate, which descends from the under surface of the cribriform plate, and ends below in a free, convoluted

margin, the **middle nasal concha.** It is rough, and marked above by numerous grooves, directed nearly vertically downward from the cribriform plate; they lodge branches of the olfactory nerves, which are distributed to the mucous membrane covering the superior nasal concha. The posterior part of the surface is subdivided by a narrow oblique fissure, the **superior meatus** of the nose, bounded above by a thin, curved plate, the **superior nasal concha;** the posterior ethmoidal cells open into this meatus. Below, and in front of the superior meatus, is the convex surface of the middle nasal concha; it extends along the whole length of the medial surface of the labyrinth, and its lower margin is free and thick. The lateral surface of the middle concha is concave, and assists in forming the **middle meatus** of the nose.

The temporal bone. Features of a constitution.

The **temporal bones** (*os temporale)* are situated at the sides and base of the

skull. Each consists of three parts: the **squama,** the **petrous,** and **tympanic parts.**

The Squama (squama temporalis). The squama forms the anterior and upper part of the bone, and is scale-like, thin, and translucent.

Surfaces. Its **outer surface** is smooth and convex; it affords attachment to the Temporalis muscle, and forms part of the temporal fossa; on its hinder part is vertical groove for the middle temporal artery. A curved line, the **temporal line,** or **supramastoid crest,** runs backward and upward across its posterior part; it serves for the attachment of the temporal fascia, and limits the origin of the Temporalis muscle. The boundary between the squama and the mastoid portion of the bone, as indicated by traces of the original suture, lies about 1 cm. below this line. Projecting from the lower part of the squama is a long, arched process, the **zygomatic process.**

The anterior end is deeply serrated and articulates with the zygomatic bone. The posterior end is connected to the squama by two roots, the **anterior**

and **posterior roots.** The posterior root, a prolongation of the upper border, is strongly marked; it runs backward above the external acoustic meatus, and is continuous with the temporal line. The anterior root, continuous with the lower border, is short but broad and strong; it is directed medialward and ends in a rounded eminence, the **articular tubercle** (*eminentia articularis*).

This tubercle forms the front boundary of the mandibular fossa, and in the fresh state is covered with cartilage. In front of the articular tubercle is a small triangular area, which assists in forming the infratemporal fossa; this area is separated from the outer surface of the squama by a ridge which is continuous behind with the anterior root of the zygomatic process, and in front, in the articulated skull, with the infratemporal crest on the great wing of the sphenoid bone.

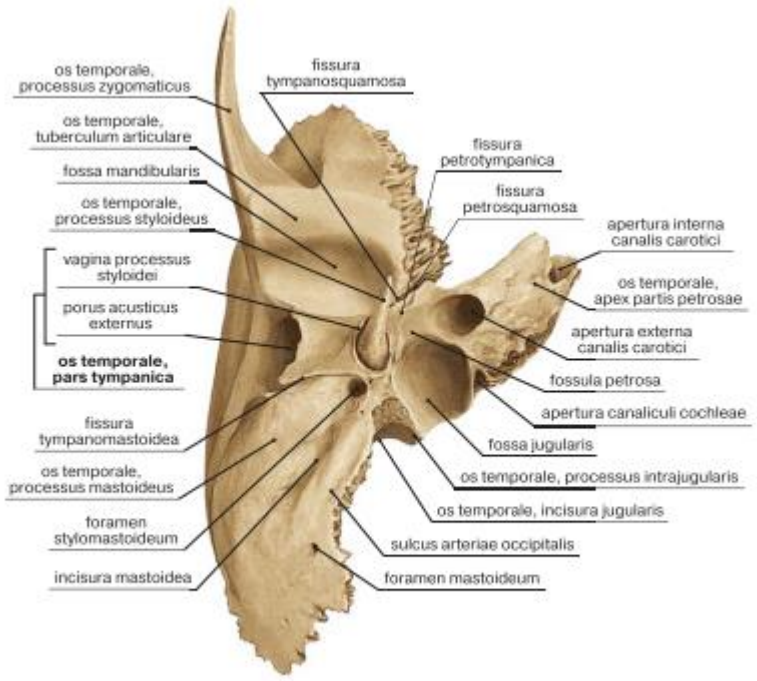


Fig. 14. The temporal bone, external aspect.

Between the posterior wall of the external acoustic meatus and the posterior root of the zygomatic process is the area called the **suprameatal triangle** (Macewen), or **mastoid fossa,** through which an instrument may be pushed into the tympanic antrum. At the junction of the anterior root with the zygomatic

process is a projection for the attachment of the temporomandibular ligament; and behind the anterior root is an oval depression, forming part of the mandibular fossa, for the reception of the condyle of the mandible. The **mandibular fossa** (*glenoid fossa*) is bounded, in front, by the articular tubercle; behind, by the tympanic part of the bone, which separates it from the external acoustic meatus; it is divided into two parts by a narrow slit, the **petrotympanic fissure** (*Glaserian fissure*). The anterior part, formed by the squama, is smooth, covered in the fresh state with cartilage, and articulates with the condyle of the mandible. Behind this part of the fossa is a small conical eminence; this is the representative of a prominent tubercle which, in some mammals, descends behind the condyle of the mandible, and prevents its backward displacement. The posterior part of the mandibular fossa, formed by the tympanic part of the bone, is non-articular, and sometimes lodges a portion of the parotid gland. The petrotympanic fissure leads into the middle ear or tympanic cavity. The chorda tympani nerve passes through a canal (*canal of Huguier*), separated from the anterior edge of the petrotympanic fissure by a thin scale of bone and situated on the lateral side of the auditory tube, in the retiring angle between the squama and the petrous portion of the temporal.

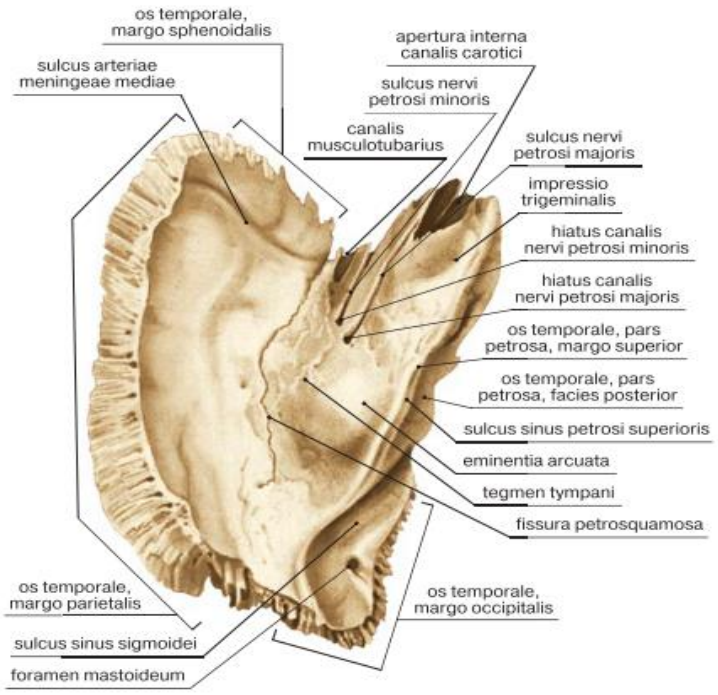


Fig. 15. The temporal bone, internal surface.

The **internal surface** of the squama is concave; it presents depressions corresponding to the convolutions of the temporal lobe of the brain, and grooves for the branches of the middle meningeal vessels.

Borders. The **superior border** is thin, and bevelled at the expense of the internal table, to overlap the squamous border of the parietal bone, forming with it the squamosal suture. Posteriorly, the superior border forms an angle, the **parietal notch,** with the mastoid portion of the bone. The **antero-inferior border** is thick, serrated, and bevelled at the expense of the inner table above and of the outer below, for articulation with the great wing of the sphenoid.

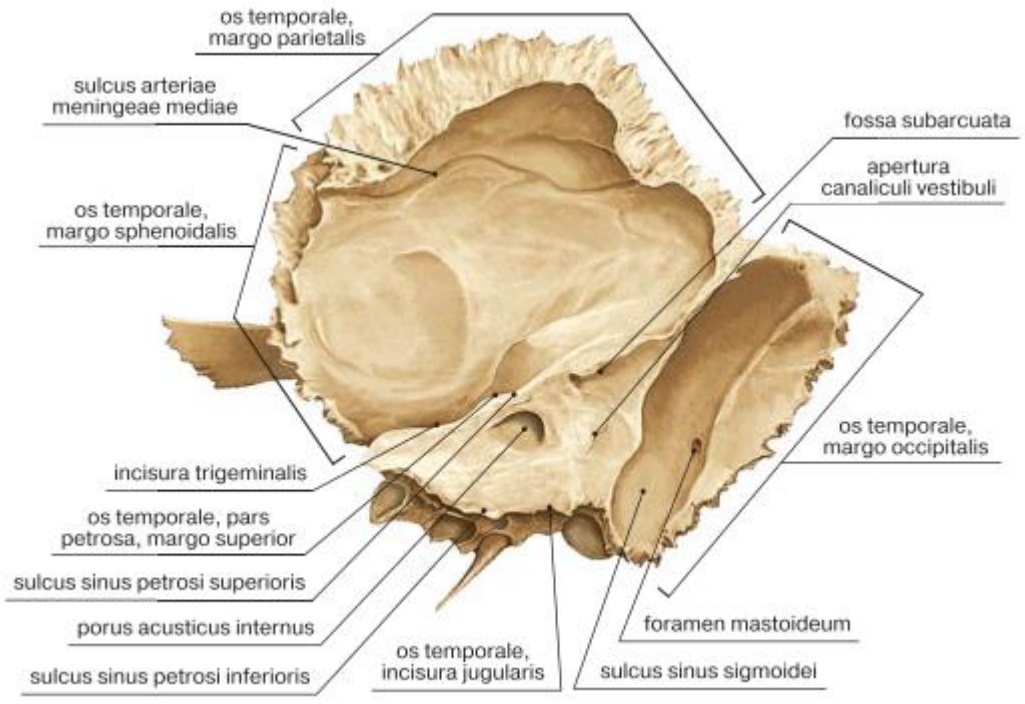


Fig. 16. The temporal bone, superior aspect.

Mastoid Portion. The mastoid portion forms the posterior part of the bone.

Surfaces. Its **outer surface** is rough, and gives attachment to the Occipitalis and Auricularis posterior. It is perforated by numerous foramina; one of these, of

large size, situated near the posterior border, is termed the **mastoid foramen;** it transmits a vein to the transverse sinus and a small branch of the occipital artery to the dura mater. The position and size of this foramen are very variable; it is not always present; sometimes it is situated in the occipital bone, or in the suture between the temporal and the occipital. The mastoid portion is continued below into a conical projection, the **mastoid process,** the size and form of which very somewhat; it is larger in the male than in the female. This process serves for the attachment of the Sternocleidomastoideus, Splenius capitis, and Longissimus capitis. On the medial side of the process is a deep groove, the **mastoid notch** (*digastric fossa*), for the attachment of the Digastricus; medial to this is a shallow furrow, the **occipital groove,** which lodges the occipital artery.

The **inner surface** of the mastoid portion presents a deep, curved groove, the **sigmoid sulcus,** which lodges part of the transverse sinus; in it may be seen the opening of the mastoid foramen. The groove for the transverse sinus is separated from the innermost of the mastoid air cells by a very thin lamina of bone, and even this may be partly deficient.

A section of the mastoid process shows it to be hollowed out into a number of spaces, the **mastoid cells,** which exhibit the greatest possible variety as to their size and number. At the upper and front part of the process they are large and irregular and contain air, but toward the lower part they diminish in size, while those at the apex of the process are frequently quite small and contain marrow; occasionally they are entirely absent, and the mastoid is then solid throughout. In addition to these a large irregular cavity is situated at the upper and front part of the bone. It is called the **tympanic antrum,** and must be distinguished from the mastoid cells, though it communicates with them. Like the mastoid cells, it is filled with air and lined by a prolongation of the mucous membrane of the tympanic cavity, with which it communicates. The tympanic antrum is bounded above by a thin plate of bone, the **tegmen tympani,** which separates it from the middle fossa of the base of the skull; below by the mastoid

process; laterally by the squama just below the temporal line, and medially by the lateral semicircular canal of the internal ear which projects into its cavity. It opens in front into that portion of the tympanic cavity, which is known as **epitympanic recess.** The tympanic antrum is a cavity of some considerable size at the time of birth; the mastoid air cells may be regarded as diverticula from the antrum, and begin to appear at or before birth; by the fifth year they are well-marked, but their development is not completed until toward puberty.

In the clinic. Mastoiditis. Infection within the mastoid antrum and mastoid cells is usually secondary to infection in the middle ear. The mastoid cells provide an excellent culture medium for infection. Infection of the bone (osteomyelitis) may also develop, spreading into the middle cranial fossa.

Drainage of the pus within the mastoid air cells is necessary and there are numerous approaches for doing this. When undertaking this type of surgery, it is extremely important that care is taken not to damage the mastoid wall of the middle ear to prevent injury to the facial nerve [VII]. Any breach of the inner table of the cranial vault may allow bacteria to enter the cranial cavity and meningitis will ensue.

Petrous Portion (pars petrosa [pyramis]). The petrous portion or **pyramid** is pyramidal and is wedged in at the base of the skull between the sphenoid and occipital. Directed medialward, forward, and a little upward, it presents for examination a base, an apex, three surfaces, and three angles, and contains, in its interior, the essential parts of the organ of hearing.

Base. The base is fused with the internal surfaces of the squama and mastoid portion.

Apex. The apex, rough and uneven, is received into the angular interval between the posterior border of the great wing of the sphenoid and the basilar part of the occipital; it presents the anterior or internal orifice of the carotid canal, and forms the postero-lateral boundary of the foramen lacerum.

Surfaces. The **anterior surface** forms the posterior part of the middle fossa of the base of the skull, and is continuous with the inner surface of the squamous portion, to which it is united by the **petrosquamous suture,** remains of which are distinct even at a late period of life. It is marked by depressions for the convolutions of the brain, and presents six points for examination:

1) near the center, an **eminence** (*eminentia arcuata*) which indicates the situation of the superior semicircular canal; 2) in front of and a little lateral to this eminence, a depression indicating the position of the tympanic cavity: here the layer of bone which separates the tympanic from the cranial cavity is extremely thin, and is known as the **tegmen tympani;** 3) a shallow groove, sometimes double, leading lateralward and backward to an oblique opening, the **hiatus of the facial canal,** for the passage of the greater superficial petrosal nerve and the petrosal branch of the middle meningeal artery; 4) lateral to the hiatus, a smaller opening, occasionally seen, for the passage of the lesser superficial petrosal nerve; 5) near the apex of the bone, the termination of the carotid canal, the wall of which in this situation is deficient in front; 6) above this canal the shallow **trigeminal impression** for the reception of the semilunar ganglion.

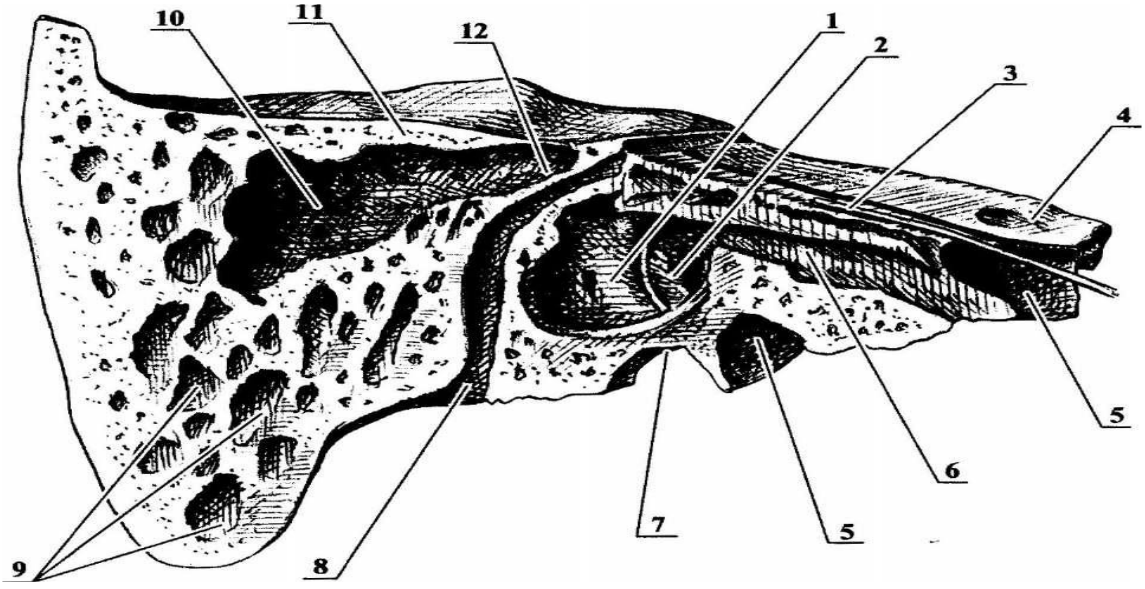


Fig. 17. The temporal bone, a vertical section along the long axis of the pyramid. 1 – promontory; 2 – tympanic cavity; 3 – pointer inserted into the

tympanic canaliculus; 4 – trigeminal impression; 5 – carotid canal; 6 – canal for auditory tube; 7 – jugular fossa; 8 – facial canal and stylomastoid foramen; 9 – mastoid air cells; 10 – mastoid antrum; 11 – tegmen tympani; 12 – prominence of lateral semicircular canal.

The **posterior surface** forms the front part of the posterior fossa of the base of the skull, and is continuous with the inner surface of the mastoid portion. Near the center is a large orifice, the **internal acoustic meatus,** the size of which varies considerably; its margins are smooth and rounded, and it leads into a short canal, about 1 cm. in length, which runs lateralward. It transmits the facial and acoustic nerves and the internal auditory branch of the basilar artery.

Behind the internal acoustic meatus is a small slit almost hidden by a thin plate of bone, leading to a canal, the **aquaeductus vestibuli,** which transmits the ductus endolymphaticus together with a small artery and vein. Above and between these two openings is an irregular depression, which lodges a process of the dura mater and transmits a small vein; in the infant this depression is represented by a large fossa, the **subarcuate fossa,** which extends backward as a blind tunnel under the superior semicircular canal.

The **inferior surface** is rough and irregular, and forms part of the exterior of the base of the skull. It presents ten points for examination:

1) near the apex is a rough surface, quadrilateral in form, which serves partly for the attachment of the Levator veli palatini and the cartilaginous portion of the auditory tube, and partly for connection with the basilar part of the occipital bone through the intervention of some dense fibrous tissue;

2) behind this is the large circular aperture of the **carotid canal,** which ascends at first vertically, and then, making a bend, runs horizontally forward and medialward; it transmits into the cranium the internal carotid artery, and the carotid plexus of nerves;

3) medial to the opening for the carotid canal and close to its posterior border, in front of the jugular fossa, is a triangular depression. At the apex of this is a small

opening, the **aquaeductus cochleae,** which lodges a tubular prolongation of the dura mater establishing a communication between the perilymphatic space and the subarachnoid space, and transmits a vein from the cochlea to join the internal jugular;

4) behind these openings is a deep depression, the **jugular fossa,** of variable depth and size in different skulls; it lodges the bulb of the internal jugular vein;

5) in the bony ridge dividing the carotid canal from the jugular fossa is the small **inferior tympanic canaliculus** for the passage of the tympanic branch of the glossopharyngeal nerve;

6) in the lateral part of the jugular fossa is the **mastoid canaliculus** for the entrance of the auricular branch of the vagus nerve;

7) behind the jugular fossa is a quadrilateral area, the **jugular surface,** covered with cartilage in the fresh state, and articulating with the jugular process of the occipital bone;

8) extending backward from the carotid canal is the **vaginal process,** a sheath-like plate of bone, which divides behind into two laminae; the lateral lamina is continuous with the tympanic part of the bone, the medial with the lateral margin of the jugular surface;

9) between these laminae is the **styloid process,** a sharp spine, about 2.5 cm. in length;

10) between the styloid and mastoid processes is the **stylomastoid foramen;** it is the termination of the facial canal, and transmits the facial nerve and stylomastoid artery;

Angles. The **superior angle,** the longest, is grooved for the superior petrosal sinus, and gives attachment to the tentorium cerebelli; at its medial extremity is a notch, in which the trigeminal nerve lies. The **posterior angle** is intermediate in length between the superior and the anterior. Its medial half is marked by a sulcus, which forms, with a corresponding sulcus on the occipital bone, the channel for the inferior petrosal sinus. Its lateral half presents an

excavation – the **jugular fossa** – which, with the jugular notch on the occipital, forms the **jugular foramen;** an eminence occasionally projects from the center of the fossa, and divides the foramen into two. The **anterior angle** is divided into two parts – a lateral joined to the squama by a suture (*petrosquamous*), the remains of which are more or less distinct; a medial, free, which articulates with the spinous process of the sphenoid.

At the angle of junction of the petrous part and the squama are two canals, one above the other, and separated by a thin plate of bone, the **septum canalis musculotubarii** (*processus cochleariformis*); both canals lead into the tympanic cavity. The upper one (*semicanalis m. tensoris tympani*) transmits the Tensor tympani, the lower one (*semicanalis tubae auditivae*) forms the bony part of the auditory tube.

Tympanic Part (pars tympanica). The tympanic part is a curved plate of bone lying below the squama and in front of the mastoid process.

Surfaces. Its **postero-superior surface** is concave, and forms the anterior wall, the floor, and part of the posterior wall of the bony external acoustic meatus. Medially, it presents a narrow furrow, the **tympanic sulcus,** for the attachment of the tympanic membrane. Its **antero-inferior surface** is quadrilateral and slightly concave; it constitutes the posterior boundary of the mandibular fossa, and is in contact with the retromandibular part of the parotid gland.

The **external acoustic meatus** is nearly 2 cm. long and is directed inward and slightly forward: at the same time it forms a slight curve, so that the floor of the canal is convex upward. In sagittal section it presents an oval or elliptical shape with the long axis directed downward and slightly backward. Its anterior wall and floor and the lower part of its posterior wall are formed by the tympanic part; the roof and upper part of the posterior wall by the squama. Its inner end is closed, in the recent state, by the tympanic membrane; the upper limit of its outer orifice is formed by the posterior root of the zygomatic process,

immediately below which there is sometimes seen a small spine, the **suprameatal spine,** situated at the upper and posterior part of the orifice.

Styloid Processus (processus styloideus). The styloid process is slender, pointed, and of varying length; it projects downward and forward, from the under surface of the temporal bone. Its proximal part (*tympanohyal*) is unsheathed by the vaginal process of the tympanic portion, while its distal part (*stylohyal*) gives attachment to the stylohyoid and stylomandibular ligaments, and to the Styloglossus, Stylohyoideus, and Stylopharyngeus muscles. The stylohyoid ligament extends from the apex of the process to the lesser horn of the hyoid bone, and in some instances is partially, in others completely, ossified.

The tympanic cavity is an air-filled cavity of irregular shape situated within the petrous part of temporal bone. Its volume is about 1 cubic cm. The cavity is invested with the mucous membrane.

The walls of the tympanic cavity.

The tympanic cavity has a roof and a floor, and anterior, posterior, medial, and lateral walls.

The tegmental wall (roof) of the tympanic cavity consists of a thin layer of bone, which separates the middle ear from the middle cranial fossa. This layer of bone is the tegmen tympani on the anterior surface of the petrous part of the temporal bone.

The jugular wall (floor) consists of a thin layer of bone that separates it from the internal jugular vein. Occasionally, the floor is thickened by the presence of mastoid air cells. Near the medial border of the floor is a small aperture, through which the tympanic branch from the glossopharyngeal nerve enters the middle ear.

The membranous (lateral) wall of the tympanic cavity consists almost entirely of the tympanic membrane, but because the tympanic membrane does not extend superiorly into the epitympanic recess, the upper part of the membranous wall is the bony lateral wall of the epitympanic recess.

The mastoid (posterior) wall is only partially complete. The lower part of this wall consists of a bony partition between the tympanic cavity and mastoid air cells. Superiorly, the epitympanic recess is continuous with the aditus to the mastoid antrum.

The anterior wall of the tympanic cavity is only partially complete. The lower part consists of a thin layer of bone that separates the tympanic cavity from the internal carotid artery. Superiorly, the wall is deficient because of the presence of:

- a large opening for the entrance of the pharyngotympanic tube into the middle ear;
- a smaller opening for the canal containing the tensor tympani muscle.

The foramen for the exit of the chorda tympani nerve from the middle ear is also associated with this wall.

The labyrinthine (medial) wall of the middle ear is also the lateral wall of the internal ear. A prominent structure on this wall is a rounded bulge (the promontory) produced by the basal coil of the cochlea, which is an internal ear structure involved with hearing.

Channels of a temporal bone.

1. **Carotid canal** ascends at first vertically, and then, making a bend, runs horizontally forward and medialward; it transmits into the cranium the internal carotid artery, and the carotid plexus of nerves.
2. **Mastoid canaliculus** begins in the lateral part of the jugular fossa and ends in tympanomastoidum fissure.
3. **Facial canal** begins in the porus acusticus internus. Then it goes frontward and lateralward till the **hiatus of the facial canal** on the anterior surface of the pyramid. Here the canal turns at right angle lateralward and backward and forms **geniculum canalis facialis,** then it goes downward and ends by **foramen stylomastoideum**.

4. In the bony ridge dividing the carotid canal from the jugular fossa is the small **inferior tympanic canaliculus** for the passage of the tympanic branch of the glossopharyngeal nerve. This canal leads to the tympanic cavity.

5. **Canalis musculotubarius.** At the angle of junction of the petrous part and the squama are two canals, one above the other, and separated by a thin plate of bone, the **septum canalis musculotubarii** (*processus cochleariformis*); both canals lead into the tympanic cavity. The upper one (*semicanalis m. tensoris tympani*) transmits the Tensor tympani, the lower one (*semicanalis tubae auditivae*) forms the bony part of the auditory (Eustachian) tube, which establishes the communication between the tympanic cavity and the nasal part of the pharynx.

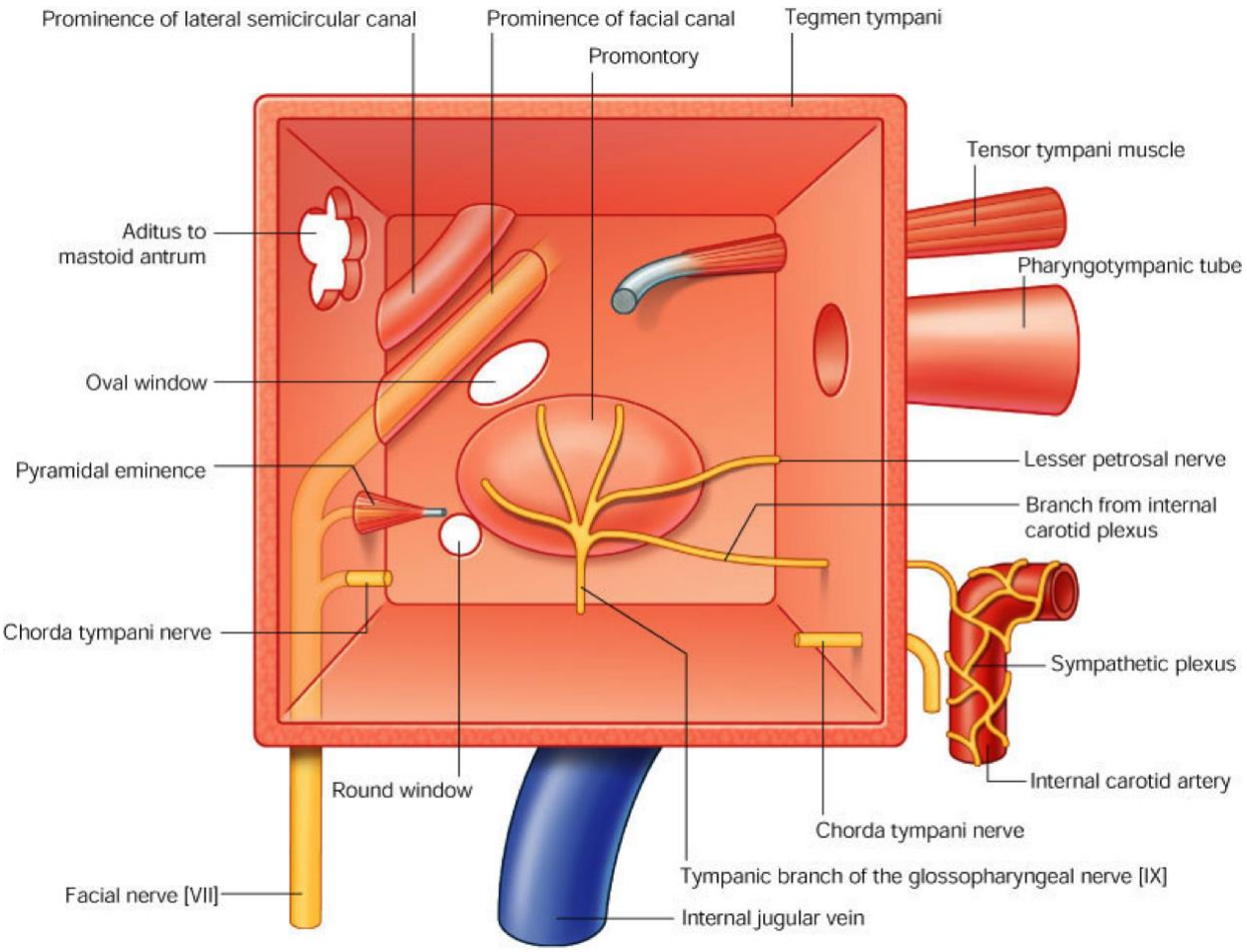


Fig. 18. Walls of the tympanic cavity.

6. **Canaliculus for chorda tympani** gives passage to a thin nerve (chorda tympani); it branches off the facial canal above the stylomastoid foramen and runs forward inside the bone reaching the posterior wall of the tympanic cavity. The chorda tympani passes through the tympanic cavity and exits through the petrotympanic fissure.

7. **Caroticotympanic canaliculi** begin on the posterior wall of the carotid canal and enter the tympanic cavity penetrating its anterior wall.

8. **Tympanic canaliculus** begins on the inferior surface of the pyramid in the petrous fossula and runs vertically upward penetrating the inferior wall of the tympanic cavity.

Bones of visceral skeleton.

The **skull** is supported on the summit of the vertebral column, and is of an oval shape, wider behind than in front. It is composed of a series of flattened or irregular bones which, with one exception (the mandible), are immovably jointed together.

The *facial skeleton* is composed of 14 bones.

Paired	**Unpaired**
1. Maxilla	1. Mandible
2. Zygomatic	2. Vomer
3. Nasal	
4. Lacrimal	
5. Palatine	
6. Inferior nasal concha.	

The mandible

The *mandible,* or the lower jaw, is the largest and the strongest bone of the face. It develops from the *first pharyngeal arch*. It has a horseshoe-shaped body, which lodges the teeth, and a *pair of rami,* which project upwards from the posterior ends of the *body*. The rami provide attachment to the muscles of mastication.

BODY. Each half of the body has outer and inner surfaces, and upper and lower borders.

The ***outer surface*** presents the following features.

1. The *symphysis menti* is the line at which the right and left halves of the bone meet each other. It is marked by a faint ridge.

2. The *mental protuberance (mentum* = chin) is a median triangular projecting area in the lower part of the midline. The inferolateral angles of the protuberance form the mental tubercles.

3. The *mental foramen* lies below the interval between the premolar teeth.

4. The *oblique line* is the continuation of the sharp anterior border of the ramus of the mandible. It runs downwards and forwards towards the mental tubercle.

5. The *incisive fossa* is a depression that lies just below the incisor teeth.

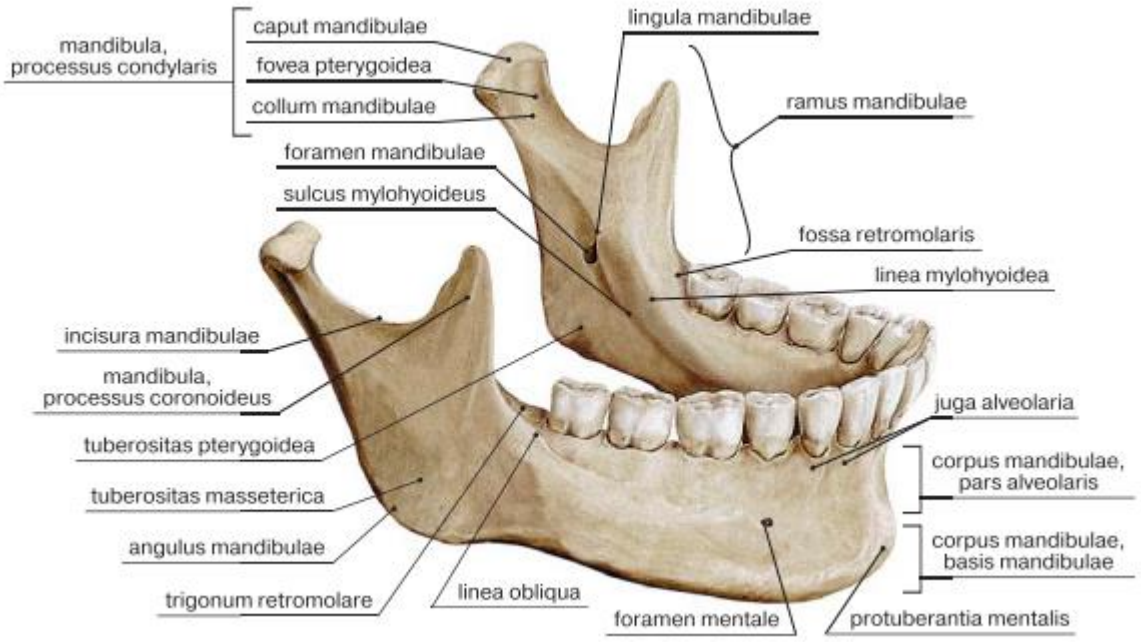


Fig. 19. Mandibula. External aspect.

The ***inner surface*** presents the following features.

1. The *mylohyoid line* is a prominent ridge that runs obliquely downwards and forwards from below the third molar tooth to the median area below the genial tubercles (see below).

2. Below the mylohyoid line, the surface is slightly hollowed out to form the *submandibular fossa*, which lodges the submandibular gland.

3. Above the mylohyoid line, there is the *sublingual fossa* in which the sublingual gland lies.

4. The posterior surface of the symphysis menti is marked by four small elevations called the superior and inferior genial tubercles.

The mylohyoid groove (present on the ramus) extends on to the body below the posterior end of the mylohyoid line.

The *upper or alveolar border* bears sockets for the teeth.

The *lower border* of the mandible is also called the *base*. Near the midline, the base shows an oval depression called the *digastric fossa*.

RAMUS. The ramus is quadrilateral in shape and has two surfaces, lateral and medial, four borders, upper, lower, anterior and posterior, and the coronoid and condyloid processes.

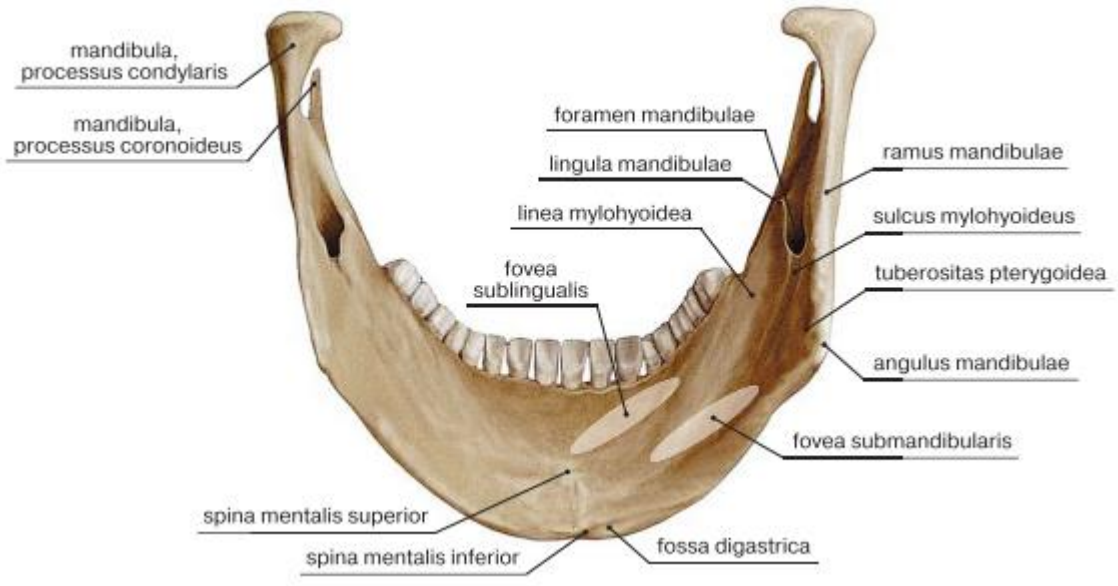


Fig. 20. Lower jaw (mandible). Inside aspect.

The *lateral surface* is flat and bears a number of oblique ridges.

The *medial surface* presents the following:

1. The *mandibular foramen* lies a little above the center of ramus at the level of occlusal surfaces of the teeth. It leads into the *mandibular canal,* which descends into the body of the mandible and opens at the *mental foramen.*

2. The anterior margin of the mandibular foramen is marked by a sharp tongue-shaped projection called the *lingula.* The lingula is directed towards the head of the mandible.

3. The *mylohyoid groove* begins just below the mandibular foramen, and runs downwards and forwards to be gradually lost over the submandibular fossa.

The *upper border* of the ramus is thin and is curved downwards forming the *mandibular notch.*The *lower border* is the backward continuation of the base of the mandible. Posteriorly, it ends by becoming continuous with the posterior border at the *angle* of the mandible.

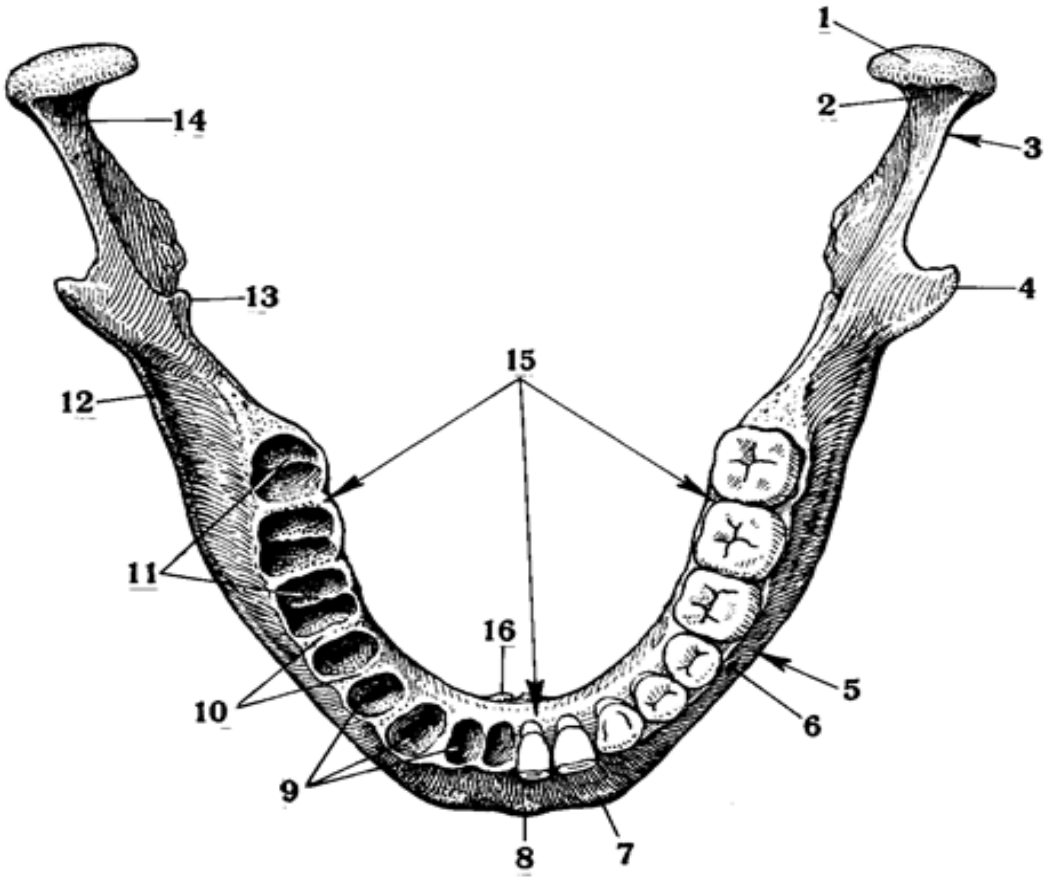


Fig. 21. Lower jaw (mandible). Upper aspect. 1 – head of lower jaw; 2 – pterygoid fovea; 3 – condylar process; 4 – coronoid process; 5 – body of lower

jaw; 6 – mental foramen; 7 – mental tuberculum; 8 –mental protuberantce; 9 – dental alveoli; 10 – interalveolar septa; 11 – interradicular septa; 12 – oblique line; 13 – lingula of lower jaw; 14 – neck of lower jaw.

The *anterior border* is thin, while the *posterior border* is thick.

The *coronoid process* is a flattened triangular upward projection from the anterosuperior part of the ramus. Its anterior border is continuous with the anterior border of the ramus. The posterior border bounds the mandibular notch.

The *condyloid process* is a strong upward projection from the posterosuperior part of the ramus. Its upper end is expanded from side to side to form the *head.* The head is covered with fibrocartilage and articulates with the temporal bone to form the temporomandibular joint. The constriction below the head is the *neck.* Its anterior surface presents a depression called the *pterygoid fovea.*

Attachments and Relations of the Mandible

1. The oblique line on the lateral side of the body gives origin to the *buccinator* as far forwards as the anterior border of the first molar tooth. In front of this origin, the *depressor labii inferioris* and the *depressor anguli oris* arise from the oblique line below the mental foramen.
2. The parts of both the inner and outer surfaces just below the alveolar margin are covered by the mucous membrane of the mouth.
3. Mylohyoid line gives origin to the *mylohyoid muscle*.
4. *Superior constrictor muscle* of the pharynx arises from an area above the posterior end of the mylohyoid line.
5. *Pterygomandibular raphe* is attached immediately behind the third molar tooth in continuation with the origin of superior constrictor.
6. *Upper genial tubercle* gives origin to the *genioglossus,* and the *lower tubercle* to *geniohyoid*.
7. *Anterior belly of the digastric* muscle arises from the digastric fossa.

8. *Deep cervical fascia* (investing layer) is attached to the whole length of lower border.

9. The *platysma* is inserted into the lower border.

10. Whole of the lateral surface of ramus except the posterosuperior part provides insertion to the *masseter muscle*.

11. Posterosuperior part of the lateral surface is covered by the *parotid gland.*

12. *Sphenomandibular ligament* is attached to the lingula.

14. The *medial pterygoid muscle* is inserted on the medial surface of the ramus, on the roughened area below and behind the mylohyoid groove.

15. The *temporalis* is inserted into the apex and medial surface of the coronoid process. The insertion extends downwards on the anterior border of the ramus.

16. The lateral pterygoid muscle is inserted into the pterygoid fovea on the anterior aspect of the neck.

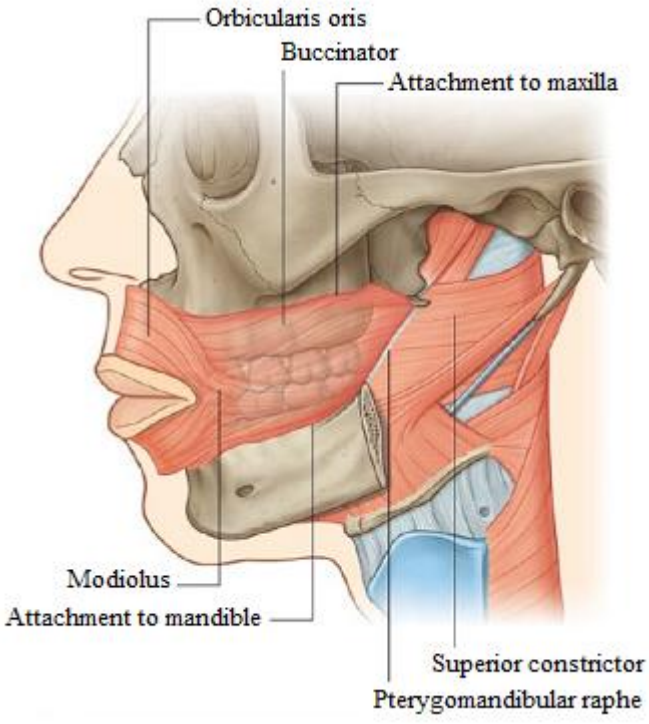


Fig. 22. Buccinator muscle.

17. The lateral surface of neck provides attachment to the *lateral ligament of the temporomandibular joint*.

Foramina and Relations to Nerves and Vessels

1. The mental foramen transmits the *mental nerve and vessels*.
2. The *inferior alveolar nerve and vessels* enter – the *mandibular canal through the mandibular foramen,* and run forwards within the canal.
3. The *mylohyoid nerve and vessels* lie in the *mylohyoid groove.*
4. The *lingual nerve* is related to the medial surface of the ramus in front of the mylohyoid groove.
5. The area above and behind the mandibular foramen is related to the *inferior alveolar nerve and vessels* and to the *maxillary artery.*
6. The *masseteric nerve and vessels* pass through the mandibular notch.
7. The *auriculotemporal nerve* and superficial temporal artery are related to the medial side of the neck of mandible.
8. Facial artery is palpable on the lower border of mandible at anteroinferior angle of masseter.

Ossification: The mandible is the *second bone, next to the clavicle, to ossify* in the body. Its greater part ossifies *in membrane.* The parts ossifying in *cartilage* include the *incisive part* below the incisor teeth, the *coronoid and condyloid processes,* and the *upper half of the ramus* above the level of the mandibular foramen.

Each half of the mandible ossifies from only one *center,* which appears at about the *6th week* of intrauterine life in the mesenchymal *sheath of Meckel's cartilage* near the future mental foramen. Meckel's cartilage is the skeletal element of *first pharyngeal arch.*

At birth, the mandible consists of two halves connected at the *symphysis menti* by fibrous tissue. Bony union takes place during the first year of life.

Age Changes in the Mandible

In Infants and Children

1. The two halves of the mandible fuse during the first year of life.

2. At birth, the *mental foramen opens* below the sockets for the two deciduous molar teeth *near the lower border*. This is so because the bone is made up only of the alveolar part with teeth sockets. The *mandibular canal runs near the lower border*. The foramen and canal gradually shift upwards.

3. The angle is *obtuse*. It is 140 degrees or more because the head is in line with the body. The coronoid process is large and projects upwards above the level of the condyle.

In Adults

1. The *mental foramen opens midway between the upper and lower borders* because the alveolar and subalveolar parts of the bone are equally developed. The mandibular canal runs parallel with the mylohyoid line.

2. The *angle reduces to about 110 or 120 degrees* because the ramus becomes almost vertical.

In Old Age

1. Teeth fall out and the alveolar border is absorbed, so that the height of body is markedly reduced.

2. The mental foramen and the mandibular canal are close to the alveolar border.

3. The angle again becomes obtuse about 140 degrees because the ramus is oblique.

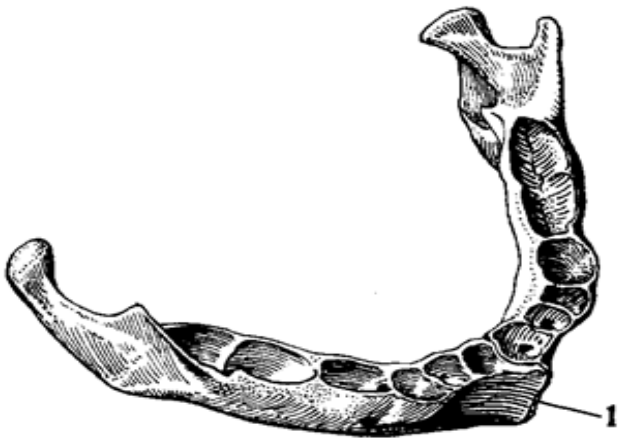


Fig. 23. Lower jaw of newborn. 1 – protuberantia mentalis.

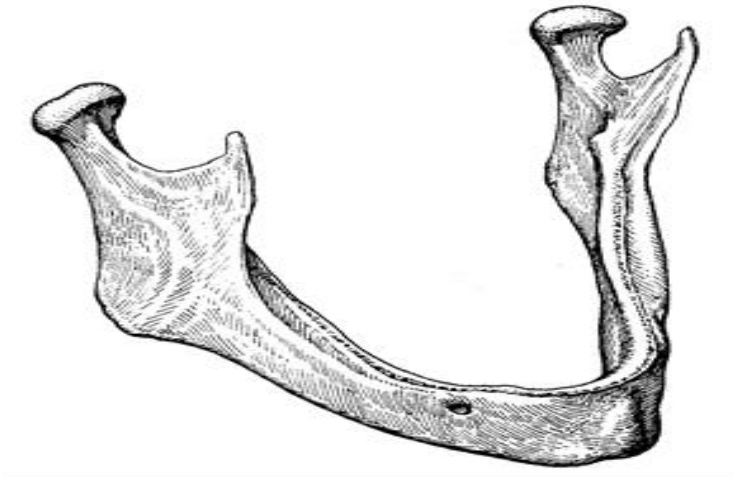


Fig. 24. Lower jaw of elderly person.

Structures Related to Mandible

Salivary glands: Parotid, submandibular and sublingual.

Lymph nodes: Parotid, submandibular and submental.

Arteries: Maxillary, superficial temporal, masseteric, inferior alveolar, mylohyoid, mental and facial.

Nerves: Lingual, auriculotemporal, masseteric, inferior alveolar, mylohyoid and mental.

Muscles of mastication: Insertions of temporalis, masseter, medial pterygoid and lateral pterygoid.

Ligaments: Lateral ligament of temporomandibular joint, stylomandibular ligament, spheno-mandibular and pterygomandibular raphe.

Maxilla

The maxillae are the largest bones of the face, excepting the mandible, and form, by their union, the whole of the upper jaw. Each assists in forming the boundaries of three cavities, viz., the roof of the mouth, the floor and lateral wall of the nose and the floor of the orbit; it also enters into the formation of two fossae, the infratemporal and pterygopalatine, and two fissures, the inferior orbital and pterygomaxillary.

Side Determination

1. Anterior surface ends medially into a deeply concave border, called the *nasal notch.* Posterior surface is convex.

2. Alveolar border with sockets for upper teeth faces downwards with its convexity directed outwards. Frontal process is the longest process, which is directed upwards.

3. Medial surface is marked by a large irregular opening, the *maxillary hiatus.*

Features. Each maxilla has a body and four processes, the frontal, zygomatic, alveolar and palatine.

Body of Maxilla. The body of maxilla is pyramidal in shape, with its base directed medially at the nasal surface, and the apex directed laterally at the zygomatic process. It has four surfaces and encloses a large cavity, the *maxillary sinus.* The surfaces are: anterior or facial, posterior or infratemporal, superior or orbital, and medial or nasal.

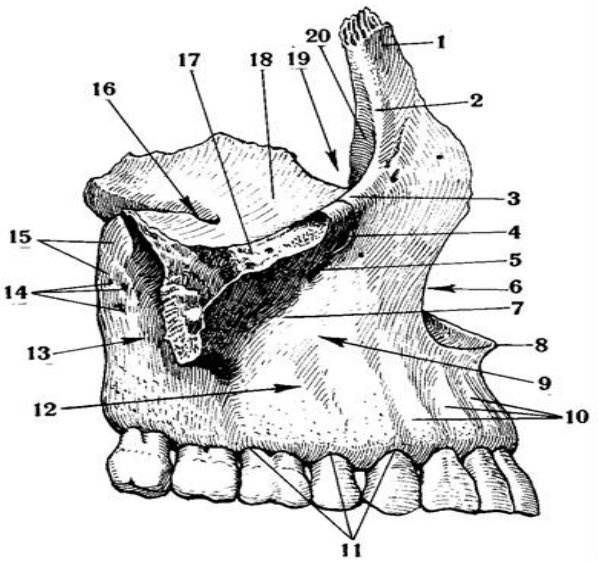


Fig. 25. Upper jaw (maxilla). Frontoexternal aspect. 1 – frontal process; 2 – anterior lacrimal crest; 3 – infraorbital margin; 4 – infraorbital suture; 5 – infraorbital foramen; 6 – nasal notch; 7 – canine fossa; 8 – anterior nasal spine; 9 – anterior surface; 10 – alveolar juga; 11 – alveolar arch; 12 – body of upper jaw; 13 – Infratemporal surface; 14 – alveolar foramina; 15 – tuber of upper jaw; 16 – infraorbital groove; 17 – zygomatic process; 18 – orbital surface; 19 – lachrymal notch; 20 – lachrymal groove.

Anterior or Facial Surface

1. Anterior surface is directed forwards and laterally.

2. Above the incisor teeth, there is a slight depression, the *incisive fossa.*

3. Lateral to canine eminence, there is a larger and deeper depression, the *canine fossa,* which gives origin to *levator anguli oris*.

4. *Above the canine fossa, there is* infraorbital foramen, *which transmits* infraorbital nerve and vessels.

5. *Levator labii superioris* arises between the infraorbital margin and infraorbital foramen.

Medially, the anterior surface ends in a deeply concave border, the *nasal notch,* which terminates below into process which with the corresponding process of opposite maxilla forms the anterior nasal spine. Anterior surface bordering the nasal notch gives origin to *nasalis* and *depressor septi.*

Posterior or Infratemporal Surface

1. Posterior surface is convex and directed backwards and laterally.

2. It forms the anterior wall of *infratemporal fossa,* and is separated from anterior surface by the zygomatic process and a rounded ridge, which descends from the process to the first molar tooth. 3. Near the center of the surface, open two or three *alveolar canals* for *posterior superior alveolar nerve and vessels.*

4. Posteroinferiorly, there is a rounded eminence, the *maxillary tuberosity,* which articulates superomedially with pyramidal process of palatine bone, and gives origin laterally to the *superficial head of medial pterygoid muscle.*

5. Above the maxillary tuberosity, the smooth surface forms anterior wall of *pterygopalatine fossa,* and is grooved by *maxillary nerve.*

Superior or Orbital Surface

1. Superior surface is smooth, triangular and slightly concave, and forms the greater part of the *floor of orbit.*

2. *Anterior border* forms a part of infraorbital margin. Medially, it is continuous with the lacrimal crest of the frontal process.

3. *Posterior border* is smooth and rounded, it forms most of the anterior margin of inferior orbital fissure. In the middle, it is notched by the infraorbital groove.

4. *Medial border* presents anteriorly the lacrimal notch, which is converted into *nasolacrimal canal* by the descending process of lacrimal bone. Behind the notch, the border articulates from before backwards with the *lacrimal, labyrinth of ethmoid, and the orbital process of palatine bone.*

5. The surface presents *infraorbital groove* leading forwards to *infraorbital canal,* which opens on the anterior surface as *infraorbital foramen.* The groove, canal and foramen transmit the *infraorbital nerve and vessels.* Near the midpoint, the canal gives off laterally a branch, the *canalis sinuous,* for the passage of *anterior superior alveolar nerve and vessels.*

6. *Inferior oblique muscle* of eyeball arises from a depression just lateral to lacrimal notch at the anteromedial angle of the surface.

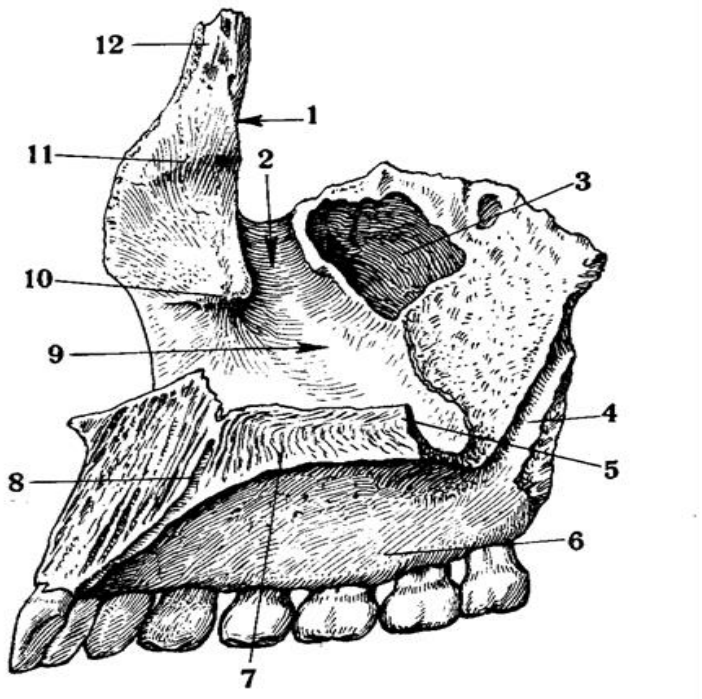


Fig. 26. Right upper jaw (maxilla). Inside aspect. 1– maxillary margin; 2 – lacrimal groove; 3 – maxillary hiatus; 4 – greater palatine groove; 5 – nasal crest; 6 – alveolar process; 7 – palatine process; 8 – incisive canal; 9 – nasal surface; 10 – conchal crest; 11 – ethmoidal crest; 12 – frontal process.

Medial or Nasal Surface

1. Medial surface forms a part of the *lateral wall of nose.*

2. *Posterosuperiorly,* it displays a large irregular opening of the maxillary sinus, the *maxillary hiatus*.

3. Above the hiatus, there are *parts of air sinuses,* which are completed by the ethmoid and lacrimal bones.

4. Below the hiatus, the smooth concave surface forms a part of *inferior meatus of nose.*

5. Behind the hiatus, the surface articulates with perpendicular plate of palatine bone, enclosing the *greater palatine canal,* which runs downwards and forwards, and transmits *greater palatine vessels and the anterior, middle and posterior palatine nerves*.

6. In front of the hiatus, there is *nasolacrimal groove,* which is converted into the nasolacrimal canal by articulation with the *descending process of lacrimal bone* and the *lacrimal process of inferior nasal concha.* The canal transmits *nasolacrimal duct to the inferior meatus of nose*.

7. More anteriorly, an oblique ridge forms the *conchal crest* for articulation with the inferior nasal concha.

8. Above the conchal crest, the shallow depression forms a part of the *atrium of middle meatus* of nose.

The Maxillary Sinus or Antrum of Highmore (sinus maxillaris)

1. The maxillary sinus is a large cavity in the body of maxilla. It is *pyramidal* in shape, with its base directed medially towards the lateral wall of nose, and the apex directed laterally into the zygomatic process of maxilla.

2. The sinus opens into the middle meatus of nose usually by two openings one of which is closed by mucous membrane. The large bony *hiatus of the sinus is reduced* in the articulated skull by following bones: a) from above, by uncinate process of ethmoid and descending part of lacrimal bone; в) from below, by inferior nasal concha; c) from behind, by perpendicular plate of palatine bone.

3. Size is variable. Average measurements are: height 3.7 cm, width, 2.5 cm, and anteroposterior depth, 3.7 cm.

4. Its *roof* is formed by the floor of orbit, and is traversed by the infraorbital canal.

5. The *floor* is formed by the alveolar process of maxilla and lies about 1.2 cm below the level of floor of nose. The floor is marked by several conical elevations produced by the roots of upper molar and premolar teeth; they may even penetrate the bony floor to lie beneath the mucous lining. Canine tooth may project into the anterolateral wall.

6. *Maxillary sinus is first to develop:* It appears as a shallow groove on the medial surface of maxilla during fourth month of intrauterine life, grows rapidly during 6 to 7 years, and reaches full size after the eruption of all permanent teeth.

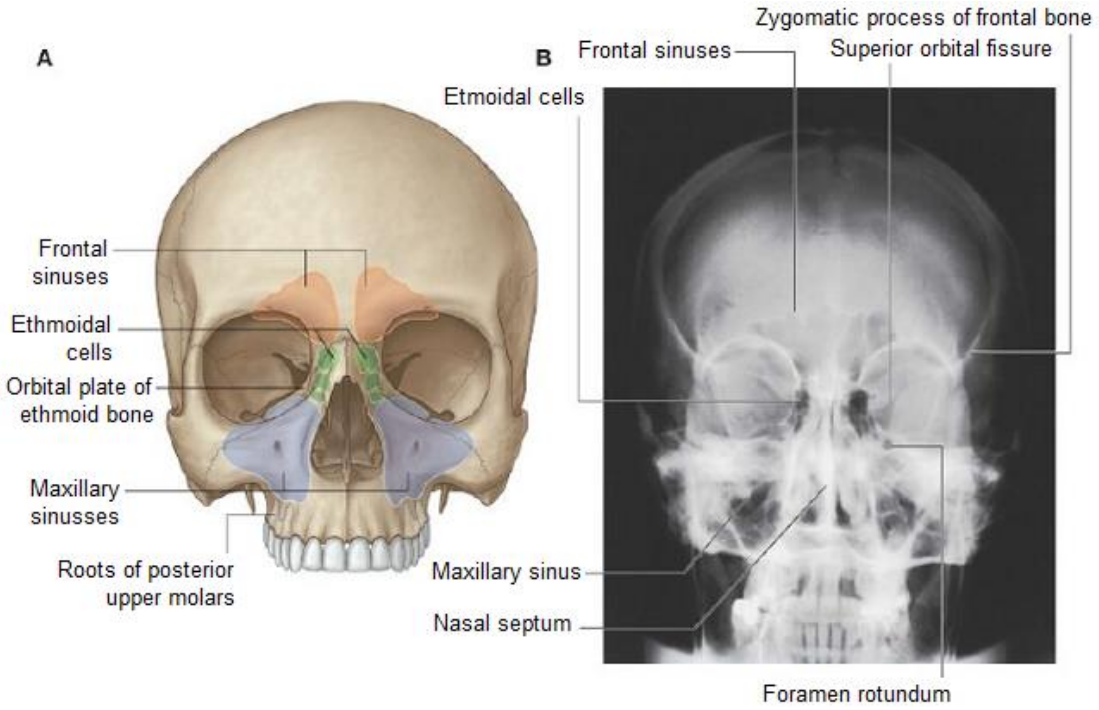


Fig. 27. Paranasal sinuses. A – Anterior view. B – Posteroanterior skull radiograph.

Four Processes of Maxilla

Zygomatic Process

The zygomatic process is a pyramidal lateral projection on which the anterior, posterior, and superior surfaces or maxilla converge. In front and behind, it is continuous with the corresponding surfaces of the body, but superiorly it is rough for articulation with the zygomatic bone.

Frontal Process

1. The frontal process projects upwards and backwards to *articulate* above with the nasal margin of frontal bone, in front with nasal bone and behind with lacrimal bone.

2. *Lateral surface* is divided by a vertical ridge, the *anterior lacrimal crest,* into a smooth anterior part and a grooved posterior part. The lacrimal crest gives attachment to *lacrimal fascia* and the *medial palpebral ligament,* and is continuous below with the infraorbital margin. The anterior smooth area gives origin to the *orbital part of orbicularis oculi* and *levator labii superioris.* The posterior grooved area forms the anterior half of the floor of *lacrimal groove*.

3. *Medial surface* forms a part of the lateral wall of nose. From above downwards, the surface presents following features:

a) uppermost area is rough for articulation with ethmoid to close the anterior ethmoidal sinuses;

b) e*thmoidal crest* is a horizontal ridge about the middle of the process. Posterior part of the crest articulates with middle nasal concha;

c) the area below the ethmoidal crest is hollowed out to form the atrium of the middle meatus;

d) below the atrium is the *conchal crest* which articulates with inferior nasal concha.

e) below the conchal crest, there lies the inferior meatus of the nose with naso-lacrimal groove ending just behind the crest.

Alveolar Process

1. The alveolar process forms half of the alveolar arch, and bears sockets for the roots of upper teeth. In adults, there are eight *sockets: canine socket is deepest;*

molar sockets are widest and divided into three minor sockets by septa; the *incisor and second premolar sockets are single;* and the *first premolar socket* is sometimes *divided into two.*

2. *Buccinator* arises from the posterior part of its outer surface up to the first molar tooth.

3. A rough ridge, the *maxillary torus,* is sometimes present on the inner surface opposite the molar sockets.

Palatine Process

1. Palatine process is a thick horizontal plate projecting medially from the lowest part of the nasal surface. It forms a large part of the roof of mouth and the floor of nasal cavity.

2. *Inferior surface* is concave, and the two palatine processes form anterior three-fourths of the bony palate. It presents numerous vascular foramina and pits for palatine glands. Posterolaterally, it is marked by two anteroposterior grooves for the greater palatine vessels and anterior palatine nerves.

3. *Superior surface* is concave from side to side, and forms greater part of the floor of nasal cavity.

4. *Medial border* is thicker in front than behind. It is raised superiorly into the nasal crest. Groove between the nasal crests of two maxillae receives lower border of vomer; anterior part of the ridge is high and is known as *incisor crest,* which terminates anteriorly into the anterior nasal spine. Incisive canal traverses near the anterior part of the medial border.

5. *Posterior border* articulates with horizontal plate of palatine bone.

6. *Lateral border* is continuous with the alveolar process.

Articulations of Maxilla

1. Superiorly, it articulates with three bones, the nasal, frontal and lacrimal.

2. Medially, it articulates with five bones, the ethmoid, inferior nasal concha, vomer, palatine and opposite maxilla.

3. Laterally, it articulates with one bone, the zygomatic.

Ossification. Maxilla ossifies in membrane from three centers, one for the maxilla proper, and two for os incisivum or *premaxilla*. The center for maxilla proper appears above the canine fossa during sixth week of intrauterine life.

Of the two premaxillary centres, the main center appears above the incisive fossa during seventh week of intrauterine life. The second center (paraseptal or prevomerine) appears at the ventral margin of nasal septum during tenth week and soon fuses with the palatal process of maxilla. Though premaxilla begins to fuse with alveolar process almost immediately after the ossification begins, the evidence for premaxilla as a separate bone may persist until the middle decades.

AGE CHANGES

At birth:

1. The transverse and anteroposterior diameters are each more than the vertical diameter. Frontal process is well marked.
2. Body consists of a little more than the alveolar process, the tooth sockets reaching to the floor of orbit.
3. Maxillary sinus is a mere furrow on the lateral wall of the nose.

In the adult: vertical diameter is greatest due to development of the alveolar process and increase in the size of the sinus.

In the old: the bone reverts to infantile condition. Its height is reduced because of absorption of the alveolar process.

DEVELOPMENTAL DISORDERS OF THE JAWS

The cleft palate is failure of fusion of two palatine processes during early prenatal development (about 12 weeks). Cleft palate may be accompanied by a cleft lip. These conditions require surgical treatment. A baby with a cleft palate may have a difficult time nursing because it is unable to create the necessary suction within the oral cavity to swallow effectively.

Fig 28. The cleft lip.

Fig. 29. An oblique facial cleft.

The cleft palate (palatum fissum) it is failure of fusion of the right and left palatine processes of maxillae, which leads to common (22% of all congenital defects) congenital malformations.

The cleft lip (labium leporinum) it is failure of fusion of the maxillary process with the middle nasal process, which leads to common congenital malformations.

An oblique facial cleft. An oblique congenital cleft occurs with nonunion of the maxillary and frontal processes. It is also called coloboma faciei. It occurs in various forms, often in the form of deep and wide grooves from the mouth to the lower eyelid.

Fig. 30. The cleft palate.

The palatine bone

The palatine bone (os palatinum) is a paired bone. It is situated in the back of the nasal cavity. Each palatine bone consists of horizontal and perpendicular plates, articulated at the right angle. The L-shaped palatine bones form the posterior third of the hard palate, part of the orbit, and part of the nasal cavity.

The horizontal plate contributes to the formation of the hard palate. It has two surfaces: nasal and palatine. The nasal surface of the horizontal plate is slightly concave and smooth, the palatine surface is rough. The nasal surface of the horizontal plate carries a posterior nasal spine on the posteromedial end and nasal crest on the medial border. The palatine surface carries one or two lesser palatine foramina. The greater palatine foramen (foramen palatinum majus) is situated in front of them. These foramina are entrances of the same named canals. The palatine vessels and nerves leave the canals through them.

The perpendicular plate takes part in formation of the lateral nasal wall. Maxillary surface of the perpendicular plate has greater palatine groove, which together with the palatine groove of the maxilla and pterygoid process forms the greater palatine canal. The canal opens on the hard palate by the greater palatine foramen.

The ethmoidal crest extends sagittaly on the nasal surface of the perpendicular plate. It is for attachment of the middle nasal concha of the ethmoid bone. The conchal crest is below and parallel to the ethmoid crest. Conchal crest serves for attachment of the inferior nasal concha.

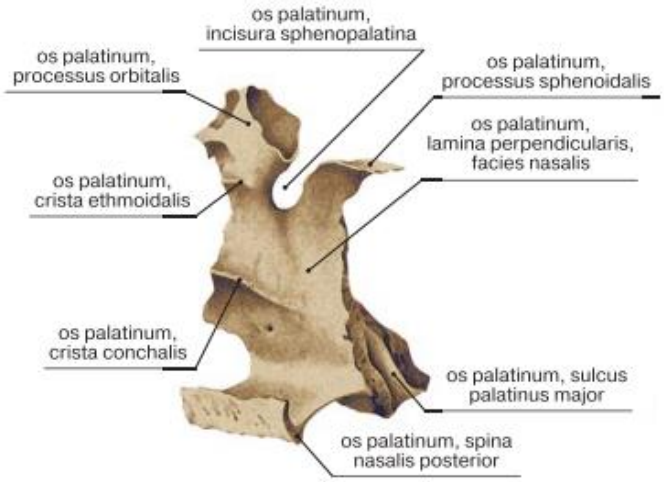


Fig. 31. Right palate bone. Inside. Posterior aspect.

The palatine bone has three processes.

The pyramidal process projects backward and laterally from the junction of the horizontal and perpendicular plates. It is wedged into the notch between the plates of the pterygoid process of the sphenoid bone and limits the pterygoid fossa from below. Nerves and vessels penetrate it vertically through the lesser palatine canals.

The superior border of the perpendicular plate terminates as two processes: ***orbital process*** and ***sphenoidal process***. The processes are separated by the sphenopalatine notch. The notch with the body of the sphenoid bone adjacent to it forms the sphenopalatine foramen.

The orbital process adjoins the orbital surface of the maxilla; it forms the posterior part of the floor of the orbit.

The sphenoidal process lies posterior to the sphenopalatine notch and approaches the sphenoid bone from below.

The nasal bones

The nasal bones (os nasale) 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, and form, by their junction, “the bridge” of the nose.

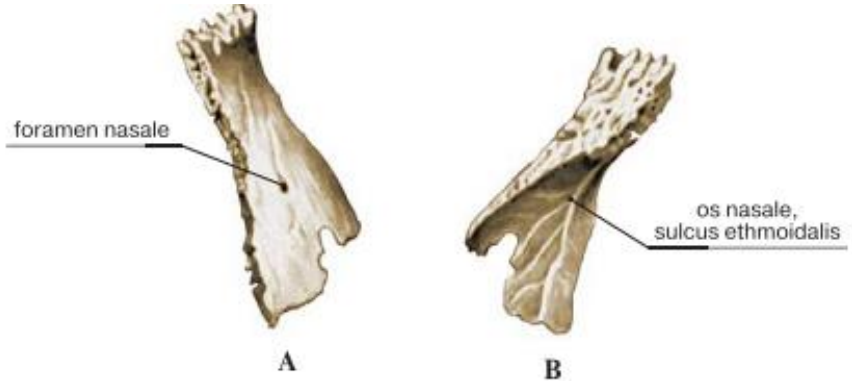


Fig. 32. The nasal bone. A – The outer surface of the nasal bone; B – The inner surface of the nasal bone.

The lacrimal bone

The lacrimal bone (os lacrimale), the smallest and most fragile bone of the face, which is situated at the front part of the medial wall of the orbit.

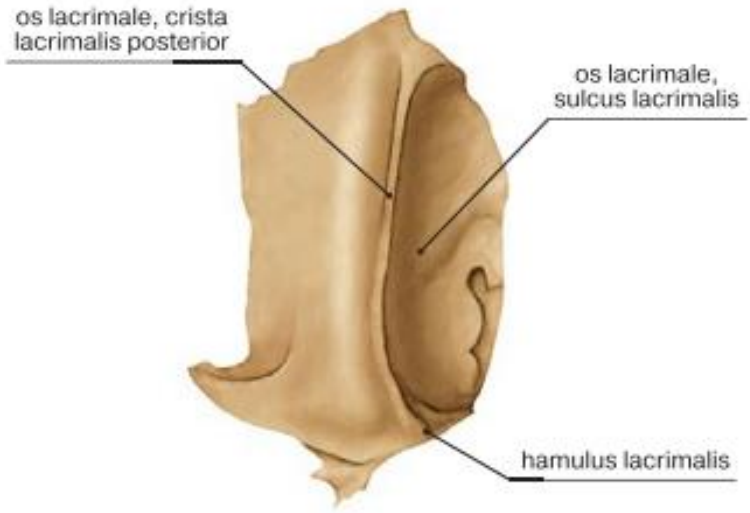


Fig. 33. The right lacrimal bone.

The zygomatic bone

The zygomatic bone (os zygomaticum) is small and quadrangular, and is situated at the upper and lateral part of the face: it forms the prominence of the cheek, part of the lateral wall and floor of the orbit, and parts of the temporal and infratemporal fossae. It presents a ***malar and a temporal surface***; **four processes**, the ***frontal, orbital, maxillary, and temporal***; and four borders.

Surfaces. ***The lateral (malar) surface*** is convex and perforated near its center by a small aperture, the zygomaticofacial foramen, for the passage of the zygomaticofacial nerve and vessels.

The temporal surface, directed backward and medialward, is concave, presenting medially a rough, triangular area, for articulation with the maxilla, and laterally a smooth, concave surface, the upper part of which forms the anterior boundary of the temporal fossa, the lower a part of the infratemporal fossa. Near the center of this surface is the zygomaticotemporal foramen for the transmission of the zygomaticotemporal nerve.

Processes. ***The frontal process*** is thick and serrated, and articulates with the zygomatic process of the frontal bone. On its orbital surface, just within the

orbital margin and about 11 mm. below the zygomaticofrontal suture is a tubercle of varying size and form, but present in 95 percent of skulls.

The orbital process is a thick, strong plate, projecting backward and medialward from the orbital margin. Its antero-medial surface forms, by its junction with the orbital surface of the maxilla and with the great wing of the sphenoid, part of the floor and lateral wall of the orbit. Its postero-lateral surface, smooth and convex, forms parts of the temporal and infratemporal fossae. Its anterior margin, smooth and rounded, is part of the circumference of the orbit. Its superior margin, rough, and directed horizontally, articulates with the frontal bone behind the zygomatic process. Its posterior margin is serrated for articulation, with the great wing of the sphenoid and the orbital surface of the maxilla.

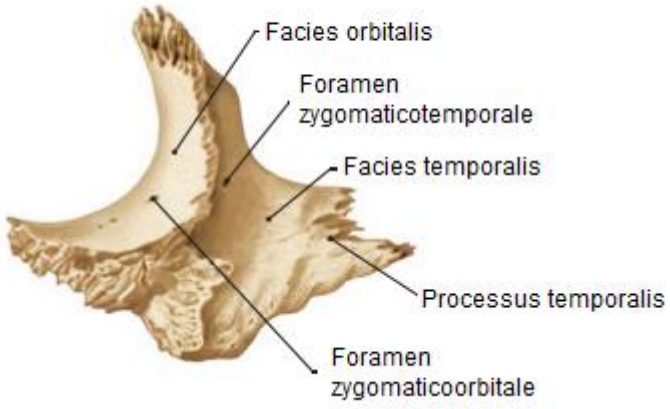


Fig. 34. **The right zygomatic bone, interior aspect**.

At the angle of junction of the sphenoidal and maxillary portions, a short, concave, non-articular part is generally seen; this forms the anterior boundary of the inferior orbital fissure: occasionally, this non-articular part is absent, the fissure then being completed by the junction of the maxilla and sphenoid, or by the interposition of a small sutural bone in the angular interval between them. The maxillary process presents a rough, triangular surface, which articulates with the maxilla. The temporal process, long, narrow, and serrated, articulates with the zygomatic process of the temporal.

The hyoid bone is U-shaped. It is situated in the anterior midline of the neck between the chin and the thyroid cartilage. At rest, it lies at the level of the third cervical vertebra behind and the base of the mandible in front. It is kept suspended in position by muscles and ligaments. The hyoid bone provides attachment to the floor of the mouth and to the tongue above, to the larynx below, and to the epiglottis and pharynx behind. The bone consists of the central part, called the body, and of two pairs of horns, cornua, greater and lesser. Each lateral end of the body is continuous posteriorly with the greater horn or cornua. However, until middle life the connection between the body and greater cornua is fibrous.

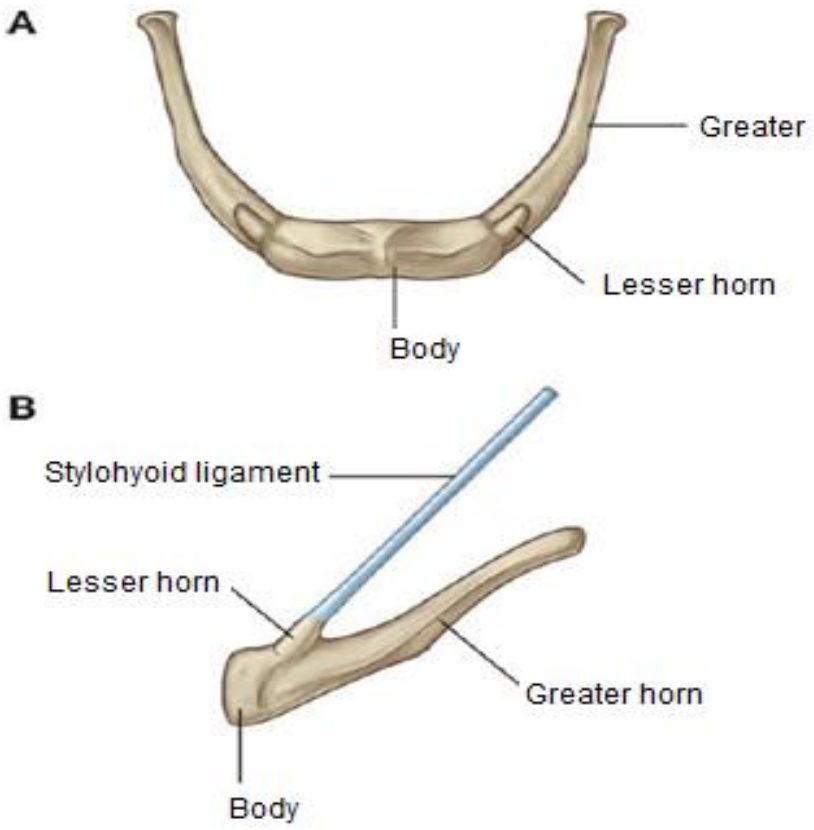


Fig. 35. Hyoid bone. A – Anterior view. B – Lateral view.

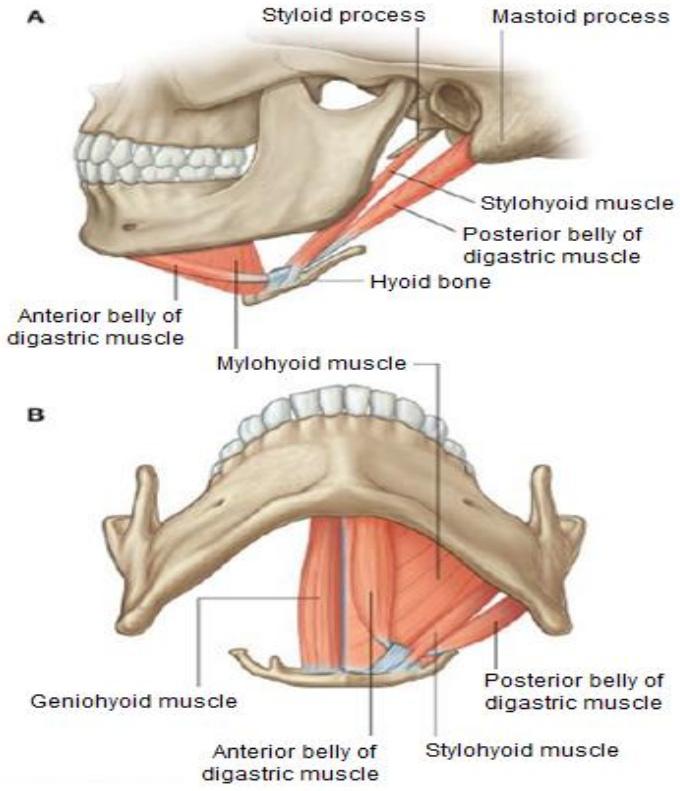


Fig. 36. Suprahyoid muscles of the neck.

Attachments on the Hyoid Bone

1. The anterior surface of the body provides insertion to the geniohyoid and mylohyoid muscles and gives origin to a part of the hyoglossus, which extends to the greater cornua.

2. The upper border of the body provides insertion to the lower fibres of the genioglossi and attachment to the thyrohyoid membrane.

3. The lower border of the body provides attachment to the pretracheal fascia. In front of the fascia, the sternohyoid is inserted medially and the omohyoid laterally.

4. Below the omohyoid, there is the linear attachment of the thyrohyoid, extending back to the lower border of the greater cornua.

5. The medial border of the greater cornua provides attachment to the thyrohyoid membrane, stylohyoid muscle and digastric pulley.

6. The lateral border of the greater cornua provides insertion to the thyrohyoid muscle anteriorly. The investing fascia is attached throughout its length.

7. The lesser cornua provides attachment to the stylohyoid ligament at its tip. The middle constrictor muscle arises from its posterolateral aspect extending on to the greater cornua.

The inferior nasal concha

This is a paired, curved, bony plate, which resides on the lateral walls of the nasal cavity below the middle nasal concha.

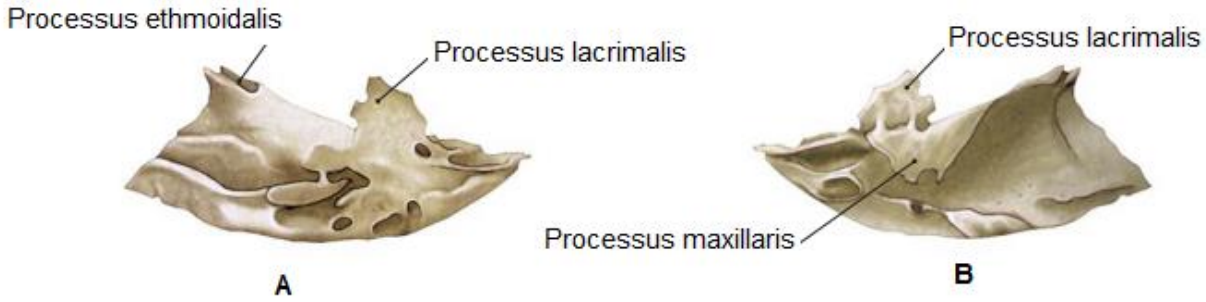


Fig. 37. The left inferior nasal concha. A – Medial aspect; B – Lateral aspect.

The vomer

This is a single, thin bone, rhomboid in shape, which forms the posterior part of the nasal septum. Its anterior border articulates with the perpendicular plate of the ethmoid bone. The superior border articulates with the body of the sphenoid bone. The inferior border articulates with the maxilla and palatine bone. The posterior border of the vomer separates nasal apertures.

The orbit

The orbits are pyramidal bony cavities, situated one on each side of the root of the nose. They provide sockets for rotatory movements of the eyeballs. They also protect the eyeballs.

Shape and Disposition

Each orbit resembles a four-sided pyramid on one side. Thus, it has:

1. An apex situated at the posterior end of orbit at the medial end of superior orbital fissure.

2. A base the orbital opening on the face.

3. Four walls: roof, floor, lateral and medial walls.

The long axis of the orbit passes backwards and medially.

Roof. It is concave from side to side. It is formed: a) mainly by the orbital plate of the frontal bone, and b) is completed posteriorly by the lesser wing of the sphenoid.

Relations

1. It separates the orbit from the anterior cranial fossa.

2. The frontal air sinus may extend into its anteromedial part.

Named features

a) the *lacrimal fossa,* placed anterolaterally, lodges the lacrimal gland;

b) the *optic canal lies* posteriorly, at the junction of the roof and medial wall;

c) the *trochlear fossa,* lies anteromedially. It provides attachment to the fibrous pulley or trochlea for the tendon of the *superior oblique muscle*.

Lateral Wall. This is the thickest and strongest of all the walls ofthe orbit. It is formed: a) by the anterior surface of the greater wing of the sphenoid bone posteriorly, b) the orbital surface of the frontal process of the zygomatic bone anteriorly.

Relations

1. The greater wing of the sphenoid separates the orbit from the middle cranial fossa.

2. The zygomatic bone separates it from the temporal fossa.

Named features

a) the *superior orbital fissure* occupies the posterior part of the junction between the roof and lateral wall;

b) the *foramen for the zygomatic nerve* is seen in the zygomatic bone;

c) *Whitnall's* or *zygomatic tubercle* is a palpable elevation on the zygomatic bone just within the orbital margin. It provides attachment to the lateral check ligament of eyeball.

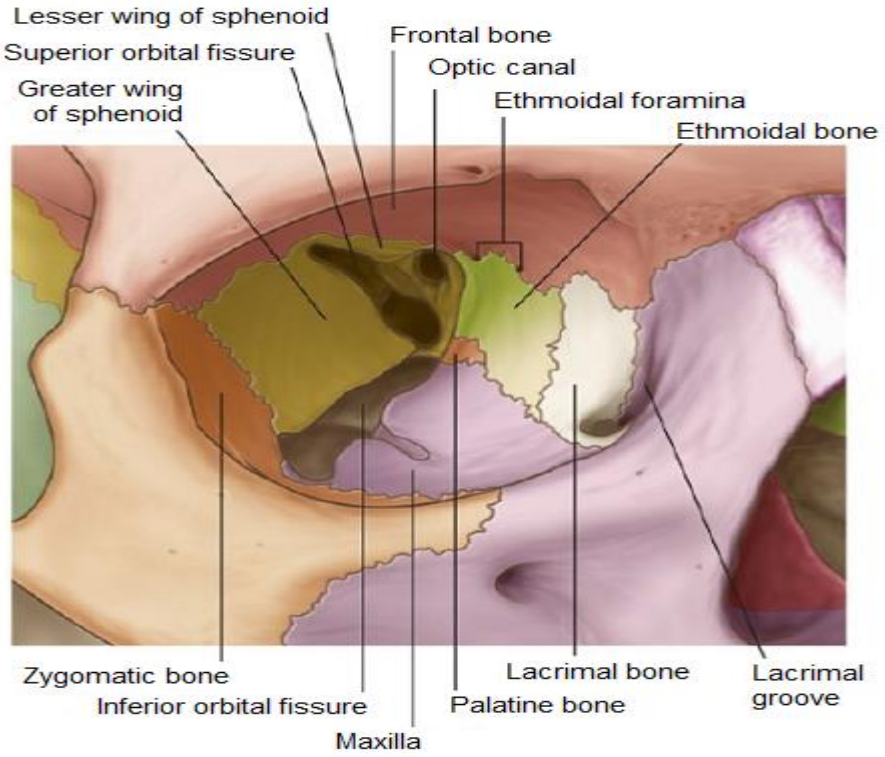


Fig. 38. The bones of the orbit.

Floor. It slopes upwards and medially to join the medial wall. It is formed:

a) mainly by the orbital surface of the maxilla;

b) by the lower part of the orbital surface of the zygomatic bone, anterolaterally;

c) the orbital process of the palatine bone, at the posterior angle.

Relation

It separates the orbit from the maxillary sinus.

Named Features

1. The *inferior orbital fissure* occupies the posterior part of the junction between the lateral wall and floor. Through this fissure, the orbit communicates with the infratemporal fossa anteriorly and with the pterygopalatine fossa posteriorly.

2. The *infraorbital groove* runs forwards in relation to the floor.

3. A small depression on anteromedial part of the floor gives origin to *inferior oblique muscle.*

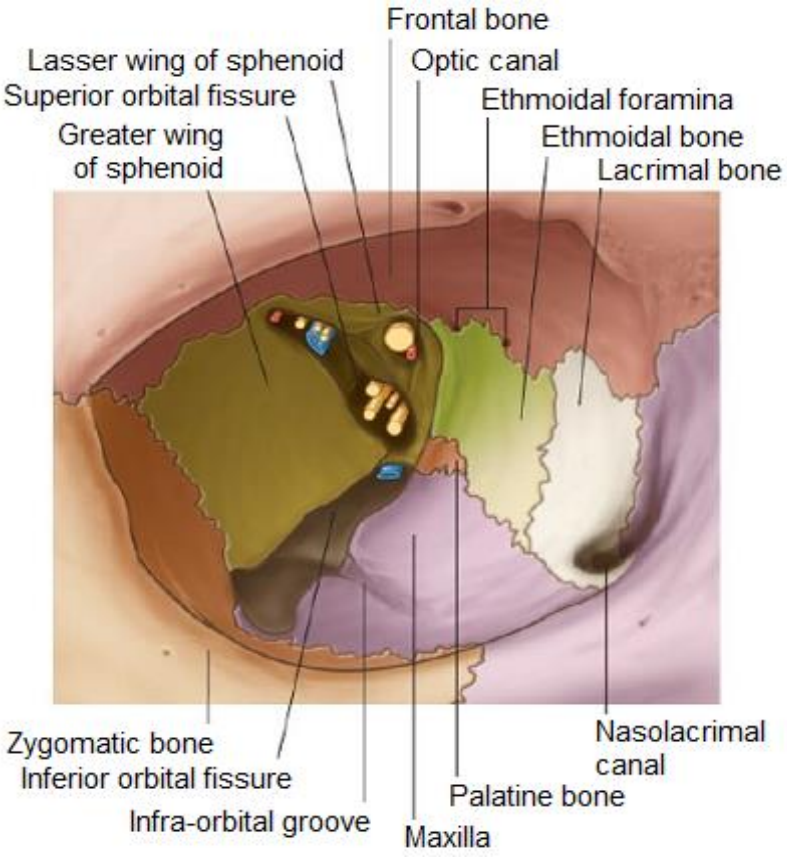


Fig. 39. Openings into the bony orbit.

Medial Wall. It is very thin. From before backwards it is formed by:

1. The frontal process of the maxilla.
2. The lacrimal bone.
3. The orbital plate of the ethmoid.
4. The body of the sphenoid bone.

Relations

1. The *lacrimal groove,* formed by the maxilla and the lacrimal bone, separates the orbit from the nasal cavity.
2. The orbital plate of the ethmoid separates the orbit from the ethmoidal air sinuses.
3. The sphenoidal sinuses, are separated from the orbit only by a thin layer of bone.

Named Features

A. The lacrimal groove lies anteriorly on the medial wall. It is bounded anteriorly by the lacrimal crest of the frontal process, of the maxilla, and posteriorly by the crest of the lacrimal bone. The floor of the groove is formed by the maxilla in front and by the lacrimal bone behind. The groove lodges the lacrimal sac, which lies deep to the lacrimal fascia bridging the lacrimal groove. The groove leads inferiorly, through the nasolacrimal duct, to the inferior meatus of the nose.

B. The *anterior and posterior ethmoidal foramina* lie on the frontoethmoidal suture, at the junction of the roof and medial wall.

Foramina in Relation to the Orbit

1.The structures passing through the *superior orbital fissure*: the *oculomotor nerve*; the *trochlear nerve*; the *lacrimal, frontal* and *nasociliary* branches of the *ophthalmic nerve;* the *abducent nerve*; the *superior ophthalmic vein*.

2. The *optic canal* transmits the *optic nerve, ophthalmic artery*.

3. The *inferior orbital fissure* transmits the *zygomatic nerve,* the *orbital branches of the pterygopalatine ganglion,* the *infraorbital nerve and vessels,* and the communication between the inferior ophthalmic vein and the pterygoid plexus of veins.

4. The *infraorbital groove and canal* transmit the corresponding nerve and vessels.

5. The *zygomatic foramen* transmits the zygomatic nerve.

6.The *anterior ethmoidal foramina* transmit the corresponding nerves and vessels.

7. The *posterior ethmoidal foramina* transmit the corresponding nerves and vessels.

The nasal cavity.

The nasal cavity (cavum nasi; nasal fossa). The nasal cavities are two irregular spaces, situated one on either side of the middle line of the face,

extending from the base of the cranium to the roof of the mouth, and separated from each other by a thin vertical septum. They open on the face through the pear-shaped anterior nasal aperture, and their posterior openings or choanae communicate, in the fresh state, with the nasal part of the pharynx. They are much narrower above than below and in the middle than at their anterior or posterior openings: their depth, which is considerable, is greatest in the middle. They communicate with the frontal, ethmoidal, sphenoidal, and maxillary sinuses.

Each cavity is bounded by a *roof, a floor, a medial and a lateral walls*. The ***roof*** is horizontal in its central part, but slopes downward in front and behind. It is formed:

a) *in front* by the nasal bone and the spine of the frontal;

b) *in the middle* by the cribriform plate of the ethmoid;

c) *behind* by the body of the sphenoid, the sphenoidal concha, the ala of the vomer and the sphenoidal process of the palatine bone.

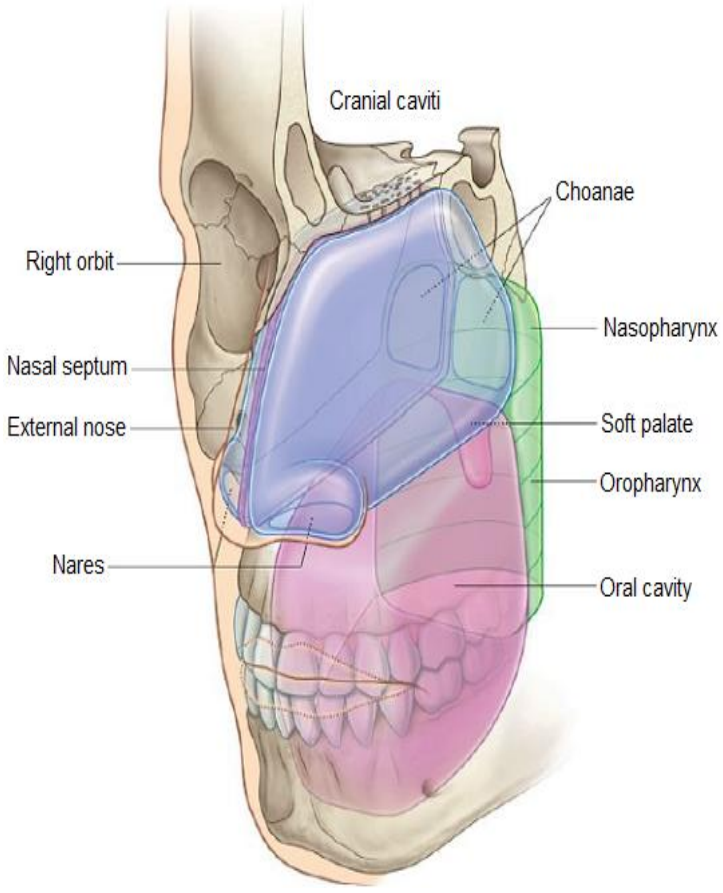


Fig. 40. Nasal cavity. Anterolateral view. Relationship to other cavities.

In the cribriform plate of the ethmoid are the foramina for the olfactory nerves, and on the posterior part of the roof is the opening into the sphenoidal sinus.

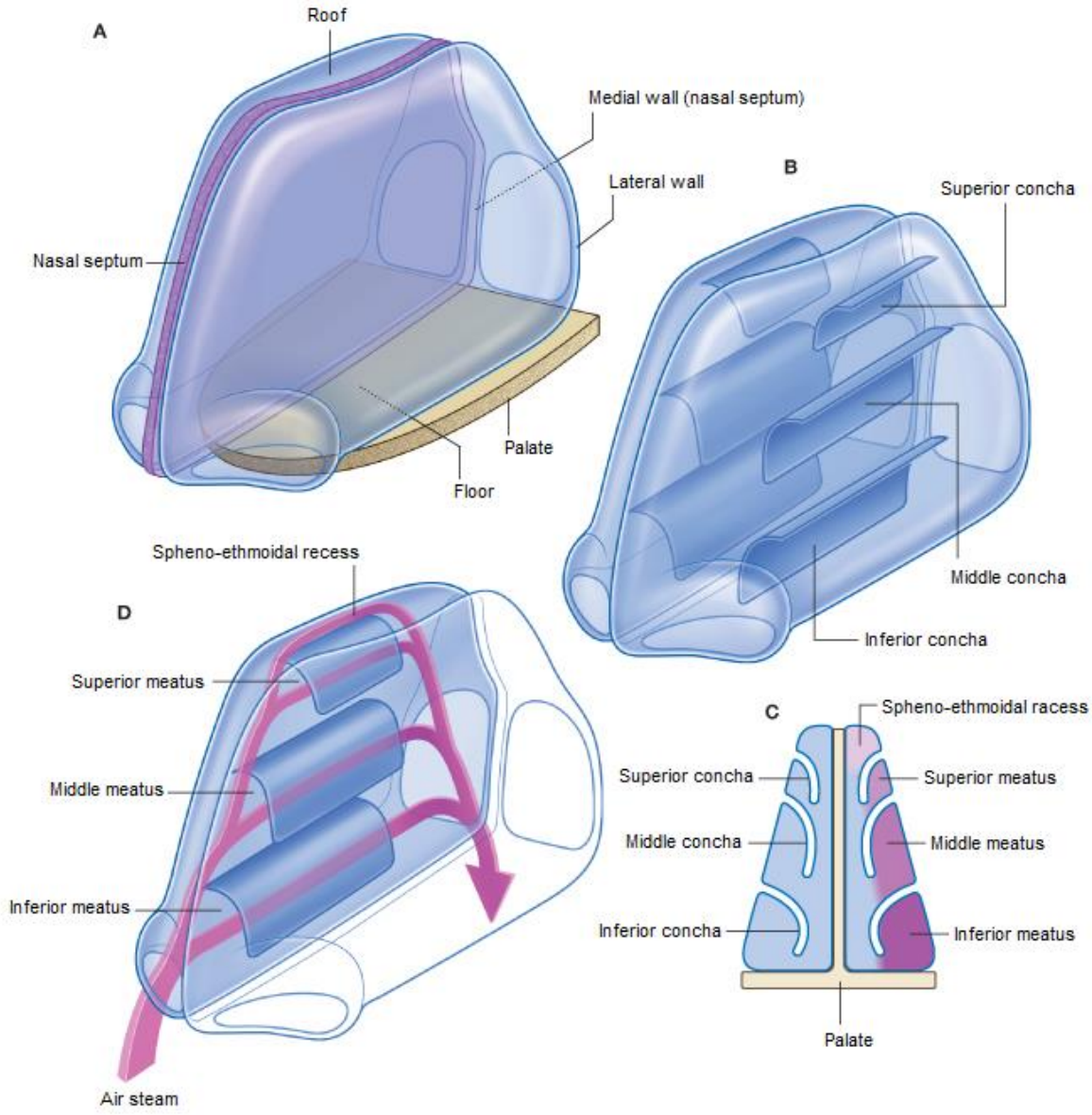


Fig. 41. Nasal cavities. A – Floor, roof, and lateral walls. B – Conchae on lateral walls. C – Coronal section. D – Air channels in right nasal cavity.

The openings of the paranasal sinuses, which are extensions of the nasal cavity that erode into the surrounding bones during childhood and early adulthood, are on the lateral wall and roof of the nasal cavities. In addition, the

lateral wall also contains the opening of the nasolacrimal duct, which drains tears from the eye into the nasal cavity.

The floor is flattened from before backward and concave from side to side. It is formed by the *palatine process of the maxilla and the horizontal part of the palatine bone;* near its anterior end is the opening of the incisive canal.

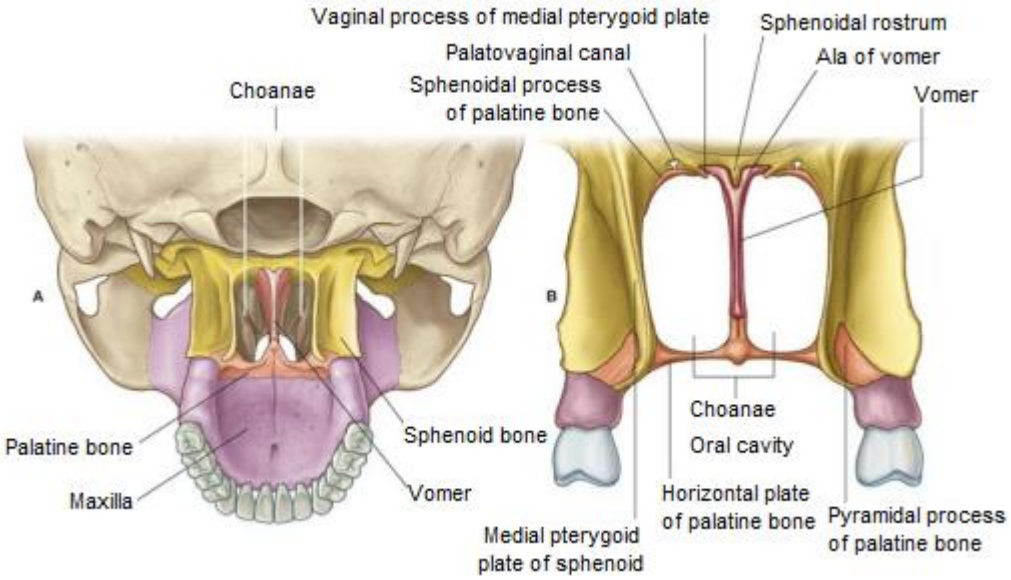


Fig. 42. Choanae (posterior view). A – Overview. B – Magnified view.

The medial wall (septum nasi), is frequently deflected to one or other side, more often to the left than to the right. It is formed:

a) in front, by the *crest of the nasal bones and frontal spine*;

b) in the middle, by the *perpendicular plate of the ethmoid*;

c) behind, by the *vomer* and the *rostrum of the sphenoid*;

d) below, by the *crest of the maxillae* and *palatine bones*.

It presents, in front, a large, triangular notch, which receives the cartilage of the septum; and behind, the free edge of the vomer. Its surface is marked by numerous furrows for vessels and nerves and by the grooves for the nasopalatine nerve, and is traversed by sutures connecting the bones of which it is formed. The ***superior meatus***, the smallest of the three, occupies the middle third of the lateral wall. It lies between the superior and middle nasal conchae; the

sphenopalatine foramen opens into it behind, and the ***posterior ethmoidal cells*** in front.

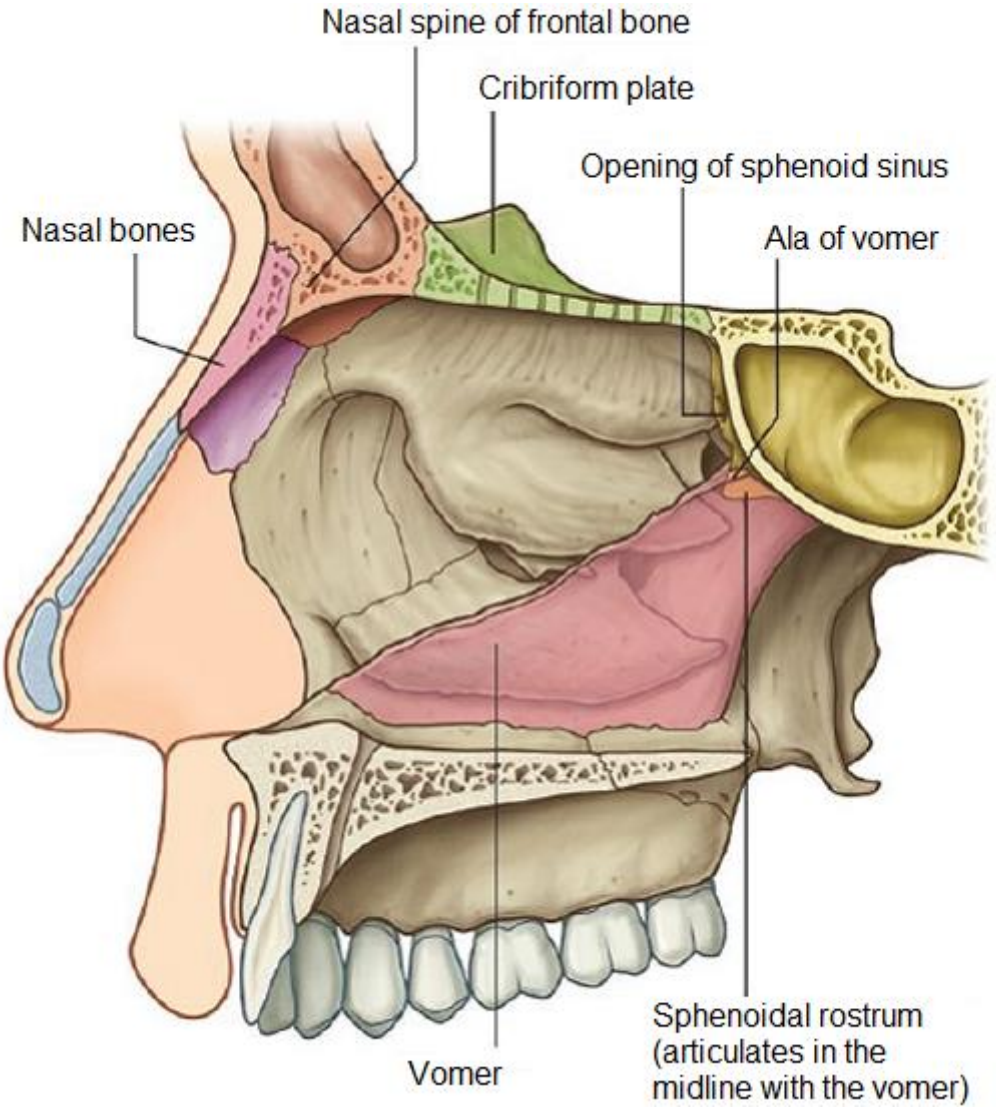


Fig. 43. Roof of the nasal cavity.

The ***sphenoidal sinus*** opens into a recess, the sphenoethmoidal recess, which is placed above and behind the superior concha.

The ***middle meatus*** is situated between the middle and inferior conchae, and extends from the anterior to the posterior end of the latter. The lateral wall of this meatus can be satisfactorily studied only after the removal of the middle concha. On it is a curved fissure, the hiatus semilunaris, limited below by the edge of the uncinate process of the ethmoid and above by an elevation named the bulla ethmoidalis; the **middle ethmoidal cells** are contained within this bulla

and **open** on or near to it. Through the hiatus semilunaris the meatus communicates with a curved passage termed the infundibulum, which communicates in front with the anterior ***ethmoidal cells*** and in rather more than fifty percent of skulls is continued upward as the frontonasal duct into the frontal air-sinus; when this continuity fails, the frontonasal duct opens

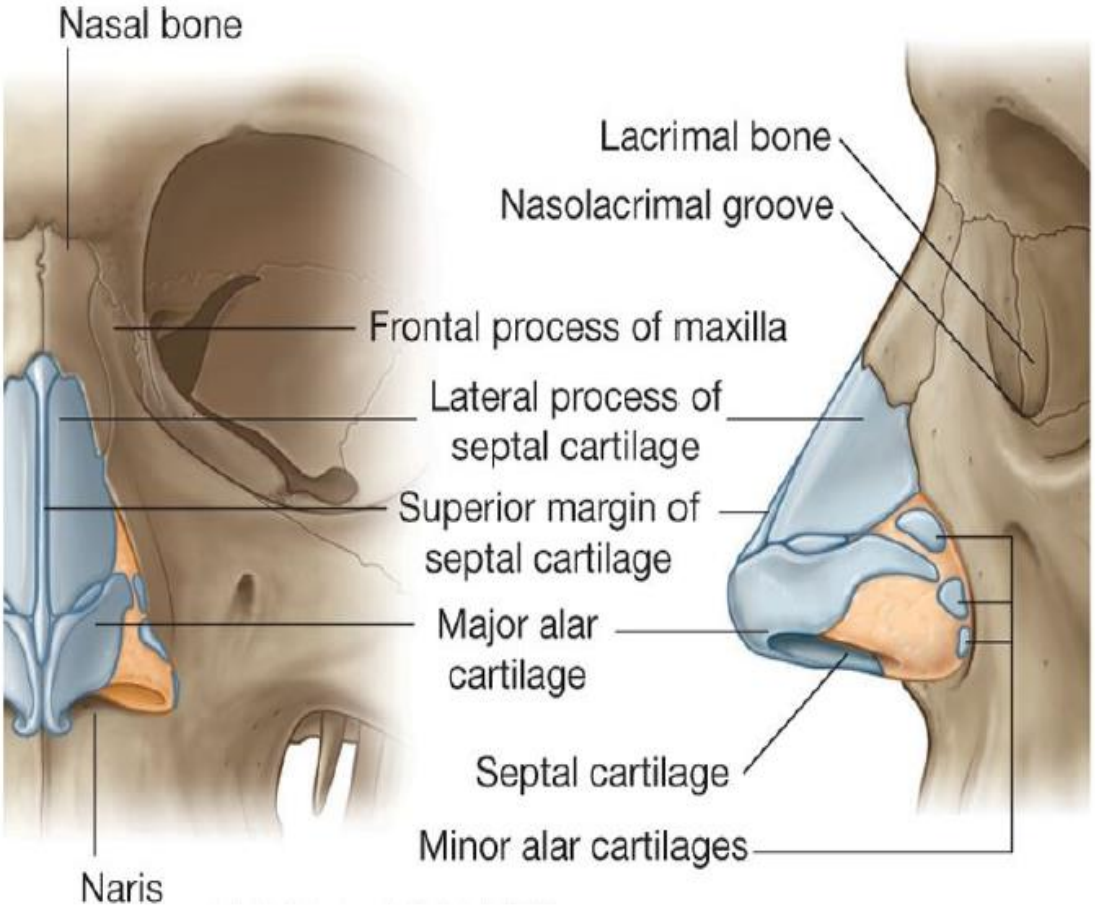


Fig. 44. External nose.

directly into the anterior part of the meatus. Below the bulla ethmoidalis and hidden by the uncinate process of the ethmoid is the opening of the **maxillary sinus** (ostium maxillare); an accessory opening is frequently present above the posterior part of the inferior nasal concha.

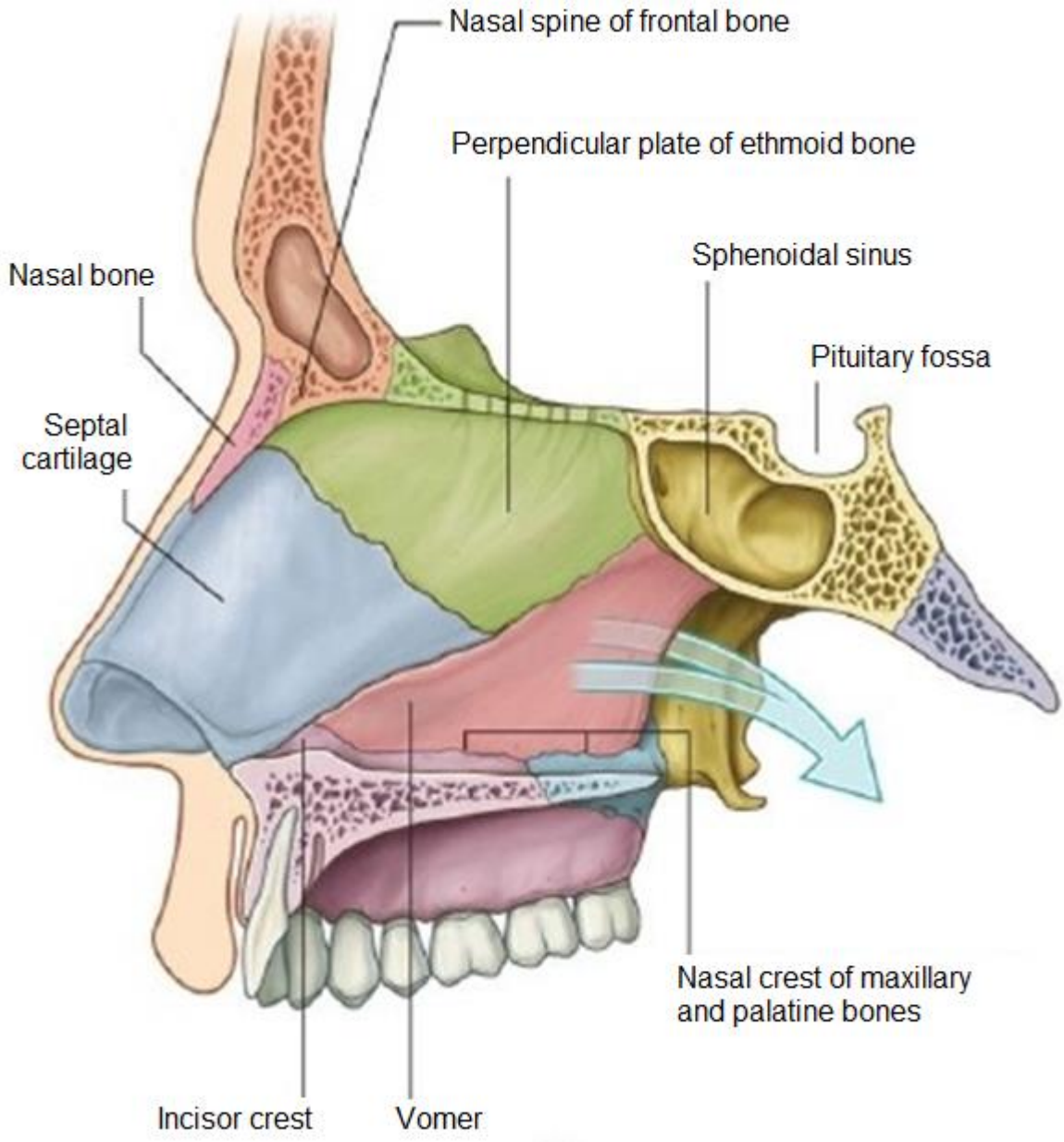


Fig. 45. The nasal cavity. Medial wall.

The ***inferior meatus***, the largest of the three, is the space between the inferior concha and the floor of the nasal cavity. It extends almost the entire length of the lateral wall of the nose, is broader in front than behind, and presents anteriorly the lower orifice of the ***nasolacrimal canal***.

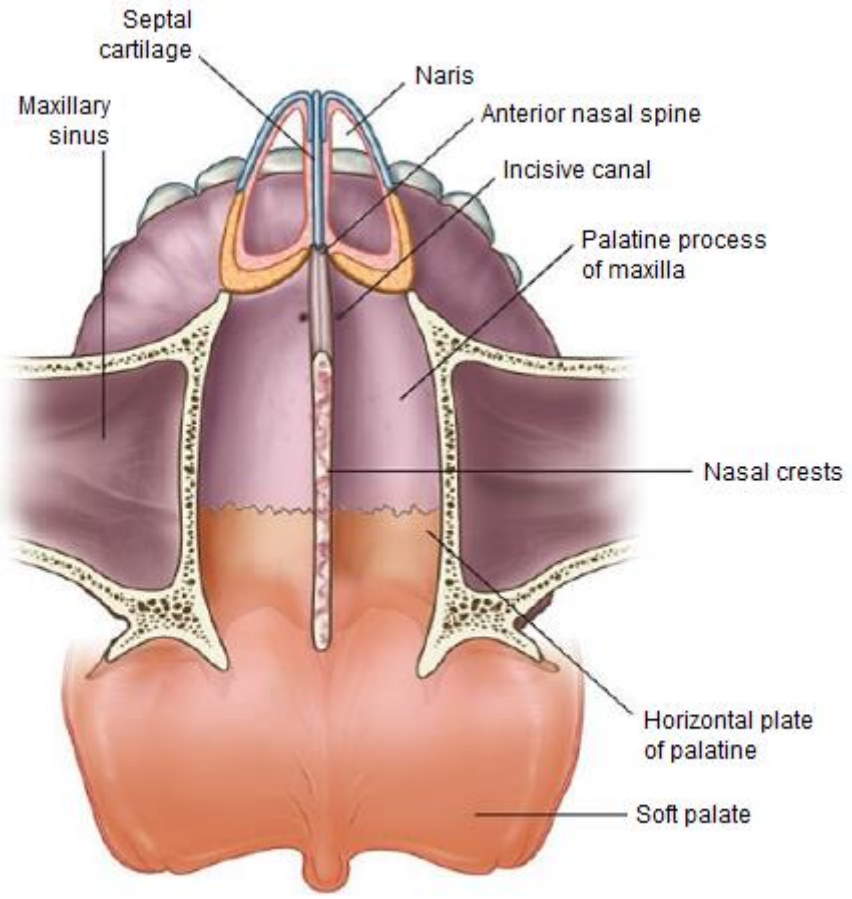


Fig. 46. Floor of the nasal cavity.

The ***Anterior Nasal Aperture*** is a heart-shaped or ***pyriform opening***, whose long axis is vertical and narrow end upward; in the recent state it is much contracted by the lateral and alar cartilages of the nose. It is bounded above by the inferior borders of *the nasal bones*; laterally by the thin, sharp margins which separate the anterior from the *nasal surfaces of the maxillae*; and below by the same borders, where they curve medialward to join each other at the *anterior nasal spine*.

The ***choanae*** are each bounded above by the under surface of the *body of the sphenoid and ala of the vomer*; below, by the posterior border of the *horizontal part of the palatine bone*; laterally, by the *medial pterygoid plate*; they are separated from each other by the posterior border of the *vomer*.

The moist, warm vascular lining within the nasal cavity is susceptible to infections, particularly if a person is not in good health. Infections of the nasal

cavity can spread to several surrounding areas. The paranasal sinuses connect to the nasal cavity and are especially prone to infection. The eyes may become reddened and swollen during a nasal infection because of the connection of the nasolacrimal duct, through which tears drain from the anterior surface of the eye to the nasal cavity. Organisms may spread via the auditory tube from the nasopharynx to the middle ear. With prolonged nasal infections, organisms may even ascend to the meninges covering the brain via the sheaths of the olfactory nerves and pass through the cribriform plate to cause *meningitis.*

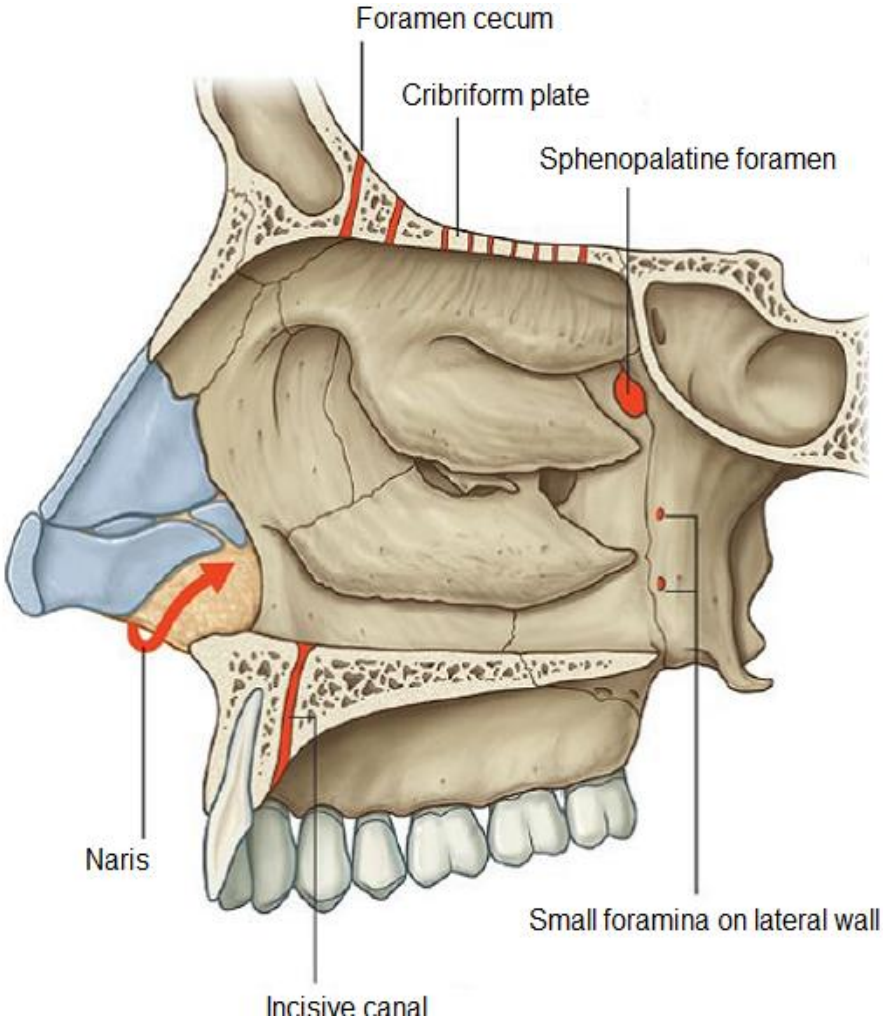


Fig. 47. Gateways to the nasal cavities.

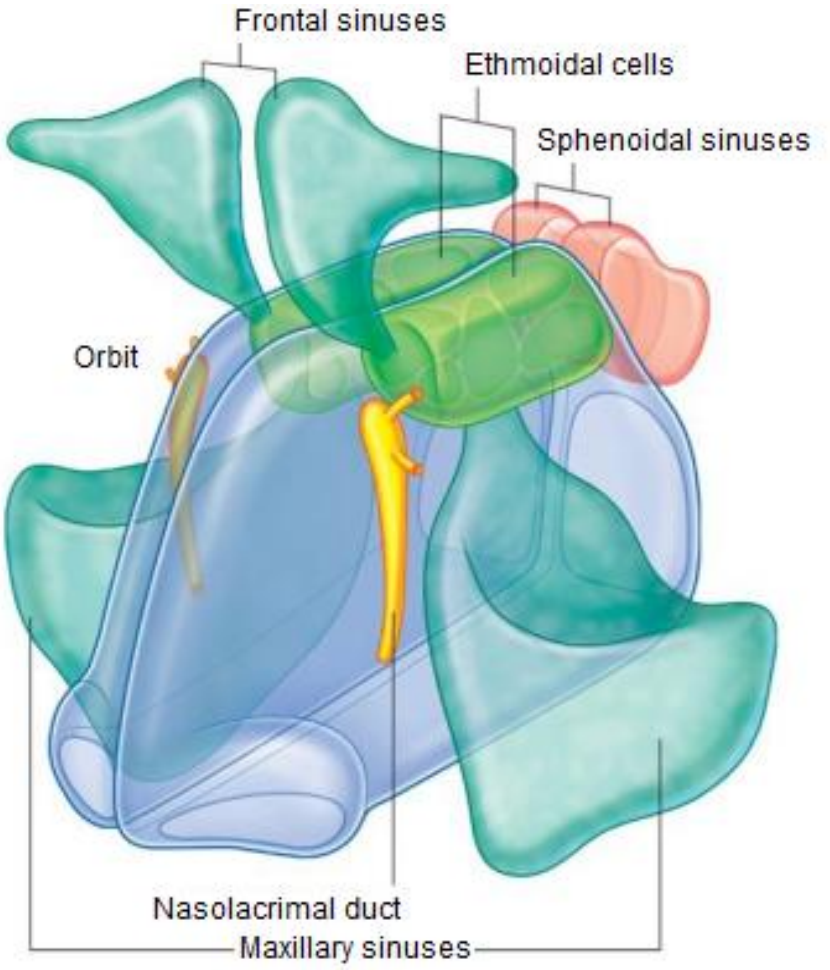


Fig. 48. Paranasal sinuses and nasolacrimal duct.

The accessory nasal sinuses, their clinical aspects

The nasal sinuses are air-containing sacs lined by ciliated epithelium and communicating with the nasal cavity through narrow, and therefore easily occluded, channels. The maxillary antrum and sphenoid sinuses are present in a rudimentary state at birth, the rest become evident at about the 8th year, but all become fully formed only in adolescence.

The frontal sinuses

The frontal sinuses are contained in the frontal bone. They vary greatly in size and one or both are occasionally absent. In section each is roughly triangular, its anterior wall forming the prominence of the forehead, its posterosuperior wall lying adjacent to the frontal lobe of the brain, and its floor

abutting against the ethmoid cells, the roof of the nasal fossa and the orbit.

The frontal sinuses are separated from each other by a median bony septum, and each in turn is further broken up by a number of incomplete septa. Each sinus drains into the anterior part of the middle nasal meatus via the infundibulum into the hiatus semilunaris.

Clinical features

1. The close relation of the frontal sinus to the frontal lobe of the brain explains how infection of this sinus may result in the development of a frontal lobe abscess.
2. A fracture involving the sinus, severe enough to tear the dura and piaarachnoid, will place the subarachnoid space in communication with the nasal cavity and cerebrospinal fluid (C.S.F.) may then be detected trickling through the nostril, usually on the affected side (C.S.F. rhinorrhoea) although, as these sinuses may communicate, a contralateral leak sometimes occurs.
3. The neurosurgeon must take into account the considerable variations in size and extent of the frontal sinus when proposing to turn down a frontal skull flap; obviously, he will want to avoid opening the sinus because of the risk of infection. He therefore consults the radiographs of the patient's skull preoperatively, which will clearly show the configuration of the sinuses.

The maxillary sinus (antrum of Highmore)

This is a pyramidal-shaped sinus occupying the cavity of the maxilla. Its medial wall forms part of the lateral face of the nasal cavity and bears on it the inferior concha. Above this concha is the opening, or *ostium*, of the maxillary sinus into the middle meatus in the hiatus semilunaris. This opening, unfortunately, is inefficiently placed as an adequate drainage point.

The infra-orbital nerve lies in a groove which bulges down into the roof of the sinus, while its floor bears the impressions of the upper premolar and molar roots. These roots are separated only by a thin layer of bone which may, in fact, be deficient so that uncovered dental roots project into the sinus. Note

that the floor of the sinus, therefore, corresponds to the level of the alveolus and not to the floor of the nasal cavity – it actually extends about 0.5in (12mm) lower than the latter.

Clinical features

1. The maxillary sinus, or antrum, may become infected either from the nasal cavity or from caries of the upper molar teeth. Antral puncture can be carried out using a trocar and cannula passed through the nasal cavity in an outward and backward direction below the inferior concha.

More adequate drainage may require removing a portion of the medial wall of the sinus below the inferior concha or fenestrating the antrum in the gingivolabial fold (Caldwell Luc operation). The old operation of draining the antrum via an extracted upper molar tooth is now seldom, if ever, performed.

2. The numerous symptoms and signs which may be produced by a carcinoma of the maxillary sinus are easily remembered anatomically.

(a) Medial invasion encroaches on the nasal cavity, producing obstruction of the nares and epistaxis. Blockage of the nasolacrimal duct in this wall may cause epiphorea (leakage of tears down the face).

(b) Invasion of the orbit displaces the globe and causes diplopia. If the infra-orbital nerve becomes involved, there will be facial pain and then anaesthesia of the skin over the maxilla.

(c) Invasion of the sinus floor may produce a visible bulge or even ulceration in the palatal roof.

(d) Lateral spread may produce a swelling of the face or a palpable mass in the gingivolabial fold.

(e) Posterior spread may involve the palatine nerves and produce severe pain referred to the teeth of the upper jaw.

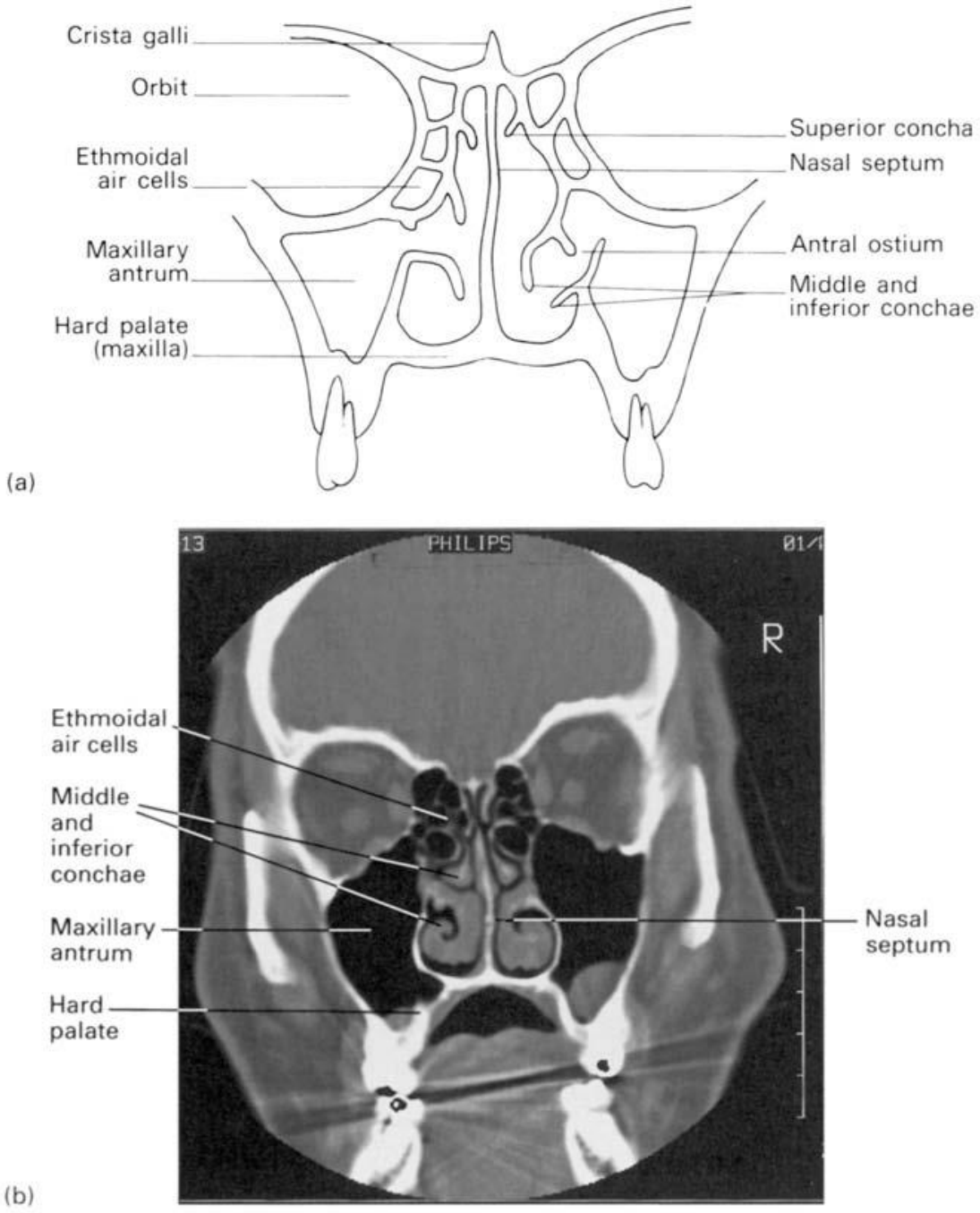


Fig. 49 (a) The maxillary antrum in coronal section. (Note the inefficient drainage of this antrum and its close inferior relationship to the teeth.) (b) The corresponding CT scan.

The ethmoid sinuses

The ethmoid sinuses are made up of a group of 8–10 air cells within the lateral mass of the ethmoid and lie between the side-walls of the upper nasal cavity and the orbits. Superiorly, they lie on each side of the cribiform plate and

are related above to the frontal lobes of the brain. These cells drain into the superior and middle meatus.

Clinical features

As with the frontal sinus, infection (ethmoiditis) may result in a frontal cerebral abscess and an ethmoidal fracture may cause a C.S.F. leakage into the nasal cavity.

The sphenoid sinuses

These lie one on either side of the midline, within the body of the sphenoid. They vary a good deal in size and may extend laterally into the greater wing of the sphenoid or backwards into the basal part of the occipital bone.

Each sinus drains into the nasal cavity above the superior concha (the sphenoethmoidal recess).

Clinical features

The pituitary gland may be excised through a fibre-optic transnasal, transsphenoidal approach in patients with pituitary tumour.

Abstract. The paranasal sinuses increase the surface of mucosa, enfold the acoustic, vestibular, visual, olfactory and gustatory apparatuses, warm air acting as heat insulation and keep constant temperature around the sense organs. Moreover, they serve as vocal resonators and decrease weight of cranial bones.

The moist, warm vascular lining within the nasal cavity is susceptible to infections, particularly if a person is not in good health. Infections of the nasal cavity can spread to several surrounding areas. The paranasal sinuses connect to the nasal cavity and are especially prone to infection. The eyes may become reddened and swollen during a nasal infection because of the connection of the nasolacrimal duct, through which tears drain from the anterior surface of the eye to the nasal cavity. Organisms may spread via the auditory tube from the nasopharynx to the middle ear. With prolonged nasal infections, organisms may even ascend to the meninges covering the brain via the sheaths of the olfactory nerves and pass through the cribriform plate to cause *meningitis.*

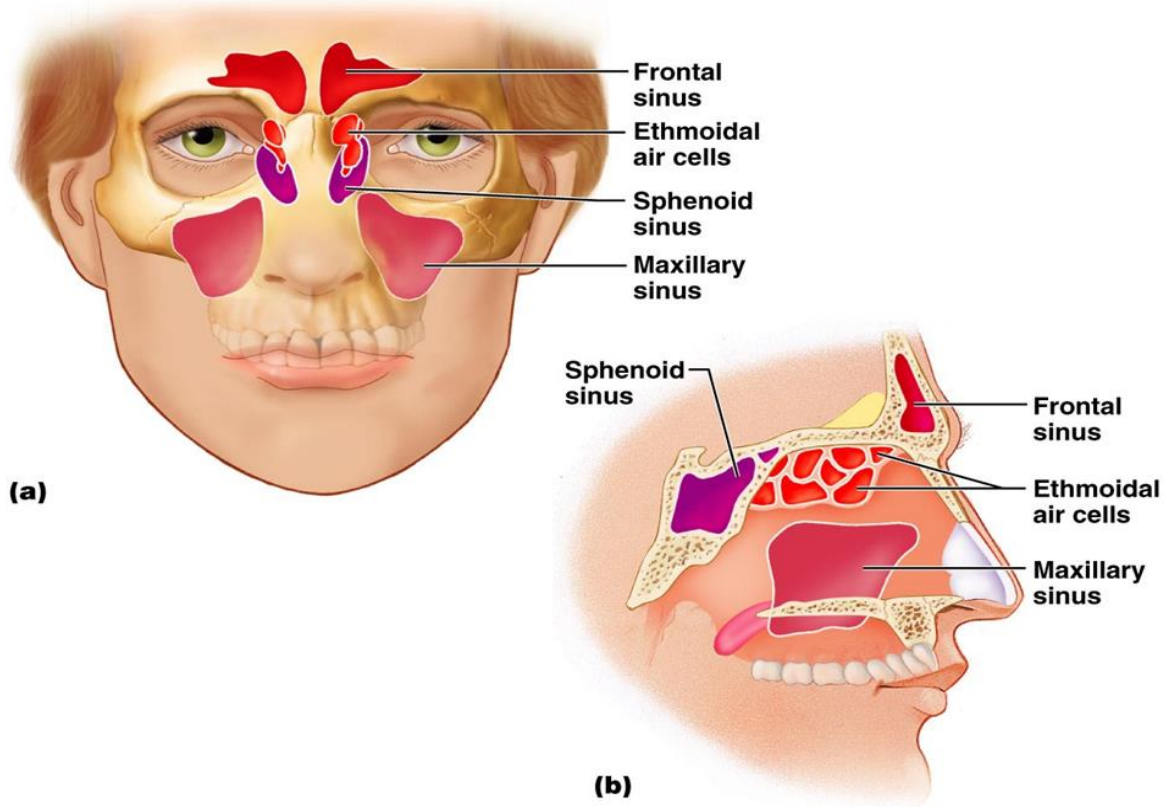


Fig. 50. Paranasal sinuses.

A – Paranasal sinuses in coronal section.

B – Paranasal sinuses in sagittal section.

The paranasal sinuses often develop inflammatory diseases (antritis, frontal sinusitis). Infection may infiltrate sinuses either from the nasal mucosa or from corrupted teeth (odontogenic sinusitis). The sinuses may accumulate pus, which requires removal by means of puncturing. Apart from medication surgical opening of the sinuses may be performed. Inflammation of the paranasal sinuses is dangerous because they neighbor the brain, eyes and hypophysis. Pus may erode bony walls of the cavities and severely affect the neighboring organs. The mucosa, tunica mucosa is divided into olfactory and respiratory regions. The olfactory region, pars olfactoria is the portion of superior nasal meatus mucosa and the respective area of the nasal septum (about 2 cm^2). This part is lined with yellowish olfactory epithelium, which contains olfactory receptors.

The often reason of functioning disorders in respiratory region is rhinitis (from Greek ‘rhinos’ – nose and ‘-ids’ – the suffix, which denotes inflammation). Chilling, irritation, viruses and allergens may cause inflammation and swelling of the mucosa.

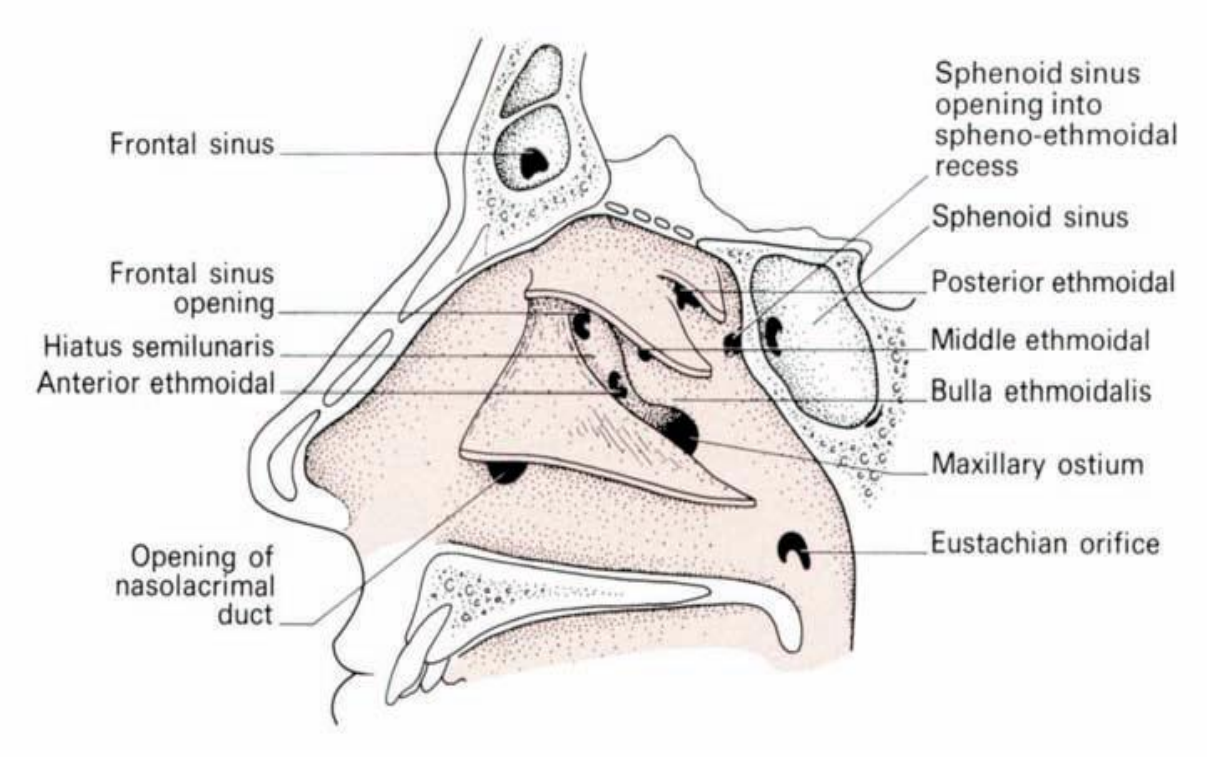


Fig. 51. The lateral wall of the right nasal cavity; the conchae have been partially removed to show structures which drain into the nose.

Skull joints

The joints in the skull are mostly sutures, a few primary cartilaginous joints and three pairs of synovial joints. Two pairs of synovial joints are present between the ossicles of middle ear. One pair is the largest temporomandibular joint. This mobile joint permits us to speak, eat, drink and laugh. Sutures are: Plane — internasal suture. Serrate — interparietal suture. Denticulate — lambdoid suture. Squamous — parietotemporal suture

Anatomical position of the skull

The skull can be placed in proper orientation by considering any one of the two planes.

1. **Reid's base** line is a horizontal line obtained by joining the infraorbital margin to the center of external acoustic meatus, i.e. auricular point.

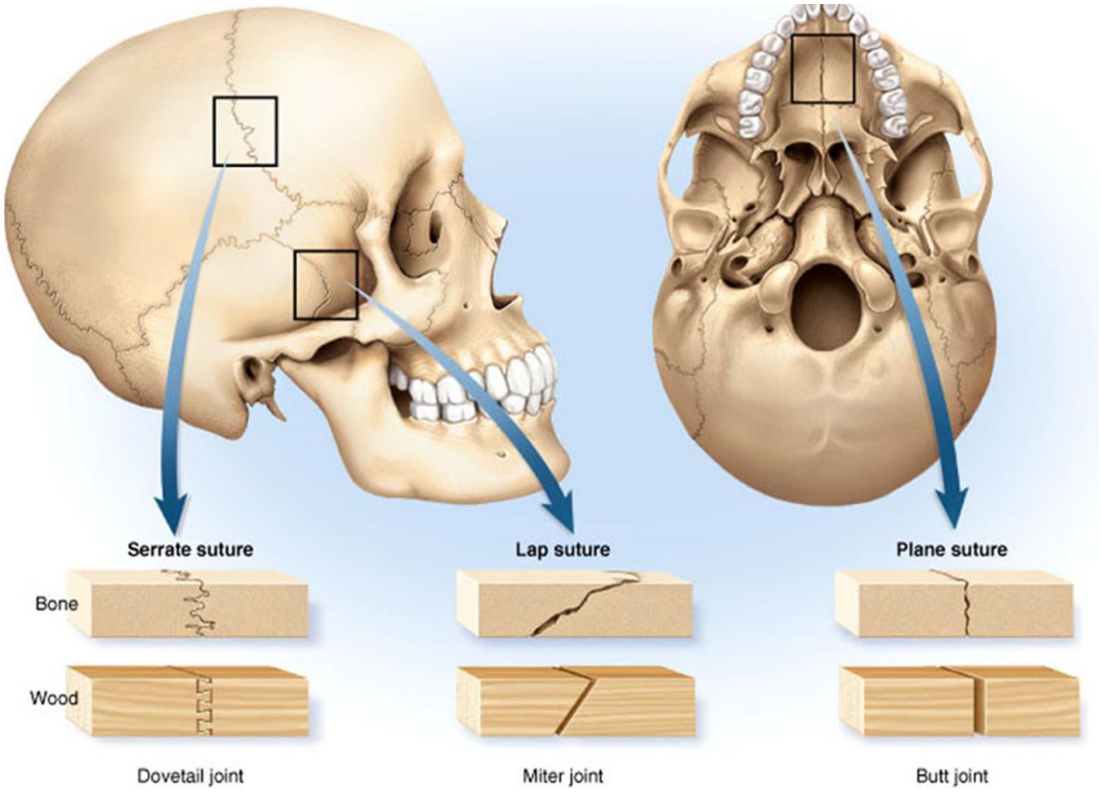


Fig. 52. Sutures of the skull.

2. **The Frankfurt's horizontal plane** of orientation is obtained by joining the infraorbital margin to the upper margin of the external acoustic meatus.

The skull can be studied as a whole. This is of greater practical importance and utility than knowing the details of individual bones.

The whole skull can be studied from the outside or externally in different views:

- Superior view or norma verticalis.
- Posterior view or norma occipitalis.
- Anterior view or norma frontalis.
- Lateral view or norma lateralis.
- Inferior view or norma basalis.

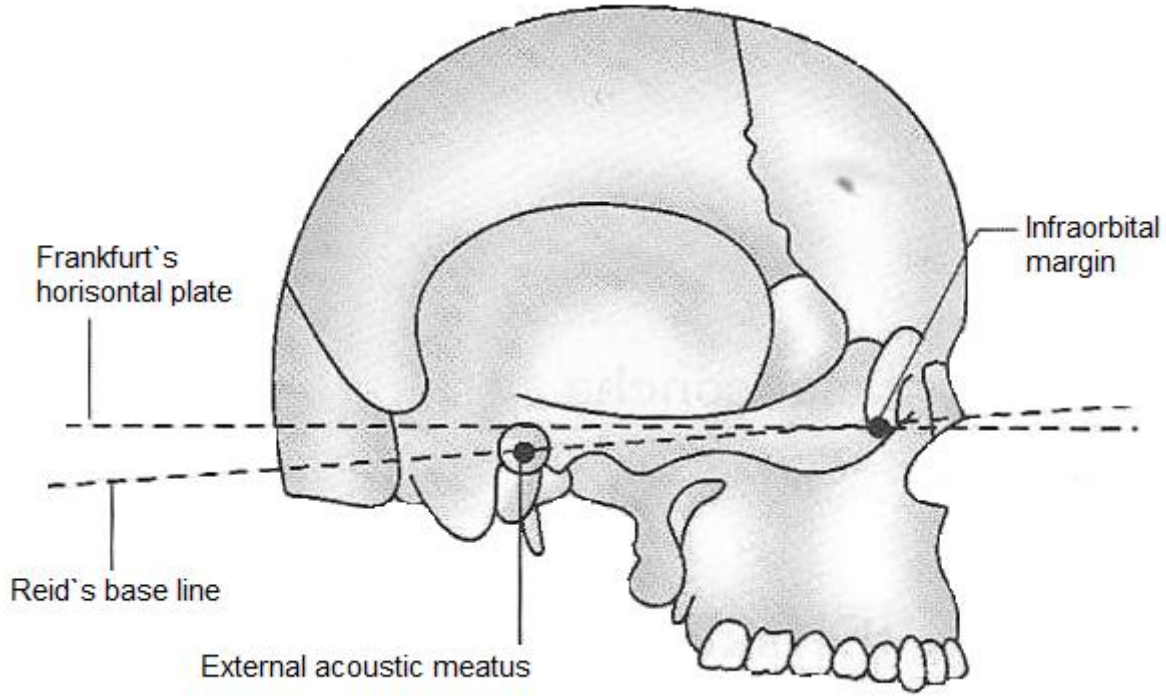


Fig. 53. Anatomical position of skull.

Methods of study of the skull

The whole skull can be studied from the inside or internally after removing the roof of the calvaria or skullcap:

- Internal surface of the cranial vault.
- Internal surface of the cranial base, which shows a natural subdivision into anterior, middle and posterior cranial fossae.

Peculiarities of skull bones

- Base of skull ossifies in cartilage while the skullcap ossifies in membrane.
- At birth, skull comprises one table only. By 4 years or so, two tables are formed. Between the two tables are diploe containing red bone marrow forming RBC, granular series of WBC and platelets. Four diploic veins drain formed blood cells into neighbouring veins.
- At birth, the four angles of parietal bone have membranous gaps or fontanelles. These allow overlapping of bones during vaginal delivery, if

required. These also allow skull bones to increase in size after birth, for housing the delicate brain.

- Some skull bones have air cells in them and are called pneumatic bones, e.g. frontal, maxilla. These give resonance to voice. These may get infected resulting in sinusitis.
- Skull bones are united mostly by sutures.
- Skull has foramina for "emissary veins" which connect intracranial venous sinuses with extracranial veins. These try to relieve raised intracranial pressure. Infection may reach through the emissary veins into cranial venous sinuses.
- Petrous temporal is the densest bone of the body. It lodges internal ear, middle ear including three ossicles, i.e. malleus, incus and stapes. Ossicles are bones within the bone and are fully formed at birth.
- Skull lodges brain, meninges, CSF, glands like hypophysis and pineal dland, venous sinuses, teeth, special senses like retina of eyeball, taste buds of tongue, olfactory epithelium, cochlear and vestibular nerve endings.

NORMA VERTICALIS

When viewed from above the skull is usually oval in shape. It is wider posteriorly than anteriorly. The shape may be more nearly circular.

Bones Seen in Norma verticalis:

- Upper part of frontal bone anteriorly.
- Uppermost part of occipital bone posteriorly.
- A parietal bone on each side.

Sutures

Coronal suture: this is placed between the frontal bone and the two parietal bones. The suture crosses the cranial vault from side to side and runs downwards and forwards.

- *Sagittal suture:* It is placed in the median plane between the two parietal bones.

• *Lambdoid suture:* It lies posteriorly between the occipital and the two parietal bones, and it runs downwards and forwards across the cranial vault.

• *Metopic suture:* This is occasionally present in about 3 to 8% individuals. It lies in the median plane and separates the two halves of the frontal bone.

Some other named features

1. *Vertex is* the highest point on sagittal suture.
2. *Vault* of skull is the arched roof for the dome of skull.
3. *Bregma* is the meeting point between the coronal and sagittal sutures. In the foetal skull, this is the site of a membranous gap, called the anterior fontanelle, which closes at 18 months of age. It allows growth of brain.
4. The *lambda* is the meeting point between the sagittal and lambdoid sutures. In the foetal skull, this is the site of the posterior fontanelle, which closes at 2 to 3 months of age.
5. The *parietal tuber (eminence)* is the area of maximum convexity of the parietal bone. This is a common site of fracture of the skull.
6. The *parietal foramen,* one on each side, pierces the parietal bone near its upper border, 2.5 to 4 cm in front of the lambda. The *parietal* foramen transmits an emissary vein from the veins of scalp into superior sagittal sinus.
7. The *obelion* is the point on the sagittal suture between the two parietal foramina.
8. The *temporal lines* begin at the zygomatic process of the frontal bone, arch backwards and upwards, and cross the frontal bone, the coronal suture and the parietal bone. Over the parietal bone, there are two lines, superior and inferior. Traced anteriorly, they fuse to form a single line. Traced posteriorly, the superior line fades out over the posterior part of the parietal bone, but the inferior temporal line continues downwards and forwards.

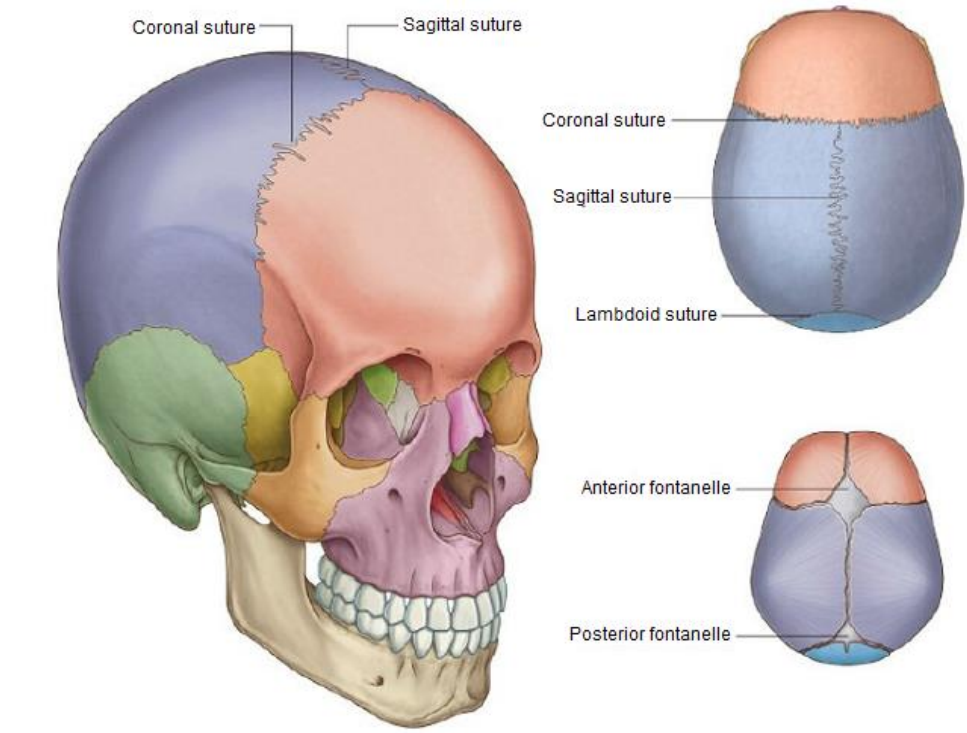


Fig. 54. The sutures and fontanelles of the skull.

NORMA OCCIPITALIS

Norma occipitalis is convex upwards and on each side, and is flattened below.

Bones seen

1. Posterior parts of the parietal bones, above.
2. Upper part of the squamous part of the occipital bone below.
3. Mastoid part of the temporal bone, on each side.

Sutures

1. The *lambdoid suture* lies between the occipital bone and the two parietal bones.
2. The *occipitomastoid suture* lies between the occipital bone and mastoid part of the temporal bone.
3. The *parietomastoid suture* lies between the parietal bone and mastoid part of the temporal bone.
4. The posterior part of the *sagittal suture* is also seen.

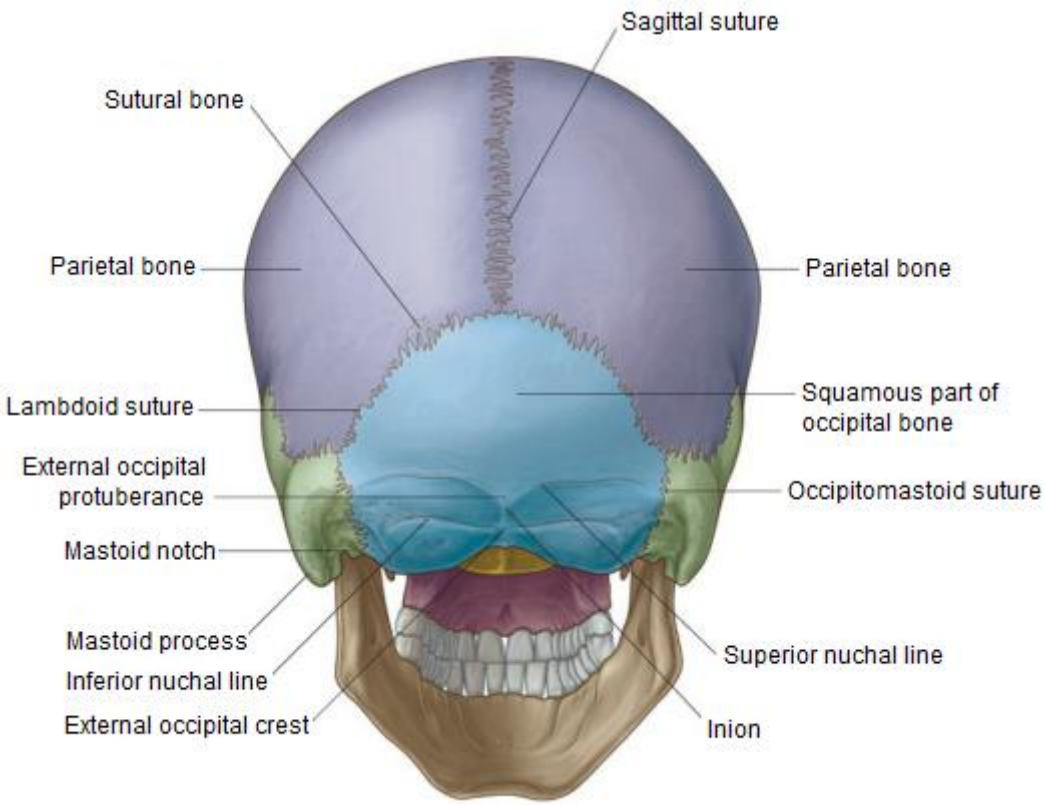


Fig. 55. Norma occipitalis.

Other features

1. *Lambda, parietal foramina* and *obelion* have been examined in the norma verticalis.

2. The *external occipital protuberance* is a median prominence in the lower part of this norma. It marks the junction of the head and the neck. The most prominent point on this protuberance is called the *inion.*

3. The *superior nuchal lines* are curved bony ridges passing laterally from the protuberance. These also mark the junction of the head and the neck. The area below the superior nuchal lines will be studied with the norma basalis.

4. The *highest nuchal lines* are not always present. They are curved bony ridges situated about 1 cm above the superior nuchal lines. They begin from the upper part of the external occipital protuberance and are more arched than the superior nuchal lines.

5. The *occipital point* is a median point a little above the inion. It is the point farthest from the glabella.

6. The *mastoid foramen* is located on the mastoid part of the temporal bone at or near the occipitomastoid suture. Internally, it opens at the sigmoid sulcus. The mastoid foramen transmits an emissary vein, and the meningeal branch of the occipital artery.

7. The *interparietal bone* is occasionally present. It is a large triangular bone located at the apex of the squamous occipital. This is not a sutural or accessory bone but represents the membranous part of the occipital bone, which has failed to fuse with the rest of the bone.

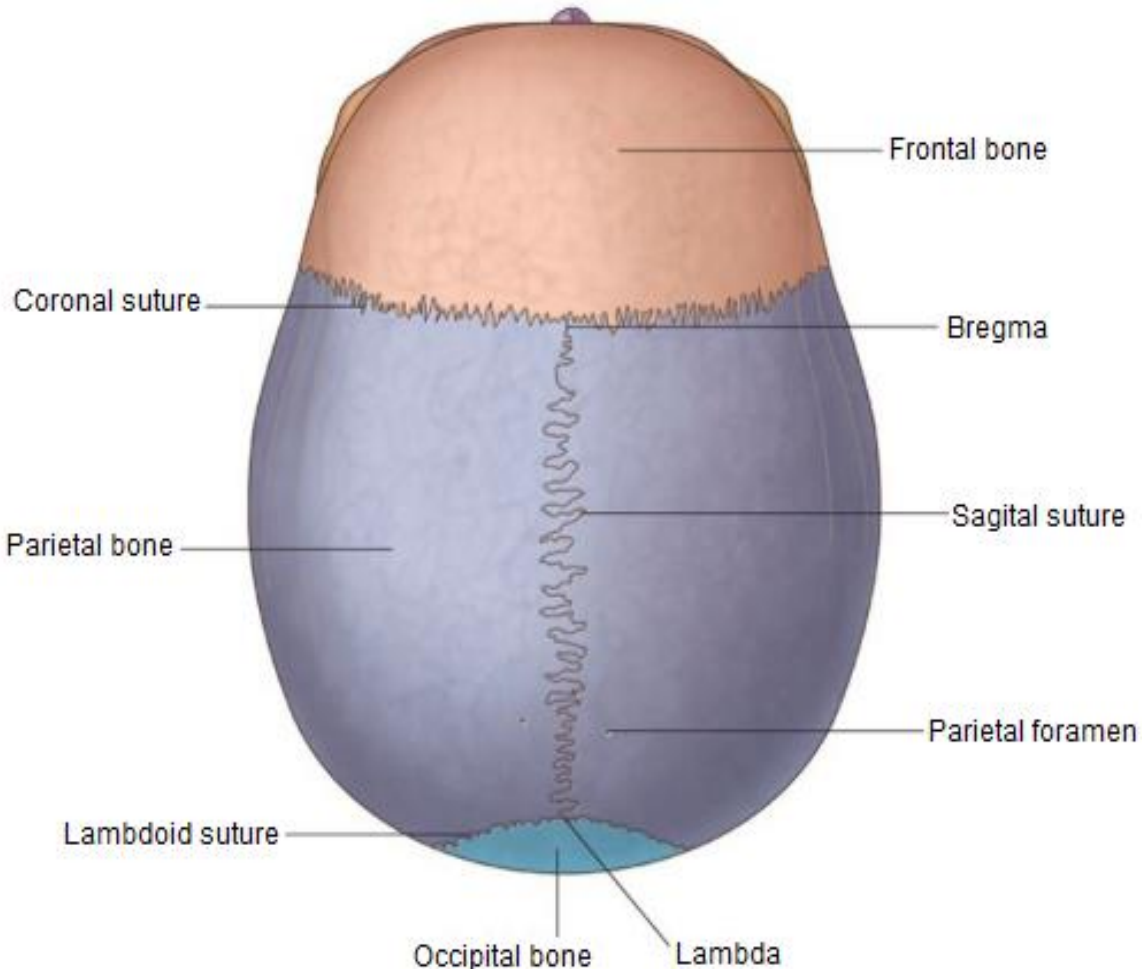


Fig. 56. Superior view of the skull.

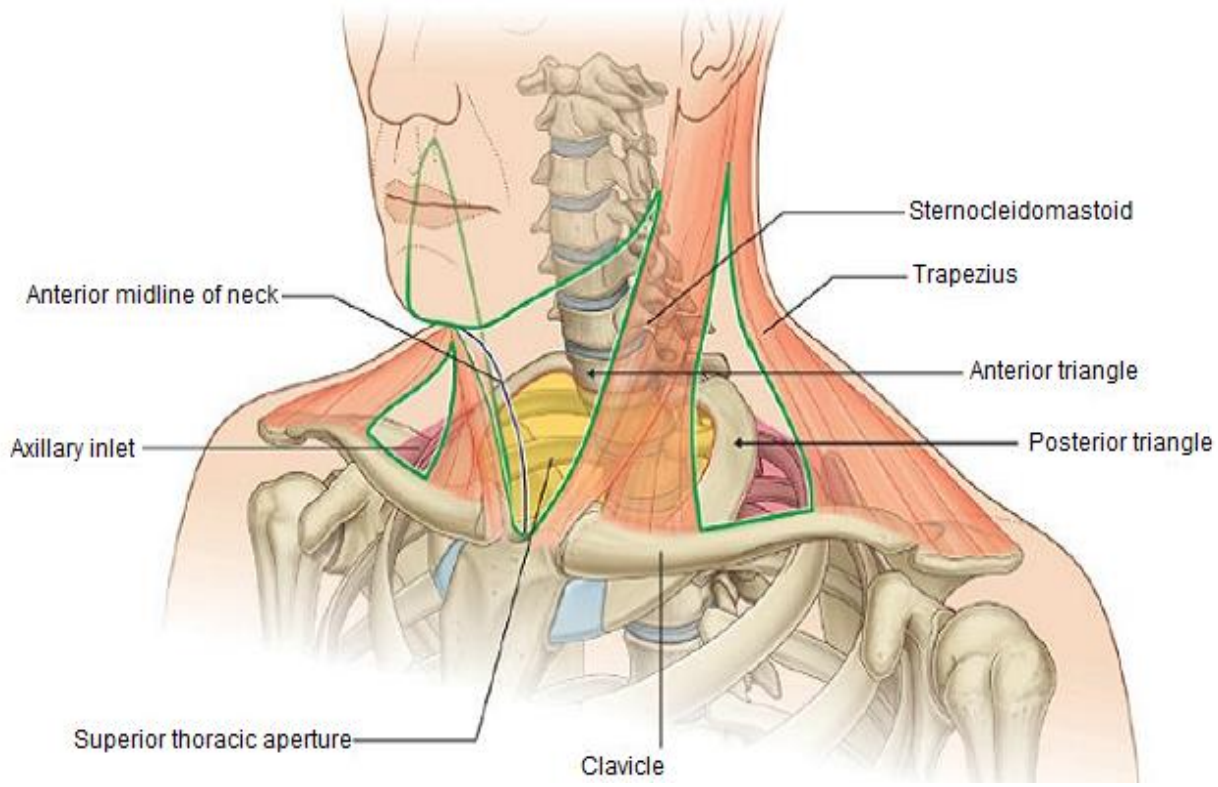


Fig. 57. Muscles of the neck.

Attachments

The upper part of the external occipital protuberance gives origin to the *trapezius,* and the lower part gives attachment to the upper end of the *ligamentum nuchae*.

1. The medial one-third of the superior nuchal line gives origin to the trapezius, and the lateral part provides insertion to the *sternocleidomastoid* above and to the *splenius capitis* below.

2. The highest nuchal lines if present provide attachment to the *epicranial aponeurosis* medially, and give origin to the *occipitalis* or occipital belly of occipitofrontalis muscle laterally. In case of absence of highest nuchal lines, these structures are attached to superior nuchal lines.

NORMA FRONTALIS

The norma frontalis is roughly oval in outline, being wider above than below.

Bones

1. *Frontal* bone forms the forehead. Its upper part is smooth and convex, but the lower part is irregular and is interrupted by the orbits and by the anterior bony aperture of nose.

2. The right and left *maxillae* form the upper jaw.

3. The right and left nasal bones form the bridge of the nose.

4. The zygomatic bones form the bony prominence of the superolateral part of the cheeks.

5. The mandible forms the lower jaw.

The norma frontalis will be studied under the following heads:

- Frontal region.
- Orbital opening.
- Anterior piriform-shaped bony aperture of the nose.
- Lower part of the face.

Frontal region

The frontal region presents the following features:

1. The *superciliary arch* is a rounded, curved elevation situated just above the medial part of each orbit. It overlies the frontal sinus and is better marked in males than in females.

2. *The glabella* is a median elevation connecting the two superciliary arches. Below the glabella, the skull to frontonasal suture at root of the nose.

3. The *nasion* is a median point at the root of the nose where the internasal suture meets with the frontonasal suture.

4. The *frontal tuber* or *eminence* is a low rounded elevation above the superciliary arch, one on each side.

Orbital openings

Each orbital opening is quadrangular in shape and is bounded by the following four margins.

1. The *supraorbital margin* is formed by the frontal bone. At the junction of its lateral two-thirds and its medial one-third, it presents the supraorbital notch or foramen.

2. The *infraorbital margin* is formed by the zygomatic bone laterally, and maxilla medially.

3. The *medial orbital margin* is ill-defined. It is formed by the frontal bone above, and by the lacrimal crest of the frontal process of the maxilla below.

4. The *lateral orbital margin* is formed mostly by the frontal process of zygomatic bone but is completed above by the zygomatic process of frontal bone. *Frontozygomatic suture* lies at their union.

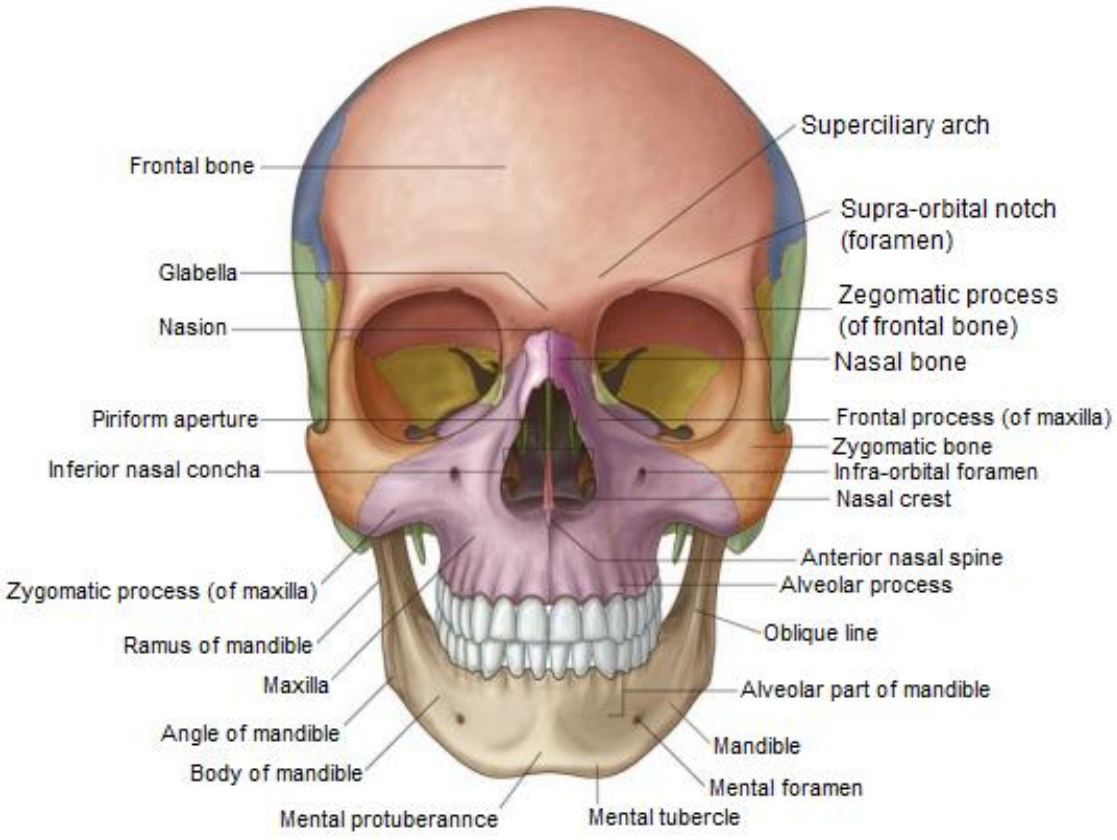


Fig. 58. Norma frontalis.

Anterior Bony Aperture of the Nose

The anterior bony aperture is pear-shaped, being wide below and narrow above. *Boundaries:*

- *Above:* by the lower border of the nasal bones.
- *Below:* by the nasal notch of the body of maxilla on each side.

Features

Note the following:

1. *Articulations of the nasal bone:*

a) *anteriorly,* with the opposite bone at the internasal suture.

b) *posteriorly,* with the frontal process of the maxilla.

c) *superiorly,* with the frontal bone at the frontonasal suture.

d) *inferiorly,* the upper nasal cartilage is attached to it.

2. The *anterior nasal spine* is a sharp projection in the median plane in the lower boundary of the piriform aperture.

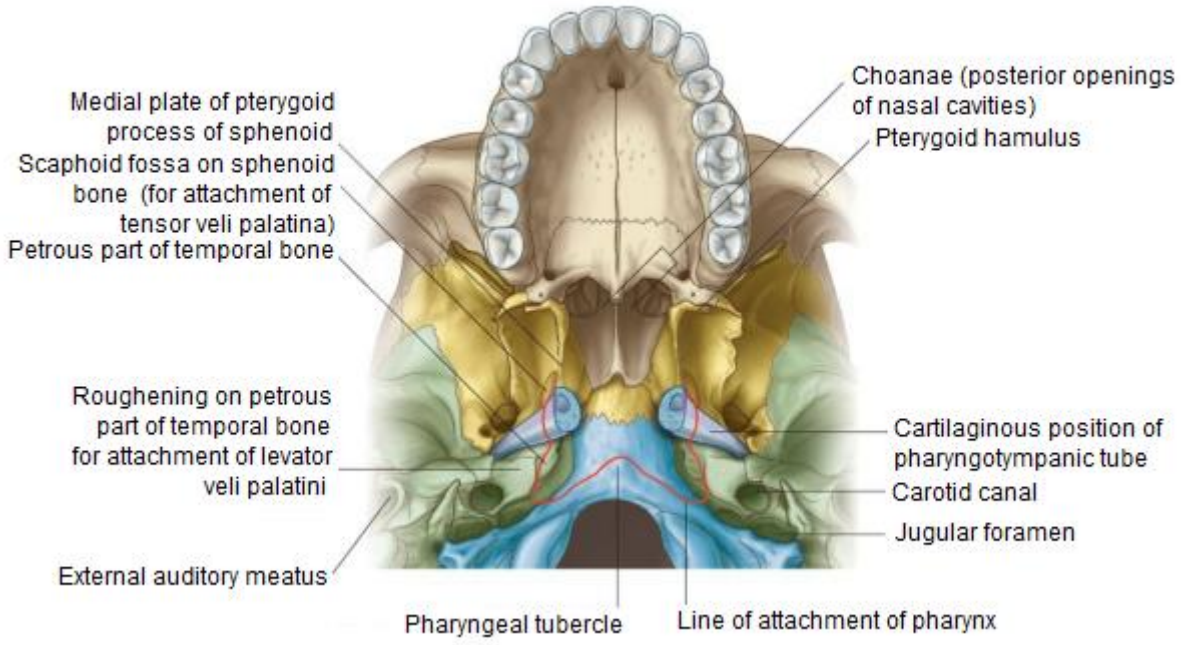


Fig. 59. External base of the skull.

Sutures of the Norma Frontalis

1. Internasal	5. Frontomaxillary
2. Frontonasal	6. Intermaxillary
3. Nasomaxillary	7. Zygomaticomaxillary
4. Lacrimomaxillary	8. Zygomaticofrontal.

Attachments

1. The medial part of the superciliary arch gives origin to the *corrugator supercilii* muscle.

2. The *procerus* muscle arises from the nasal bone near the median plane.

3. The orbital part of the *orbicularis oculi* arises from the frontal process of the maxilla and from the nasal part of the frontal bone.

4. The *medial palpebral ligament* is attached to the frontal process of the maxilla between the frontal and maxillary origins of the orbicularis oculi.

5. The *levator labii superioris alaeque nasi* arises from the frontal process of the maxilla in front of the orbicularis oculi.

5. The *levator labii superioris* arises from the maxilla between the infraorbital margin and the infraorbital foramen.

6. The *levator anguli oris* arises from the canine fossa.

7. The *nasalis* and the *depressor septi* arise from the surface of the maxilla bordering the nasal notch.

8. The *incisivus* muscle arises from an area just below the depressor septi. It forms part of orbicularis oris.

9. The *zygomaticus major and minor* arise from the surface of the zygomatic bone. The *zygomaticus minor* muscle arises below the zygomaticofacial foramen. The *zygomaticus major* arises lateral to the minor muscle.

10. *Buccinator* arises from maxilla and mandible opposite molar teeth and from *pterygomandibular raphe*. It also forms part of orbicularis oris.

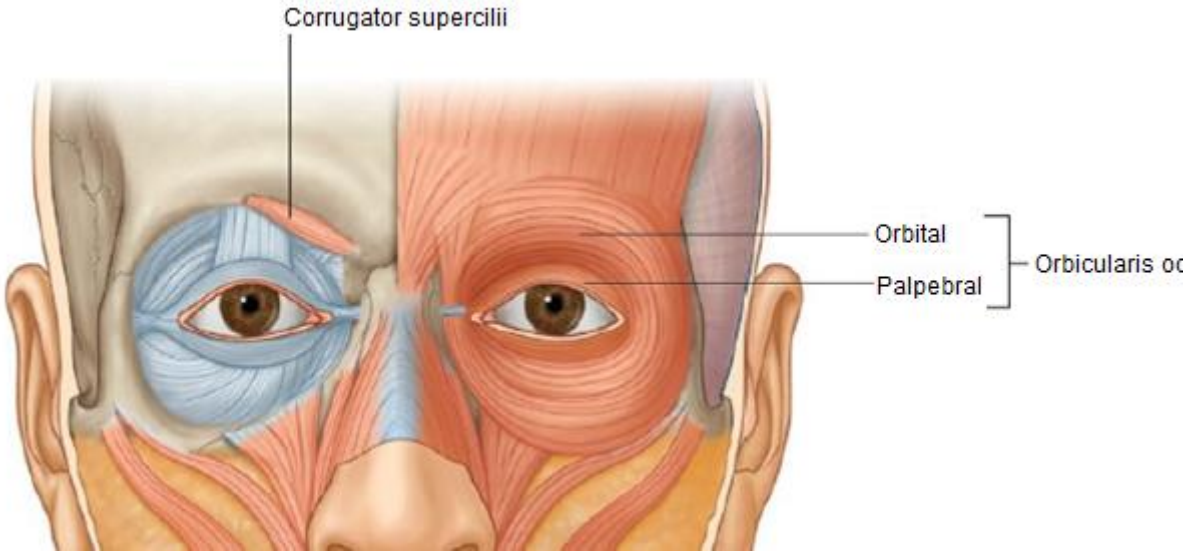


Fig. 60. Orbital group of facial muscles.

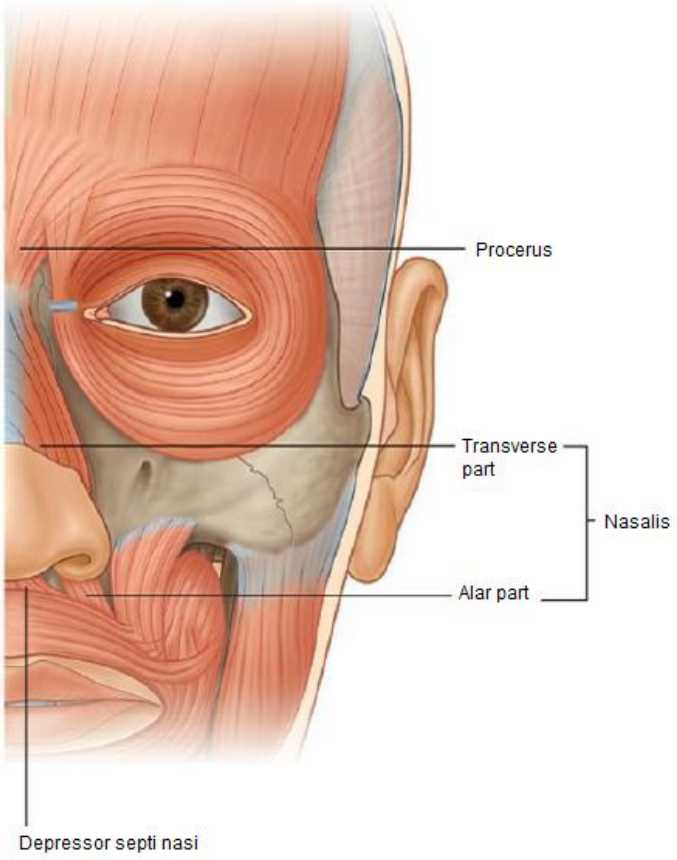


Fig. 61. Nasal group of facial muscles.

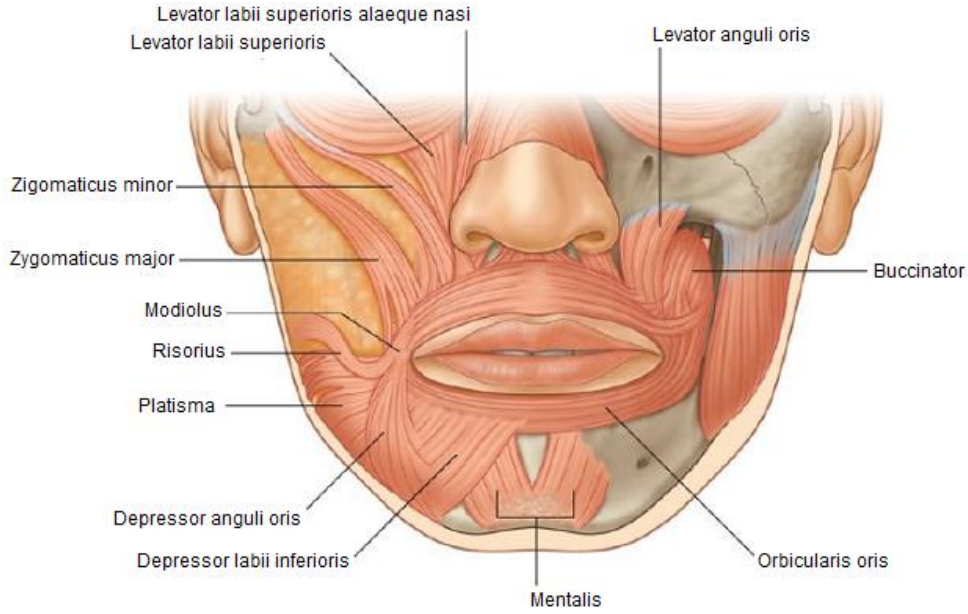


Fig.62. Oral group of facial muscles.

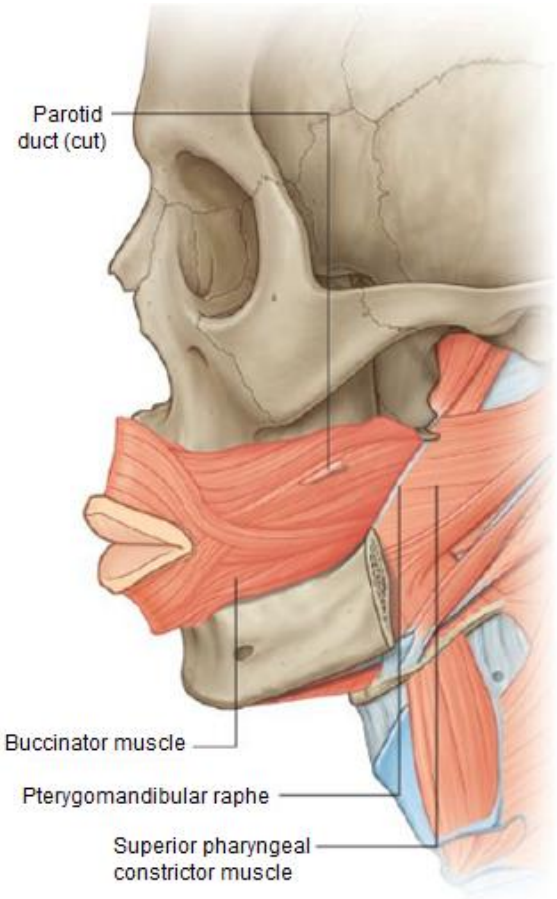


Fig. 63. Buccinator muscle.

Structures Passing through Foramina

1. The *supraorbital notch or foramen* transmits the *supraorbital nerves and vessels*.

2. The *external nasal nerve* emerges between the nasal bone and upper nasal cartilage.

3. The *infraorbital foramen* transmits the *infraorbital nerve and vessels*.

4. The *zygomaticofacial foramen* transmits the nerve of the same name, a branch of *maxillary nerve.*

5. The *mental foramen* on the mandible transmits the mental nerve and vessels.

NORMA LATERALIS

Features

1. *Temporal Lines*. The *temporal lines* have been studied in the norma verticalis. The inferior temporal line, in its posterior part, turns downwards and forwards and becomes continuous with the *supramastoid crest* on the squamous temporal bone near its junction with the mastoid temporal. This crest is continuous anteriorly with the posterior root of the zygomatic arch.

2. *Zygomatic Arch*. The *zygomatic arch* is a horizontal bar on the side of the head, in front of the ear, a little above the tragus.

It is formed by the temporal process of the zygomatic bone in anterior one-third and the zygomatic process of the temporal bone in posterior two-thirds. The *zygomaticotemporal suture* crosses the arch obliquely downwards and backwards.

Above the zygomatic arch is temporal fossa, which is filled by temporalis muscle. Attached to lower margin of zygomatic arch is masseter muscle; contraction of both temporalis and masseter may be felt by clenching the teeth.

The arch is separated from the side of the skull by a gap which is deeper in front than behind. Its *lateral surface* is subcutaneous. The posterior end of the zygomatic arch or *zygoma* is attached to the squamous temporal bone by

anterior and *posterior roots.* The *articular tubercle* of the root of the zygoma lies on its lower border, at the junction of the anterior and posterior roots. The anterior root passes medially in front of the *articular fossa.* The posterior root passes backwards along the lateral margin of the mandibular or articular fossa, then above the external acoustic meatus to become continuous with the supramastoid crest. Two projections are visible in relation to these roots. One is articular tubercle at its lower border. Another tubercle is visible just behind the mandibular or articular fossa and is known as *postglenoid tubercle.*

3. External Acoustic Meatus. The *external acoustic meatus* opens just below the posterior part of the posterior root of zygoma. Its anterior and inferior margins and the lower part of the posterior margin are formed by the tympanic plate, and the posterosuperior margin is formed by the squamous temporal bone. The margins are roughened for the attachment of auricular cartilage.

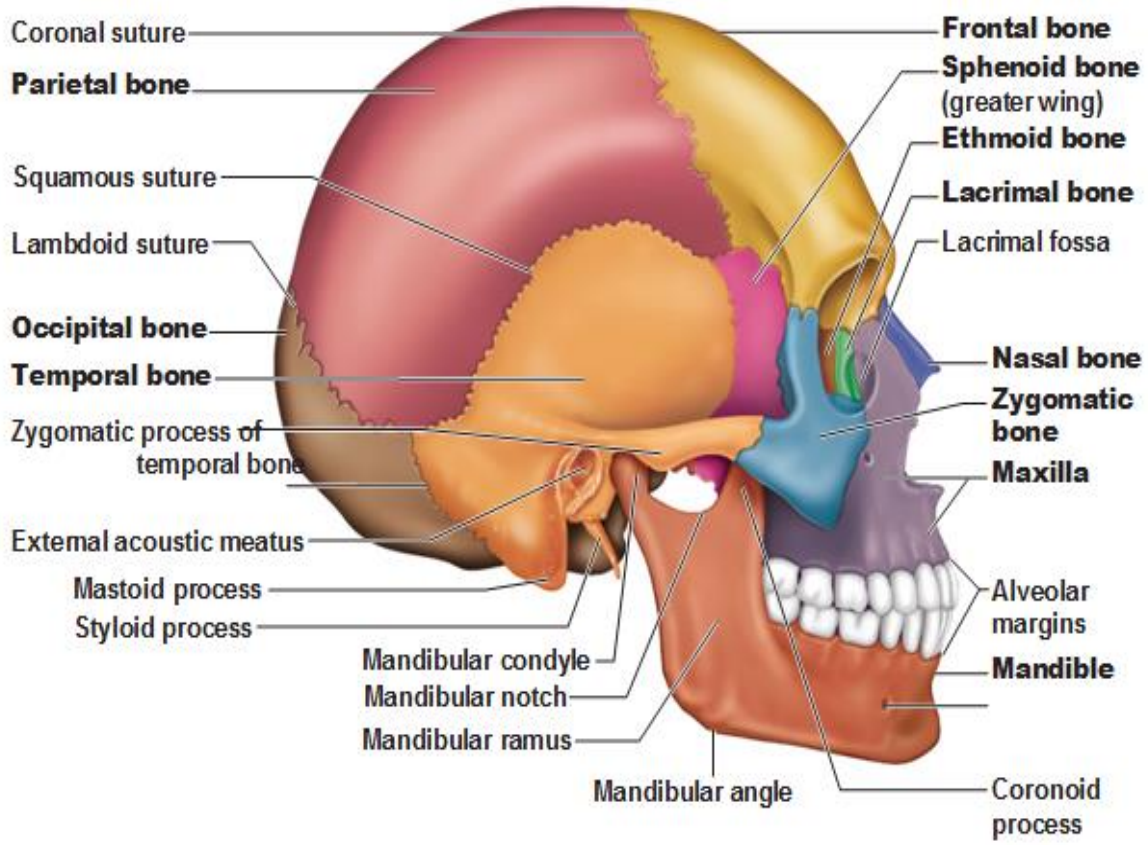


Fig. 64. Lateral view of the skull.

The *suprameatal triangle* is a small depression posterosuperior to the meatus. It is *bounded* above by the supramastoid crest, in front by the posterosuperior margin of the external meatus, and behind by a vertical tangent to the posterior margin of the meatus. The *suprameatal spine* may be present on the anteroinferior margin of the triangle. The triangle forms the lateral wall of the tympanic or mastoid antrum.

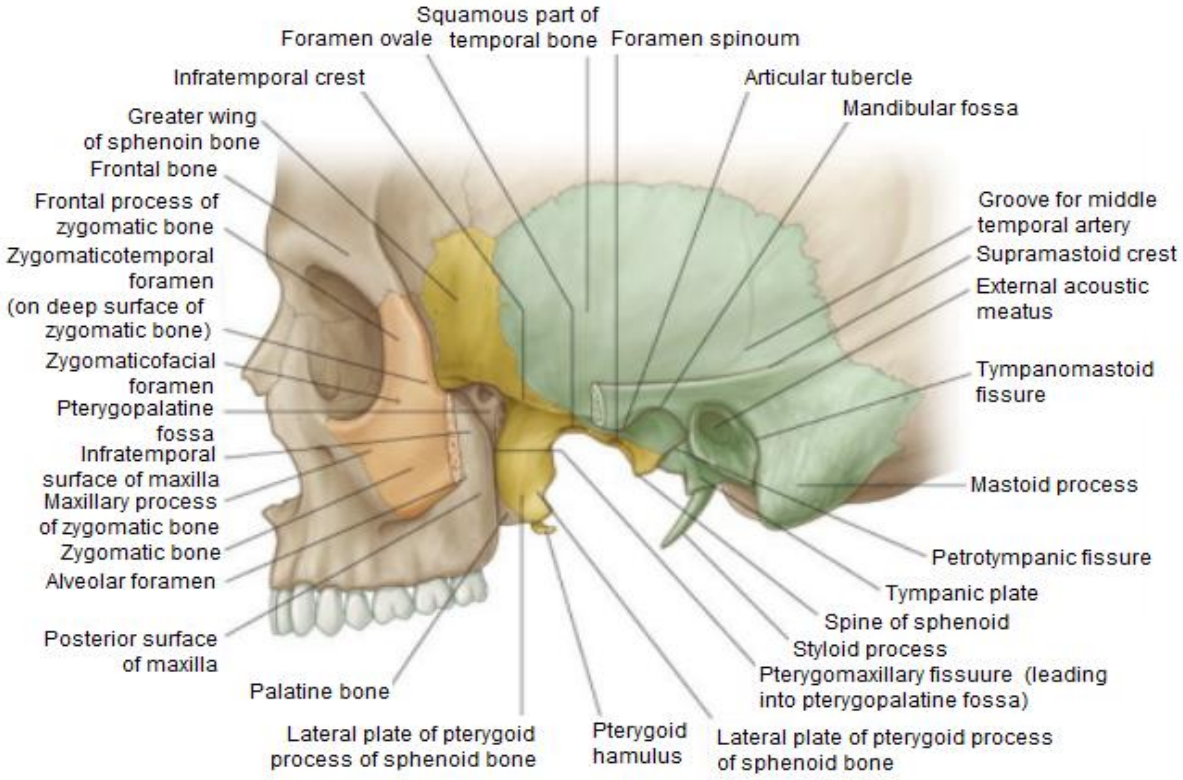


Fig. 65. Lateral view of the skull.

4. Mastoid portion of the temporal bone

The *mastoid portion of the temporal bone* lies just behind the external acoustic meatus. It is continuous anterosuperiorly with the squamous temporal bone. A partially obliterated *squamomastoid suture* may be visible just in front of and parallel to the roughened area for muscular insertions.

The mastoid portion of the temporal bone articulates posterosuperiorly with the posteroinferior part of the parietal bone at the horizontal *parietomastoid suture*, and posteriorly with the squamous occipital bone at the *occipitomastoid*

suture. These two sutures meet at the lateral end of the lambdoid suture. The *asterion* is the point where the parietomastoid, occipitomastoid and lambdoid sutures meet. In infants, the asterion is the site of the *posterolateral* or *mastoid fontanelle,* which closes at the end of the first year.

The *mastoid process* is a nipple-like large projection from the lower part of the mastoid temporal bone, posteroinferior to the external acoustic meatus. It appears during the second year of life. The *tympanomastoid fissure* is placed on the anterior aspect of the base of the mastoid process. The *mastoid foramen* lies at or near the occipitomastoid suture.

5. Styloid Process

The *styloid process* is a needle-like thin, long projection from the norma basalis situated anteromedial to the mastoid process. It is directed downwards, forwards and slightly medially. Its base is partly ensheathed by the tympanic plate. The apex or tip is usually hidden from view by the posterior border of the ramus of the mandible.

Temporal Fossa

Its boundaries:

- Above, by the superior temporal line of the frontal bone.
- Below, by the upper border of the zygomatic arch laterally, and by the infratemporal crest of the greater wing of the sphenoid hone medially. Through the gap deep to the zygomatic arch, temporal fossa communicates with the infratemporal fossa.
- The anterior wall is formed by the zygomatic bone and by parts of the frontal and sphenoid bones. This wall separates the fossa from the orbit.
- Floor: the anterior part of the floor is crossed by an H-shaped suture where four bones, frontal, parietal, greater wing of sphenoid and temporal adjoin each other. This area is termed the pterion. It lies 4 cm above the midpoint of the zygomatic arch and 2.5 cm behind the frontozygomatic suture. Deep to the

pterion lie the middle meningeal vein, the anterior division of the middle meningeal artery, and the stem of the lateral sulcus of brain.

On the temporal surface of the zygomatic bone forming the anterior wall of the fossa there is the zygomaticotemporal foramen.

Infratemporal Fossa

Its boundaries:

• Above, by theinfratemporal crest.

• In the front, by maxilla.

• Medially, by pterygoid process.

• Laterally, by the zygomatic arch and the ramus of the mandible.

The infratemporal fossa contains the lateral pterygoid muscle together with the vessels and nerves.

The infratemporal fossa communicates with the orbit via the inferior orbital fissure. It also communicates with the pterygopalatine fossa via the pterygomaxillary fissure.

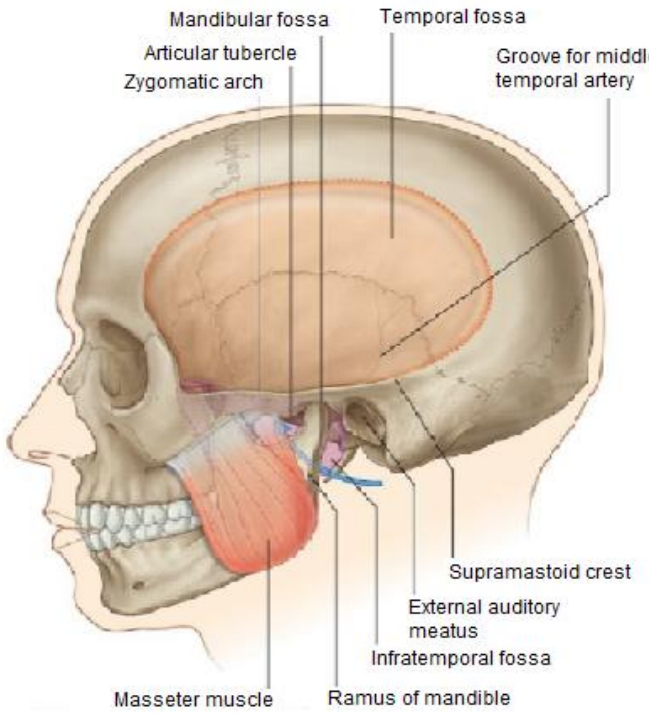


Fig. 66. Temporal and infratemporal fossae.

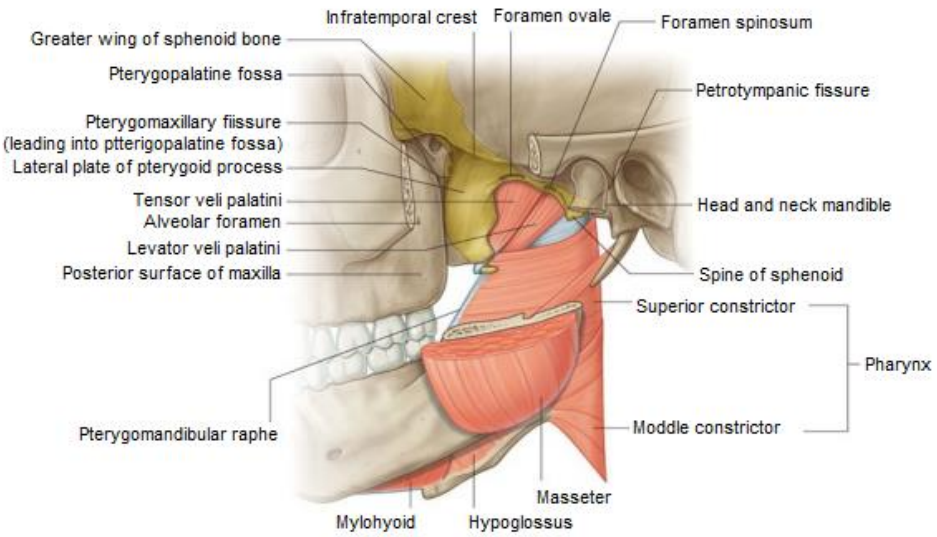


Fig. 67. Infratemporal fossa.

Pterygopalatine Fossa

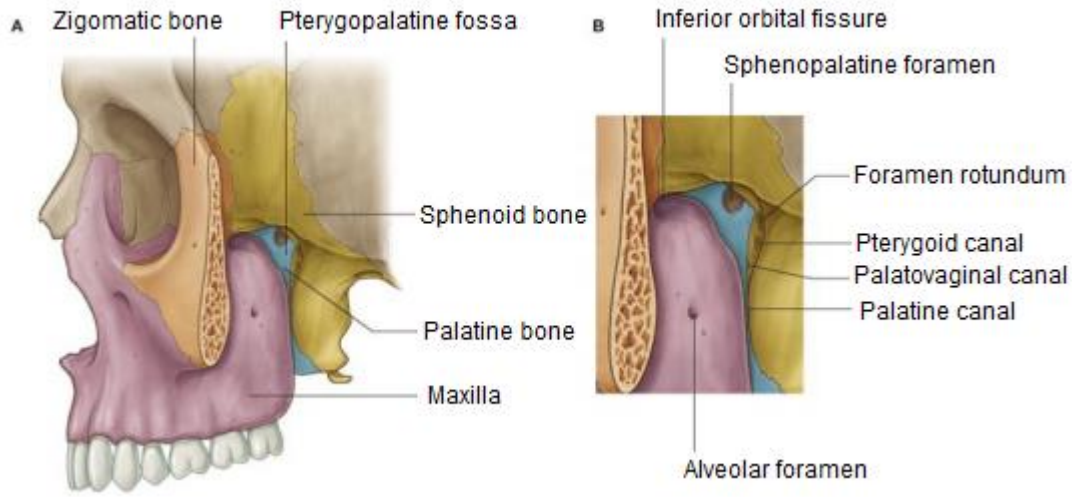


Fig. 68. Pterygopalatine fossa. A - Anterolateral view. B - Lateral view.

Its boundaries:

• Above, by the infratemporal crest.

• In the front, by maxilla.

• Medially, by the perpendicular plate of the palatine bone.

• In the back, by the pterygoid process.

The pterygopalatine fossa contains vessels and nerves, which enter (or exit) it through the following openings:

- foramen rotundum leads into the cranial cavity;
- the greater palatine canal – into the oral cavity;
- foramen sphenopalatinum – into the nasal cavity;
- superior orbital fissure – into the orbit;
- canalis pterygoideus opens on the external surface of the base of the skull near the foramen lacerum.

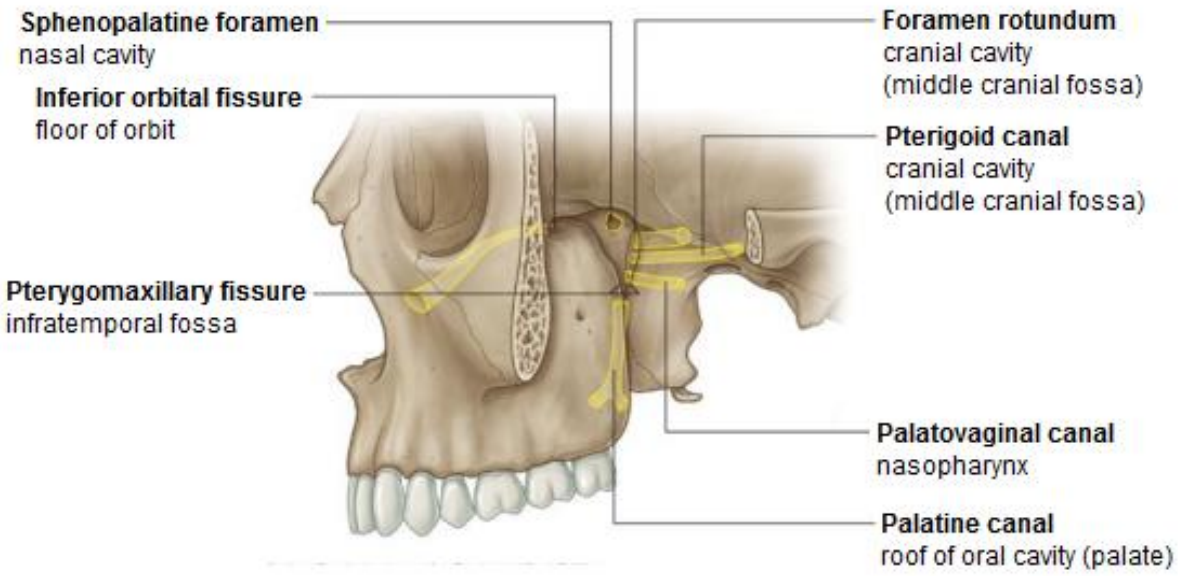


Fig. 69. Connections of the pterygopalatine fossa.

Attachments

1. The *temporal fascia* is attached to the superior temporal line and to the area between the two temporal lines. Inferiorly, it is attached to the outer and inner lips of the upper border of the zygomatic arch.

Anterior branch Pterion

- The *temporalis muscle* arises from the whole of the temporal fossa, except the part formed by the zygomatic bone. Beneath the muscle there lie the *deep temporal vessels* and *nerves*. The *middle temporal vessels* produce vascular markings on the temporal bone just above the external acoustic meatus.

• The medial surface and lower border of the zygomatic arch give origin to the *masseter.*

• The *lateral ligament* of the *temporomandibular joint* is attached to the tubercle of the root of the zygoma.

• The *sternocleidomastoid, splenius capitis and longissimus capitis* are inserted in that order from before backwards on the posterior part of the lateral surface of the mastoid process. Posterior belly of digastric arises from mastoid notch. The groove obliquely placed is due to occipital artery.

The *gap* between the zygomatic arch and the side of the skull transmits:

• Tendon of the temporalis muscle.

• Deep temporal vessels.

• Deep temporal nerves.

Structures Passing Through Foramina

1. The *tympanomastoid fissure* on the anterior aspect of the base of the mastoid process transmits the *auricular branch* of *vagus nerve.*

2. The mastoid foramen transmits:

• *An emissary vein connecting the sigmoid sinus with the posterior auricular vein.*

• A meningeal branch of the occipital artery

3. The *zygomaticotemporal foramen* transmits the nerve of the same name and a minute artery

NORMA BASALIS

For convenience of study, the norma basalis is divided arbitrarily into anterior, middle and posterior parts. The *anterior part* is formed by the hard palate and the alveolar arches. The *middle and posterior parts* are separated by an imaginary transverse line passing through the anterior margin of the foramen magnum.

Anterior Part of Norma Basalis: *Alveolar Arch*

Alveolar arch bears sockets for the roots of the upper teeth.

Hard Palate.

Formation:

• Anterior two-thirds, by the palatine processes of the maxillae.

• Posterior one-third by the horizontal plates of the palatine bones.

• *Sutures:* The palate is crossed by a cruciform suture made up of intermaxillary, interpalatine and palatomaxillary sutures.

• Shows pits for the palatine glands.

• The *incisive fossa* is a deep fossa situated anteriorly in the median plane. Two *incisive* canals, right and left, pierce the walls of the incisive fossa, usually one on each side, but occasionally in the median plane, the left being anterior and the right, posterior.

• The *greater palatine foramen,* one on each side, is situated just behind the lateral part of the palatomaxillary suture. A groove leads from the foramen towards the incisive fossa.

• The *lesser palatine foramina*, two or three in number on each side, lie behind the greater palatine foramen, and perforate the pyramidal process of the palatine bone.

• The *posterior border* of the hard palate is free and presents the *posterior nasal spine* in the median plane.

• The *palatine crest* is a curved ridge near the posterior border. It begins behind the greater palatine foramen and runs medially.

Middle part of norma basalis

The middle part extends from the posterior border of the hard palate to the arbitrary transverse line passing through the anterior margin of the foramen magnum.

Median area shows:

• The posterior border of the *vomer*.

• A *broad bar of bone* formed by fusion of the posterior part of the body of sphenoid and the basilar part of occipital bone.

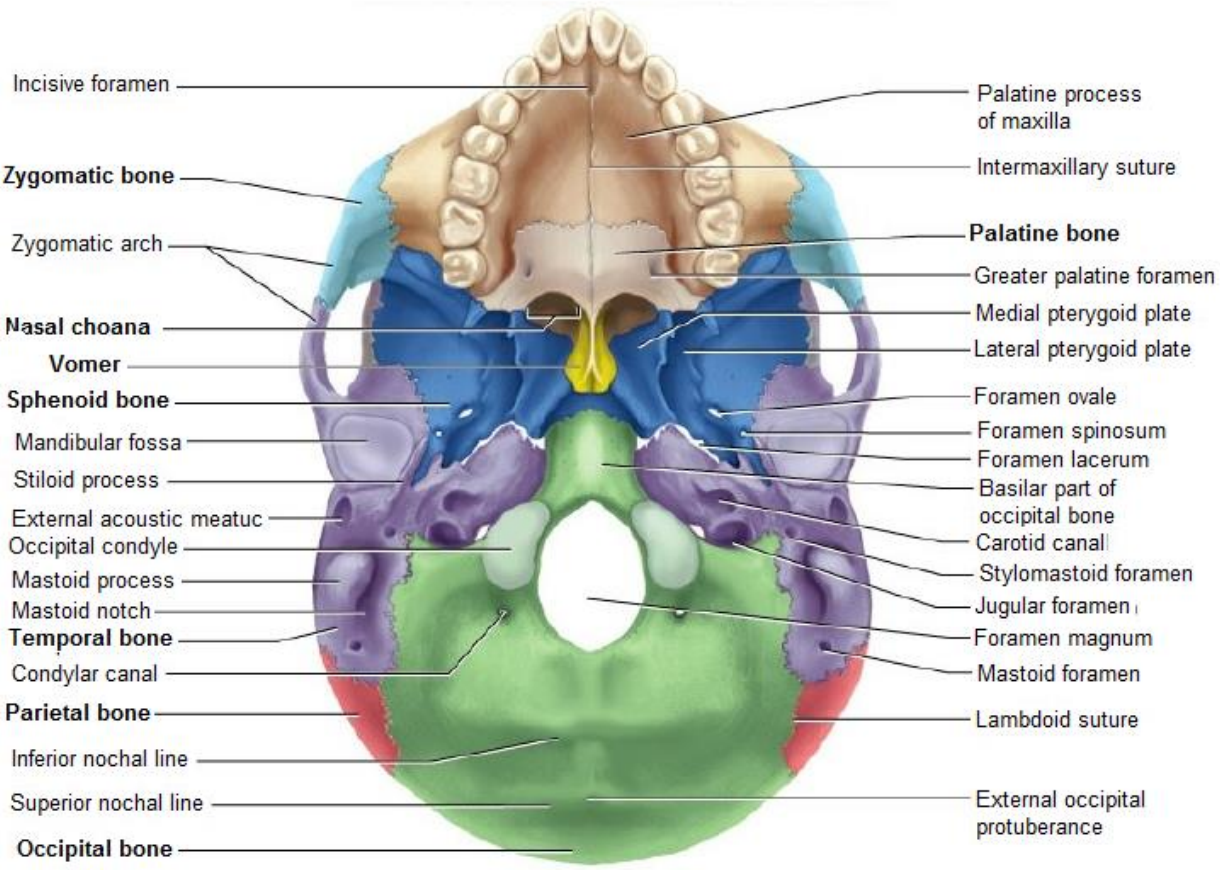


Fig. 70. Skull. Lower aspect. External base of the skull.

The vomer separates the two posterior nasal apertures. Its inferior border articulates with the bony palate. The superior border splits into two *alae* and articulates with the *rostrum* of the *sphenoid hone*. The *palatinovaginal canal.* The inferior surface of the vaginal process of the medial pterygoid plate is marked by an anteroposterior groove, which is converted into the palatinovaginal canal by the upper surface of the sphenoidal process of the palatine bone. The canal opens anteriorly into the posterior wall of the pterygopalatine fossa.

- The *vomerovaginal canal.* The lateral border of each ala of the vomer comes into relationship with the vaginal process of the medial pterygoid plate, and may overlap it from above to enclose the vomerovaginal canal.
- The broad bar of the bone is marked in the median plane by the *pharyngeal tubercle*, a little in front of the foramen magnum.

Lateral Area

1. The lateral area shows two parts of the sphenoid bone – pterygoid process and greater wing. Also seen are three parts of the temporal bone, petrous temporal, tympanic plate and squamous temporal.

2. The *pterygoid process* projects downwards from the junction of greater wing and the body of sphenoid behind the third molar tooth. Inferiorly, it divides into the *medial and lateral pterygoid plates*, which are fused together anteriorly, but are separated posteriorly by the V-shaped *pterygoid fossa*. The fused anterior borders of the two plates articulate medially with the perpendicular plate of the palatine bone, and are separated laterally from the posterior surface of the body of the maxilla by the pterygomaxillary fissure. The *medial pterygoid plate* is directed backwards. It has medial and lateral surfaces and a free posterior border.

3. The infratemporal surface of *the greater wing of the sphenoid.*

Posterior part of norma basalis

Median Area

1. The median area shows from before backwards:

(a) The foramen magnum.

(b) The external occipital crest.

(c) The external occipital protuberance.

2. The *foramen magnum* is the largest foramen of the skull. It opens upwards into the posterior cranial fossa, and downwards into the vertebral canal. It is oval in shape, being wider behind than in front where it is overlapped on each side by the occipital condyles.

3. The *external occipital crest* begins at the posterior margin of the foramen magnum and ends posteriorly and above at the external occipital protuberance.

In the clinic

Medical imaging of the head

Radiography

Until two decades ago, the standard method of imaging the head was plain radiography. The radiographs are taken in three standard projections-namely the posteroanterior view, the lateral view, and the Towne's view. Additional views are obtained to assess the foramina at the base of the skull and the facial bones. Currently, skull radiographs are used in cases of trauma, but such use is declining. Skull fractures are relatively easily detected. The patient is assessed and treatment is based upon the underlying neurological or potential neurological complications.

Computed tomography

Since the development of the first computed tomography (CT) scanner, cerebral CT has been the "workhorse" of neuroradiological examination. It is ideally used for head injury because the brain and its coverings can be easily and quickly examined and blood is easily detected. By altering the mathematical algorithm of the data set the bones can also be demonstrated. With intravenous contrast, CT angiography can be used to demonstrate the position and the size of an intracerebral aneurysm before endovascular treatment.

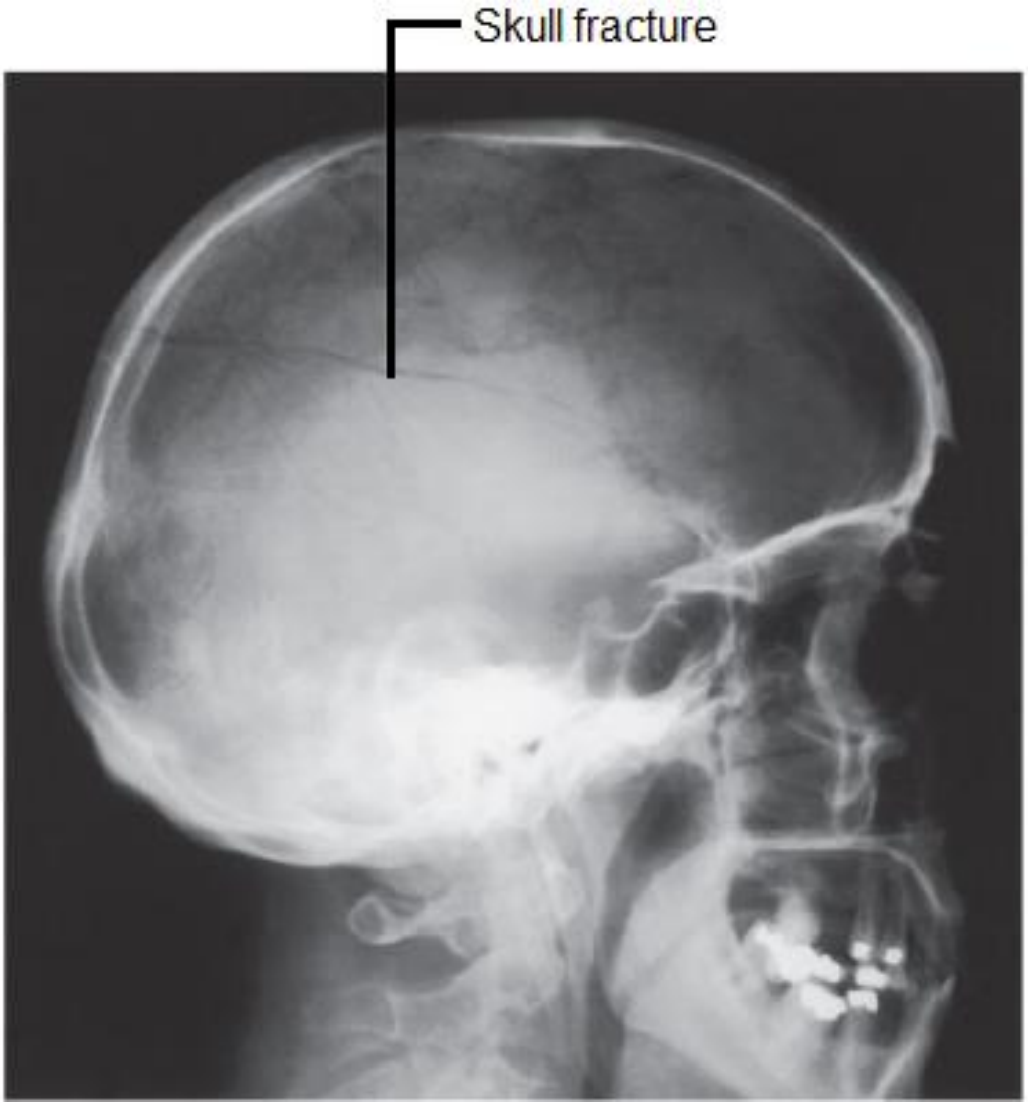


Fig. 71. Radiography of the skull.

Magnetic resonance imaging

Magnetic resonance imaging (MRI) is unsurpassed by other imaging techniques in its ability for contrast resolution. The brain and its coverings, cerebrospinal fluid (CSF), and the vertebral column can be easily and quickly examined. Newer imaging sequences permit CSF fluid suppression to define periventricular lesions.

Magnetic resonance angiography has been extremely useful in determining the completeness of the intracranial vasculature (circle of Willis), which is necessary in some surgical conditions. MRI is also a powerful tool in the assessment of carotid stenosis.

Ultrasonography

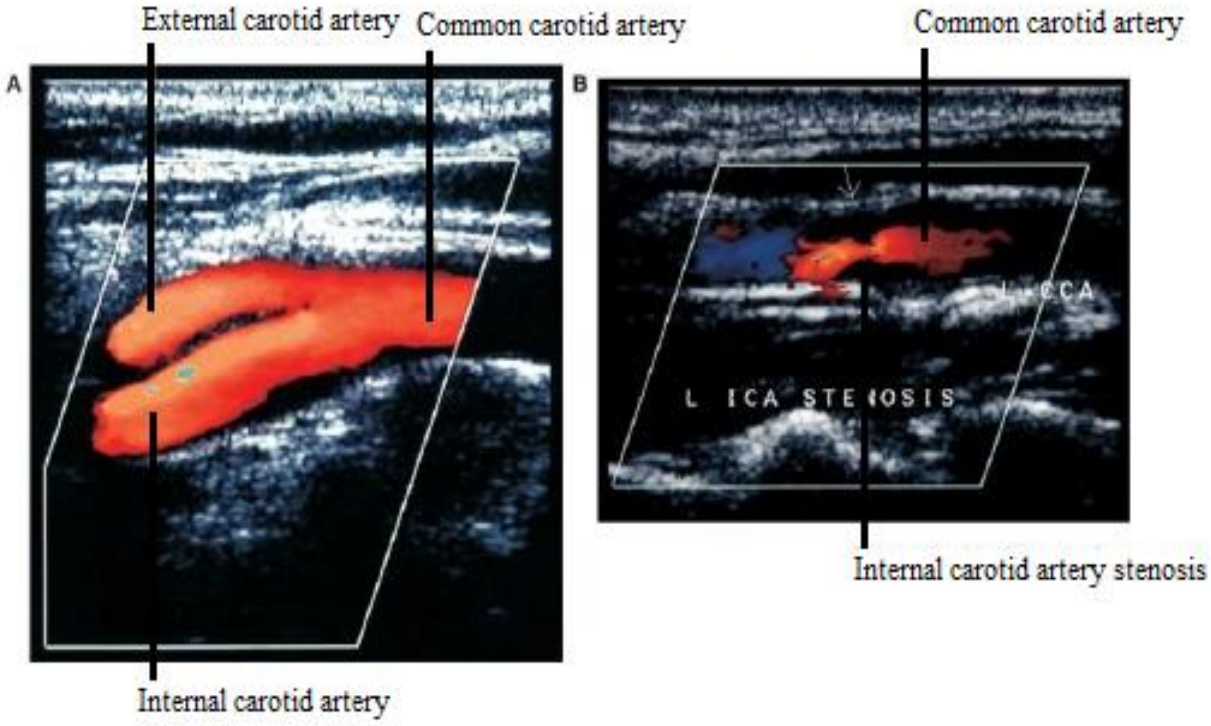


Fig. 72. Ultrasound scans. A – Normal carotid bifurcation. B – Internal carotid artery stenosis.

Initial work using ultrasound to assess the brain appeared fruitless, but with increasing probe technology, it is now possible to carry out intracranial Doppler studies, which enable a surgeon to detect whether a patient is experiencing cerebral embolization from a carotid plaque. Extracranial ultrasound is extremely important in tumor staging and in assessing neck masses and the carotid bifurcation. Ultrasound is useful in children because they have an acoustic window through the fontanelles.

Clinical application

Fractures of the skull vault and extradural hematoma

The skull vault is a remarkably strong structure-and quite rightly, because it protects our most vital organ, the brain. The shape of the skull vault is of

critical importance and its biomechanics prevent fracture. From a clinical standpoint skull fractures alert clinicians to the nature and force of an injury and potential complications. The fracture itself is usually of little consequence (unlike, say, a fracture of the tibia). Of key importance is the need to minimize the extent of primary brain injury and to treat potential secondary complications, rather than focusing on the skull fracture. Skull fractures that have particular significance include depressed skull fractures, compound fractures, and pterion fractures.

Depressed skull fractures

In a depressed skull fracture, a bony fragment is depressed below the normal skull convexity. This may lead to secondary arterial and venous damage with hematoma formation. Furthermore, a primary brain injury can also result from this type of fracture.

Compound fractures

In a compound fracture, there is a fracture of the bone together with a breach of the skin, which may allow an infection to enter. Typically, these fractures are associated with scalp lacerations and can usually be treated with antibiotics. Important complications of compound fractures include meningitis, which may be fatal. A more subtle type of compound fracture involves fractures across the sinuses.

These may not be appreciated on first inspection, but are an important potential cause of morbidity and should be considered in patients who develop intracranial infections secondary to trauma.

Pterion fractures

The pterion is an important clinical point on the lateral aspect of the skull. To find the precise point of the pterion, an imaginary line 1 inch (2.5 cm) above the zygomatic arch, and 1-inch (2.5 cm) posterior to the lateral orbital margin will approximate to this region. At the pterion, the frontal, parietal, greater wing

of the sphenoid and temporal bones come together. Importantly, deep to this structure is the middle meningeal artery. An injury to this point of the skull is extremely serious because damage to this vessel may produce a significant extradural hematoma, which can be fatal. The tympanic canaliculus opens on or near the lower end of the carotid canal, to the root of the styloid process, at the anterior end of the mastoid notch.

STRUCTURES PASSING THROUGH FORAMINA

1. Each incisive foramen transmits:
    - The terminal parts of the greater palatine vessels from the palate to the nose.
    - The terminal part of the nasopalatine nerve from the nose to the palate.
2. The greater palatine foramen transmits:
    - The greater palatine vessels.
    - The anterior palatine nerve, both of which run forwards in the groove that passes forwards from the foramen.
3. The lesser palatine foramina transmit the middle and posterior palatine nerves.
4. The palatinovaginal canal transmits:
    - A pharyngeal branch from the pterygopalatine ganglion.
    - A small pharyngeal branch of the maxillary artery.
5. The vomerovaginal canal (if patent) transmits branches of the pharyngeal nerve from pterygopalatine ganglion and vessels.
6. The foramen ovale transmits:

- The mandibular nerve.
- The accessory meningeal artery.
- An emissary vein connecting the cavernous sinus with the pterygoid plexus of veins.

7. The foramen spinosum transmits the middle meningeal artery, the meningeal branch of the mandibular nerve or nervus spinosus, and the posterior trunk of the middle meningeal vein.

8. The emissary sphenoidal foramen transmits an emissary vein connecting the cavernous sinus with the pterygoid plexus of veins.

9. The carotid canal transmits the internal carotid artery, and the venous and sympathetic plexuses around the artery.

10. The structures passing through the foramen lacerum are: during life the lower part of the foramen is filled with cartilage, and no significant structure passes through the whole length of the canal, except for the meningeal branch of the ascending pharyngeal artery and an emissary vein from the cavernous sinus. However, the upper part of the foramen is traversed by the internal carotid artery with venous and sympathetic plexuses around it. In the anterior part of the foramen, the greater petrosal nerve unites with the deep petrosal nerve to form the nerve of the pterygoid canal, which leaves the foramen by entering the pterygoid canal in the anterior wall of the foramen lacerum.

11. The medial end of the petrotympanic fissure transmits the chorda tympani nerve, anterior ligament of malleus and the anterior tympanic artery.

13. The foramen magnum transmits the following.

Through the narrow anterior part – 3 structures:

- Apical ligament of dens.
- Vertical band of cruciate ligament.
- Membrana tectoria.

Through wider posterior part – 2 structures:

- Lowest part of medulla oblongata
- Three meninges.

Through the subarachnoid space – 9 structures pass:

- Spinal accessory nerves – 2.

- Vertebral arteries – 2.
- Sympathetic plexus around the vertebral arteries – 2.
- Posterior spinal arteries – 2.
- Anterior spinal artery – 1.

14. The hypoglossal or anterior condylar canal transmits the hypoglossal nerve, the meningeal branch of the hypoglossal nerve, the meningeal branch of the ascending pharyngeal artery, and an emissary vein connecting the sigmoid sinus with the internal jugular vein.

15. The posterior condylar canal transmits an emissary vein connecting the sigmoid sinus with suboccipital venous plexus.

16. The jugular foramen transmits the following structures.

Through the anterior part:

- Inferior petrosal sinus.
- Meningeal branch of the ascending pharyngeal artery.

Through the middle part: IX, X and XI cranial nerves.

Through the posterior part:

- Internal jugular vein.
- Meningeal branch of the occipital artery. The glossopharyngeal notch near the medial end of the jugular foramen lodges the inferior ganglion of the glossopharyngeal nerve.

17. The mastoid canaliculus in the lateral wall of the jugular fossa transmits the auricular branch of the vagus. The nerve passes laterally through the bone, crosses the facial canal, and emerges at the tympanomastoid fissure. The nerve is extracranial at birth, but becomes surrounded by bone as the tympanic plate and mastoid process develop.

18. The tympanic canaliculus on the thin edge of partition between the jugular fossa and carotid canal transmits the tympanic branch of glossopharyngeal nerve to the middle ear cavity.

19. The stylomastoid foramen transmits the facial nerve and the stylomastoid branch of the posterior auricular artery.

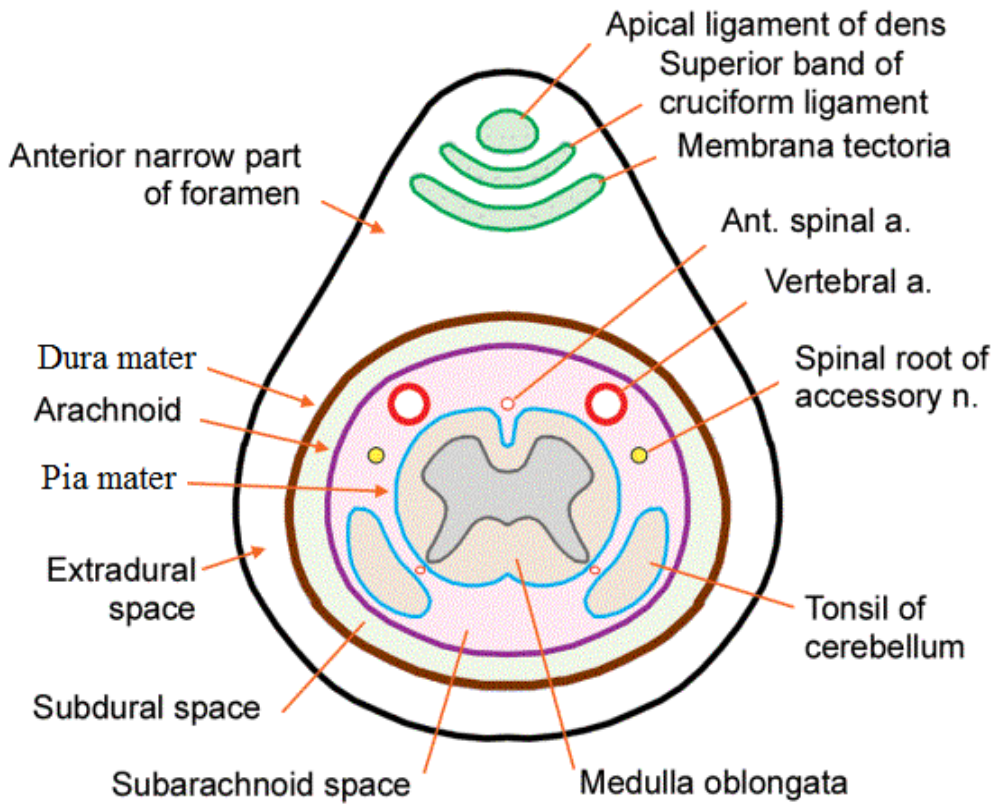


Fig. 73. Structures passing through foramen magnum.

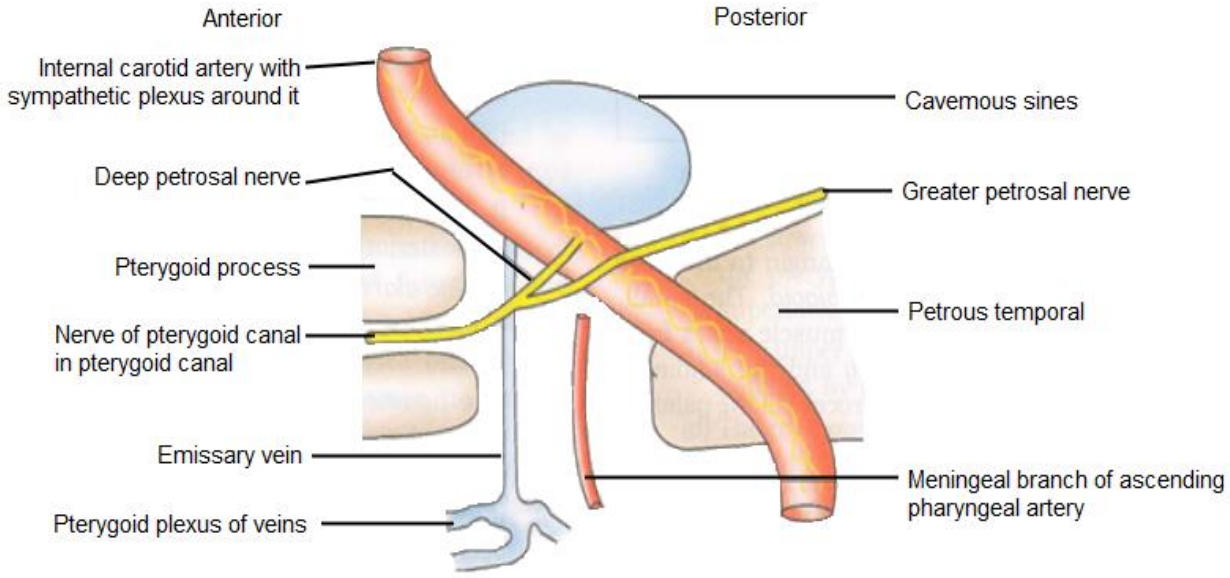


Fig. 74. Diagram showing some relationships of the foramen lacerum.

INTERIOR OF THE SKULL

Before beginning a systematic study of the interior, the following general points may be noted.

1. The cranium is lined internally by *endocranium* which is continuous with the pericranium through the foramina and sutures.

2. The *thickness* of the cranial vault is variable. The bones covered with muscles, i.e. temporal and posterior cranial fossae are thinner than those covered with scalp. Further, the bones are thinner in females than in males, and in children than in adults.

3. Most of the cranial bones consist of:

- an *outer table* of compact bone which is thick, resilient and tough;
- an *inner table* of compact bone which is thin and brittle.
- the *diploe* which consists of spongy bone filled with red marrow, in between the two tables.

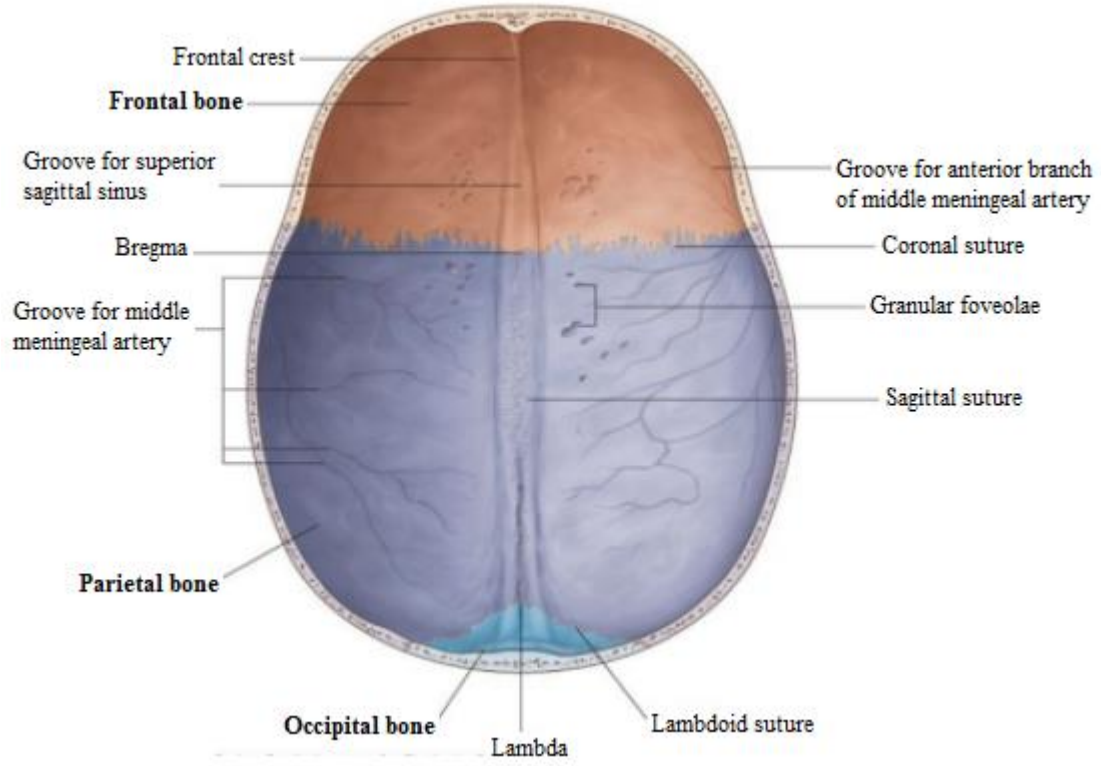


Fig. 75. Roof of the cranial cavity.

The skull bones derive their blood supply mostly from the meningeal arteries from inside and very little from the arteries of the scalp. Blood supply from the outside is rich in those areas where muscles are attached, e.g. the temporal fossa and the suboccipital region. The blood from the diploe is drained by four diploic veins on each side draining into venous sinuses. Many bones like vomer, pterygoid plates do not have any diploe.

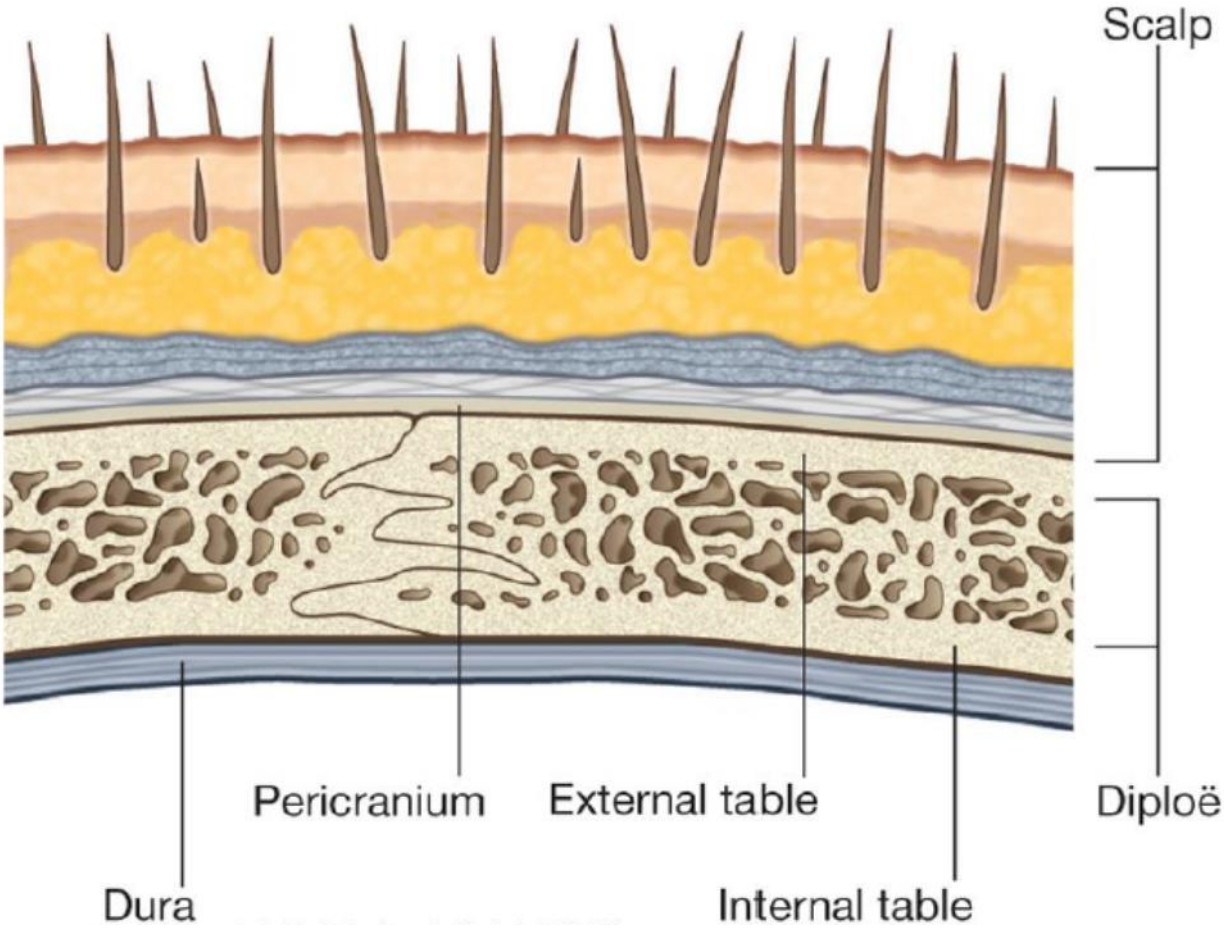


Fig. 76. Calvaria.

INTERNAL SURFACE OF CRANIAL VAULT

The shape, the bones present, and the sutures uniting them have been described with the norma verticalis.

The following features may be noted:

1. The *internal table* is thin and brittle. It presents *markings* produced by meningeal vessels, venous sinuses, arachnoid granulations, and to some extent

by cerebral gyri. It also presents raised ridges formed by the attachments of the dural folds.

2. *The external table* made of compact bone.

3. The *frontal crest* lies anteriorly in the median plane. It projects backwards.

4. The *sagittal sulcus* runs from before backwards in the median plane. It becomes progressively wider posteriorly. It lodges the superior sagittal sinus.

5. The *granular foveolae* are deep, irregular, large, pits situated on each side of the sagittal sulcus. They are formed by arachnoid granulations. They are larger and more numerous in aged persons.

6. The *vascular markings.* The groove for the anterior branch of the middle meningeal artery, and the accompanying vein runs upwards 1 cm behind the coronal suture. Smaller grooves for the branches from the anterior and posterior branches of the middle meningeal vessels run upwards and backwards over the parietal bone.

7. The *parietal foramina* open near the sagittal sulcus 2.5 to 3.75 cm in front of the lambdoid suture.

8. The *impressions for cerebral gyri* are less distinct. These become very prominent in cases of raised intracranial tension.

Clinical applications. The internal table is also known as the vitreous plate because in case of a head injury it breaks even when the integrity of the external plate is retained (this can lead to the damage of brain meninges).

INTERNAL SURFACE OF THE BASE OF SKULL

The interior of the base of skull presents natural subdivisions into the anterior, middle and posterior cranial fossae. The dura mater is firmly adherent to the floor of fossae and is continuous with pericranium through the.foramina and fissures.

Anterior cranial fossa. *Boundaries*.

- *Anteriorly and on the sides,* by the frontal bone.

- Posteriorly, *it is separated from the middle cranial fossa by the free* posterior border *of the* lesser wing of the sphenoid, *the* anterior clinoid process, *and the* anterior margin of the sulcus chiasmaticus.

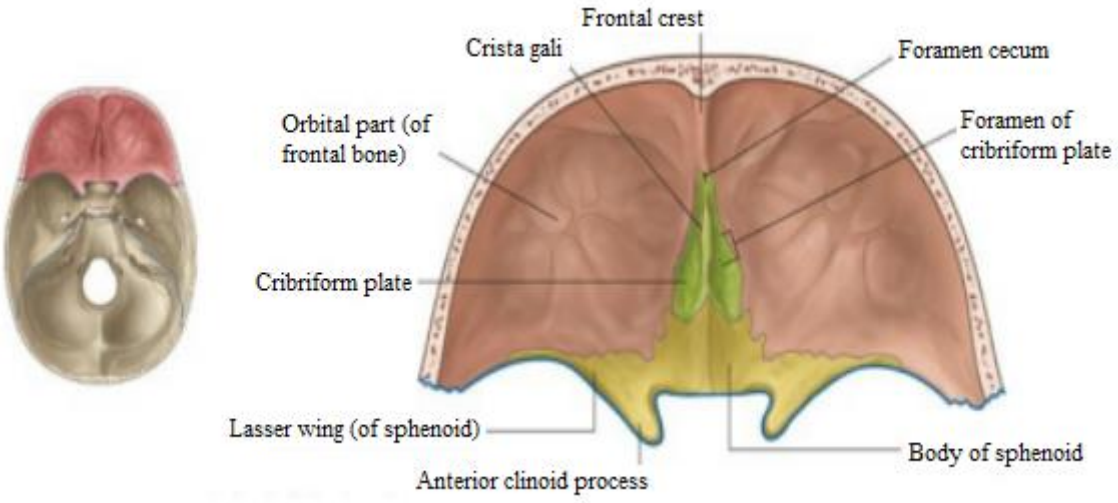


Fig. 77. Anterior cranial fossa.

Floor

In the median plane, it is formed anteriorly by the *cribriform plate of the ethmoid bone,* and posteriorly by the superior surface of the anterior part of the *body of the sphenoid.*

On each side, the floor is formed mostly by the *orbital plate of the frontal bone,* and is completed posteriorly by the lesser wing of the sphenoid.

Other Features

1. The *cribriform plate of the ethmoid bone* separates the anterior cranial fossa from the nasal cavity. It is quadrilateral in shape.

- *Anterior* margin articulates with the frontal bone at the *frontoethmoidal suture,* which is marked in the median plane by the *foramen caecum.* This foramen is usually blind, but is occasionally patent.
- *Posterior margin* articulates with the jugum sphenoidale. At the posterolateral corners, we see the *posterior ethmoidal canals.*

- Its *lateral margins* articulate with the orbital plate of the frontal bone: the suture between them presents the *anterior ethmoidal canal* placed behind the crista galli.

Anteriorly, the cribriform plate has a midline projection called the *crista galli.* On each side of the crista galli there are foramina through which the *anterior ethmoidal nerve and vessels* pass to the nasal cavity. The plate is also perforated by *numerous foramina* for the passage of olfactory nerve rootlets.

2. The *orbital plate of the frontal bone* separates the anterior cranial fossa from the orbit. It supports the orbital surface of the frontal lobe of the brain, and presents reciprocal impressions. The *frontal air sinus* may extend into its anteromedial part. The *medial margin* of the plate covers the labyrinth of the ethmoid; and the *posterior margin* articulates with the lesser wing of the sphenoid.

3. The *lesser wing of the sphenoid* is broad medially where it is continuous with the jugum sphenoidale and tapers laterally. The free *posterior border* fits into the *stem of the lateral sulcus of the brain.* It ends medially as a prominent projection, the *anterior clinoid process.* Inferiorly, the posterior border forms the upper boundary of the *superior orbital fissure.* Medially, the lesser wing is connected to the body of the sphenoid by *anterior and posterior roots*, which enclose the *optic canal.*

Middle cranial fossa

It is deeper than the anterior cranial fossa, and is shaped like a butterfly, being narrow and shallow in the middle; and wide and deep on each side.

Boundaries. *Anterior*

- Posterior border of the lesser wing of the sphenoid.
- Anterior clinoid process.
- Anterior margin of the sulcus chiasmaticus.

Posterior

- Superior border of the petrous temporal bone.

- The dorsum sellae of the sphenoid. *Lateral*
- Greater wing of the sphenoid.
- Anteroinferior angle of the parietal bone.
- The squamous temporal bone in the middle.

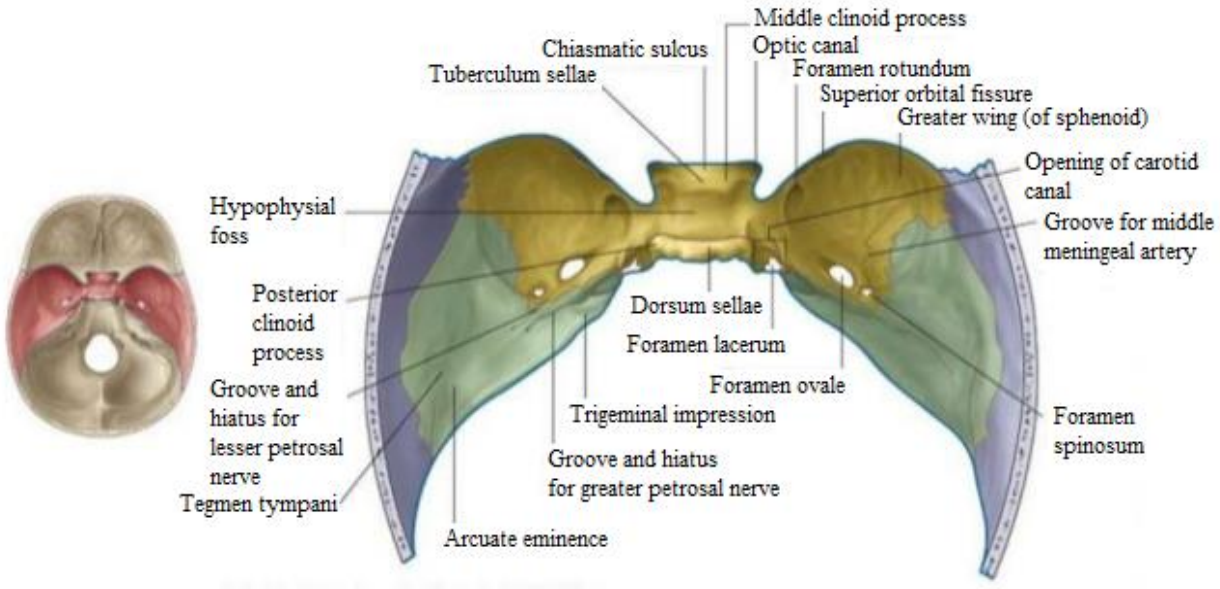


Fig. 78. Middle cranial fossa.

Floor. Floor is formed by body of sphenoid in the median region and by greater wing of sphenoid, squamous temporal and anterior surface of petrous temporal on each side.

Other Features Median Area

The body of the sphenoid presents the following features.

1. The *sulcus chiasmaticus* or *optic groove* leads, on each side, to the optic canal. The optic chiasma does not occupy the sulcus, it lies at a higher level well behind the sulcus.

2. The *optic canal* leads to the orbit. It is bounded laterally by the lesser wing of the sphenoid, in front and behind by the two roots of the lesser wing, and medially by the body of sphenoid.

3. The *sella turcica.* The upper surface of the body of the sphenoid is hollowed out in the form of a Turkish saddle, and is known as the sella turcica. It consists

of the tuberculum sellae in front, the hypophyseal fossa in the middle and the *dorsum sellae* behind.

4. The *tuberculum sellae* separates the optic groove from the *hypophyseal fossa.* Its lateral ends form the *middle clinoid process,* which may join the anterior clinoid process.

5. The *hypophyseal fossa* lodges the hypophysis cerebri. Beneath the floor of fossa lie the sphenoidal air sinuses.

6. The *dorsum sellae* is a transverse plate of bone projecting upwards; it forms the back of the saddle. The superolateral angles of the dorsum sellae are expanded to form the *posterior clinoid processes.*

Lateral Area

1. The lateral area is deep and lodges the temporal lobe of the brain.

2. It is related anteriorly to the orbit, laterally to the temporal fossa, and inferiorly to the infratemporal fossa.

3. The *superior orbital fissure* opens anteriorly into the orbit. It is *bounded* above by the *lesser wing*, below by the greater wing, and medially by the *body of the sphenoid*. The medial end is wider than the lateral. The long axis of the fissure is directed laterally, upwards and forwards. The lower border is marked by a small projection, which provides attachment to the *common tendinous ring of Zinn.* The ring divides the fissure into three parts.

4. The *greater wing of the sphenoid* presents the following features:

a) the *foramen rotundum* lies posteroinferior to the medial end of the superior orbital fissure. It leads anteriorly to the pterygopalatine fossa containing pterygopalatine ganglia.

b) the *foramen ovale* lies posterolateral to the foramen rotundum and lateral to the lingula. It leads inferiorly to the infratemporal fossa.

c) the *foramen spinosum* lies posterolateral to the foramen ovale. It also leads, inferiorly, to the infratemporal fossa.

d) the emissary sphenoidal foramen *or foramen of Vesalius.* These foramina have been seen on the base of the skull.

e) the groove for the middle meningeal vessels leads forwards from the foramen spinosum.

5. The foramen lacerum lies at the posterior end of the carotid groove and posteromedial to the foramen ovale. Its upper end is bounded posterolaterally by the apex of the petrous temporal bone, and anteromedially by the body of the sphenoid and by the posteromedial margin of greater wing.

6. The anterior surface of the petrous temporal bone *presents the following features:*

- the trigeminal impression lies near the apex, behind the foramen lacerum. It lodges the trigeminal ganglion within its dural cave.
- the hiatus and groove for the greater petrosal nerve are present lateral to the trigeminal impression. They lead to the foramen lacerum.
- the hiatus and groove for the lesser petrosal nerve, lie lateral to the hiatus for the greater petrosal nerve. They lead to the foramen ovale. Still more laterally there is the arcuate eminence which is produced by the superior semicircular canal.
- the tegmen tympani is a thin plate of bone anterolateral to the arcuate eminence. It forms a continuous sloping roof for the tympanic antrum, for the tympanic cavity and for the canal for the tensor tympani. The lateral margin of the tegmen tympani is turned downwards, it forms the lateral wall of the bony auditory tube. Its lower edge is seen in the squamotympanic fissure and divides it into the petrotympanic and petrosquamous fissures. The cerebral surface of the squamous temporal bone is concave. It shows impressions for the temporal lobe and grooves for branches of the middle meningeal vessels.

Posterior Cranial Fossa

This is the largest and deepest of the three cranial fossae. The posterior cranial fossa contains the *hindbrain*, which consists of the *cerebellum behind and the pons and medulla in front.*

Boundaries

Anterior

- The superior border of the petrous temporal bone.
- The dorsum sellae of the sphenoid bone.

Posterior

- Squamous part of the occipital bone.

On each side

- Mastoid part of the temporal bone.
- The mastoid angle of the parietal bone.

Floor

Median area

- Sloping area behind the dorsum sellae or clivus in front
- The foramen magnum in the middle
- The squamous occipital behind.

Lateral area

- Condylar or lateral part of occipital bone.
- Posterior surface of the petrous temporal bone.
- Mastoid temporal bone.
- Mastoid angle of the parietal bone.

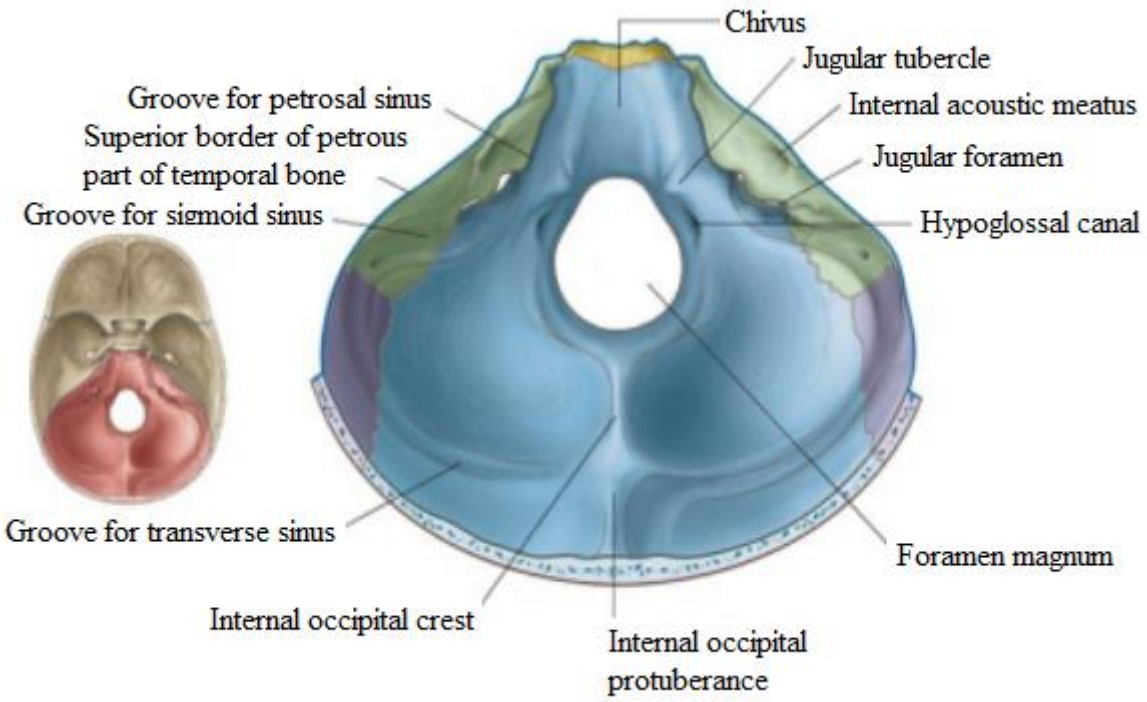


Fig. 79. Posterior cranial fossa.

Other Features median area

1. The *clivus* is the sloping surface in front of the foramen magnum. It is formed by fusion of the posterior part of the body of the sphenoid including the dorsum sellae with the basilar part of the occipital bone or basiocciput. It is related to the *basilar plexus of veins,* and supports the pons and medulla. On each side, the clivus is separated from the petrous temporal bone by the *petro-occipital fissure,* which is grooved by the inferior petrosal sinus, and is continuous behind with the jugular foramen.

2. The *foramen magnum* lies in the floor of the fossa. It is *bounded* anteriorly by the basiocciput, posteriorly by the squamous part of the occipital bone, and on each side by the condylar part of the occipital bone. The anterior part of the foramen is narrow because it is *overlapped* by the medial surfaces of the oçcipital condyles.

3. The *squamous part of the occipital bone* shows the following features.

The ***internal occipital crest*** runs in the median plane from the internal occipital protuberance to the foramen magnum where it forms a shallow depression, the *vermian fossa*.

The ***internal occipital protuberance*** lies opposite the external occipital protuberance. It is related to the confluence of sinuses, and is grooved on each side by the beginning of transverse sinuses.

The ***transverse groove*** is quite wide and runs laterally from the internal occipital protuberance to the mastoid angle of the parietal bone where it becomes continuous with the sigmoid sulcus. The transverse sulcus lodges the *transverse sinus.* The right transverse sulcus is usually wider than the left and is continuous medially with the superior sagittal sulcus.

On each side of the internal occipital crest there are *deep fossae* which lodge the cerebellar hemispheres.

Lateral area

1. The *condylar part of the occipital bone* is marked by the following:

- The *jugular tubercle* lies over the occipital condyle.
- The *hypoglossal canal* pierces the bone posteroanterior to the jugular tubercle and runs obliquely forwards and laterally along the line of fusion between the basilar and the condylar parts of the occipital bone.
- The *condylar canal* opens in the lower part of the sigmoid sulcus which indents the jugular process of occipital bone.

2. The *posterior surface of the petrous part of the temporal bone* forms the anterolateral wall of the posterior cranial fossa. The following features may be noted:

- The *internal acoustic meatus* opens above the anterior part of the jugular foramen. It is about 1 cm long and runs transversely in a lateral direction. It is closed laterally by a perforated plate of bone known as *lamina cribrosa*, which separates it from the internal ear.

- The orifice of the *aqueduct of the vestibule* is a narrow slit lying behind the internal acoustic meatus.

- The *subarcuate fossa* lies below the arcuate eminence, lateral to the internal acoustic meatus.

3. The *jugular foramen* lies at the posterior end of the petro-occipital fissure between the deep jugular notch of the petrous temporal bone above and the shallow jugular notch of the occipital bone below. The upper margin is sharp and irregular, and presents the *glossopharyngeal notch.* The lower margin is smooth and regular.

4. The *mastoid part of the temporal bone* forms the lateral wall of the posterior cranial fossa just behind the petrous part of the bone. Anteriorly, it is marked by the *sigmoid groove*, which begins as a downward continuation of the transverse groove at the mastoid angle of the parietal bone, and ends at the jugular foramen. The sigmoid sulcus lodges the *sigmoid sinus*, which become the internal jugular vein at the jugular foramen. The sulcus is related anteriorly to the *tympanic antrum*. The *mastoid foramen* opens into the upper part of the sulcus.

Attachments and relations of the interior of the skull

Attachment on Vault

1. The frontal crest gives attachment to the falx cerebri.

2. The lips of the sagittal sulcus give attachment to the falx cerebri.

Anterior cranial fossa

1. The crista galli gives attachment to the falx cerebri.

2. The orbital surface of the frontal bone supports the frontal lobe of the brain.

3. The anterior clinoid processes give attachment to the free margin of the tentorium cerebelli.

Middle cranial fossa

1. The middle cranial fossa lodges the *temporal lobe of the cerebral hemisphere.*

2. The tuberculum sellae provides attachment to the *diaphragma sellae*.

3. The hypophyseal fossa lodges the *hypophysis cerebri.*

4. Upper margin of the dorsum sellae provides attachment to the diaphragma sellae, and the posterior clinoid process to anterior end of the attached margin of tentorium cerebelli.

5. One *cavernous sinus* lies on each side of the body of the sphenoid. The internal carotid artery passes through the cavernous sinus.

6. The superior border of the petrous temporal bone is grooved by the *superior petrosal sinus* and provides attachment to the *attached margin of the tentorium cerebelli.* It is grooved in its medial part by the *trigeminal nerve.*

Posterior cranial fossa

1. The posterior cranial fossa contains the hindbrain, which consists of the cerebellum behind, and the pons and medulla in front.

2. The lower part of the clivus provides attachment to the *apical ligament of the dens* near the foramen magnum, upper vertical band of *cruciate ligament* and to the membrana tectoria just above *the apical ligament.*

3. *The internal occipital crest* gives attachment to the falx cerebelli.

4. *The jugular tubercle* is grooved by the ninth, tenth and eleventh cranial nerves as they pass to the jugular foramen.

5. *The subarcuate fossa on the posterior surface of petrous temporal bone lodges the* flocculus of the cerebellum.

Structures passing through foramina. The following foramina seen in the cranial fossae have been dealt with under the normal basalis: foramen ovale, foramen spinosum, emissary sphenoidal foramen, foramen lacerum, foramen magnum, jugular foramen, hypoglossal canal, and posterior condylar canal. Additional foramina seen in the cranial fossae are as follows.

1. The foramen caecum in the anterior cranial fossa is usually blind, but occasionally it transmits a vein from the upper part of nose to the superior sagittal sinus.

2. The posterior ethmoidal canals transmit the vessels of the same name.

3. The anterior ethmoidal canals transmit the corresponding nerves and vessels.

4. The optic canal transmits the optic nerve and the ophthalmic artery.

5. The three parts of the superior orbital fissure transmit the following structures:

Lateral part:

- lacrimal nerve;
- frontal nerve;
- trochlear nerve;
- superior ophthalmic vein;
- meningeal branch of the lacrimal artery;
- anastomotic branch of the middle meningeal artery, which anastomoses with the recurrent branch of the lacrimal arteiy.

Middle part:

- upper and lower divisions of the oculomotor nerve;
- nasociliary nerve in between the two divisions of the oculomotor;
- the abducent nerve, inferolateral to the foregoing nerves.

Medial part:

- inferior ophthalmic vein;
- sympathetic nerves from the plexus around the internal carotid artery.

6. The foramen rotundum transmits the maxillary nerve.

7. The internal acoustic meatus transmits the seventh and eighth cranial nerves and the labyrinthine vessels.

Principles governing fractures of the skull

1. Fractures of the skull are prevented by: its elasticity, rounded shape, construction from a number of secondary elastic arches, each made up of a single bone, the muscles covering the thin areas.

2. Since the skull is an elastic sphere filled with the semifluid brain, a violent blow on the skull produces a splitting effect commencing at the site of the blow and tending to pass along the lines of least resistance.

3. The base of the skull is more fragile than the vault, and is more commonly involved in such fractures, particularly along the foramina.

4. The inner table is more brittle than the outer table. Therefore, fractures are more extensive on the inner table. Occasionally only the inner table is fractured and the outer table remains intact.

5. The common sites of fracture in the skull are: the parietal area of the vault and the middle cranial fossa of the base. This fossa is weakened by numerous foramina and canals. The facial bones commonly fractured are: the nasal bone and the mandible.

FOETAL SKULL

Dimensions

1. Skull is large in proportion to the other parts of skeleton.

2. *Foetal skeleton* is small as compared to calvaria. In foetal skull, the facial skeleton is l/8th of calvaria; in adults, it is half of calvaria. The foetal skeleton is small due to rudimentary mandible and maxillae, non-eruption of teeth, and small size of maxillary sinus and nasal cavity. The large size of calvaria is due to precocious growth of brain.

3. *Base of the skull* is short and narrow, though internal ear is almost of adult size the petrous temporal has not reached the adult length.

Structure of bones

The bones of cranial vault are smooth; there is no diploe. The tables and diploe appear by fourth year of age.

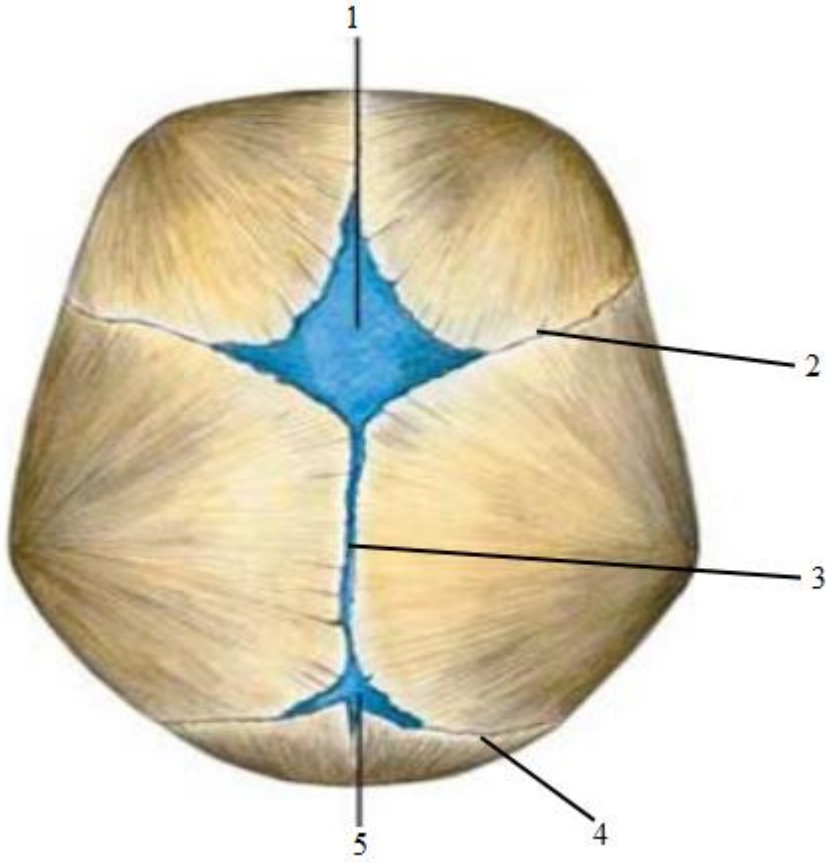


Fig. 80. The neonatal skull. Superior aspect. 1 – Anterior fontanelle; 2 – Coronal suture; 3 – Sagittal suture; 4 – Lambdoid suture; 5 – Posterior fontanelle.

Bony prominences:

a. Frontal and parietal tubera are prominent.

b. Glabella, superciliary arches and mastoid processes are not developed.

Ossification of Bones.

1. Two halves of frontal bone are separated by metopic suture.

2. The mandible is also present in two halves. It is a derivative of first branchial arch.

3. Occipital bone is in four parts (squamous one, condylar two, and basilar one).

4. The four bony elements of temporal bone are separate, except for the commencing union of the tympanic part with the squamous and petrous parts.

The second center for styloid process has not appeared. Unossified membranous gaps a total of 6 fontanelles at the angles of the parietal bones are present.

5. Paranasal Air Sinuses: these are rudimentary or absent.

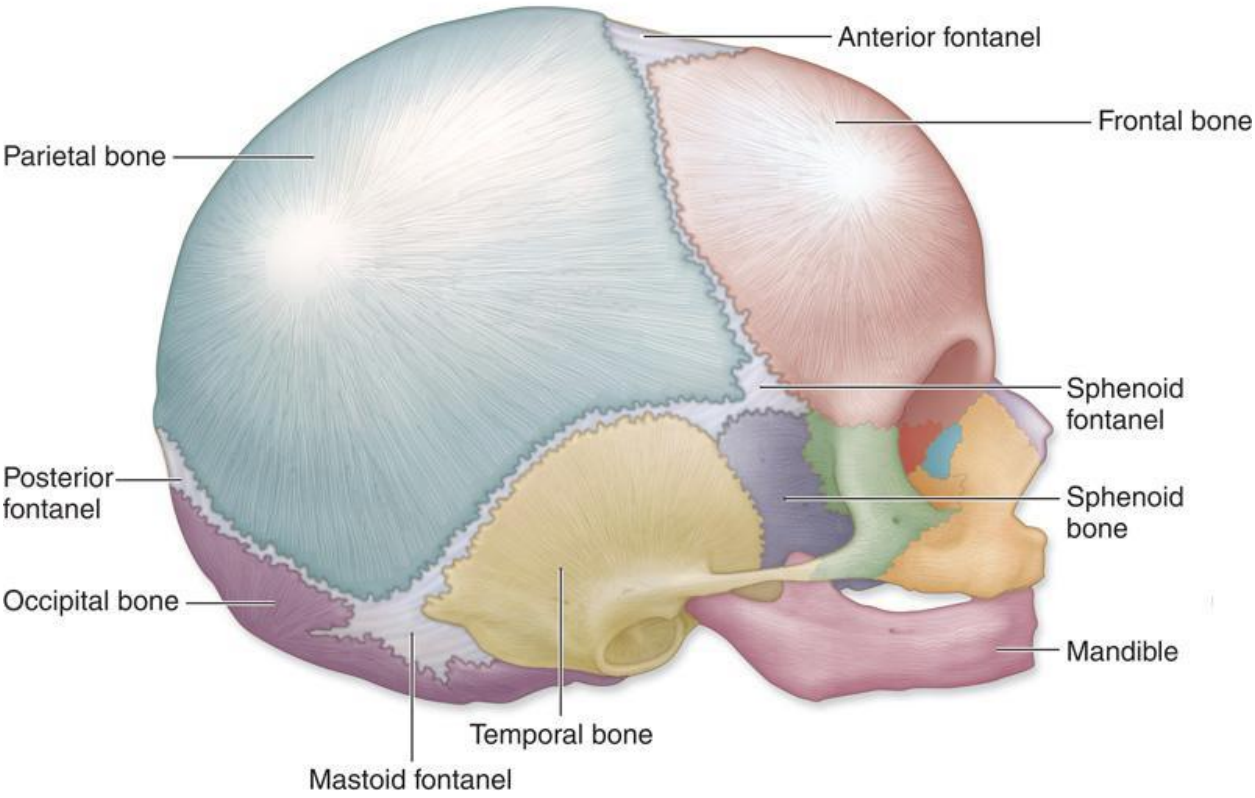


Fig. 81. The neonatal skull. Lateral aspect.

At birth the skull is large in proportion to the other parts of the skeleton, but its facial portion is small, and equals only about one-eighth of the bulk of the cranium as compared with one-half in the adult. The frontal and parietal eminences are prominent, and the greatest width of the skull is at the level of the latter; on the other hand, the glabella, superciliary arches, and mastoid processes are not developed. Ossification of the skull bones is not completed, and many of them, e.g., the occipital, temporals, sphenoid, frontal, and mandible, consist of more than one piece. Unossified membranous intervals, termed fontanelles, are seen at the angles of the parietal bones; these fontanelles are six in number: two, an anterior and a posterior, are situated in the middle line, and two, an antero-lateral and a postero-lateral, on either side.

The **anterior or bregmatic fontanelle** is the largest, and is placed at the junction of the sagittal, coronal, and frontal sutures; it is lozenge-shaped, and measures about 4 cm. in its antero-posterior and 2.5 cm. in its transverse diameter. The **posterior fontanelle** is triangular in form and is situated at the junction of the sagittal and lambdoidal sutures. The **lateral fontanelles** are small, irregular in shape, and correspond respectively with the sphenoidal and mastoid angles of the parietal bones.

An additional fontanelle is sometimes seen in the sagittal suture at the region of the obelion. The fontanelles are usually closed by the growth and extension of the bones, which surround them, but sometimes they are the sites of separate ossific centers, which develop into sutural bones. The posterior and lateral fontanelles are obliterated within a month or two after birth, but the anterior is not completely closed until about the middle of the second year.

The smallness of the face at birth is mainly accounted for by the rudimentary condition of the maxillae and mandible, the non-eruption of the teeth, and the small size of the maxillary air sinuses and nasal cavities. At birth the nasal cavities lie almost entirely between the orbits, and the lower border of the anterior nasal aperture is only a little below the level of the orbital floor. With the eruption of the deciduous teeth, there is an enlargement of the face and jaws, and these changes are still more marked after the second dentition.

The skull grows rapidly from birth to the seventh year, by which time the foramen magnum and petrous parts of the temporals have reached their full size and the orbital cavities are only a little smaller than those of the adult. Growth is slow from the seventh year until the approach of puberty, when a second period of activity occurs: this results in an increase in all directions, but it is especially marked in the frontal and facial regions, where it is associated with the development of the air sinuses. Obliteration of the sutures of the vault of the skull takes place as age advances. This process may commence between the ages of thirty and forty, and is first seen on the inner surface, and some ten years

later on the outer surface of the skull. The dates given are, however, only approximate, as it is impossible to state with anything like accuracy the time at which the sutures are closed. Obliteration usually occurs first in the posterior part of the sagittal suture, next in the coronal, and then in the lambdoidal.

Clinical application. During normal childbirth, the fetal skull comes under tremendous pressure. Bones may even shift, altering the shape of the skull. A common occurrence during molding of the fetal skull is for the occipital bone to be repositioned under the two parietal bones. In addition, one parietal bone may shift so as to overlap the other. This makes delivery easier for the mother. If a baby is born breech (buttocks first), these shifts do not occur. Delivery becomes much more difficult, often requiring the use of forceps.

POSTNATAL GROWTH OF SKULL

The growth of calvaria and facial skeleton proceeds at different rates and over different periods. Growth of calvaria is related to growth of brain, whereas that of the facial skeleton is related to the develop-ment of dentition, muscles of mastication, and of the tongue. The rates of growth of the base and vault are also different.

Growth of the Vault

1. *Rate:* rapid during first year, and then slow up to the seventh year when it is almost of adult size.
2. *Growth in breadth:* this growth occurs at the sagittal suture, sutures bordering greater wings, occipitomastoid suture, and the petro-occipital suture at the base.
3. *Growth in height:* this growth occurs at the frontozygomatic suture, pterion, squamosal suture, and asterion.
4. *Growth in anteroposterior diameter:* This growth occurs at the coronal and lambdoid sutures.

Growth of the Base

The base grows in anteroposterior diameter at three cartilaginous plates situated between the occipital and sphenoid bones, between the pre- and post-sphenoids, and between the sphenoid and ethmoid.

Growth of the Face

1. Growth of orbits and ethmoid is complete by seventh year.
2. In the face, the growth occurs mostly during first year, although it continues till puberty and even later.

Closure of Fontanelles

Anterior fontanelle by 18 months, mastoid fontanelle by 12 months, posterior fontanelle by 2-3 months and sphenoidal fontanelle by 2-3 months.

Thickening of Bones

1. Two tables and diploe appear by fourth year. Differentiation reaches maximum by about 35 years, when the diploic veins produce characteristic marking in the radiographs.
2. Mastoid process appears during second year and the mastoid air cells during 6th year.

Obliteration of Sutures of the Vault

1. Obliteration begins on the inner surface between 30 and 40 years, and on the outer surface between 40 and 50 years.
2. The timings are variable, but it usually takes place first in the lower part of the coronal suture, next in the posterior part of the sagittal suture, and then in the lambdoid suture.

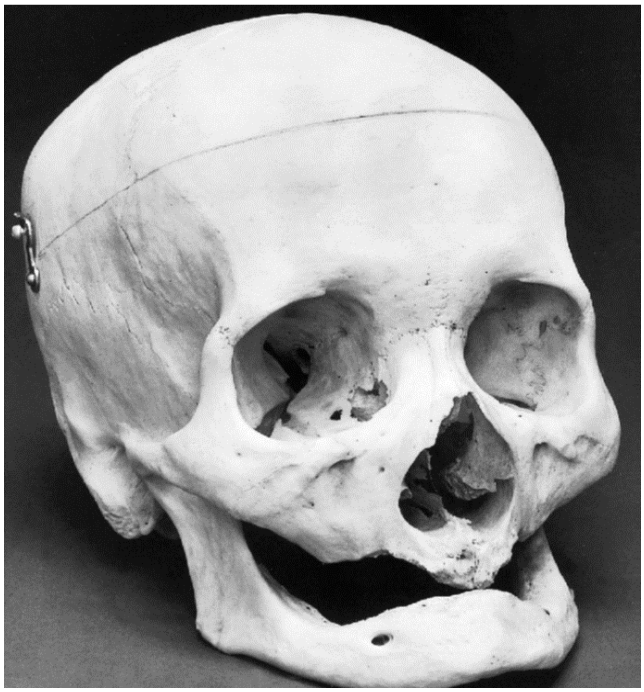


Fig. 82. A geriatric skull. Note the loss of teeth and the degeneration of bone, particularly in the facial region.

In Old Age

The skull generally becomes thinner and lighter but in small proportion of cases it increases in thickness and weight. The most striking feature is reduction in the size of mandible and maxillae due to loss of teeth and absorption of alveolar processes. This causes decrease in the vertical height of the face and a change in the angles of the mandible, which become more obtuse.

SEX DIFFERENCES IN THE SKULL

There are no sex differences until puberty. The postpubertal differences are listed in Table 1.

Table. 1. Sex differences in the skull.

Features	Males	Females
1. Weigt	Heavier	Lighter
2. Size	Larger	Smaller
3. Capacity	Greater in males	10% less then males
4. Walls	Thicker	Thinner

5. Muscular ridges, glabella, superciliary arches, temporal lines, mastoid processes, superior nuchal lines, and external occipital protuberance	More marked	Less marked
6. Tympanic plate	Larger and margins roughened	Smaller and margins are less roughened
7. Supraorbital margin	More rounded	Sharp
8. Forehead	Sloping (receding)	Vertical
9. Frontal and parietal tubera	Less prominent	More prominent
10. Vault	Rounded	Somewhat flattened
11. Contour of face	Longer due to greater depth of the jaws. Chin is bigger and projects more forwards. In general, the skull is more rugged due to muscular markings and processes, and zygomatic bones are more massive	Rounded, facial bones are smoother, and mandible, and maxillae are smaller

Until the age of puberty, there is little difference between the skull of the female and that of the male. The skull of an adult female is, as a rule, lighter and smaller, and its cranial capacity about 10 percent less, than that of the male. Its walls are thinner and its muscular ridges less strongly marked; the glabella, superciliary arches, and mastoid processes are less prominent, and the corresponding air sinuses are small or rudimentary. The upper margin of the orbit is sharp, the forehead vertical, the frontal and parietal eminences prominent, and the vault somewhat flattened. The contour of the face is more rounded, the facial bones are smoother, and the maxillae and mandible and their contained teeth smaller. From what has been said it will be seen that more of the infantile characteristics are retained in the skull of the adult female than in that of the adult male. A well-marked male or female skull can easily be recognized as such, but in some cases the respective characteristics are so indistinct that the determination of the sex may be difficult or impossible.

Wormian or Sutural Bones

These are small irregular bones found in the region of the fontanelles, and are formed by additional ossification centres. They are most common at the lambda and at the asterion; common at the pterion (epipteric bone); and rare at the bregma (os Kerckring). Wormian bones are common in hydrocephalic skulls.

CRANIOMETRY

Cephalic Index

It expresses the shape of the head, and is the proportion of breadth to length of the skull. The length or longest diameter is measured from the glabella to the occipital point, the breadth or widest diameter is measured usually a little below the parietal tubera. It is calculated as a ration of maximal breadth to maximal length multiplied by 100. The obtained result is called the cranial (or cephalic) index. Three variations of human skull are distinguished depending on the magnitude of the cranial index:

- *Dolichocranic* or long-headed when the index is 75 or less.
- *Mesocranic* when the index is between 75 and 80.
- *Brachycranic* or short-headed or round- headed when the index is above 80.

Dolichocephaly is a feature of primitive races like Eskimos, Negroes, etc. **Brachycephaly** through **mesocephaly** has been a continuous change in the advanced races, like the Europeans.

Abnormal Crania

Oxycephaly or acrocephaly, tower-skull, or steeple-skull is an abnormally tall skull. It is due to premature closure of the suture between presphenoid and postsphenoid in the base, and the coronal suture in skullcap, so that the skull is very short antero-posteriorly. Compensation is done by the upward growth of skull for the enlarging brain.

Scaphocephaly or boat-shaped skull is due to premature synostosis in the sagittal suture, as a result the skull is very narrow from side to side but greatly elongated.

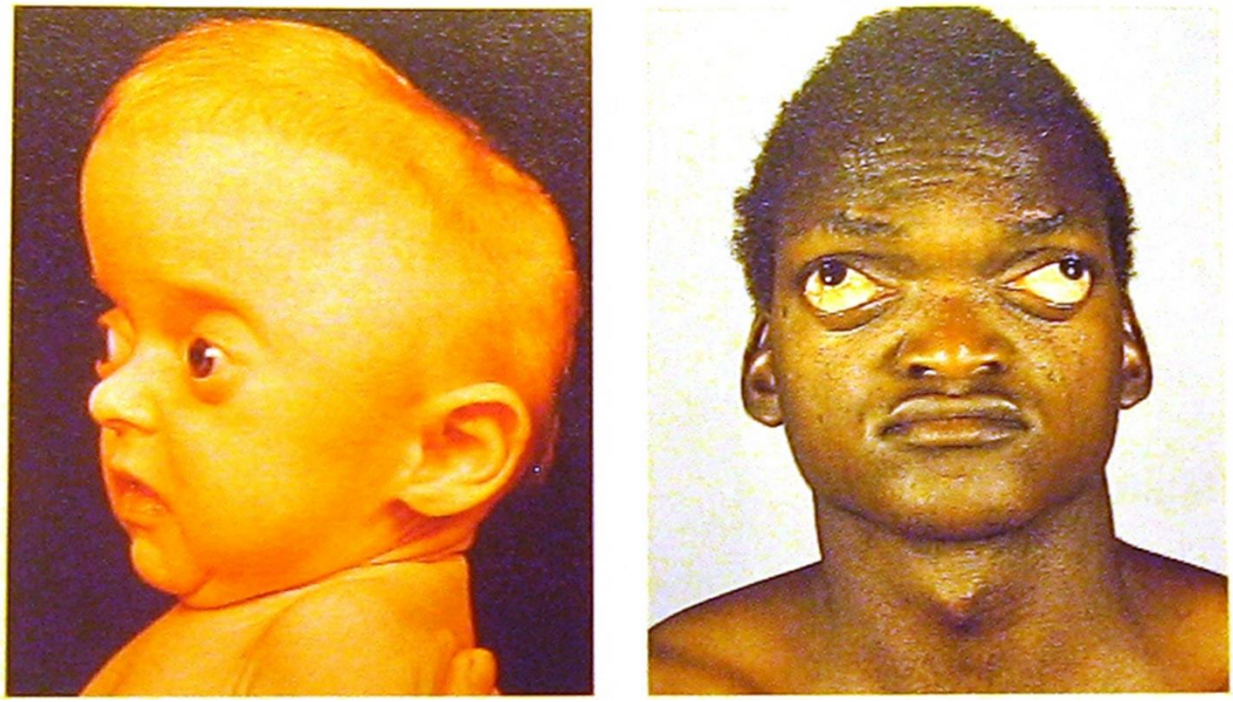


Fig. 83. Scaphocephaly.

THE TEMPOROMANDIBULAR JOINT

The temporomandibular joint, articulatio temporomandibularis, is paired and formed by the articulation of the head of the mandible (ellipsoid in shape) with the mandibular fossa of the temporal bone. It belongs to the group of the bicondylar, combined joints.

The articular surfaces are incongruent. Therefore, inside the joint there is the articular disk, discus articularis, which fuses with the fibrous capsule and divides the articular cavity of the joint into two isolated levels - the upper and the lower (complex joint).

Fibrous capsule. In the region of the temporal bone, the capsule is attached to the margins of the mandibular fossa, fossa mandibularis, covers in the front the articular tubercle, tuberculum articulare, and in the back reaches the

petrotympanic fissure. On the mandible, the capsule attaches to the edge of the articular surface of the head in the front (above the pterygoid fossa), while in the back it inserts into the neck of the mandible.

Ligaments. The capsule is reinforced by the lateral ligament, lig. laterale, whose fibers run obliquely from the zygomatic process of the temporal bono to the neck of the mandible. Importantly, (ho following fasciae (ligaments) thicken in order to stabilize the mandible:

1) lig. stylomandibular, which runs from the styloid process of the temporal bone to the posterior angle of the mandible;

2) lig. sphenomandibulare, which extends from the spine of the sphenoid towards the lingula of the mandible.

Movements. The temporomandibular joint permits the following movements:

1) elevation and depression of themandible occurs around the frontal axis in the lower level of the joint. When the mandible is exceedingly depressed, the articular disk with the head of the mandible may be displaced onto the articular tubercle;

2) protrusion of the mandible occurs in the upper level of the joint in such a way that the head together with the articular disk are drawn onto the articular tubercle;

3) lateral movements of the mandible occur such that on one side the head remains in the fossa, whereas on the opposite side it: is drawn onto the articular tubercle together with the articular disc.

Clinical applications. Violent, opening of the mouth may cause dislocations of the mandible (especially in the old age). In t his case, the head is drawn from the articular fossa and is displaced forward away from the articular tubercle (into the infratemporal fossa). Reduction is accomplished by depressing the jaw, applying pressure on the teeth, and then forcing in to the back.

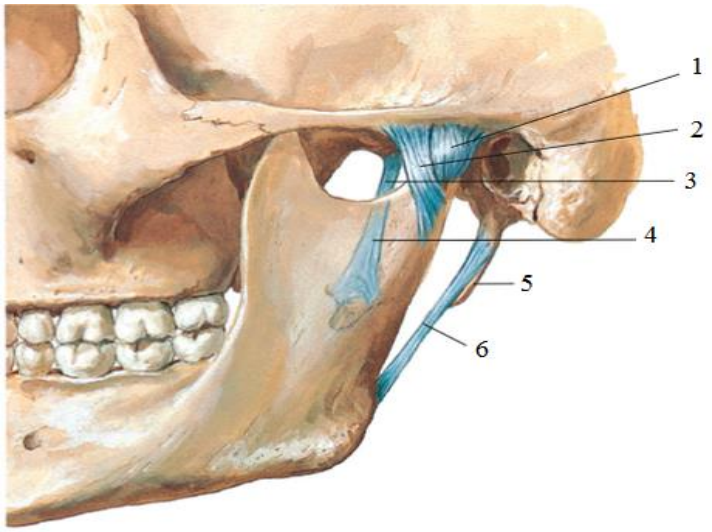


Fig. 84. Temporo-mandibular joint, ligaments, lateral view.

1 – joint capsule; 2 – lateral (temporomandibular) ligament; 3 – sphenomandibular ligament; 4 – sphenomandibular ligament (phantom); 5 – styloid process; 6 – stylomandibular ligament.

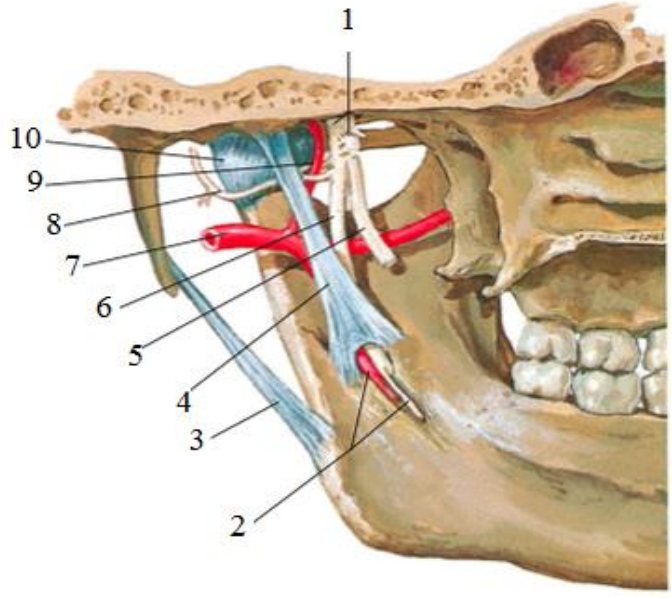


Fig. 85. Temporo-mandibular joint, ligaments and vessels, medial view.

1 – Mandibular nerve and otic ganglion 2 – Mylohyoid branch of inferior alveolar artery and mylohyoid nerve 3 – stylomandibular ligament 4 – sphenomandibular ligament 5 – lingual nerve 6 – inferior alveolar nerve 7 –

maxillary artery 8 – auriculotemporal nerve 9 – middle meningeal artery 10 – joint capsule.

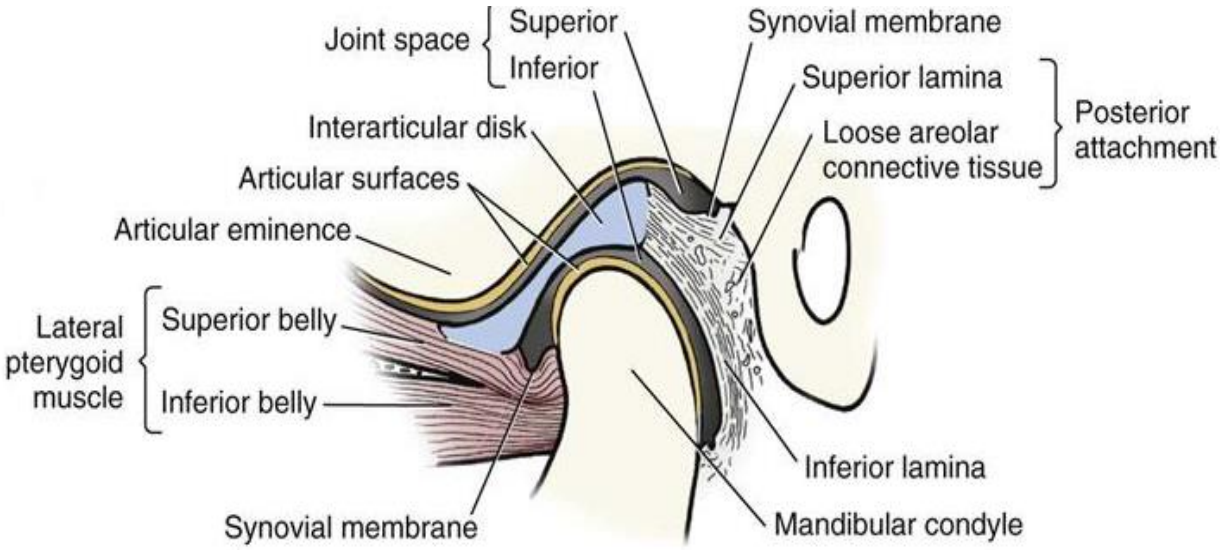


Fig. 86. Temporo-mandibular joint, in sagittal plane.

Fig. 87. Temporo-mandibular joint, in sagittal plane.

DEVELOPMENT OF THE SKULL

Three parts of the skull undergo different developmental paths. The development of the skull in humans is a complex process, which reflects the events of the historical development of the skull. When examining the

development of the skull, it is necessary to distinguish its three parts, each of which develops in a different way:

- the cranial base, similar to the internal axial skeleton, develops from the cartilaginous model;
- cranial bones of the calvaria are derived from the mesenchymatous model and develop from the dermal bones of the exoskeleton;
- visceral skeleton develops from the visceral arches.

Development of the cranial base. The cranial base is the oldest part of the skull. During embryonic development, the skull base undergoes three developmental stages. At the beginning of the 6-7 week, a condensation and thickening of the mesenchyme occurs around the anterior end of the notochord. It forms a mesenchymatous model of the cranial base. At the end of the 7^{th} week, within this mesenchymatous model, parachordal and prechordal cartilages develop, which fuse together forming a cartilaginous cranial base. Moreover, otic and nasal capsules develop around the sensory organs. A special capsule for the eye does not develop. The peak in the development of the cartilaginous cranial base is achieved at the beginning of the third month of embryonic life. During this period, a uniform cartilaginous model of the cranial base exists, in which independent future bones have not yet separated from each other.

Ossification of the cranial base cartilage begins at the end of the second month of embryonic development. From this cartilaginous model, the following bones undergo ossification via the endochondral mechanism: ethmoid and sphenoid bones, petrous part of the temporal bone, basilar and lateral parts of the occipital bone as well as the lower nasal concha.

In adults, cartilage persists in the cranial base in the form of synchondroses: spheno-occipital, spheno-petrosal, petro-occipital. The foramen lacerum is also encircled by cartilage.

The development of the cranial vault bones (calvaria). Simultaneously with the development of the mesenchymatous cranial base, a membranous

capsule begins to appear around the developing brain and becomes the desmocranium. Beginning with the second week, ossification centers appear in the mesenchymatous capsule. These ossification centers begin the endodesmal ossification of the bones of the cranial vault. Its elements are the frontal and parietal bones, the upper part of the occipital squama, and the squamous part of the temporal bone.

Therefore, the bones of the cranial vault omit the cartilaginous stage and ossify directly from the mesenchymatous model.

At birth, the cranial vault is not completely ossified. Between the bones of the vault, there are regions of connective tissue corresponding to the fontanelles. Wide spaces between cranial vault bones persist at birth, where cranial sutures will soon be formed.

The development of the visceral skeleton. The bones of the visceral skeleton develop from the visceral (branchial) embryonic arches. At the end of the first month and at the beginning of the second month of embryonic development, arcuate transverse projections are formed on either side of the embryonic brain. They are called the branchial arches. The first and the second arches are known as visceral arches. Between the arches, there are furrows named branchial pouches.

From the mesoderm of the first visceral (mandibular) arch the following elements develop: the maxilla and mandible, zygomatic bones and the auditory ossicles (the malleus and incus). From the second (hyoid) visceral arch the following structures develop: the stapes, the styloid process of the temporal bone, lesser horns of the hyoid bone. The third and fourth branchial arches give rise to the hyoid bone and laryngeal cartilages.

In the embryonic development, the mandible is formed from two halves, which fuse together only after birth during the first year of life.

The development of the face, lips and palate with special reference to their congenital deformities.

Around the primitive mouth, or stomodaeum, develop the following:

1. The *frontonasal process,* which projects down from the cranium. Two olfactory pits develop in it and rupture into the pharynx to form the nostrils. Definitively, this process forms the nose, the nasal septum, nostril, the philtrum of the upper lip (the small midline depression) and the premaxilla - the V-shaped anterior portion of the upper jaw, which usually bears the four incisor teeth.
2. The *maxillary processes* on each side, which fuse with the frontonasal process and become the cheeks, upper lip (exclusive of the philtrum), upper jaw and palate (apart from the premaxilla).
3. The *mandibular processes,* which meet in the midline to form the lower jaw.

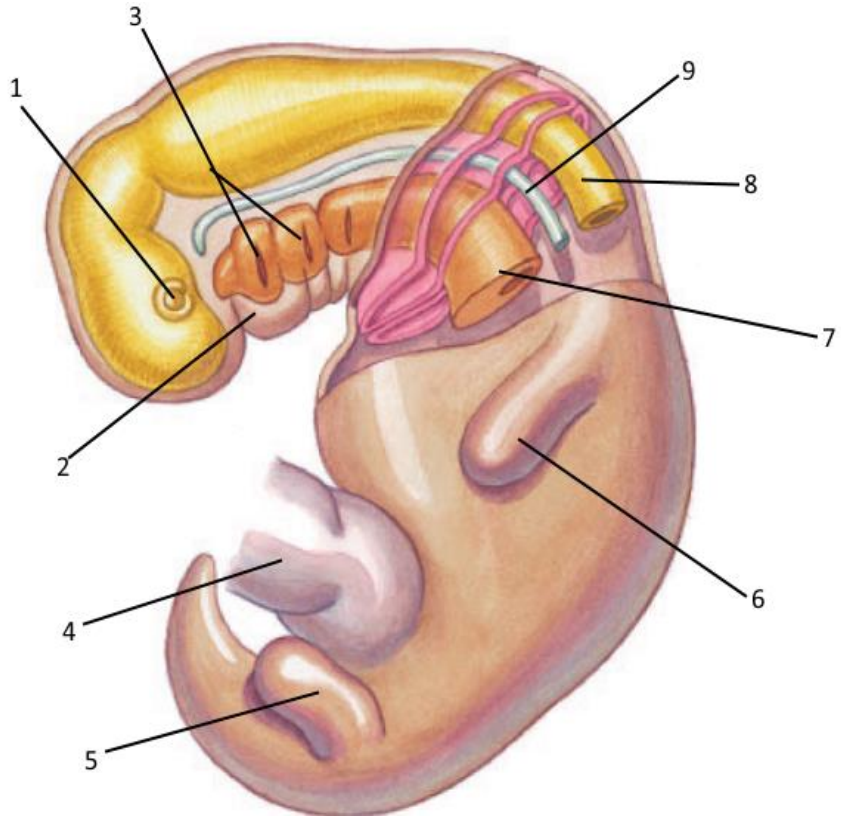


Fig. 88. A schematic diagram of a chordate embryo. 1 – Primitive eye; 2 – Pharynx; 3 – Pharyngeal pouches; 4 – Umbilical cord; 5, 6 – Limb bud; 7 – Gut; 8 – Dorsal hollow nerve cord; 9 – Notochord.

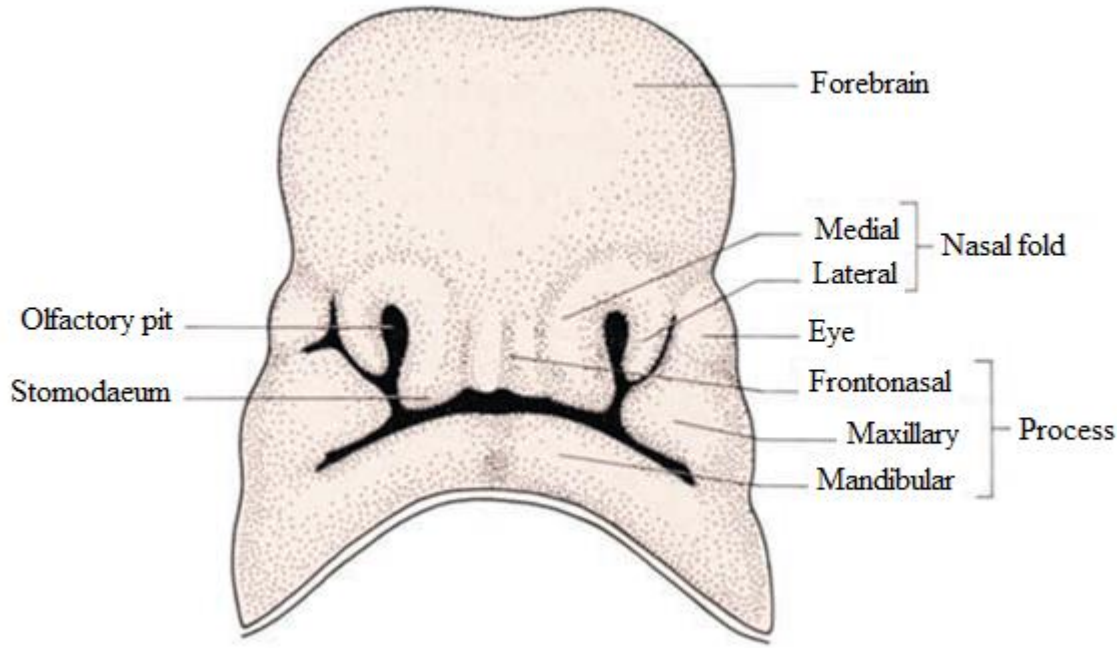


Fig. 89. The ventral aspect of a fetal head showing the three processes, frontonasal, maxillary and mandibular, from which the face, nose and jaws are derived.

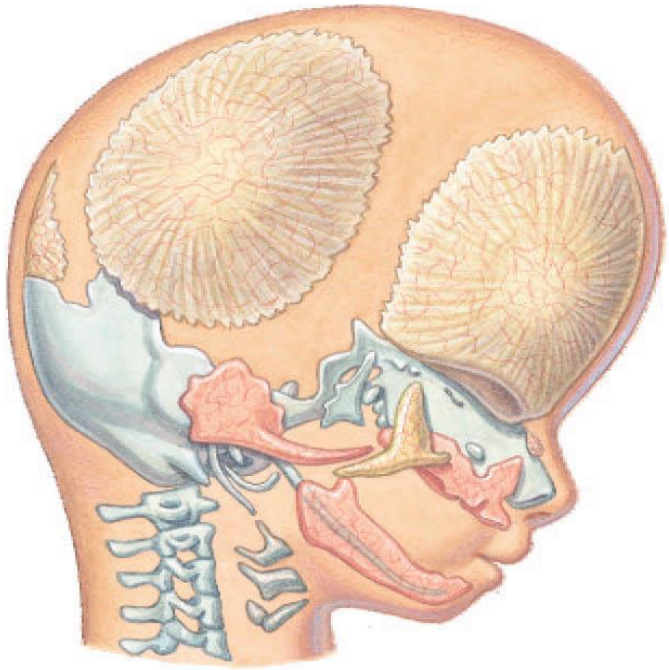


Fig. 90. The embryonic skull at 12 weeks is composed of bony elements from three developmental sources: the chondrocranium (colored

blue-gray), the neurocranium (colored light yellow), and the viscerocranium (colored red).

Abnormalities of this complex fusion process are numerous and constitute one of the commonest groups of congenital deformities. It is estimated that one child in 600 is born with some degree of either cleft lip or palate.

Frequently, these anomalies are associated with other congenital conditions such as spina bifida, syndactyly (fusion of fingers or toes), etc. Indeed, it is good clinical practice to search a patient with any congenital defect for others.

The following anomalies are associated with defects of fusion of the face.

1. ***Macrostoma*** and ***microstoma*** are conditions where either too little or too great a closure of the stomodaeum occurs.

2. ***Cleft upper lip*** (or 'hare lip') – this is only very rarely like the upper lip of a hare, i.e. a median cleft, although this may occur as a failure of development of the philtrum from the frontonasal process. Much more commonly, the cleft is on one or both sides of the philtrum, occurring as failure of fusion of the maxillary and frontonasal processes. The cleft may be a small defect in the lip or may extend into the nostril, split the alveolus or even extend along the side of the nose as far as the orbit. There may be an associated cleft palate.

3. ***Cleft lower lip*** – occurs very rarely but may be associated with a cleft tongue and cleft mandible.

4. ***Cleft palate*** is a failure of fusion of the segments of the palate. The following stages may occur:

a) bifid uvula, of no clinical importance;

b) partial cleft, which may involve the soft palate only or the posterior part of the hard palate also;

c) complete cleft, which may be unilateral, running the full length of the maxilla and then alongside one face of the premaxilla, or bilateral in which the palate is cleft with an anterior V separating the premaxilla completely.

5. *Inclusion dermoids* may form along the lines of fusion of the face. The most common of these is the external angular dermoid at the lateral extremity of the upper eyebrow. Occasionally this dermoid extends through the skull to attach to the underlying dura.

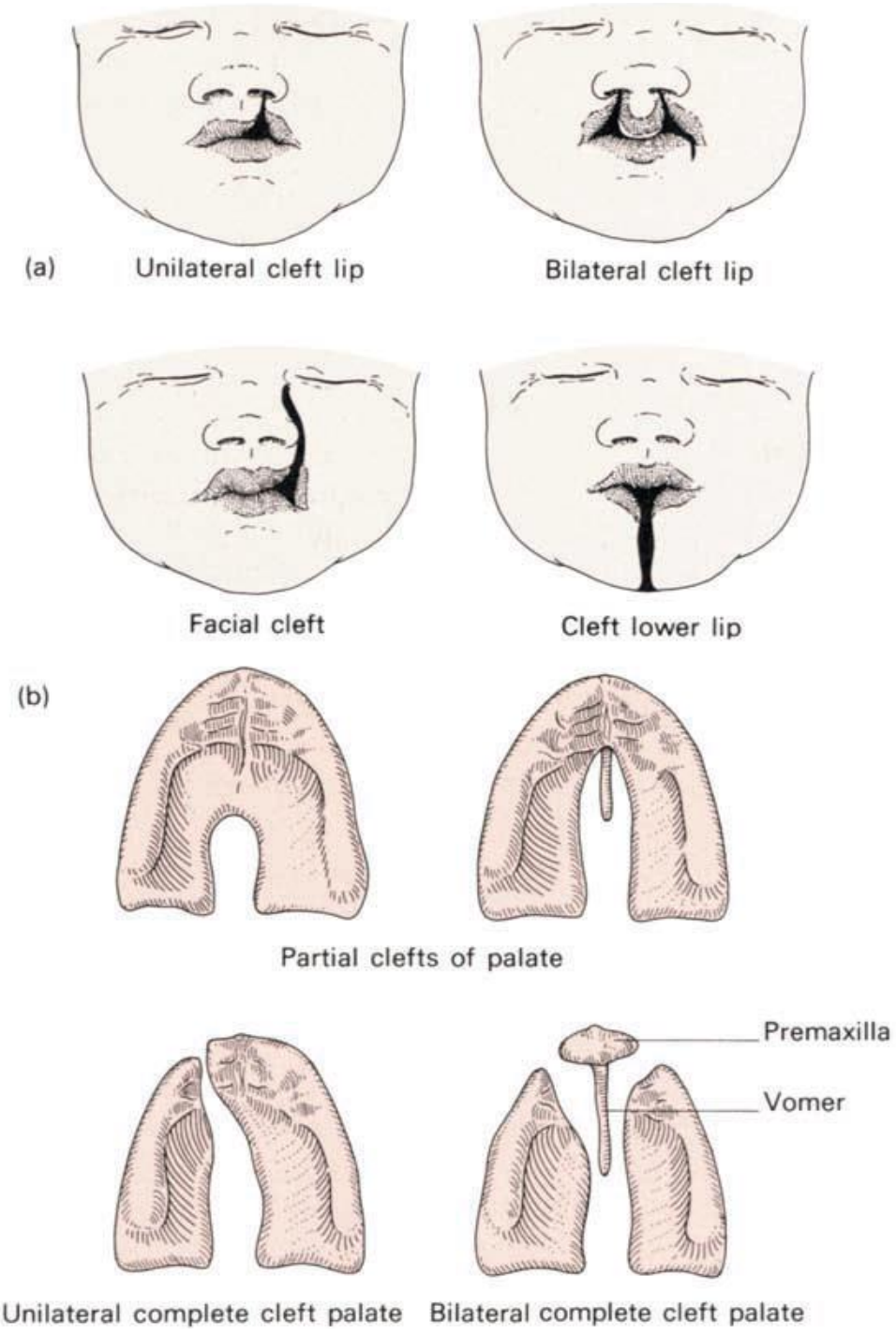


Fig. 91. Types of (a) cleft lip and (b) cleft palate.

OSSIFICATION OF CRANIAL BONES

Frontal: It ossifies in membrane. Two primary centres appear during eighth week near frontal eminences. At birth, the bone is in two halves, separated by a suture, which soon start to fuse. But remains of metopic suture may be seen in about 9% of adult skulls.

Parietal: It also ossifies in membrane. Two centres appear during seventh week near the parietal eminence and soon fuse with each other.

Occipital: It ossifies partly in membrane and partly in cartilage. The part of the bone above highest nuchal line ossifies in membrane by two centres which appear during second month of foetal life, it may remain separate as interparietal bone.

The following centres appear in cartilage:

Two centres for squamous part below highest nuchal line appear during seventh week. One Kerckring center appears for posterior margin of foramen magnum during sixteenth week.

Two centres one for each lateral parts appear during eighth week. One centre appears for the basilar part during sixth week.

Temporal: *Squamous* and *tympanic* parts ossify in membrane. *Squamous part* by one center which appears during seventh week. *Tympanic part* from one center which appears during third month.

Petromastoid and *styloid* parts ossify in cartilage. *Petromastoidpartis* ossified by several centres which appear in cartilaginous ear capsule during fifth month. *Styloid process* develops from cranial end of second branchial arch cartilage. Two centres appear in it. Tympanohyal before birth and stylohyal after birth.

Sphenoid: It ossifies in two parts:

Presphenoidal part which lies in front of tuberculum sellae and lesser wings ossifies from six centers in cartilage: Two for body of sphenoid during

ninth week; two for the two lesser wings during ninth week; two for the two sphenoidal conchae during fifth month.

Postsphenoidal part consisting of posterior part of body, greater wings and pterygoid processes ossifies from eight centres:

Two centres for two greater wings during eighth week forming the root only; two for postsphenoidal part of body during fourth month; two centres appear for the two pterygoid hamulus during third month of foetal life. These six centres appear in cartilage. Two centres for medial pterygoid plates appear during ninth week and the remaining portion of the greater wings and lateral plates ossify in membrane from the centres for the root of greater wing only.

Ethmoid: It ossifies in cartilage. Three centres appear in cartilaginous nasal capsule. One centre appears in perpendicular plate during first year of life. Two centres one for each labyrinth appear between fourth and fifth months of intrauterine life.

Mandible: Each half of the body is ossified in membrane by one centre which appears during sixth week near the mental foramen. The upper half of ramus ossifies in cartilage. Ossification spreads in condylar and coronoid processes above the level of the mandibular foramen.

Inferior nasal concha: It ossifies in cartilage. One centre appears during fifth month in the lower border of the cartilaginous nasal capsule.

Palatine: One centre appears during eighth week in perpendicular plate. It ossifies in membrane.

Lacrimal: It ossifies in membrane. One centre appears during twelfth week.

Nasal: It also ossifies in membrane from one centre which appears during third month of intrauterine life.

Vomer: It ossifies in membrane. Two centres appear during eighth week on either side of midline. These fuse by twelfth week.

Zygomatic: It ossifies in membrane by one centre which appears during eighth week.

Maxilla: It also ossifies in membrane by three centres. One for main body which appears during sixth week above canine fossa.

Two centres appear for premaxilla during seventh week and fuse soon.

CLINICAL ANATOMY

1. Fontanelles are sites of growth of skull, permitting growth of brain.

If fontanelles fuse early, brain growth is stunted; such children are less intelligent.

If anterior fontanelle is bulging, there is raised intracranial pressure, if anterior fontanelle is depressed, it shows decreased intracranial pressure, mostly due to dehydration. Bones override at the fontanelle helping to decrease size of head during vaginal delivery. Caput succedaneum is soft tissue swelling on any part of skull due to rupture of capillaries. Skull becomes normal within one week.

2. The *nasal bone is one of the most commonly fractured bones of the face.* Mandible and parietal eminence are the next bones to be fractured.

3. Pterion is the thin part of skull. In roadside accidents, the anterior division of middle meningeal artery may be ruptured, leading to clot formation between the skull bone and dura mater or extradural haemorrhage. The clot compresses the motor area of brain, leading to paralysis of the opposite side. The clot must be sucked out at the earliest by trephining. The head must be protected by a helmet.

4. Fracture of the anterior cranial fossa may cause bleeding and discharge of cerebrospinal fluid through the nose. It may also cause a condition called *black eye* which is produced by seepage of blood into the eyelid.

5. Fracture of the middle cranial fossa produces:

Bleeding and discharge of CSF through the ear.

Bleeding through the nose or mouth may occur due to involvement of the sphenoid bone.

The seventh and eighth cranial nerves may be damaged if the fracture also passes through the internal acoustic meatus. If a semicircular canal is damaged, vertigo may occur.

6. The middle cranial fossa is most commonly fractured. The fracture line usually follows a definite course. It begins at the parietal tuber which is usually the site of injury and passes through the parietal bone, the squamous temporal, and the petrous temporal bones usually involving the tegmen tympani, and frequently involving the internal acoustic meatus and the foramen ovale.

7. Fracture of the posterior cranial fossa causes bruising over the mastoid region extending down over the sternocleidomastoid muscle.

8. The mandible is commonly fractured at the canine socket where it is weak. Involvement of the inferior alveolar nerve in the callus may cause neuralgic pain, which may be referred to the areas of distribution of the buccal and auriculotemporal nerves. If the nerve is paralysed, the areas supplied by these nerves become insensitive. The next common fracture of the mandible occurs at the angle and neck of mandible.

9. Carcinoma of maxillary sinus arises from mucosal lining. Thin wall of the sinus may allow extension of the growth upwards into the orbit pushing the eyeball medially into the nasal cavity, forwards on the cheek, or backwards into the infratemporal fossa. Extraction of molar teeth may damage the floor of the sinus.

10. In a suspected case of murder, fracture of the hyoid bone strongly indicates throttling or strangulation.

Table 2. Major Foramina of the Skull

Foramen	**Location**	**Structures transmitted**
Carotid canal	Petrous part of temporal bone	Internal carotid artery and sympathetic nerves
Greater palatine foramen	Palatine bone of hard	Greater palatine nerve

	palate	and descending palatine vessels
Hypoglossal canal	Anterolateral edge of occipital condyle	Hypoglossal nerve and branch of ascending pharyngeal artery
Incisive foramen	Anterior region of hard palate, posterior to incisors	Branches of descending palatine vessels and nasopalatine nerve
Inferior orbital fissure	Between maxilla and greater wing of sphenoid bone	Maxillary nerve of trigeminal cranial nerve, zygomatic nerve, and infraorbital vessels
Infraorbital foramen	Inferior to orbit in maxilla	Infraorbital nerve and artery
Jugular foramen	Between petrous part of temporal and occipital bones, posterior to carotid canal	Internal jugular vein; vagus, glossopharyngeal, and accessory nerves
Foramen lacerum	Between petrous part of temporal and sphenoid bones	Branch of ascending pharyngeal artery and internal carotid artery
Lesser palatine foramen	Posterior to greater palatine foramen in hard palate	Lesser palatine nerves
Foramen magnum	Occipital bone	Union of medulla oblongata and spinal cord, meningeal membranes, and accessory nerves; vertebral and spinal arteries
Mandibular foramen	Medial surface of ramus of mandible	Inferior alveolar nerve and vessels
Mental foramen	Below second premolar on lateral side of mandible	Mental nerve and vessels
Nasolacrimal canal	Lacrimal bone	Nasolacrimal (tear) duct
Cribriform foramina	Cribriform plate of ethmoid bone	Olfactory nerves

Optic foramen	Back of orbit in lesser wing of sphenoid bone	Optic nerve and ophthalmic artery
Foramen ovale	Greater wing of sphenoid bone	Mandibular nerve (branch) of trigeminal nerve
Foramen rotundum	Within body of sphenoid bone	Maxillary nerve (branch) of trigeminal nerve
Foramen spinosum	Posterior angle of sphenoid bone	Middle meningeal vessels
Stylomastoid foramen	Between styloid and mastoid processes of temporal bone	Facial nerve and stylomastoid artery
Superior orbital fissure	Between greater and lesser wings of sphenoid bone	Four cranial nerves (oculomotor, trochlear, ophthalmic nerve of trigeminal, and abducens)
Supraorbital foramen	Supraorbital ridge of orbit	Supraorbital nerve and artery
Zygomaticofacial foramen	Anterolateral surface of zygomatic bone	Zygomaticofacial nerve and vessels

EPONYMES AND EPONYMIC SYNDROMES OF THE HUMAN SKULL

The recent integration processes in the educational and scientific processes contribute to the application of new terms that are understood by the scientist and educator of any field of knowledge. In this process, important knowledge of both historical value and national special character is lost. Important is the study of eponyms in the medical field of knowledge.

In the morphological sciences (human anatomy, clinical, topographic and pathological anatomy, histology, embryology, cytology, etc.) eponyms are used for a long time and constantly. The author's names cover a wide range of anatomical formations from the most important nodal to the less important for practical medicine. But knowledge of these names is important for professional doctor, teacher, scientist. Experts use the terms eponyms, which contributes to their professional development, increases the intellectual level of the physician,

because in the eponym is a part of history, culture that has been created, from ancient times, by the great contributors to the medical field of knowledge to the present.

Eponym (gr. Eponymos – the one who gives the name, the name) – the person on whose behalf (surname) is formed the name of the locality, country, people. Eponyms are medical terms that have their own names, anthroponyms and toponyms, which refer to the inventor or region of mass spread of the disease. In science, the eponym is the name of a phenomenon (such as a disease), a concept, structure, or method by the name of the person who first discovered or described them (Quincke, Wakernagel's Law, Kronecker's symbol, etc.).

Today in anatomy, eponymous names are increasingly found in various publications and textbooks on clinical anatomy. They have survived despite the new anatomical (medical) nomenclature in clinical practice. Widely used in foreign publications and textbooks.

The use of eponyms in the scientific literature makes the text laconic and vivid. Specialists use eponymous terms, although they are removed from the official nomenclature. Studying the eponyms of a modern student, young scientist, medical worker, allows you to learn more deeply about the history of your science and specialty, to understand the origin on which modern morphological sciences are based. Experienced medical practitioners, scientists in the field of morphology, compile dictionaries, using the terms eponyms.

Such publications are needed for medical students, as they are lacking in Ukraine. The use of anatomical terms, which include the names or surnames of the researchers who first described the anatomical formation, contribute to a better orientation in the topographic-anatomical location of the organ or area, this is required to work with scientific literature, where these terms are labeled eponymously, then clarity of meaning. Dictionaries, textbooks, monographs,

manuals, dissertation studies capture the names with their proper names, and therefore attract the attention of linguistic researchers.

Teaching experience has shown that many students experience difficulties in learning and understanding a number of terms that are encountered in the educational literature, but are not properly explained during practical classes, tests and exams.

Albrecht bone is an additional bone that lies between the occipital and cuneiform bones.

Andernach Gunther (1487-1574), French anatomist and surgeon, native of Switzerland (from Andernach). From 1527 he lived in Paris, teaching anatomy and surgery. He studied A. Vesaly, his lectures were listened to by Miguel Servet. The scientific works of Andernach were widely known and served as a significant complement to the anatomy of A. Vesalius.

Andernach Bones [G.J.Anderrnach] – an additional bone of the cranial vault; intracranial bones.

Apert Syndrome (Apert). Combination of skull deformity and syndactyly. Congenital malformation of the skull (tower skull, moon-shaped face, flattened nose, bulging eyes), high palate (sometimes with splitting), syndactyly, polydactyly, radioulnar synostosis with tight mobility in the elbow.

Arnold Friedrich (1803-1890), German anatomist. He was born in Landau. He received his medical education in Heidelberg. In 1826 he defended his doctoral thesis on the structure of the main part of the sympathetic nerve of the person. He then headed the departments in Zurich (1835-1840), Freiburg (1840-1845), Tubingen (1845-1852) and Heidelberg (1852-1890). His numerous scientific works are devoted to the structure of the brain and the peripheral nervous system.

Arnold Canal [F.Arnold] (Arnold Canal Nameless, Arnold Petrous Foramen, canaliculus innominatus) – an inconstant foramen (foramen petrosum)

in the greater wing of the sphenoid bone (between the foramen ovale and foramen rotundum), penetrating by the lesser petrosal nerve.

Bergmann Ernst (1836-1907), a well-known surgeon. He was born in Riga. After graduating from the University of Dorpat (1860) he was an assistant at the surgical clinic, then (1871) professor at the same university until 1878. He was briefly professor at Wurzburg, and in 1882 was elected professor at the University of Berlin. As a consultant surgeon, he participated in the Franco-Prussian (1870-1871) and Russo-Turkish (1877-1878) wars. He gained extensive experience in field surgery, which he endured in peacetime as the creator of the Emergency Relief Society in Berlin. He studied all areas of surgery, but paid special attention to the treatment of wounds. Bergman's work on skull surgery, especially in the area of gunshot wounds, is classic.

Bergman quadrangle [E.Bergmann] - according to the craniocerebral topography scheme Krenlein is a topographic anatomical reference for the opening of otogenic pus in the middle cranial fossa.

Battle symptom (Battle). Changing the color of the skin in the area of the mastoid process until the appearance of ecchymosis. Determine the fracture of the skull.

Bertin's bones [E.J.Bertin] (sphenoid conchae, conchae sphenoidales) are thin bony plates of the anterior surface of the body of the sphenoid bone, which limit the aperture of the sphenoid sinus (apertura sinus sphenoidalis) with its upper edges.

Bichat Marie François Xavier (1771-1802), French anatomist and physiologist. Born in Tiorette. He studied medicine in Montpellier, Lyon and Paris. In 1797, in Paris began to read lectures on normal and pathological anatomy, physiology and surgery. In 1800 he was appointed a doctor in a Paris hospital. The founder of the doctrine of the tissues, the creator of the general anatomy of the nervous system, physiological direction in medicine. He divided the nervous system into the autonomic and animal parts, and in 1800 introduced

the term "autonomic nervous system". His scientific works are widely known "Physiological studies of life and death" (1800), "General anatomy in its complement to physiology and medicine" (1802).

Basal fossa [MFXBichat] (fossa pterygopalatina) is a slit space in the infratemporal area, bounded anteriorly by the tuber and infratemporal surface of the maxilla, posteriorly by the pterygoid process of the sphenoid bone; medially by the perpendicular plate of the palatine bone; superiorly by the infratemporal crest of the greater wing of the sphenoid bone. Contents: pterygopalatine node of the maxillary nerve, its orbital and upper posterior nasal branches, maxillary vessels.

Blumenbach Johann (1752-1840), German physician and anatomist, zoologist and anthropologist. Born in Gotha. He studied medicine in Jena, Goettingen. In 1776-1835 he headed the Department of Clinical Medicine at the University of Goettingen. In his studies, using the comparative-anatomical method, he noted the common origin of different species of animals. One of the founders of anthropology. In his dissertation "On the Natural Varieties of the Human race" (1776), he described 5 species of modern races of man and expressed his opinion about their only origin.

Blumenbach slope [J.F.Blumenbach] (slope, clivus) – a chute is formed by the body of a sphenoid bone and the basilat part of the occipital bone; extends between the dorsum of the Turkish saddle and the foramen magnum of the occipital bone; it houses the medulla oblongata, the pons and the arterial circle of the brain.

Breschet channels [G.Breschet] (Dupuytren channels, canals diploicae) are channels of the spongy substance of the flat bones of the skull vault in which the spongy veins extend.

Broca (1824-1880), French surgeon, anatomist and anthropologist. Born in Santa Fe la Grande. He studied medicine in Paris. He worked as a surgeon. Since 1848 he has been a projector at the Faculty of Medicine of the University

of Paris. Since 1867 – Professor of Clinical Surgery and a member of the French Medical Academy. In 1859 he founded the Paris Anthropological Society and became the director of the anthropological laboratory he founded. He developed anthropometry technique and designed a number of tools for measuring the body. He founded the journal Anthropological Review. In 1865 he published a textbook on descriptive human anatomy.

Broca alveolocondillary plane [P.Broca] – conditional horizontal plane drawn through the lower points of occipital condyles and cells of the upper incisors.

Budinov plate [DT Budinov] is a cartilage plate that lies between the occipital margin of the parietal bone and the occipital squama in fetuses and newborns; promotes bone replacement during labor.

Vesalius Andrew (1515-1564), a scientist of the Renaissance, the founder of modern scientific anatomy. Born in Brussels to a royal pharmacist family. He graduated from the University of Louisville, then studied medicine in Paris, where he was a student of the famous anatomist J. Sylvia. In 1537 he returned to Louvain, continued to pursue anatomy, with the risk of life extracting corpses. In 1537 he went to Padua, received the title of Doctor of Medicine and was appointed Professor of Surgery and Anatomy. In 1538, his "Six Anatomical Tables" published jointly with the artist Stefan van Kalkar were published. In 1543, in Basel he published his main scientific work "On the Structure of the Human Body in Seven Books," based on the autopsy and preparation of human corpses, contained criticism of Galen's false views. In the same year, a short excerpt from this work was published – Epitome. Fierce opponents forced A. Vesalius to leave Padua University and take up the post of court physician, Charles V, and then his son Philip II. In 1559 A. Vesalius moved to Madrid. Deprived of the anatomy of being persecuted, he burned part of his manuscripts and made a pilgrimage to Palestine in 1564. On the way back after a shipwreck, he got to Zante Island in the Ionian Sea, where he soon died.

Vesalius bone [A.Vesalius] (the bone of the anterior fontanelle, os fonticuli anterioris) is an additional bone formed at the place of the anterior parietal fontanelle.

Vesalius foramen [A.Vesalius] (foramen venosum) – a foramen in the greater wing of the sphenoid bone that is between the foramen rotundum and foramen ovale; penetrates with the emissary vein of Vesalia (v. emissaria).

Vidianus canal [G.G.Vidianus] (pterygoid canal, canalis pterygoideus) is a sagittally directed canal at the base of the pterygoid processes of the sphenoid bone that connects the outer surface of the base of the skull with the pterygoid fossa; pierced by a vascular-nerve bundle (pterygoid arteries, veins, nerves).

Vick'Azira bone [F.Vicq-d'Azyr] (Goethe bone, Kelliker's bone, incisor bone, os incisivum) is the anterior-inferior part of the maxilla with the upper incisors, sometimes a separate bone; according to the embryological nomenclature is called maxillary (premaxilla); an alternative term is "palatum primum" (primary palate).

Whithnall tuberculum [S.E.Whithnall] (tuberculum marginale) is a hump on the orbital surface of the frontal process of the zygomatic bone.

Highmore Nathaniel (1613-1685), English physician and anatomist. Born in Fordingbridge, Hampshire. In 1634 he entered the Faculty of Natural Sciences of the University of Oxford, after which in 1641 he worked as a physician in Cherbourg. He studied descriptive human anatomy. Great influence on the development of anatomy as a science had his work "Anatomical study of the human body", published in 1651.

Sinus Highmore (sinus maxillaris) – a cavity in the body of the maxilla, covered with mucous membrane, filled with air, opens into the middle nasal meatus.

Garsin symptom (Garsin). Unilateral paralysis of the cranial nerves without sensory and motor disorders of the trunk and increased intracranial pressure. Observed for tumors of the skull base.

Henle Friedrich (1809-1885), German anatomist and pathologist. Born in Nuremberg. He received his medical education from the University of Bonn and was a student of I. Muller. In 1832 he defended his doctoral scientific work, after which he worked in Paris. In 1840 he was elected head of the department of anatomy in Zurich. In 1844 – Professor of Anatomy in Heidelberg. From 1852 to the end of his life he was professor and director of the Anatomical Institute in Goettingen. He was intensively engaged in the anatomy and microscopic anatomy of the internal organs of man. In 1882, in Kharkov, Professor Wagner and Prospector Popov translated his textbook «An Essay on Human Anatomy».

Genle spine [F.G.J.Henle] (Zuckercandle spine, spina suprameatica) – protrusion on the external surface of the temporal bone, above the upper end of the external auditory meatus; it is topographic anatomical landmark for operational access to the antrum of the mastoid process.

Glazer fissure [J.H.Glaser] (Gugier Canal, Chivinini Canal, petrotympanic fissure, fissura petrotympanica) – narrow space between squama and protruding end of petrous part (pyramid) of temporal bone; the posterior part of the tympanic fissure (fissura tympanosquamosa) intersects the mandibular fossa of the temporal bone; the chorda tympani canal is opened in the petrotympanic fissure; through the petrotympanic fissure the anterior and posterior tympanic arteries (aa. tympanicae anterior et posterior) penetrate into the tympanic cavity.

Dorello canal [Dorello] is a canal in the petrous part of the temporal bone, formed by a furrow of the inferior petrous sinus and a dura mater of the brain. Its contents: inferior petrous sinus, arterial vessels and abductor nerve, which goes into the cavernous sinus.

Ingrassias protrusion [G.Ingrassias] (spine of sphenoid bone, spina ossis sphenoidalis) is a pointed bone plate, which ends a greater wing of sphenoid bone.

Inggrassias wing [G.Ingrassias] (ala minor ossis sphenoidalis, the lesser wing of the sphenoid bone) is a paired plate of the sphenoid body.

Camper Peter (1722-1789), Dutch doctor, anthropologist, paleontologist, artist. Born in Leiden, he studied natural science and medicine there. In 1747 he received the degree of Doctor of Philosophy. From 1750 – Professor of Philosophy and then Medicine in Franeker, in 1755-1761 – Professor of Anatomy and Surgery in Amsterdam. In 1763-1773 - Professor of Anatomy and Surgery and Internal Medicine in Greningen. His works are devoted to various issues of medicine, normal and comparative anatomy. It describes the structure of the lens, the pneumatic bones of the birds, and the mucous bursae of muscles.

Camper Face Angle [P.Camper]. Angulus facialis is formed by an auriculo-nasal line (Camper line) and a line that connects the midline of the glabella with the nasal spine. It is topographic-anatomical landmark in plastic surgery.

Camper line [P.Camper] linea auriculonasalis) – connects the anterior nasal spine of the maxilla with the upper end of the external auditory canal. It is topographic-anatomical landmark for constructing the facial angle of Camper when planning plastic surgery on the face.

Kerkring bone [Th.Kerckring] (ossicula Kerckringi) is a variant of occipital bone development; a separate point of ossification at the site of the external occipital protuberance; in childhood it can be an independent bone.

Carthusian syndrome. It is characterized by congenital half-face hypertrophy, dental dysplasia, varicose veins of the leg, syndactyly, hypogenitalism.

Killian grooves [H.F.Killian] are the main grooves of the nasal walls that appear within 8-10 weeks of pre-natal development on the lateral walls of the nose and in the area of the future ethmoid labyrinth.

Kocher Theodore (1841-1917), Swiss surgeon, Nobel laureate in 1909 Since 1886 he has been an assistant at the surgical clinic in Berne. In 1872-1911

he was professor of surgery in Berne. He made a major contribution to all areas of surgery: Developed the problem of goiter, graft disease, investigated the mechanisms of action on the tissues of firearms, spinal cord injuries, proposed a number of original tools and methods for the treatment of inguinal hernias and dislocations. Author of the original manual of surgical surgery (1892-1907).

Kocher point [E.Th.Kocher]. It is determined on the vault of the head 1 cm forward from the coronal suture and 2 cm away from the sagittal line; topographic anatomical reference point for puncture of the anterior horn of the lateral ventricle of the brain.

Face cruzon [O.Crouzon]. It is "clouded" shape of face and head with pronounced craniofacial dysostosis due to multiple premature synostoses of coronal and occipital-parietal sutures and, due to premature, hump-like formation in the region of the anterior fontanelle whose bone plate reaches the angle of the nose due to premature ossification.

Landucert canal [FP Landuzert] (cranial-pharyngeal canal of the sphenoid bone, canalis craniopharyngealis ossis sphenoidalis). It is located at the bottom of the pituitary fossa, opens with a "pharyngeal opening" on the lower surface of the body of the sphenoid bone, close to the junction of the vomer wings. Contents: Continuation of the dura mater as a connective tissue junction containing venous formations. Occurs rarely (2%).

Lucas sulcus [R.C.Lucas] (spinous sulcus, sulcus spinosus) – an indentation from a chorda tympani that is located on the spine of the greater wing of the sphenoid bone.

Marfan syndrome. Arachnodactyly in combination with various orbital, skeletal and visceral defects. Clinically, malformations are manifested in the form of dolichocephaly, Gothic palate, prognathous, kyphosis, keeled chest, limb lengthening, arachno-dactyly, joint loosening. There may be an aortic aneurysm, anomalies of the arteries, and valvular apparatus of the heart. Radiographically note diffuse osteoporosis of metaphyseal parts of bones.

Meckel Johann Friedrich (1724-1774), German anatomist, pupil of A. Haller. Born in Wetzlar. He received his medical education at the Universities of Goettingen and Berlin. In 1748 he defended his doctoral thesis on the V pair of cranial nerves. In 1749 he was a member of the Royal Academy in Berlin. From 1751 Professor of Anatomy and Botany at the University of Berlin. He also taught at a midwifery school and practiced medicine. Known for numerous works on the anatomy of the peripheral nervous system, especially the trigeminal nerve, embryology. He founded the Anatomical Museum in Halle.

Meckel's cartilage [J.F.Meckel]. It is the cartilage of the lower part of the first visceral arch of the human embryo, around which the mandible develops.

Meckel Fossa [J.F.Meckel] (trigeminal impression, impressio trigeminalis). It is determined near the apex of the petrous part of the temporal bone, which contain the sensitive node of the trigeminal nerve (ganglion trigeminale Gasseri).

Moser cell [H.P. Mosher] (bulla ethmoidalis) is a large cell of a ethmoid labyrinth within a hooked process. Between the hooked process and the lower surface of the ethmoid bulla is a semilunar fissure, through which the maxillary sinus communicates with the middle nasal meatus.

Morana foramen [S.F. Morand] (foramen caecum). It is located on the inner surface of the base of the skull, bounded by the lower part of the frontal crest and the wings of the crista galli of the ethmoid bone.

Morgagni Giovanni (1682-1771), Italian anatomist and physician, pupil of A. Valsalva. Born in Botti. For 59 years he was a professor of anatomy in Padua. Known for his work on normal, pathological anatomy, which were of great importance for the development of anatomical direction in medicine. He created a museum of injuries, anomalies and tumors of various organs. He is considered the founder of pathological anatomy as a science.

Morgany concha [G.B.Morgagni] (upper nasal concha, concha nasalis superior; upper ethmoid concha, concha ethmoidalis superior). It is outgrowth on the medial wall of the ethmoid labyrinth; participates in the formation of the lateral wall of the nasal cavity.

Otto foramen [D.O. Ott] (stony-fissure slit, fissura petrosquamosa) is the anterior portion of the tympanosquamous fissure, between the squama and the convex edge of the petrous part of the temporal bone, where the petrosquamous canaliculus opens.

Prenset tubercle [L.Princeteau]. It is elevation or upper margin within the apex of the petrous part of the temporal bone (margo superior partis petrosae) to which the superior petrous sinus adjoins.

Poirier line [P.J.Poirier]. It is made on the skull vault between the nasion and the lambda.

Retzius Andreas (1796-1860), Swedish anatomist. He graduated from Lund University and studied in Copenhagen; in 1819 received his degree of Doctor of Medicine. In 1823 – Professor of Anatomy at the Veterinary Institute in Stockholm, and since 1824 – Professor of Normal Anatomy at the Karolinska Institute. His works are devoted to various issues of comparative anatomy. He described the connection between the spinal nerves and the sympathetic trunks (1832), specified the structure of a number of elements of the vascular system (1843) of the stomach in humans and animals. Investigated the structure of the liver; studied the structure of the skull of the Scandinavian peoples and classified the races according to the shape of the skull. He founded the Museum of Normal Anatomy in Stockholm.

Retzius main index [A.A.Retzius]. It is anthropometric and topographic-anatomical index of the percentage of the width of the skull to its length.

Riolan Jean (1577-1657), French physician and anatomist. Born in Paris. Professor of Anatomy and Botany in Paris. He described many anatomical

formations: meniscuses of the knee, mesentery, omentum, omental processes, and seminiferous tubules.

Riolan bones [J.Riolan] are inconstant small isolated bones in the petrooccipital suture of the base of the skull (ossa suturalia).

The Riche fossa [Ch.P.Richet] (fossa pterygomaxillaris). It is consists of two fossae: sphenomaxillary and sphenopalatine; extends cranially into the infratemporal fossa. Its content: pterygoid muscles and inter-pterygoid and spheno-temporal fissures filled with fiber and deep venous plexus.

Robyn Syndrome (Robin). Congenital injury, characterized by underdevelopment of the mandible (microgeniya), underdevelopment and contraction of the tongue (glossoptosis) and cleft palate. Often combined with other defects.

Rousseau bone [L.F.E.Rousseau] is an additional lacrimal bone (ossicula lacrimalis accessoria) that is anterior to the main lacrimal bone; variant of facial bone development.

Santorini concha [G.D.Santorini] (highest nasal concha, concha nasalis suprema) is a non-constant thin bone plate of the medial wall of the ethmoid labyrinth, defined above the upper nasal concha.

Scarps foramens [A. Scarpa]. These are foramens in the intermaxillary suture through which vessels and nerves pass.

Scott line [J.H.Scott] (incisor line). It connects the incisal opening on the bone palate with the foramen stylomastoideum of the temporal bone. This line is topographic anatomical landmark and anthropometric index of the shape of the skull (brachy- or dolichomorphic).

Stenon (Stenen) Niels (Stenon, Stensen) (1638-1686), Danish anatomist, geologist and paleontologist. Born in Copenhagen. He received his medical education in Copenhagen with T. Bartolin and in Leiden with J. Sylvia. He then worked with Blazius in Amsterdam, where in 1660 he opened the parotid duct. In 1663 he received a doctorate in medicine at Leiden. From 1669 he stayed in

France, Italy, Germany, Holland, and in 1672 returned to Denmark. In 1672 he was appointed Professor of Anatomy in Copenhagen. He studied the anatomy of the muscles, brain, bone system. Known for his work "The Language of Brain Anatomy", "The Experience of Observing Muscles and Glands", "On the Principles of Myology or the Geometric Description of Muscles", which contained new ideas at the time.

Stenon canal [N. Stenon] (incisor canal, canalis incisivus) is an unpaired bone canal that begins with an incisal opening in front of the median palatine suture; contains a greater palatine artery and nasopalatine nerve.

Stenon foramen [N.Stenon] (foramen incisivum) is a hole behind the medial incisors, in the median palatane suture leading to the incisal canal. The posterior septal branches of the sphenopalatine artery and the branches of the greater palatine artery from the descending palatine artery (branches of the maxillary artery) and the nasopalatine nerve (branch of the maxillary nerve) pass through the foramen incisivum.

Tarina hiatus [P.Tarin] (hiatus canalis n. petrosi majoris). This is an opening on the anterior surface of the petrous part of the temporal bone through which the superficial greater petrous nerve exits.

Falloppio Gabriel (1523-1562), Italian anatomist. Born in Modena. He studied medicine in Ferrara and Pisa. Since 1551 – Professor of Anatomy and Surgery in Padua. Known for his studies of the organ of hearing and balance, as well as the reproductive system of man.

Fallopia channel [G.Falliopio] (canal of the facial nerve, canalis n. facialis) - located inside the petrous part of the temporal bone; begins at the bottom of the internal auditory meatus, crosses the longitudinal axis of the petrous part from the back to forward, rotates laterally near its anterior surface, forming the knee of the canal of the facial nerve and runs laterodorsally parallel to the longitudinal axis of the petrous part; above the tympanic cavity it arcs

downwards and ends with a stylomastoid foramen. Through the channel passes VII pair of cranial nerves.

Ferrein canal [A. Ferrein] (canalis nasolacrimalis canalis) is a bone junction between the orbital fossa and the lower nasal meatus; formed by the lacrimal groove and the lacrimal process of the lower nasal concha; length 12-14 mm, diameter – 3-4 mm.

Hando-Schuler-Christian disease. Cranial xanthomatosis. The disease is a violation of cholesterol metabolism and infiltration of lipoid and plasma cells of the flat bones, dura and skin. Clinically - exophthalmos, sexual underdevelopment, in the skin – small yellowish nodules, fractures of long tubular bones, lesions of the facial nerve, hearing loss, nystagmus, cerebellar disorders. On radiographs of the skull and other bones – cells of osteoporosis with unequal intensity with uneven contours (skull type map). The disease begins at the age of 10, affects boys more often, the disease is progressive.

Jacobson channel [L.L. Jacobson] (tympanic canaliculus tympanicus) – begins with an external (lower) apertura (apertura externa) at the bottom of the petrous fossil on the lower surface of the petrous part of the temporal bone, goes upward, penetrates the tympanic cavity along medial wall, further to the promontory in the form of a furrow; enters on the anterior surface of the petrous part of the temporal bone, where it opens with an internal (upper) aperture (apertura interna) – a hiatus of the lesser petrous canal; contains tympanic nerve – branch of glossopharyngeal nerve (IX pair of cranial nerves).

CONTROL QUESTIONS

1. Name three parts of human skull, which follow different developmental path.

2. Why does the skull base ossify via endochondral mechanism?

3. Name the skull bones, which develop from cartilage?

4. Why are the cranial vault bones derived from the connective tissue?

5. What bones arise from the first visceral arch?

6. What bones develop from the second visceral arch? What bones develop from the third and fourth branchial arches?

7. Why is the skull divided into two regions? Name these regions.

8. What is the structure of cranial flat bones?

9. Bones of the neurocranium: the occipital bone (the structure, parts, foramens, canals).

10. Bones of the neurocranium: the frontal bone (the structure, parts, foramens, frontal sinus).

11. Bones of the neurocranium: the temporal bone (the structure, parts, processes, foramens, canals).

12. Point out the tegmen tympani. What is its clinical importance?

13. The walls of the tympanic cavity.

14. Name major canals of the temporal bone. Demonstrate the openings of facial canal, carotid canal and musculotubal canal.

15. Describe the path of the facial canal.

16. What does the musculotubal canal contain? What parts is it divided into?

17. What do the mastoid air cells of the temporal bone communicate with? What is its clinical importance?

18. Bones of the neurocranium: the sphenoid bone (the structure, parts, foramens).

19. What resides in the Turkish saddle? Why is the X-ray examination of the Turkish saddle has clinical importance?

20. Bones of the neurocranium: the ethmoid bone (the structure, plates, the ethmoidal labyrinth).

21. Bones of the visceral skeleton: the maxilla (structure, parts, processes, maxillary sinus).

22. Bones of the visceral skeleton: the mandible (structure, parts, processes, foramens).

23. Bones of the visceral skeleton: the palatine bone (structure, plates, processes, and foramens).

24. Bones of the visceral skeleton: the zygomatic bone, the lacrimal bone, the hyoid bone (their structure).

25. Visceral (facial) skeleton: temporal fossa, infratemporal fossa, pterygopalatine fossa. Their boundaries, contents, communications.

26. Neurocranium: the calvaria (bones, connections), the bony palate.

27. Neurocranium: external surface of the base of the skull (borders, foramens).

28. Neurocranium: internal surface of the base of the skull (borders, structure of the anterior, middle and posterior cranial fossae).

29. Nasal cavity: walls, the bony nasal septum, nasal conchae, nasal meatuses and its communications.

30. What formations open into the: 1) superior nasal meatus; 2) middle nasal meatus; 3) inferior nasal meatus?

31. Show the frontal sinus and its opening.

32. What structures represent air-filled cavities of the ethmoid bone?

33. What is the function of the air sinuses in the bones of the skull?

34. Show the Highmore sinus and explain its clinical importance.

35. Orbital cavity: walls, the communications of the orbit. To describe and demonstrate their on the preparation.

36. Name the sutures of the calvaria.

37. Name the three cranial fossae.

38. Name cranial fontanelles. When do they ossify?

39. What is the clinical significance of the dates of fontanelle closure?

40. What happens to the skull bones during the birth process?

41. What changes take place after birth?

42. When do the cranial sutures form and when do they begin to obliterate?

43. What are the characteristics of the skull in elderly?

44. Name major skull anomalies. What skull anomalies occur?

45. How is the cranial index calculated?

46. What are the three variants of the skull distinguished on the bases of the cranial index value?

47. Name basic sexual differences of the skull. How are they determined?

48. Name major types of sutures.

49. Recall cranial synchondroses.

50. Explain why fibrous articulations are present in the region of the calvaria, whereas on the base of the skull synchondroses prevail?

51. What is located inside the temporomandibular joint?

52. How is the fibrous capsule of the temporomandibular joint attached?

53. Name the ligaments of the temporomandibular joint.

54. What types of movements are possible in the temporomandibular joint?

SITUATION PROBLEMS

1. A casualty has a fracture of the base of the skull in the region of the hypoglossal canal. Which bone was damaged?

A. The frontal

B. The parietal

C. The occipital*

D. The temporal

E. The sphenoid

2. After collision of two cars, a driver got deformation of the right occipital condyle. Which part of the occipital bone can be injured?

A. Basilar part

B. External surface of the squamous part

C. Internal surface of the squamous part

D. Lateral part*

E. Nasal part

3. A casualty has a trauma of soft tissues and parietal bones in the sagittal suture area with profuse bleeding. Which formation is probably injured?

A. Sinus rectus

B. Sinus petrosus superior

C. Sinus transverse

D. Sinus sagittalis inferior

E. Sinus sagittalis superior*

4. A casualty has a fissure in the region of the groove for transverse sinus. Which part of the occipital bone can be injured?

A. Internal surface of the squamous part*

B. External surface of the squamous part

C. Basilar part

D. Lateral part

E. Nasal part

5. Purulence of occipital soft tissues took place after a trauma. Through which anatomical formation can the purulent process spread to the cranial cavity?

A. Foramen caecum

B. Condylar canal*

C. Foramen rotundum

D. Optic canal

E. Carotid canal

6. A casualty has a fracture of the base of the skull in the region of foramen spinosum and foramen rotundum. Which bone is damaged?

A. The frontal

B. The parietal

C. The sphenoid*

D. The temporal

E. The ethmoid

7. On the radiological investigation in a patient was diagnosed fracture of the nasal septum in the superior 1/3. Which bone is damaged?

A. The frontal

B. The parietal

C. The sphenoid

D. The ethmoid*

E. The temporal

8. Patient admitted to hospital with an injury of the base of the skull. On the radiological investigation in a patient was diagnosed destruction and increase of the hypophyseal fossa. Which anatomical structure is damaged?

A. Optic canal

B. Foramen rotundum

C. Pterygoid canal

D. Superior orbital fissure

E. Sphenoidal sinus*

9. On the radiological investigation in a patient was diagnosed increase of the Turkish saddle's cavity, destruction of the different part of the hypophyseal fossa and anterior clinoid processes. Which endocrine gland is damaged?

A. The pituitary gland (hypophysis)*

B. Epiphysis

C. Suprarenal gland

D. Thyroid gland

E. Parathyroid gland

10. A casualty has a fracture of the base of the skull. Line of the injure passed through prechiasmatic sulcus and carotid sulcus. Which part of the sphenoid bone is damaged?

A. Greater wing

B. Body*

C. Lesser wing

D. Pterygoid process

E. Posterior clinoid process

11. A child was admitted to an otolaryngologic department with inflammation of the middle ear. Disease began with nasopharynx inflammation. It is detected that the infection lo the tympanic cavity through the auditory tube located in:

A. Canalis caroticus

B. Canaliculus tympanicus

C. Canalis musculotubarius*

D. Canaliculus chordae tympani

E. Canaliculi caroticotympanici

12. An 8-year-old boy with purulent otitis has the infection spread from the tympanic cavity into the bulb of internal jugular vein. Such complication develop in case of one of the tympanic cavity walls thinning. Which wall is it?

A. Medial

B. Superior

C. Lateral

D. Inferior*

E. Anterior

13. A 9-year-old girl with purulent otitis has the infection spread from the tympanic cavity into the middle cranial fossa. Such complication develop in case of one of the tympanic cavity walls thinning. Which wall is it?

A. Medial

B. Anterior

C. Lateral

D. Inferior

E. Superior*

14. A 7-year-old boy with purulent otitis has the infection spread from the tympanic cavity into the inner ear. Such complication develop in case of one of the tympanic cavity walls thinning. Which wall is it?

A. Medial*

B. Anterior

C. Lateral

D. Inferior

E. Superior

15. A 6-year-old boy with purulent otitis has the infection spread from the tympanic cavity into the mastoid antrum. Such complication develop in case of one of the tympanic cavity walls thinning. Which wall is it?

A. Medial

B. Posterior*

C. Lateral

D. Inferior

E. Superior

16. At birth defect, mandibular midline slit. Which non-union processes of the maxilla leads to the development of anomalies?

A. Mandibular

B. Maxillary

C. Palatine*

D. Frontal

E. Zygomatic

17. At the victim was the trauma of the upper jaw with a damage of the infraorbital foramen. Which surface of the upper jaw was broken?

A. Nasal

B. Orbital

C. Anterior*

D. Infratemporal

E. Temporal

18. At the victim was the trauma of the maxilla, knocked out the first molar dens. Which process of the maxilla is damaged?

A. Nasal

B. Frontal

C. Palatine

D. Alveolar*

E. Temporal

19. Purulence of orbit soft tissues took place after an eye′s trauma. Through what anatomical formation can the purulent process spread to the middle cranial fossa?

A. Through the anterior ethmoidal foramen

B. Through the posterior ethmoidal foramen

C. Through the superior orbital fissure*

D. Through the inferior orbital fissure

E. Through the zygomaticoorbital foramen

20. Chronic rhinitis is complicated with the signs of maxillary sinus mucous tunic affection (maxillary sinusitis). Through what nasal cavity formation has the infection spread?

A. Ethmoidal infundibulum

B. Sphenoethmoidal recess

C. Sphenopalatine foramen

D. Maxillary hiatus*

E. Ethmoid cells

21. During the first days of a newborn child, a pediatrician detected that milk gets into the child's nasal cavity. What malformation does this fact indicate?

A. Esophagus constriction

B. Diverticulum of esophagus

C. Esophageal atresia

D. Cleft clip

E. Non-closed palate*

22. During a meal, milk gets into the nasal cavity of a newborn child. What is the probable cause of this pathology?

A. Cleft palate*

B. Nasal septum deviation to the right

C. Basal skull fracture

D. Cleft clip

E. Nasal septum deviation to the left

23. Purulence of orbit soft tissues took place after an eye’s trauma. Through what anatomical formation can the purulent process spread to the pterygopalatine fossa?

A. Through the round foramen

B. Through the inferior orbital fissure*

C. Through the pterygoid canal

D. Through the superior orbital fissure

E. Through the zygomaticoorbital foramen

24. A sick has an acute inflammation of nasolacrimal duct mucous membrane. It is known that after influenza nasal discharges had been observed for a long time. From what part of the nasal cavity could the infection get to the nasolacrimal duct?

A. Superior nasal meatus

B. Middle nasal meatus

C. Inferior nasal meatus*

D. Common nasal meatus

E. Sphenoethmoidal recess

25. A patient has a suppurative inflammation of the sphenoid sinus. What part of the nasal cavity does the pus flow out into?

A. Meatus nasi inferior

B. Meatus nasi communis

C. Meatus nasi medius

D. Meatus nasi superior*

E. Infundibulum.

26. A patient has an inflammation of sphenoid sinus. Where does the aperture of this sinus open?

A. Infundibulum

B. Common nasal meatus

C. Middle nasal meatus

D. Inferior nasal meatus

E. Sphenoethmoidal recess*

27. A 30-year-old patient with a second upper molar pulp inflammation appealed to a doctor with complaints of headache and nose rheum. After examination, pulpitis complicated with sinusitis was diagnosed. Which sinus did the infection enter from this tooth root canal?

A. Maxillary sinus*

B. Frontal sinus

C. Sphenoidal sinus

D. Ethmoid cells

E. Mastoid cells

28. A patient has a suppurative inflammation of the frontal sinus. What part of the nasal cavity does the pus flow out into?

A. Meatus nasi inferior

B. Meatus nasi medius*

C. Meatus nasi communis

D. Meatus nasi superior

E. Infundibulum

29. After carried flu, a patient has the labouringly nasal breath, enhanceable temperature, head pains, lacrimation, and sickliness at palpation in area of fossa canina on the right. Inflammation of what additional cavity of nose complicated the disease?

A. Sinus maxillaris dexter*

B. Sinus frontalis dexter

C. Sinus shenoidalis dexter

D. Middle cells of ethmoid bone on the right

E. Bulla ethmoidalis dexter

30. After a 2-y.o. child has had flu, there appeared complaints about earache. A doctor revealed hearing impairment and inflammation of the middle ear. How did the infection penetrate into the middle ear?

A. Through the auditory tube*

B. Through foramen jugularis

C. Through canalis caroticus

D. Through atrium mastoideum

E. Through canalis nasolacrimalis

31. Examination of a patient revealed an abscess of pterygopalatine fossa. Where can the infection spread to unless the disease is managed in time?

A. To the orbit *

B. To the interpterygoid space

C. To the frontal sinus

D. To sphenoid sinus

E. To the tympanic cavity

32. Examination of a 6-month-old child revealed a delay in closure of the occipital fontanelle. When should it normally close?

A. Until 3 months*

B. Before the child is born

C. Until 6 months

D. Until the end of the first year of life

E. Until the end of the second year of life

33. Examination of a 2-year-old child revealed a delay in closure of the frontal fontanelle. When should it normally close?

A. Until 3 months

B. Before the child is born

C. Until 6 months

D. Until the end of the first year of life*

E. Until the end of the second year of life

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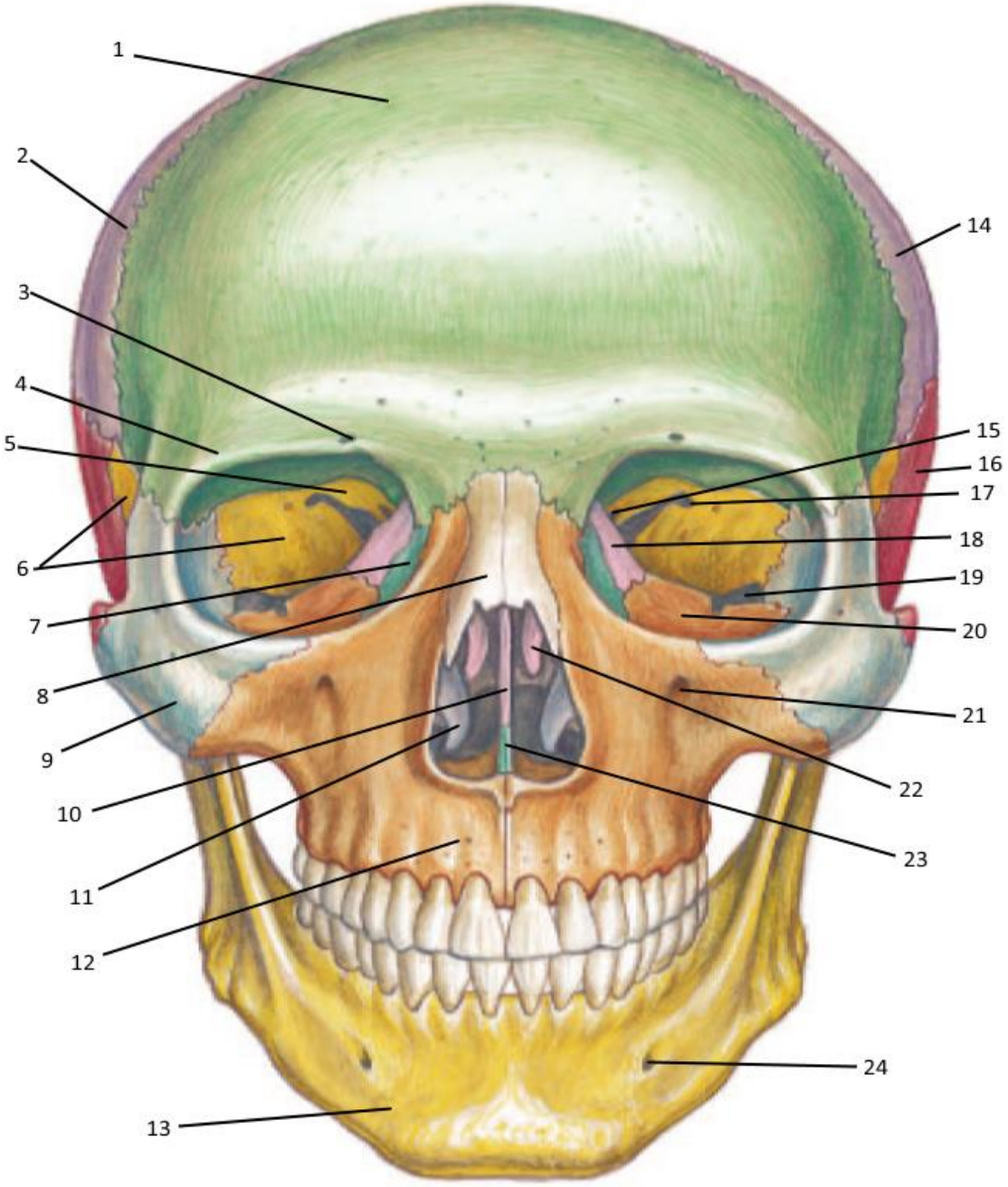

Fig. 92. An anterior view of the skull. 1 – Frontal bone; 2 – Coronal sututre; 3 – Supraorbital foramen; 4 – Supraorbital margin; 5 – Lesser wing of the sphenoid bone; 6 – Greater wing of the sphenoid bone; 7 – Lacrimal bone; 8 – Nasal bone; 9 – Zygomatic bone; 10 – Perpendicular plate of the ethmoid bone; 11 – Inferior nasal concha; 12 – Maxilla; 13 – Mandible; 14 – Parietal bone; 15 – Optic canal; 16 – Temporal bone; 17 – Superior orbital fissure; 18 – Orbital plate of the ethmoid bone; 19 – Inferior orbital fissure; 20 – Orbital surface of maxilla; 21 – Infraorbital foramen; 22 – Middle nasal concha of the ethmoid bone; 23 – Vomer; 24 – Mental foramen.

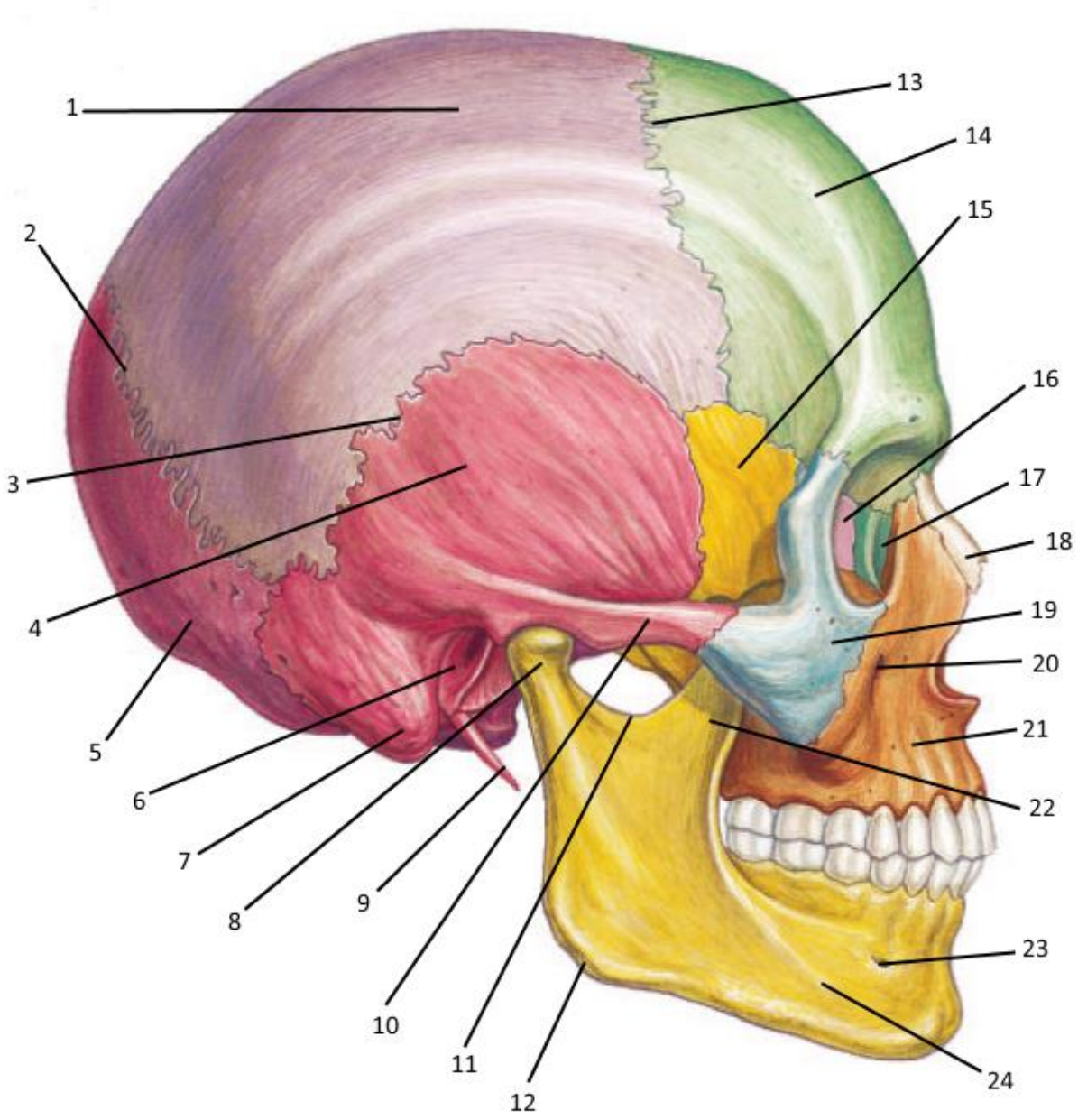

Fig. 93. A lateral view of the skull. 1 – Parietal bone; 2 – Lambdoid suture; 3 – Squamous suture; 4 – Temporal bone; 5 – Occipital bone; 6 – External acoustic meatus; 7 – Mastoid process; 8 – Condylar process of mandible; 9 – Styloid process; 10 – Zygomatic process; 11 – Mandibular notch; 12 – Angle of mandible; 13 – Coronal suture; 14 – Frontal bone; 15 – Sphenoid bone; 16 – Ethmoid bone; 17 – Lacrimal bone; 18 – Nasal bone; 19 – Zygomatic bone; 20 – Infraorbital foramen; 21 – Maxilla; 22 – Coronoid process of mandible; 23 – Mental foramen; 24 – Mandible.

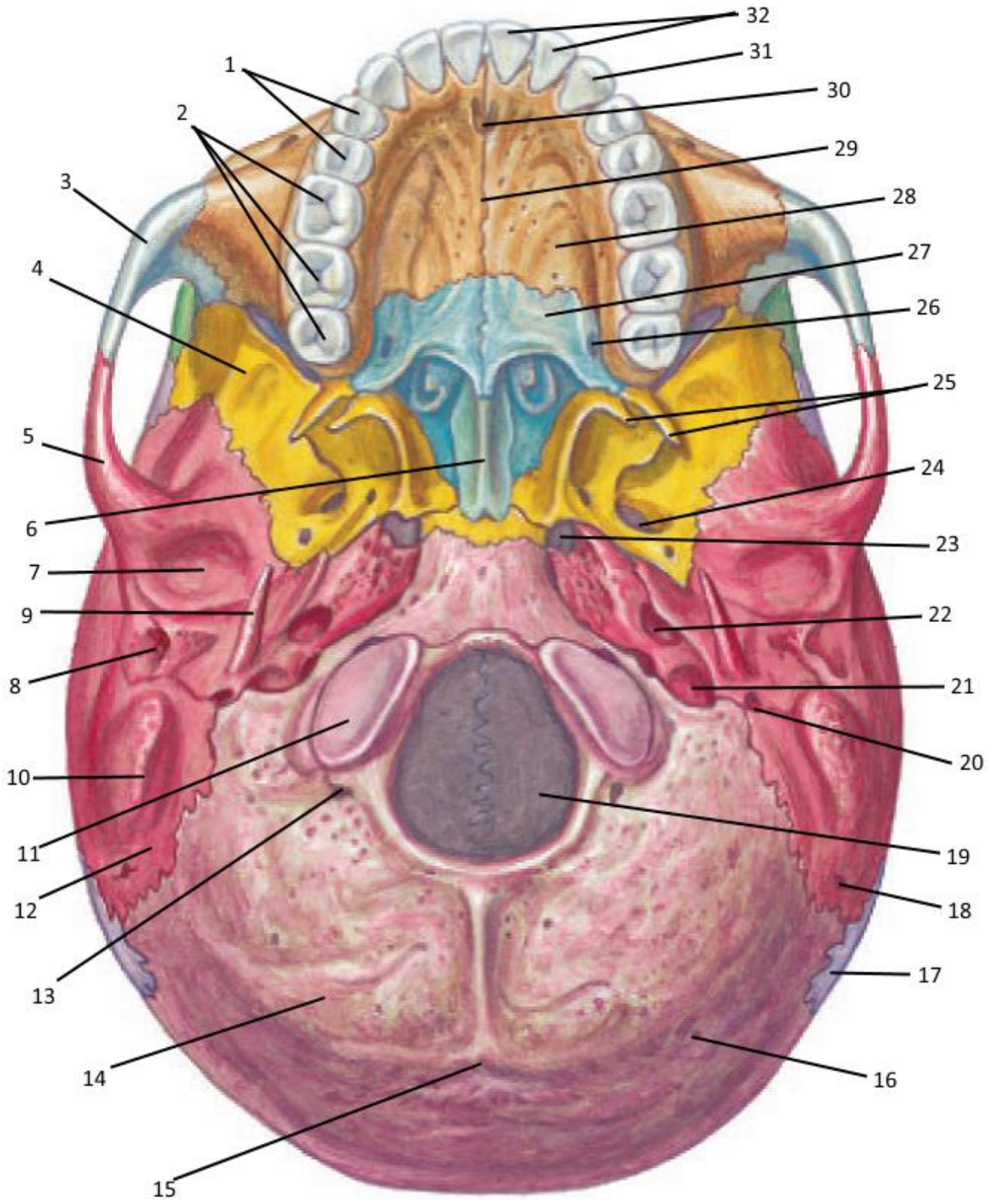

Fig. 94. An inferior view of the skull. 1 – Premolars; 2 – Molars; 3 – Zygomatic bone; 4 – Sphenoid bone; 5 – Zygomatic process; 6 – Vomer; 7 – Mandibular fossa; 8 – External acoustic meatus; 9 – Styloid process; 10 – Mastoid process; 11 – Occipital condyle; 12 – Temporal bone; 13 – Condyloid canal; 14 – Occipital bone; 15 – External occipital protuberance; 16 – Superior nuchal line; 17 – Parietal bone; 18 – Mastoid foramen; 19 – Foramen magnum; 20 – Stylomastoid foramen; 21 – Jugular fossa; 22 – Carotid canal; 23 – Foramen lacerum; 24 – Foramen ovale; 25 – Medial and lateral pterygoid processes of sphenoid bone; 26 – Greater palatine foramen; 27 – Palatine bone; 28 – Palatine process of maxilla; 29 – Medial palatine suture; 30 – Incisive foramen; 31 – Canine; 32 – Incisors.

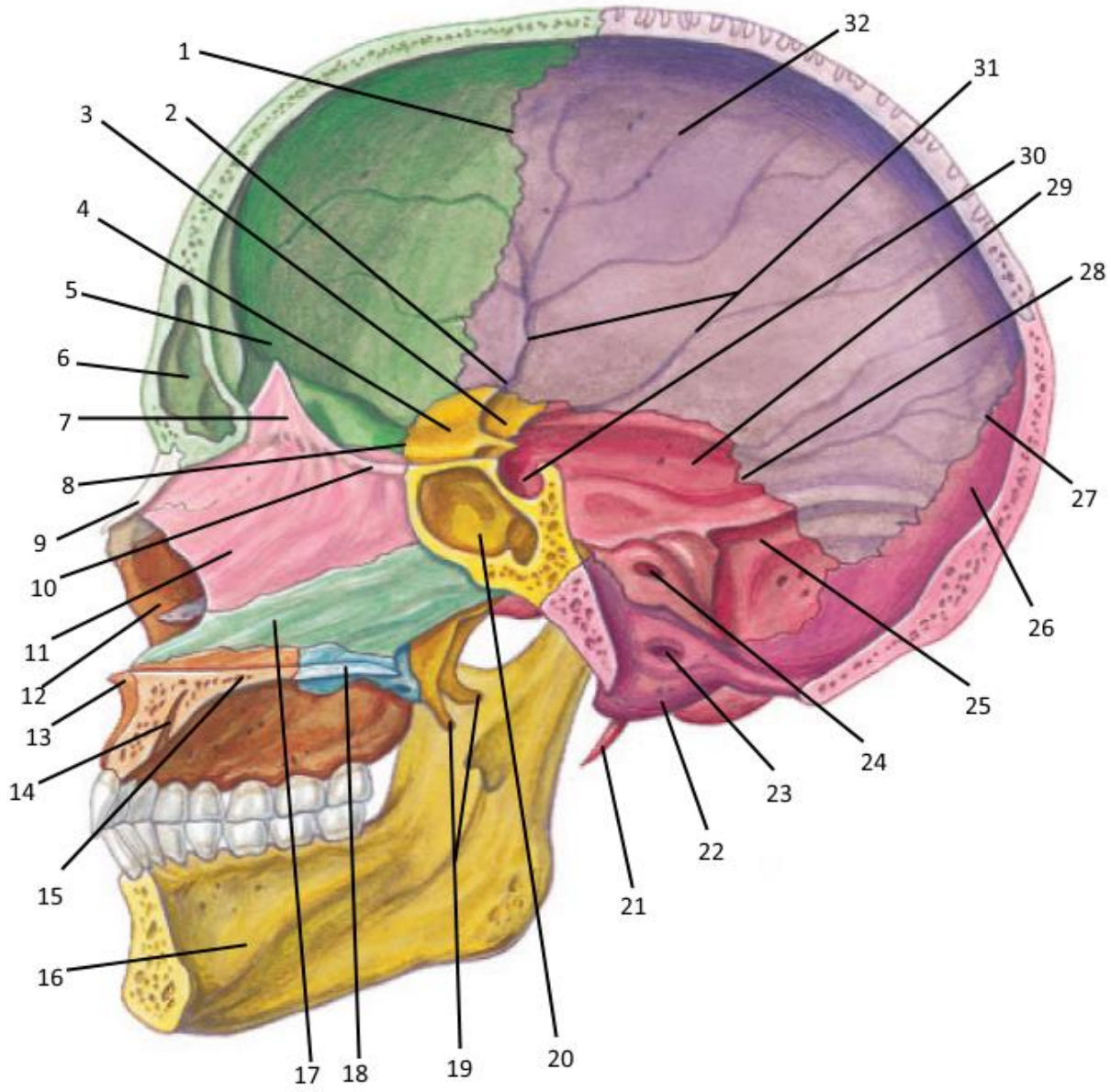

Fig. 95. A sagittal view of the skull. 1 – Coronal suture; 2 – Sphenoparietal suture; 3 – Greater wing of sphenoid bone; 4 – Lesser wing of sphenoid bone; 5 – Frontal bone; 6 – Frontal sinus; 7 – Crista galli; 8 – Sphenofrontal suture; 9 – Nasal bone; 10 – Cribriform plate of ethmoid bone; 11 – Perpendicular plate of ethmoid bone; 12 – Maxilla; 13 – Anterior nasal spine; 14 – Incisive foramen; 15 – Palatine process of maxilla; 16 – Mandible; 17 – Vomer; 18 – Palatine bone; 19 – Medial and lateral plates of pterygoid process; 20 – Sphenoidal sinus; 21 – Styloid process; 22 – Occipital condyle; 23 – Hypoglossal canal; 24 – Internal acoustic meatus; 25 – Groove for sigmoid sinus; 26 – Occipital bone; 27 – Lambdoid suture; 28 – Squamous suture; 29 – Temporal bone; 30 – Sella turcica; 31 – Grooves for middle meningeal artery; 32 – Parietal bone.

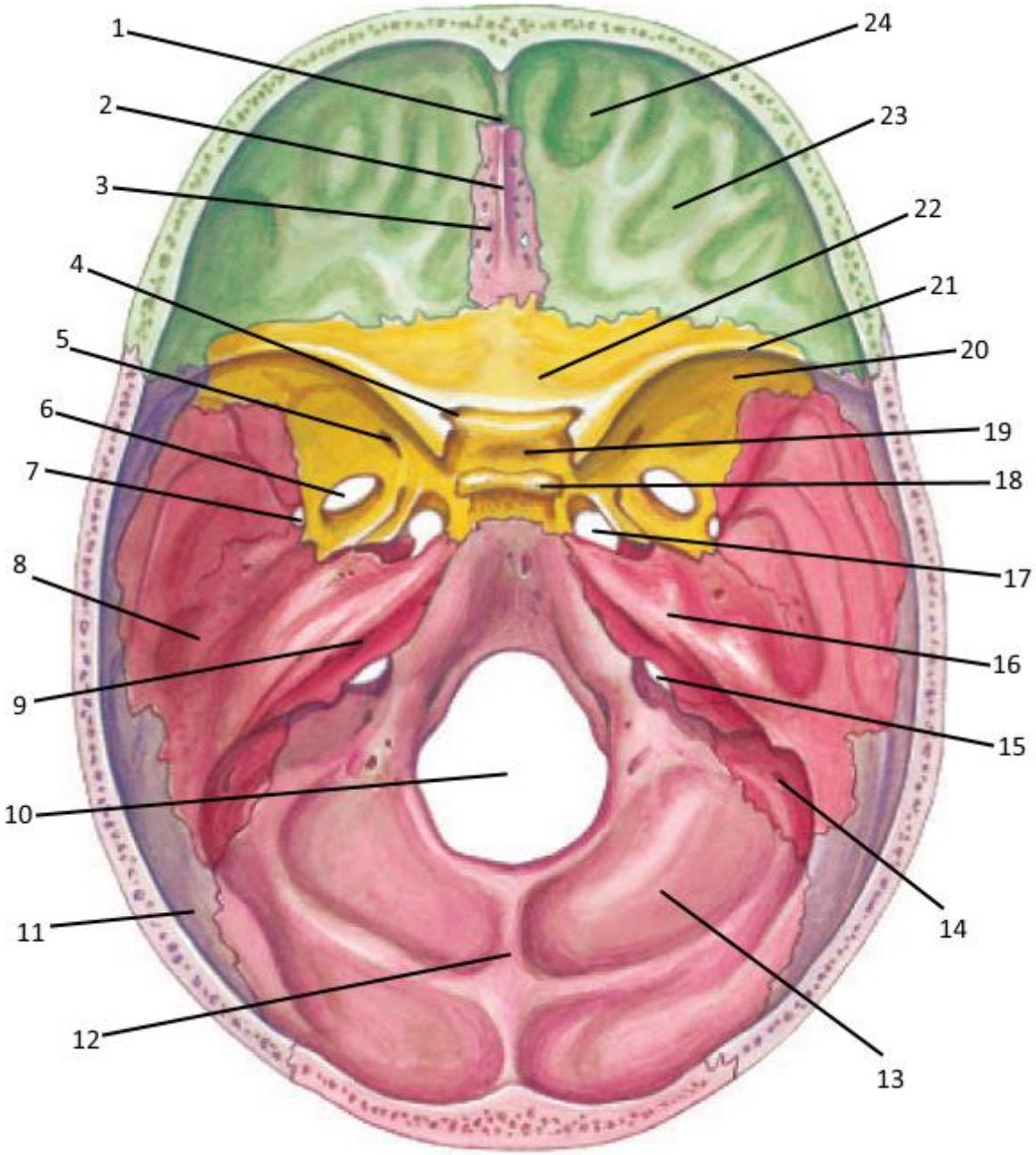

Fig. 96. The floor of the cranial cavity. 1 – Foramen cecum; 2 – Crista galli of ethmoid bone; 3 – Cribriform plate of ethmoid bone; 4 – Optic canal; 5 – Foramen rotundum; 6 – Foramen ovale; 7 – Foramen spinosum; 8 – Temporal bone; 9 – Internal acoustic meatus; 10 – Foramen magnum; 11 – Parietal bone;12 – Internal occipital crest; 13 – Posterior cranial fossa; 14 – Mastoid foramen;15 – Jugular foramen; 16 – Petrous part of temporal bone; 17 – Foramen lacerum; 18 – Dorsum sellae; 19 – Sella turcica; 20 – Greater wing of sphenoid bone; 21 – Lesser wing of sphenoid bone; 22 – Sphenoid bone; 23 – Frontal bone; 24 – Anterior cranial fossa.

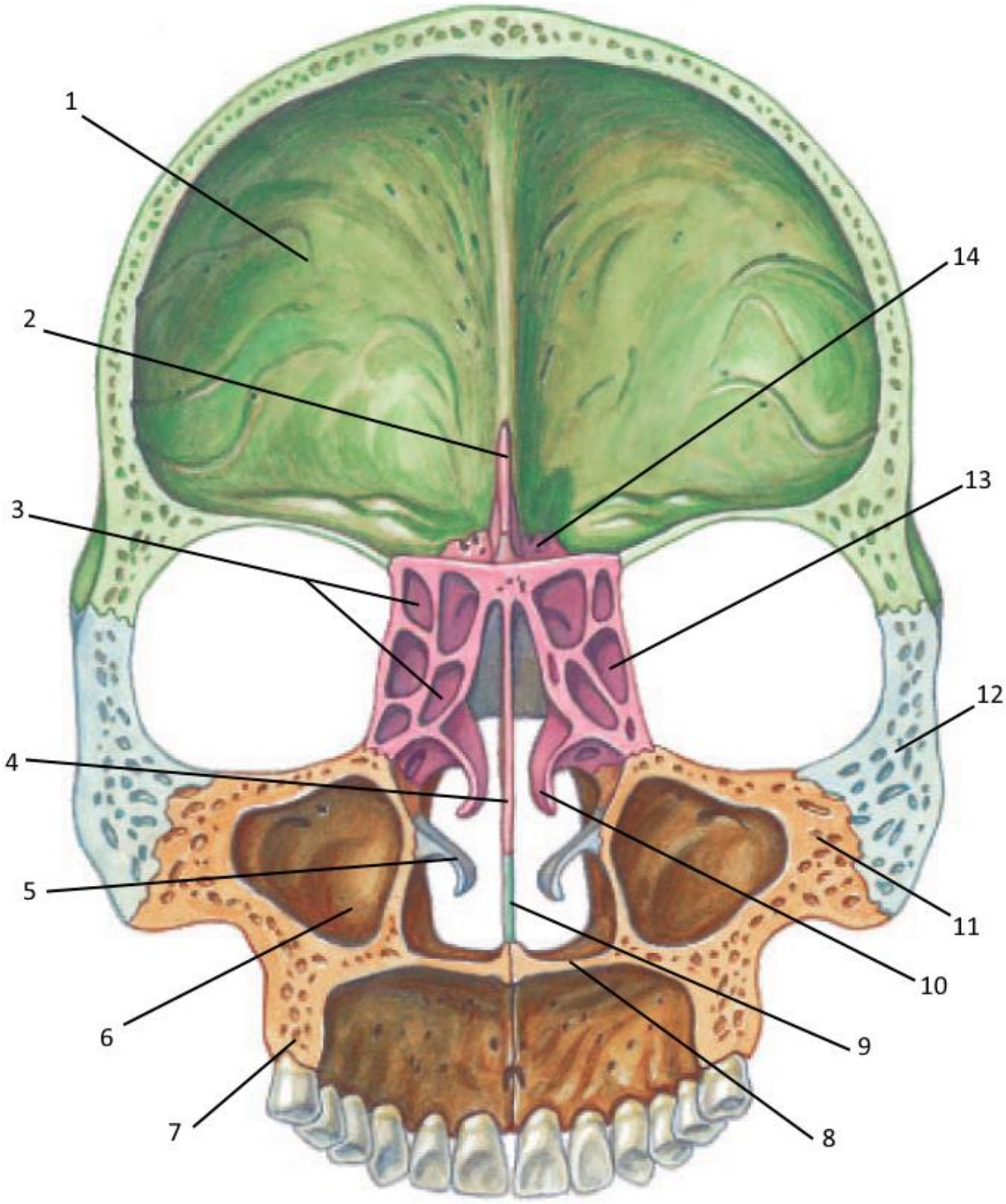

Fig. 97. A posterior view of a frontal (coronal) section of the skull. 1 – Frontal bone; 2 – Crista galli of ethmoid bone; 3 – Ethmoidal sinuses; 4 – Perpendicular plate of ethmoid bone; 5 – Inferior nasal concha; 6 – Maxillary sinus; 7 – Alveolar process of maxilla; 8 – Palatine process of maxilla; 9 – Vomer; 10 – Middle nasal concha; 11 – Maxilla; 12 – Zygomatic bone; 13 – Ethmoid bone; 14 – Cribriform plate of ethmoid bone.

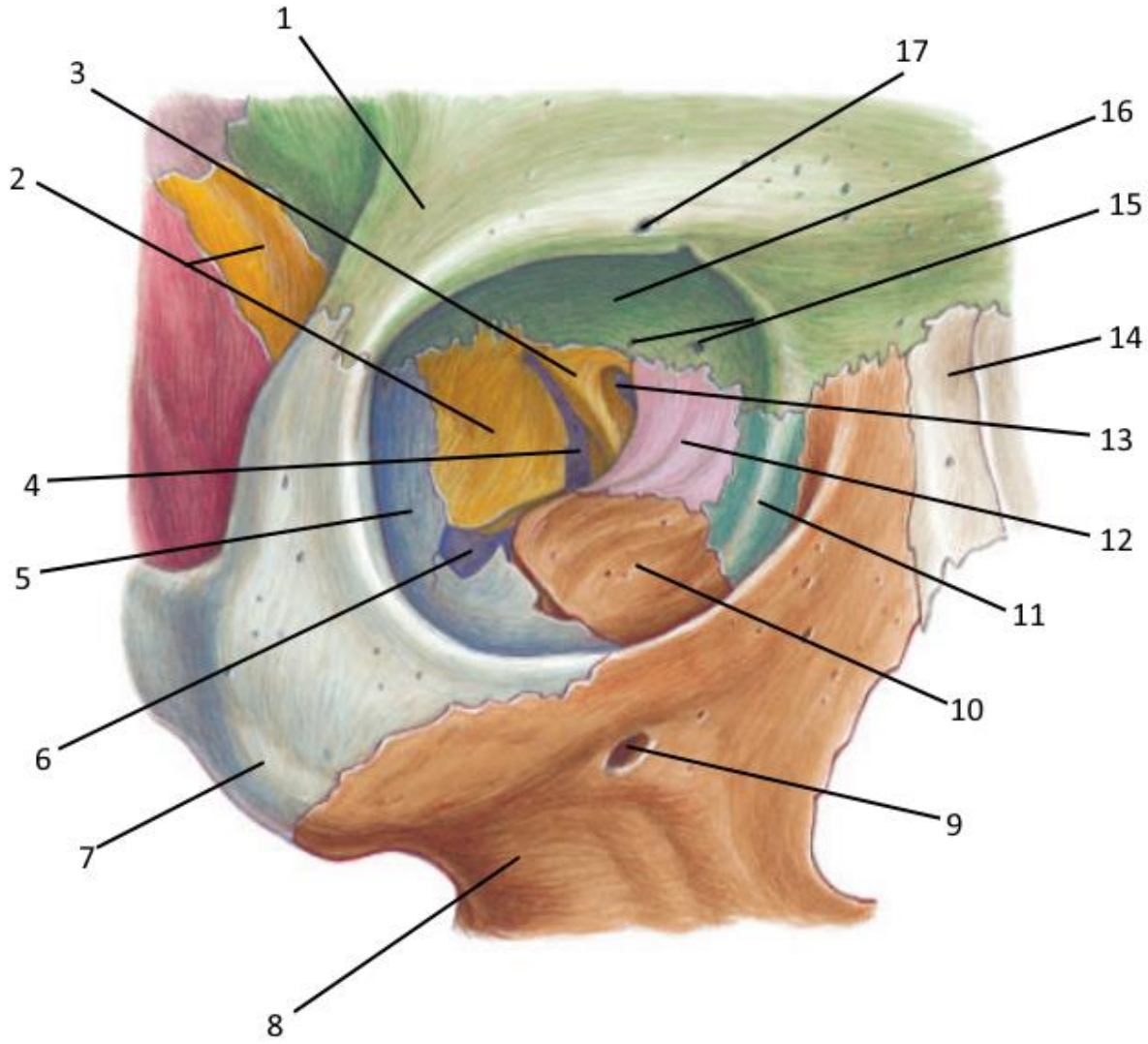

Fig. 98. Bones of the orbit. 1 – Frontal bone; 2 – Greater wing of sphenoid bone; 3 – Lesser wing of sphenoid bone; 4 – Superior orbital fissure; 5 – Orbital surface of zygomatic bone; 6 – Inferior orbital fissure; 7 – Zygomatic bone; 8 – Maxilla; 9 – Infraorbital foramen; 10 – Orbital surface of maxilla; 11 – Lacrimal bone; 12 – Orbital plate of ethmoid bone; 13 – Optic canal; 14 – Nasal bone; 15 – Anterior and posterior ethmoidal foramina; 16 – Orbital plate of frontal bone; 17 – Supraorbital foramen.

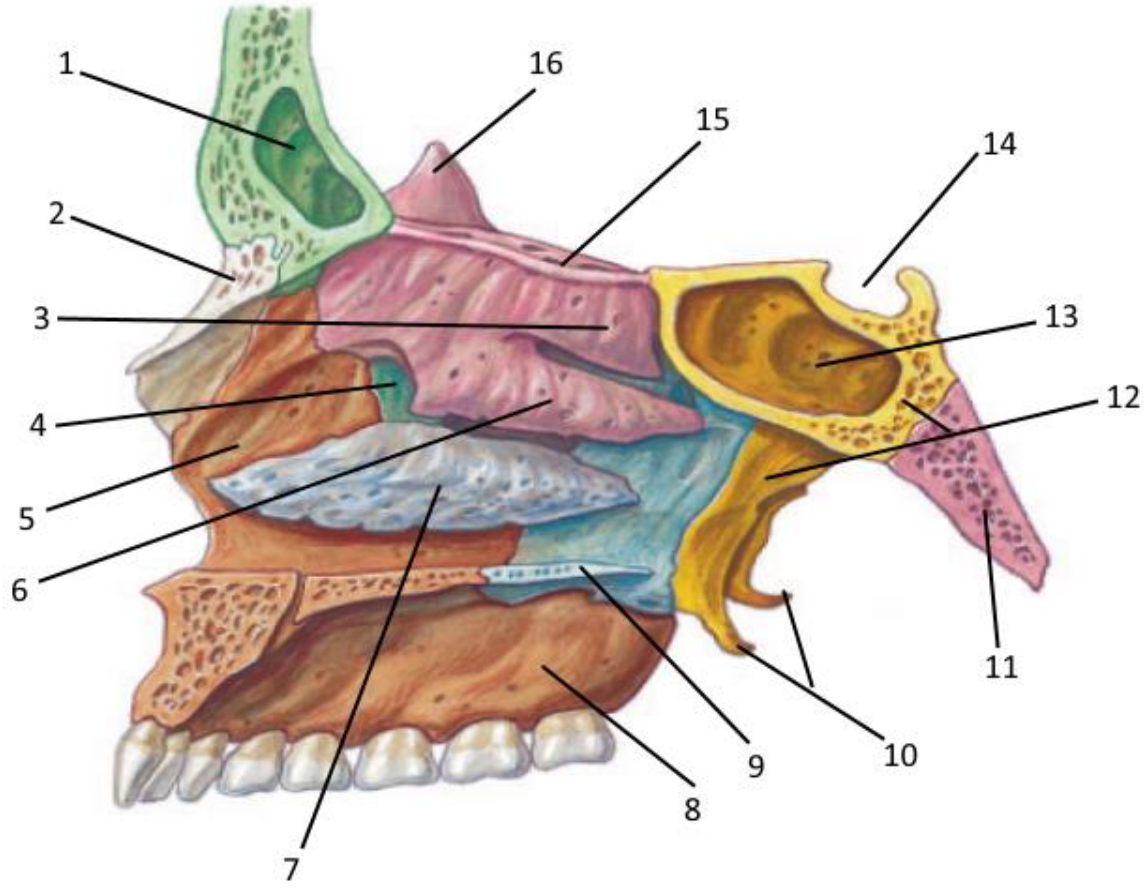

Fig. 99. The lateral view of the nasal cavity. 1 – Frontal sinus; 2 – Nasal bone; 3 – Superior nasal concha; 4 – Lacrimal bone; 5 – Frontal process of maxilla; 6 – Middle nasal concha; 7 – Inferior nasal concha; 8 – Maxilla; 9 – Palatine bone; 10 – Medial and lateral plates of sphenoid bone; 11 – Basilar part of occipital bone; 12 – Sphenoid bone; 13 – Sphenoidal sinus; 14 – Sella turcica; 15 – Cribriform plate of ethmoid bone; 16 – Crista galli of ethmoid bone.

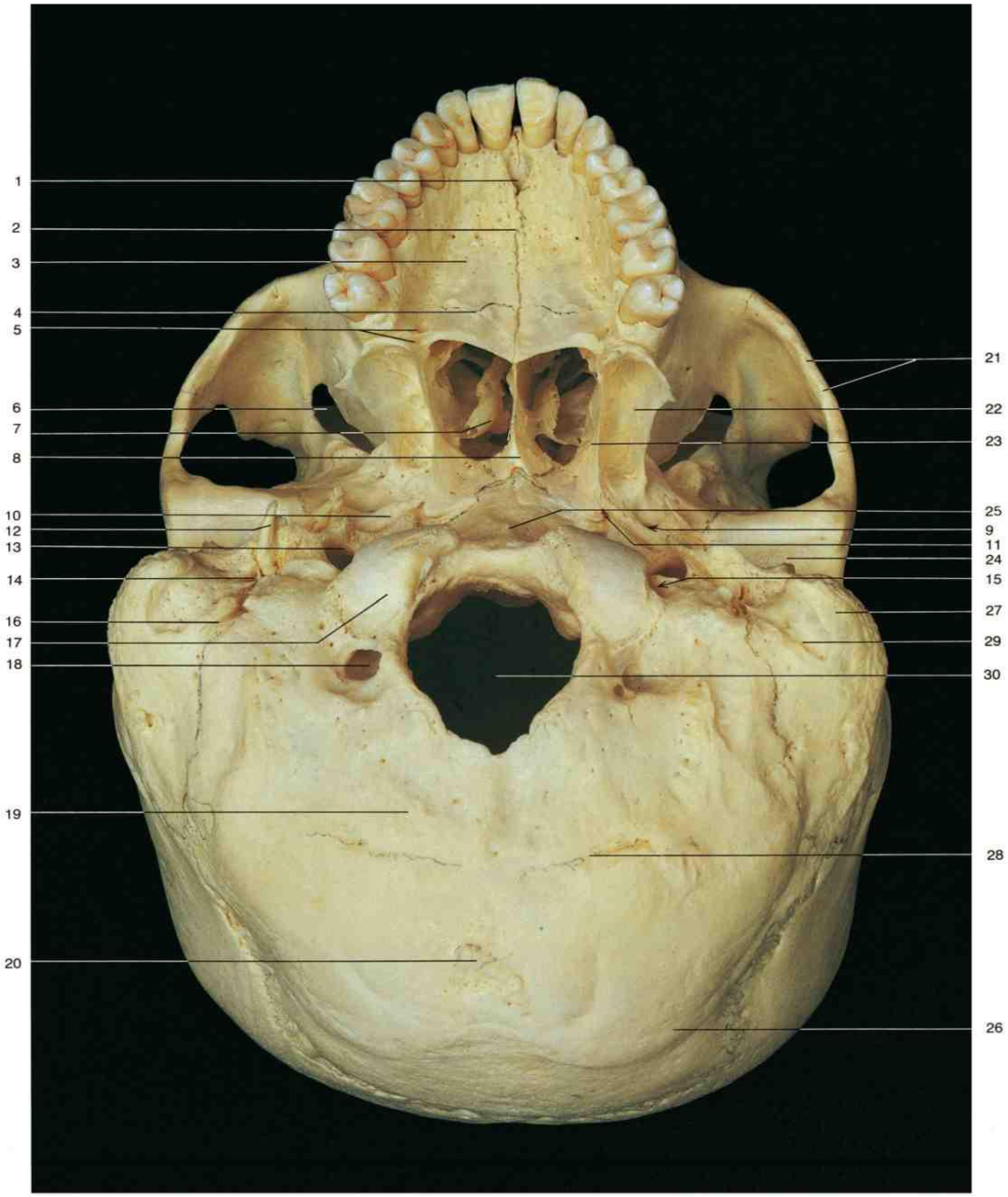

Fig. 100. Base of the skull (inferior aspect). 1- Incisive canal; 2 - Median palatine suture; 3 - Palatine process of maxilla; 4 - Palatomaxillary suture; 5 - Greater and lesser palatine foramina; 6- Inferior orbital fissure; 7 - Middle concha (process of ethmoidal bone); 8- Vomer; 9 - Foramen ovale; 10 - Groove for auditory tube; 11 - Pterygoid canal; 12 - Styloid process; 13 - Carotid canal; 14 - Stylomastoid foramen; 15 - Jugular foramen; 16 - Groove for occipital artery; 17 - Occipital condyle; 18 - Condylar canal; 19 – Nuchal plane; 20 - External occipital protuberance; 21 - Zygomatic arch; 22 - Lateral pterygoid plate; 23 - Medial pterygoid plate; 24 - Mandibular fossa; 25 - Pharyngeal tubercle; 26 - Superior nuchal line; 27 - Mastoid process; 28 - Inferior nuchal line; 29 - Mastoid notch; 30 - Foramen magnum.

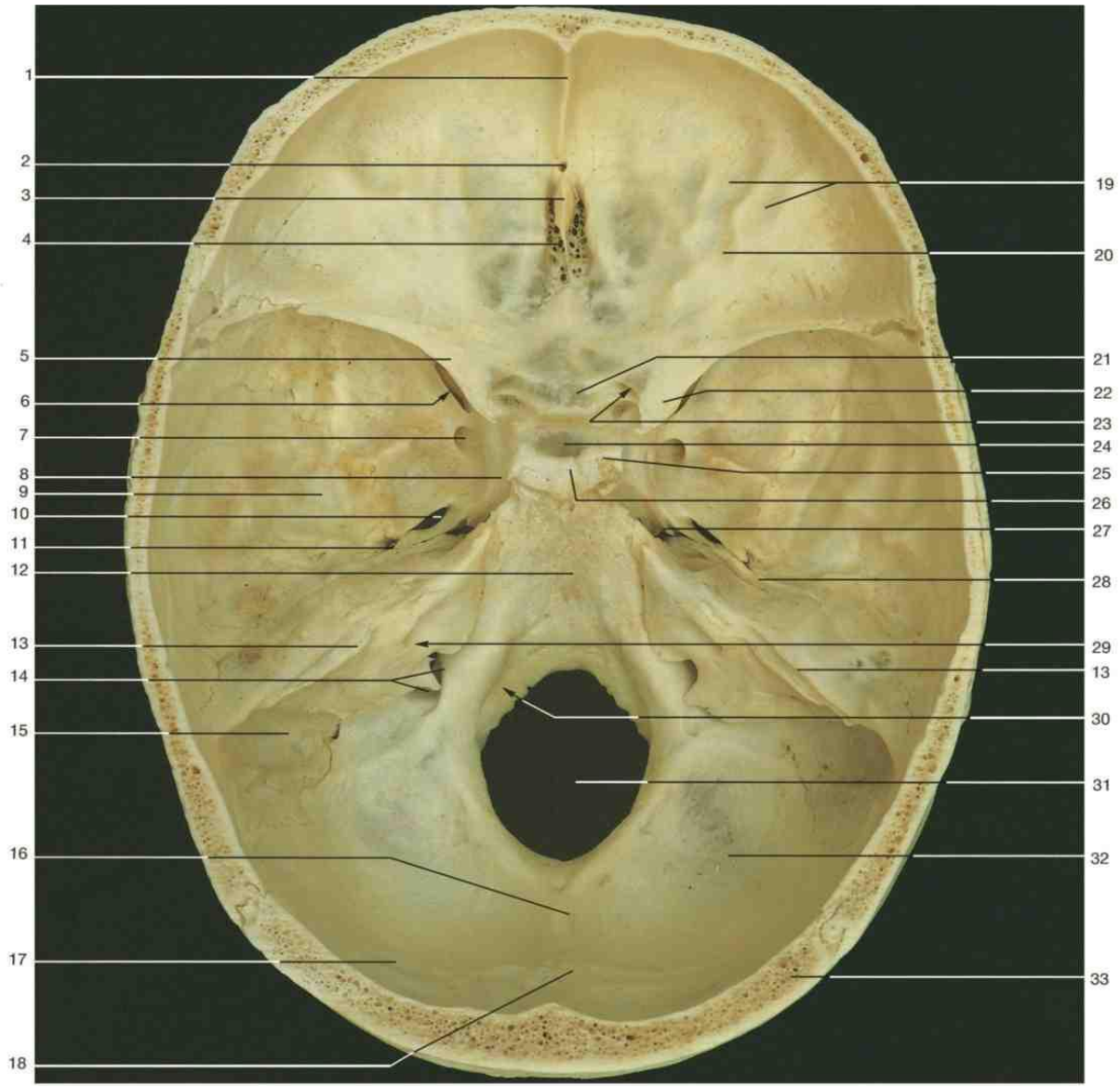

Fig. 101. Base of the skull, calvaria removed (internal aspect).

1 - Frontal crest; 2 - Foramen cecum; 3 - Crista galli; 4 - Cribriform plate of ethmoidal bone; 5 - Lesser wing of sphenoidal bone; 6 - Superior orbital fissure; 7 - Foramen rotundum; 8 - Carotid sulcus; 9 - Middle cranial fossa; 10 - Foramen ovale; 11 - Foramen spinosum; 12 – Clivus; 13 - Groove for superior petrosal sinus; 14 - Jugular foramen; 15 - Groove for sigmoid sinus; 16 - Internal occipital crest; 17 - Groove for transverse sinus; 18 - Internal occipital protuberance; 19 - Digitate impressions; 20 - Anterior cranial fossa; 21 - Chiasmatic sulcus; 22 - Anterior clinoid process; 23 - Optic canal; 24 - Sella turcica (hypophysial fossa); 25 - Posterior clinoid process; 26 - Dorsum sellae; 27 - Foramen lacerum; 28 - Groove for greater petrosal nerve; 29 - Internal acoustic meatus; 30 - Hypoglossal canal; 31 - Foramen magnum; 32 - Posterior cranial fossa; 33 - Diploe.

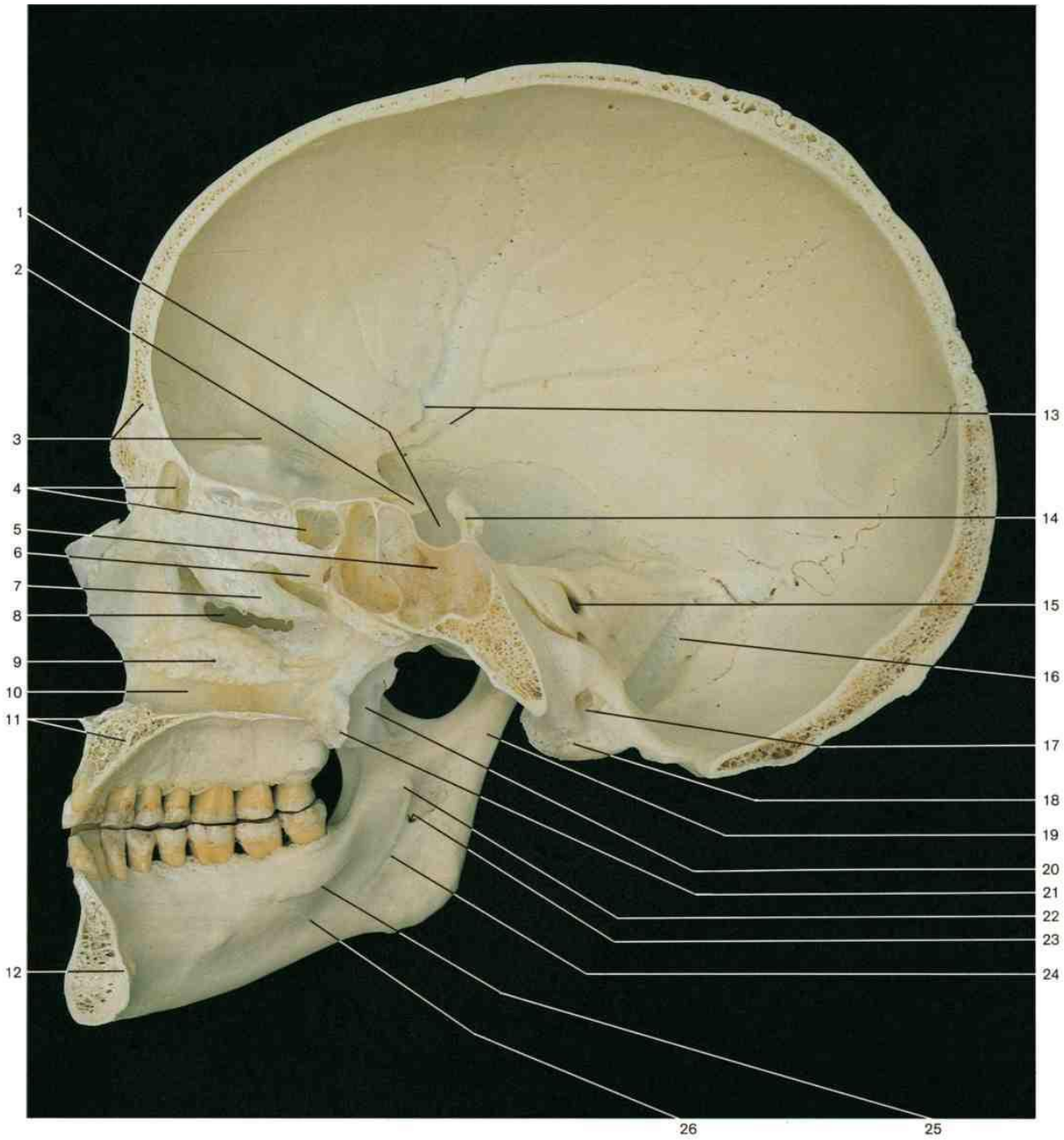

Fig. 102. Median section through the skull, right half (internal aspect).

1- Hypophysial fossa (sella turcica); 2 - Anterior clinoid process; 3 - Frontal bone; 4 - Ethmoidal air cells; 5 - Sphenoidal sinus; 6 - Superior concha; 7 - Middle concha; 8 - Maxillary hiatus; 9 - Inferior concha; 10 - Inferior meatus; 11 - Anterior nasal spine; and maxilla; 12 - Mental spine or genial tubercle; 13 - Groove for middle meningeal artery; 14 - Dorsum sellae; 15 - Internal acoustic meatus; 16 - Groove for sigmoid sinus; 17 - Hypoglossal canal; 18 - Occipital condyle; 19 - Condylar process; 20 - Lateral pterygoid plate of pterygoid process; 21 - Medial pterygoid plate; 22 - Lingula of mandible; 23 - Mandibular foramen; 24 - Mylohyoid groove; 25 - Mylohyoid line; 26 - Submandibular fovea

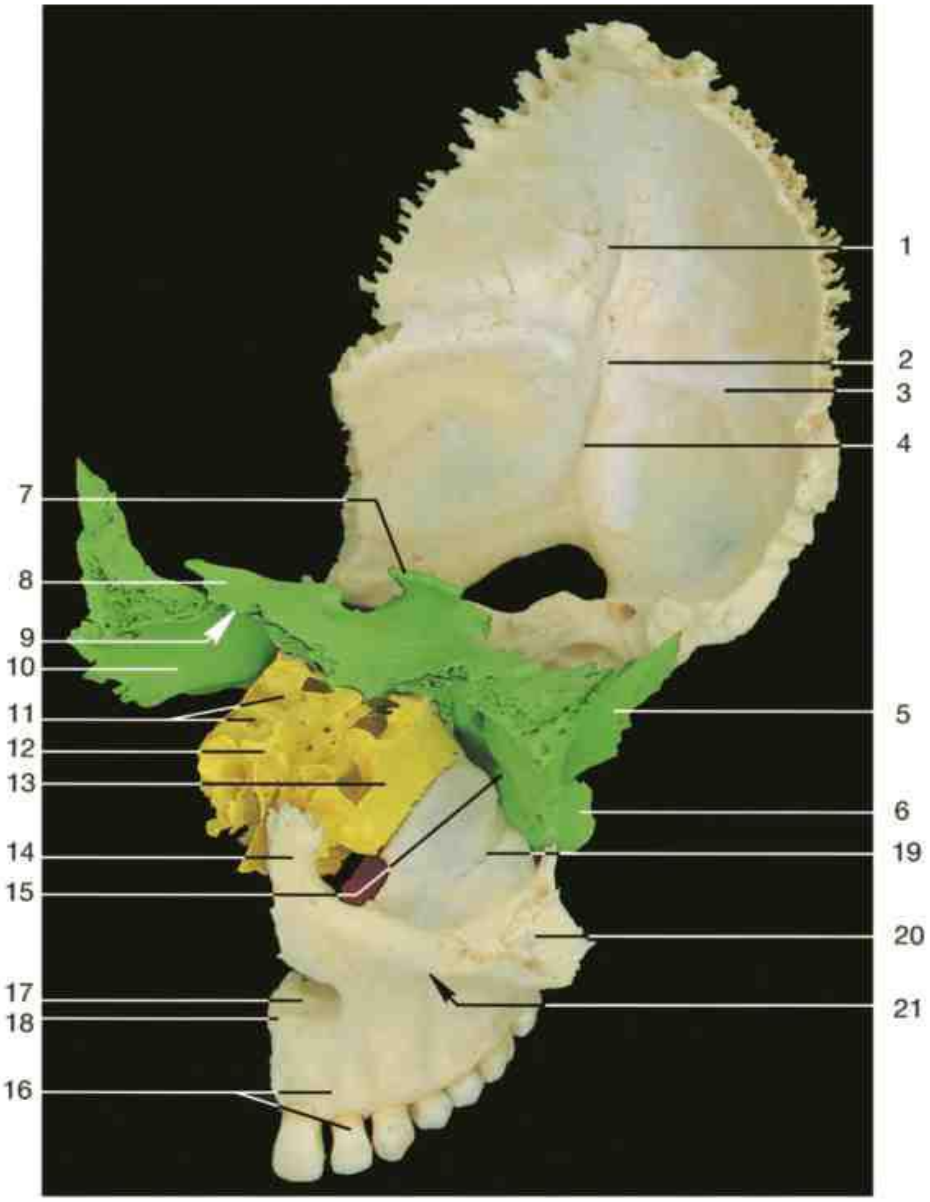

Fig. 103. Part of a disarticulated base of skull. The mosaic of the facial bones [sphenoidal bone (green), ethmoidal bone (yellow), and palatine bone (red)] is seen from the antero-lateral aspect.

Occipital bone: 1 - Groove for superior sagittal sinus; 2 - Internal occipital protuberance; 3 - Groove for transverse sinus; 4 - Internal occipital crest.

Sphenoidal bone: 5 - Greater wing (temporal surface); 6 - Lateral pterygoid plate; 7 - Dorsum sellae; 8 - Lesser wing; 9 - Superior orbital fissure; 10 - Greater wing (orbital surface).

Ethmoidal bone: 11 - Ethmoidal air cells; 12 - Crista galli; 13 - Orbital plate.

Maxilla: 14 - Frontal process; 15 - Inferior orbital fissure; 16 - Alveolar process with teeth; 17 - Palatine process; 18 - Anterior nasal spine; 19 - Infra-orbital groove; 20 - Zygomatic process; 21 - Location of infra-orbital foramen

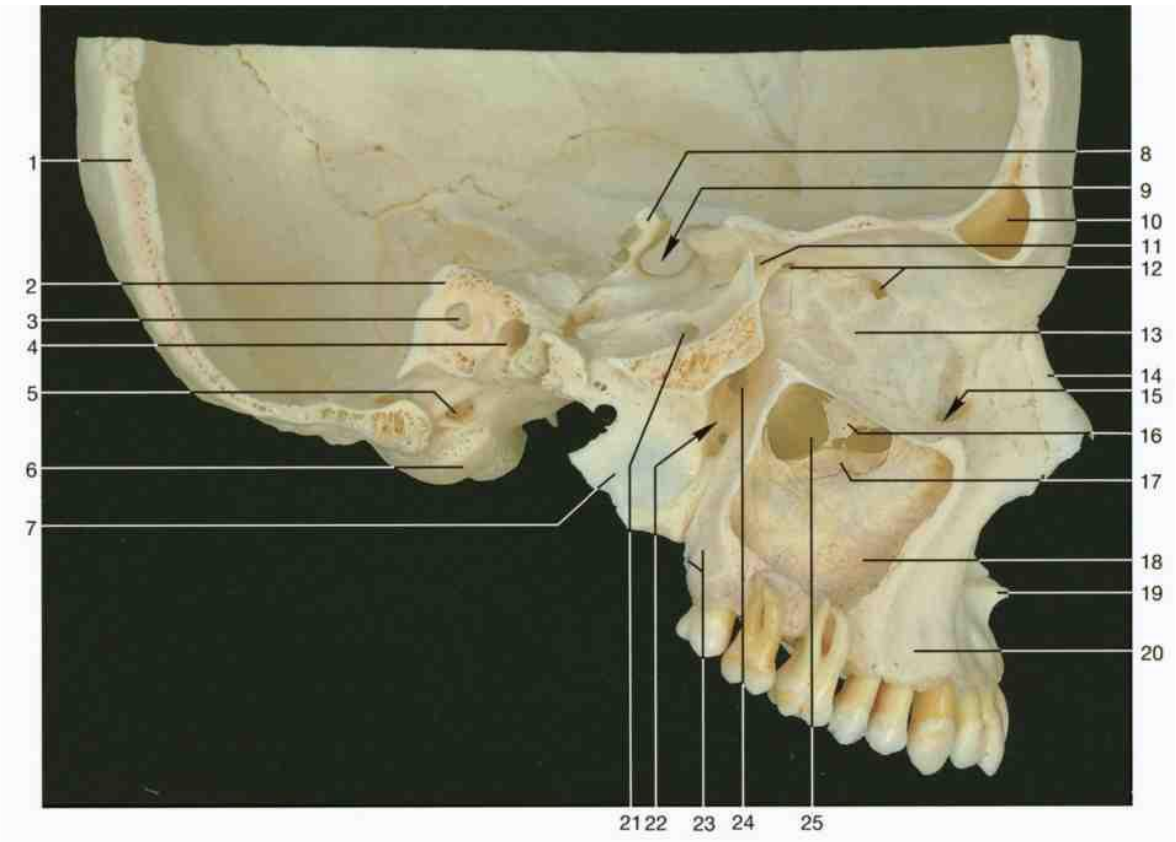

Fig. 104. Paramedian section through the skull, right side (lateral aspect). Frontal and maxillary sinuses are opened.

1 - Occipital bone; 2 - Temporal bone (petrous part); 3 - Internal acoustic meatus; 4 - Carotid canal; 5 - Hypoglossal canal; 6 - Occipital condyle; 7 - Lateral plate of pterygoid process; 8 - Dorsum of sella turcica; 9 - Sella turcica; 10 - Frontal sinus; 11 - Optic canal; 12 - Posterior and anterior ethmoidal foramina; 13 - Orbital plate of ethmoidal bone; 14 - Nasal bone; 15 - Nasolacrimal canal; 16 - Uncinate process; 17 - Inferior nasal concha (maxillary process); 18 - Maxillary sinus; 19 - Anterior nasal spine; 20 - Alveolar process of maxilla; 21 - Foramen rotundum; 22 - Pterygopalatine fossa; 23 - Tuberosity of maxilla with alveolar foramina; 24 - Sphenopalatine foramen; 25 - Maxillary hiatus.

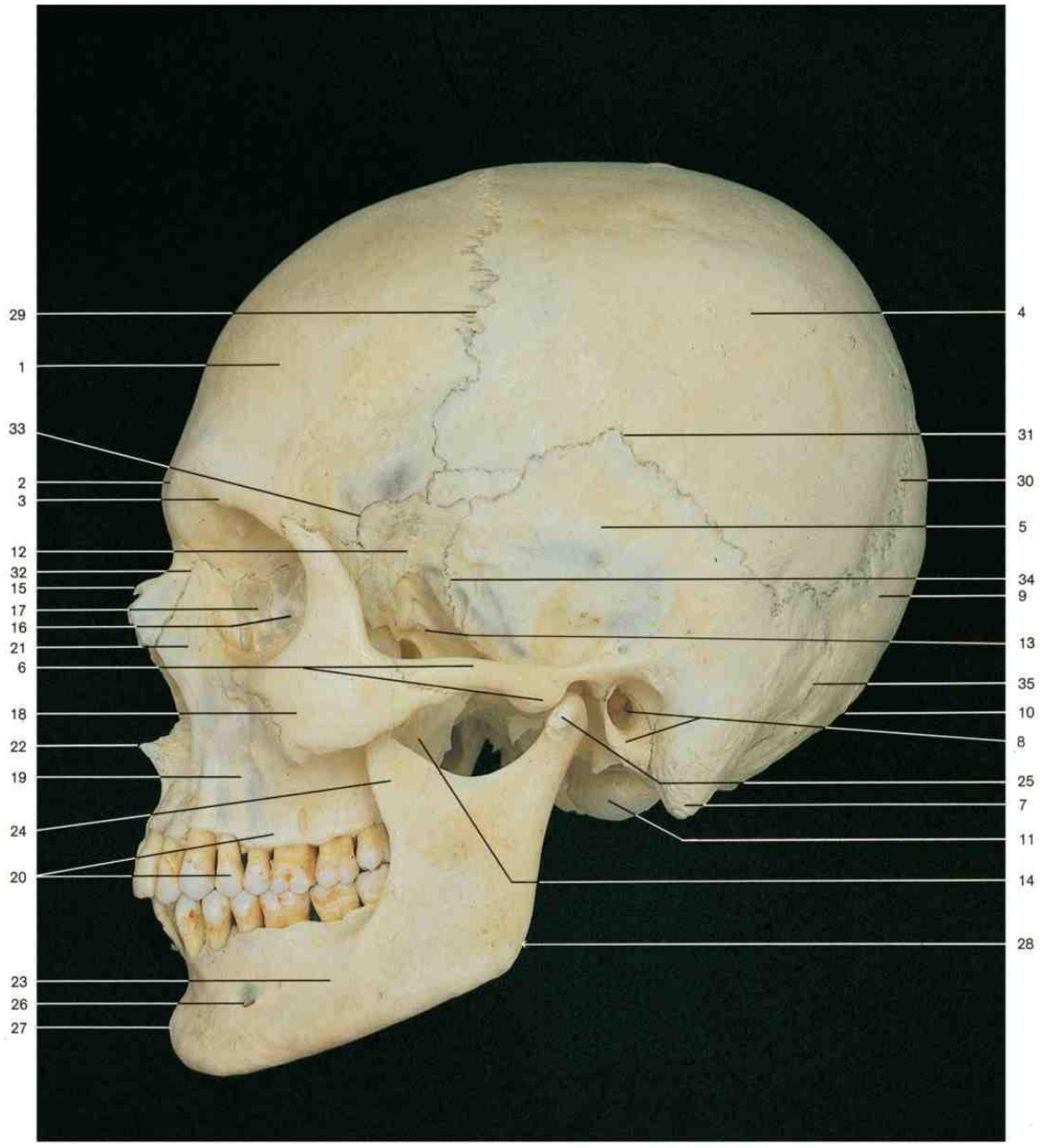

Fig. 105. Lateral aspect of the skull.

1 - Frontal bone; 2 - Glabella; 3 - Supraorbital margin; 4 - Parietal bone; 5 - Temporal bone (squamous part); 6 - Zygomatic process (articular tubercle); 7 - Mastoid process; 8 - Tympanic part (tympanic plate) and external acoustic meatus; 9 - Occipital bone (squamous part); 10 - External occipital protuberance; 11 - Occipital condyle; 12 - Sphenoidal bone (greater wing); 13 - Infratemporal crest of sphenoid; 14 - Pterygoid process (lateral pterygoid plate); 15 - Nasal bone; 16 - Ethmoidal bone (orbital part); 17 - Lacrimal bone. **Sutures:** 18 - Zygomatic bone; 19 - Maxilla (body); 20 - Alveolar process and teeth; 21 - Frontal process; 22 - Anterior nasal spine; 23 - Mandible (body); 24 - Coronoid process; 25 - Condylar process; 26 - Mental foramen; 27 - Mental protuberance; 28 - Angle of the mandible; 29 - Coronal suture; 30 - Lambdoid suture; 31 - Squamous suture; 32 - Nasomaxillary suture; 33 - Frontosphenoid suture; 34 - Sphenosquamosal suture; 35 - Occipitomastoid suture.

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