

# Head

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# The Head – Leading from the Top

The skeleton of the head (Caput/Cephalon), i.e. the skull (Cranium), consists of two parts: the facial bones (Viscerocranium) and the skull (Neurocranium). The border between the two – the roof of one and the floor of the other – is the base of the skull (Basis cranii), which lies roughly in an oblique plane defined by the eyebrows, the external opening of the outer ear canal and the base of the occiput.

## Skull Cap (Calvaria) and Scalp

The highly arched **Calvaria** (skull cap, cranial cap) forms a longitudinal oval dome over the cranial base and protects the cranial cavity (Cavitas cranii), in which the brain (Cerebrum) surrounded by hard and soft meninges (Meninges) floats in the cerebrospinal fluid (CSF). The Calvaria is divided in frontal, parietal, temporal, and occipital regions formed by identically named bones (Os frontale, Os parietale, Os temporale and Os occipitale).

The skin of the Calvaria is tough ("**scalp**") and firmly adherent to a flat tendon, which spans from the forehead to the occiput. This tendon (Galea aponeurotica) is part of the M. occipitofrontalis, a mimic muscle that raises eyebrows and wrinkles the skin of the forehead horizontally. Skin and tendon are movable on the skull cap and can be relatively easily lifted off and removed as the scalp. Vascular injuries of the scalp can lead to a severe but usually not-life threatening bleeding.

## Skull Base

The base of the skull forms the roof of the two orbits (Orbitae) and the nasal cavity (Cavitas nasi), but also the roof of the throat (Pharynx, reaching up to the base of the skull) and the base of the occiput which articulates at the occipital foramen (Foramen magnum) with the first cervical vertebra. Numerous foramina, canals, and fissures cover the cranial base and serve as passageways for many nerves and blood vessels. At the bottom side of the skull base, pointing towards the Viscerocranium, numerous processes, spines, and notches (Processus/Spinnae/Incisurae) are present, to which muscles and ligaments are attached. The upper side of the skull base, the floor of the Neurocranium, is less irregular and resembles terraces on three floors: the top floor, the anterior cranial fossa (Fossa cranii anterior), is positioned above the Orbitae. One step down, the middle cranial fossa (Fossa cranii media) is located at the level of the temporal bones. The last step leads down into the posterior cranial fossa (Fossa cranii posterior) with the Foramen magnum.

## Facial Bones and Cavities

The largest **facial bone**, the maxillary bone (Maxilla), is placed in the centre of the Viscerocranium. The Maxilla forms the floor of the Orbitae, most of the sidewalls of the nasal cavity, the anterior part of the palate, and carries the maxillary row of teeth. Like many other bones of the skull, the maxilla is "pneumatized", i.e. it is hollow and filled with air which is drawn from the nasal cavity (Sinus maxillaris, paranasal sinuses). Besides the Maxilla, half a dozen other smaller bones are involved in the construction of the Viscerocranium.

Breathing, smelling, tasting, chewing, swallowing, speaking, seeing, and being seen – these are the tasks of the **organs** that are supported and protected by the Viscerocranium.

The eyes and their auxiliary apparatus (Organum visus, → p. 98) are responsible for vision. Being seen is the responsibility of the facial muscles. The permanent activity of these muscles, which do not control bones but the facial skin, is responsible for the formation of wrinkles.

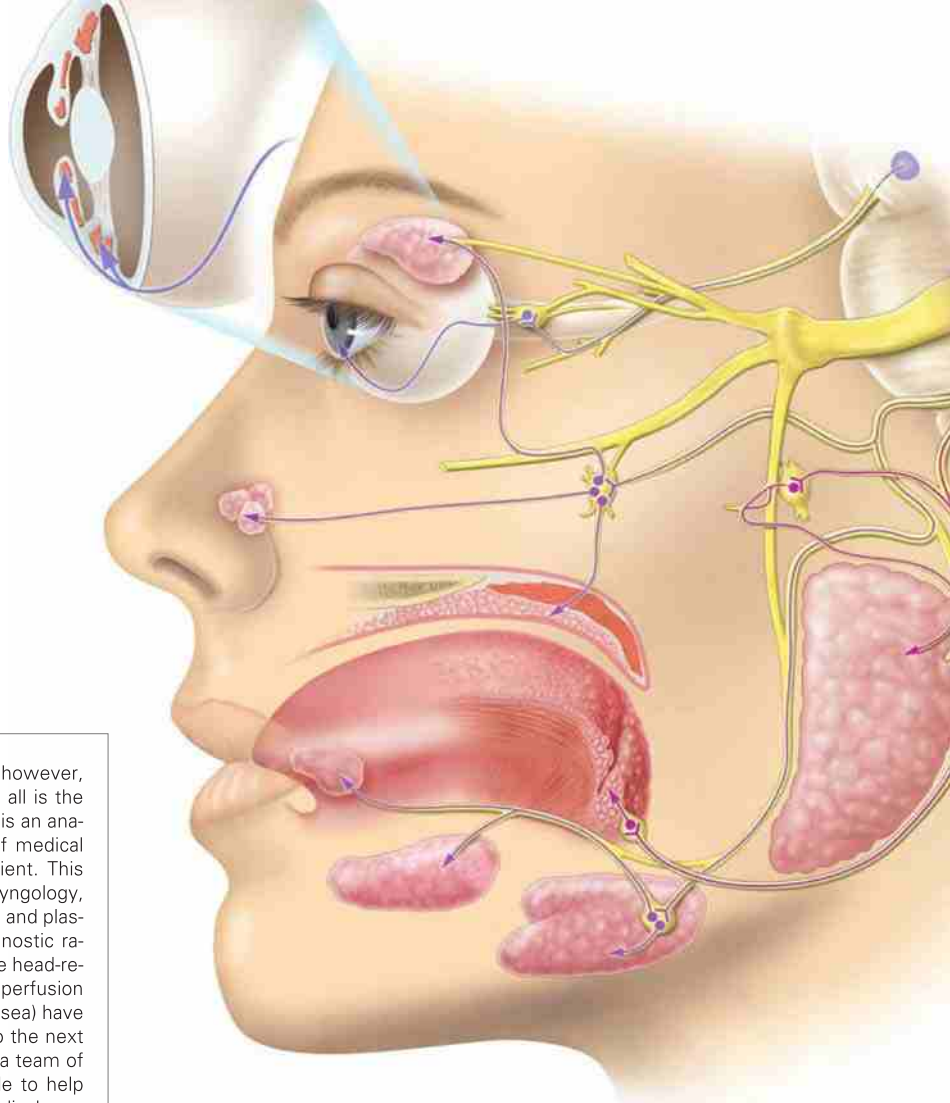
The olfactory sense is up to the nose (Nasus), even though it only performs it with its smallest part, the olfactory epithelium at the roof of the nasal cavity under the base of the skull. The outer cartilage-framed nasal vestibule (Vestibulum nasi) and the far more spacious, bony inner nasal cavity (Cavitas nasalis ossea) serve for breathing: Through the inner nostrils (Choanae), the nasal cavity opens behind the throat (Pharynx) which in turn communicates much more caudally with the Larynx and the windpipe (Trachea).

Biting, chewing, talking, tasting, and swallowing are the functions of the oral cavity (Cavitas oris) and the accompanying organs. Similar to the nose, the oral cavity also has a vestibule (Vestibulum oris), the space between lips (Labiae) and cheeks (Buccae) on one side and the teeth (Dentes) on the other side.

Behind the teeth lies the larger oral cavity proper (Cavitas oris propria) which is almost completely filled by the tongue (Lingua) at a closed bite. At its posterior aspect, the oral cavity opens towards the Pharynx and, at the price of choking, the respiratory tract and ingestive tract cross here. The roof of the mouth, the palate (Palatum), also forms the floor of the nasal cavity. In the front, the palate is rigid and bony, while dorsally towards the Pharynx it becomes soft, flexible, and muscular. The Uvula dangles from the soft part of the palate. The floor of the mouth, which is surrounded by the movable mandible (Mandibula) and which carries the tongue, is made of muscle plates. During speech almost all of these structures act together (along with many other structures), whereby the nose is used as an additional resonator.

Two **pits** of the facial skeleton are important: If one removes (first imaginary, later on in reality during the dissection sessions) the ascending bony branch of the Mandibula (Ramus mandibulae), which leads to the temporomandibular joint (Articulatio temporomandibularis), one enters the soft tissues of the lateral aspect of the head from "behind the cheek" and enters a space that is referred to as the infratemporal fossa (Fossa infratemporalis). Positioned in this region are masticatory muscles (Mm. pterygoidei medialis and lateralis) and several branches of nerves. In addition, the terminal branches of the large external carotid artery lead towards the centre of the Viscerocranium.

In the direction of the Orbita, the Fossa infratemporalis extends further inwards and cranially into a wider space, the pterygopalatine fossa (Fossa pterygopalatina). It is essential to locate this cavity during dissection and its contents and multiple pathways are important to remember. This cavity is a "key distributor" for vessels and nerves of the Viscerocranium. Since it is hidden and its anatomy is extremely complex, all anatomists adore it and like to examine students on it.



### Clinical Remarks

Ailments and injuries of the head are frequent events; however, diseases affecting the skull base are rare. Common to all is the fact that they are often life-threatening. Since the head is an anatomically complex system, consultation by a variety of medical experts is required to ensure optimal care of the patient. This team of experts includes medical disciplines like otolaryngology, head and neck surgery, neurosurgery, oral, dental, facial and plastic surgery, ophthalmology, radiation therapy, and diagnostic radiology and neuroradiology. Some patients with a severe head-related ailment (e.g. unclear headache or impaired blood perfusion in a region of the brain stem resulting in vertigo and nausea) have experienced an odyssey of referrals from one doctor to the next before encountering the one physician or, even better, a team of medical experts who identify the problem and are able to help this patient. As a response to this, some university medical centres now offer a co-ordinated, multidisciplinary team approach to provide quality treatment and follow-up for such patients. Thus, therapeutic strategies are discussed and co-ordinated among the members of the different medical disciplines involved in each particular case in order to provide the most optimal patient care and allow for a speedy recovery of the patient.

### → Dissection Link

The dissection of the **superficial facial region** at the lateral sagittal plane of the head (head in a lateral position) is showing the facial arteries and veins, muscles of facial expression, all branches of the N. facialis, and the peripheral branches of the N. trigeminus.

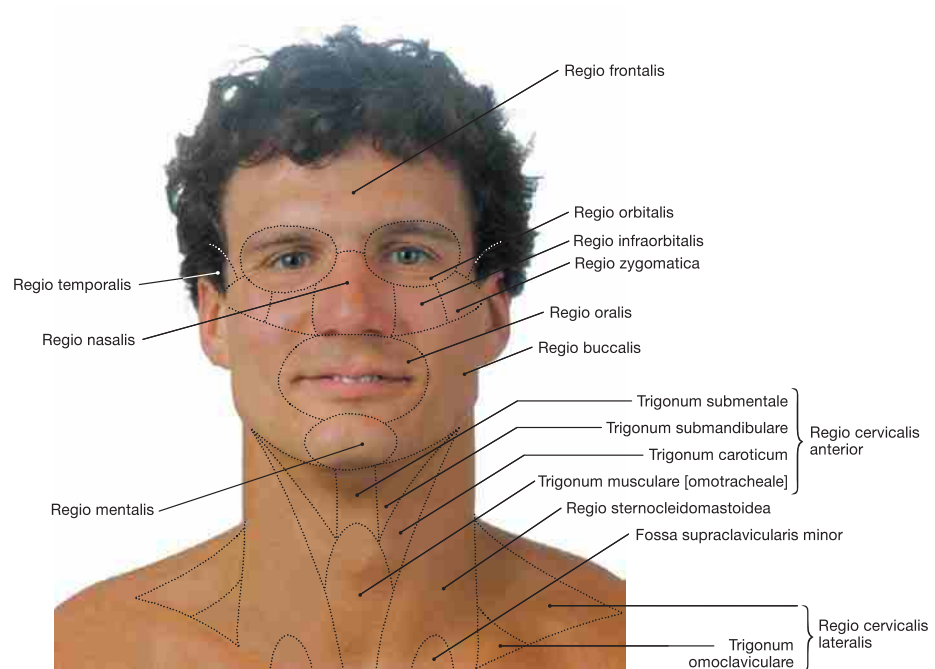
The dissection of the **deep facial region** includes the removal of the Glandula parotidea, the presentation of the Plexus parotideus (N. facialis [VII]), the dissection of the Fossa retromandibularis, the representation of all four masticatory muscles, and the demonstration of the course of the A. maxillaris up to its terminal branches, as well as the preparation of the temporomandibular joint with presentation of the Discus articularis and identification of the Chorda tympani.

Dissection of the **midsagittal** planes of the head (head in medial position): The dissection of the nasal septum with its cartilaginous and bony parts as well as the Fila olfactoria and the N. nasopalatinus is followed by the removal of the nasal septum and the presentation of the lateral nasal wall with openings of the paranasal sinuses and the Ductus nasolacrimalis. The Fossa pterygopalatina is opened and its contents are displayed. Finally, the A. sphenopalatina at the Foramen sphenopalatinum is located, followed by the full dissection of the oral cavity with representation of the Glandulae submandibularis and sublingualis, Nn. lingualis, hypoglossus, and glossopharyngeus, as well as the dissection of the palatal muscles beneath the auditory tube cartilage, and of the tonsillar fossa.

### EXAM CHECK LIST

- Development: Neurocranium, Viscerocranium, Nn. craniales, sensory organs, Facies, Cranium with Calvaria, Basis cranii, exit points with penetrating structures, Articulatio temporomandibularis and Fossa infratemporalis
- head and neck muscles, Fascia and facial muscles, masticatory muscles, fascia of the head, Os hyoideum and suprahyal muscles
- components of the head: Cavum nasi (with orifices), Sinus paranasales, topographic relationships, Cavum oris, Dentes, Lingua, Glandulae oris, Palatum and function of the Palatum molle (cleft formation), Isthmus faucium, WALDEYER's tonsillar ring, Tonsillae, Pharynx, Fossa pterygopalatina, innervation and supply of all structures, facial paralysis and course of the Nn. craniales [IV, VII–XII]

## Regions of head and neck



**Fig. 8.1 Regions of the head and neck, Regiones capitis et colli;** frontal view.

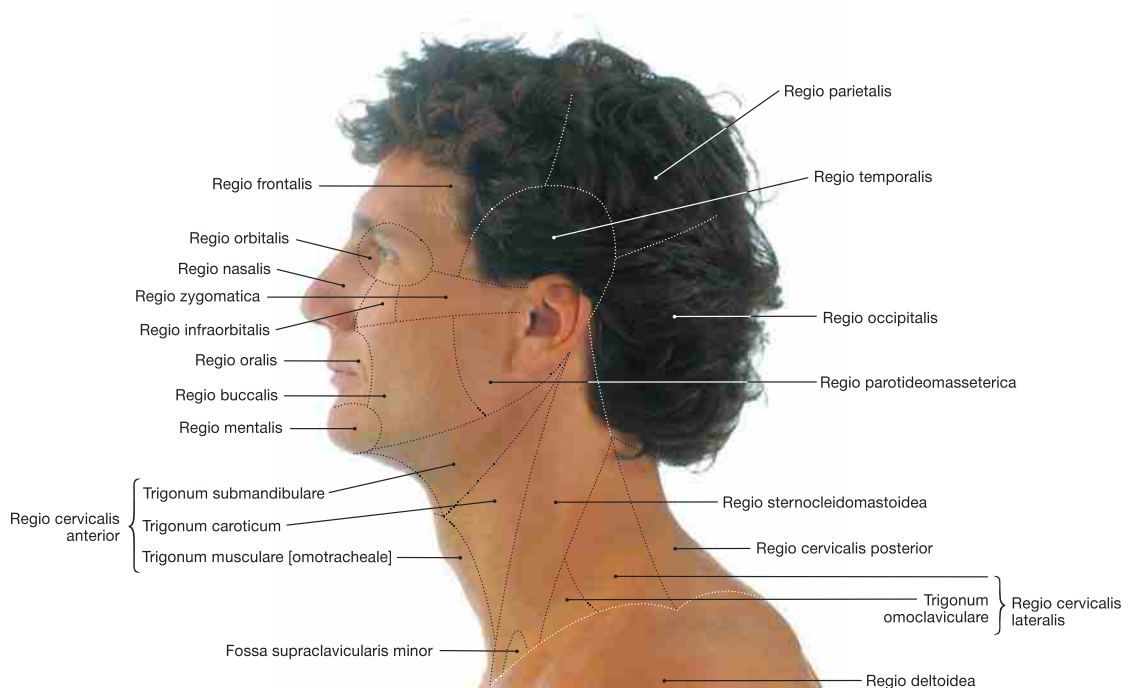
The **head** is divided into the following topographic regions:

- Regio frontalis
- Regio temporalis
- Regio orbitalis
- Regio nasalis
- Regio infraorbitalis
- Regio zygomatica
- Regio oralis
- Regio buccalis
- Regio mentalis

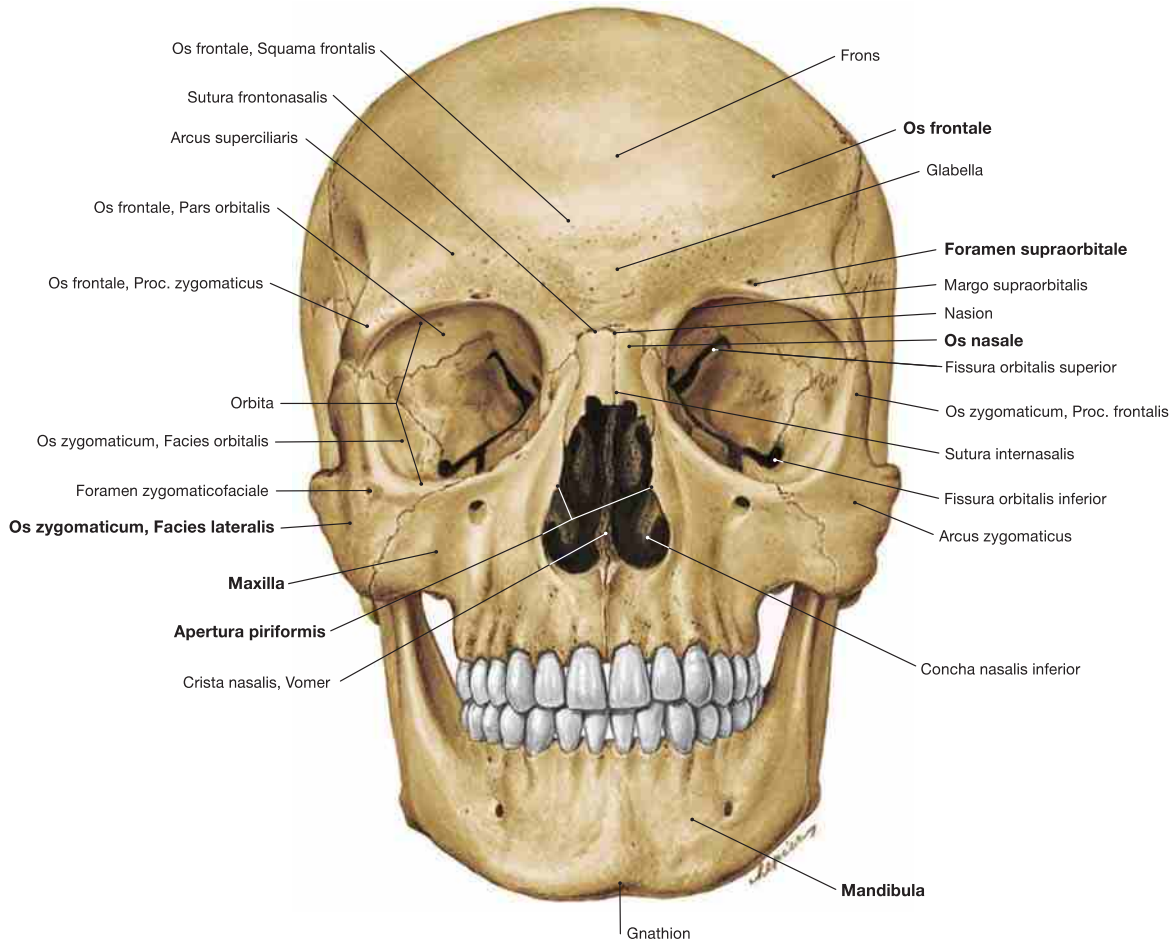
- Regio parietalis
- Regio occipitalis
- Regio parotideomasseterica

The **neck** is divided into the following topographic regions:

- Regio cervicalis anterior, composed of Trigonum submentale, Trigonum submandibulare, Trigonum caroticum, and Trigonum musculare (omotracheale)
- Regio sternocleidomastoidea with Fossa supraclavicularis minor
- Regio cervicalis lateralis with Trigonum omoclaviculare
- Regio cervicalis posterior

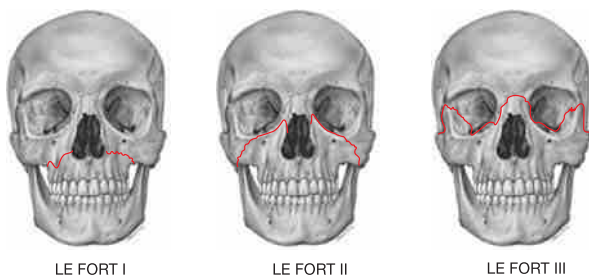


**Fig. 8.2 Regions of the head and neck, Regiones capitis et colli;** lateral view.



**Fig. 8.3 Skull, Cranium;** frontal view.  
 From bottom to top one can see the lower jaw or mandible (Mandibula), the two upper jaws or maxillary bones (Maxillae), the nasal bones (Ossa nasalia) located between the maxillary bone and the orbit (Orbita) as well as the frontal bone (Os frontale) above the orbit. The frontal bone (**Os frontale**) consists of four parts (→ Fig. 8.23). Above the upper margin of the orbit (Margo supraorbitalis) the bilateral Arcus superciliaris bulges out. A part of the Os frontale protrudes me-

dially downwards and forms a portion of the medial margin of the orbit. At the lateral aspect, the Proc. zygomaticus has contact with the Proc. frontalis of the Os zygomaticum. Both form the lateral margin of the orbit. The zygomatic bone (**Os zygomaticum**) constitutes the major part of the lateral and lower margins of the orbit. The pair of nasal bones (**Os nasale**) is connected to the Os frontale by the Sutura frontonasalis and to each other by the Sutura internasalis.



**Fig. 8.4 LE FORT's fractures.**

**Clinical Remarks**

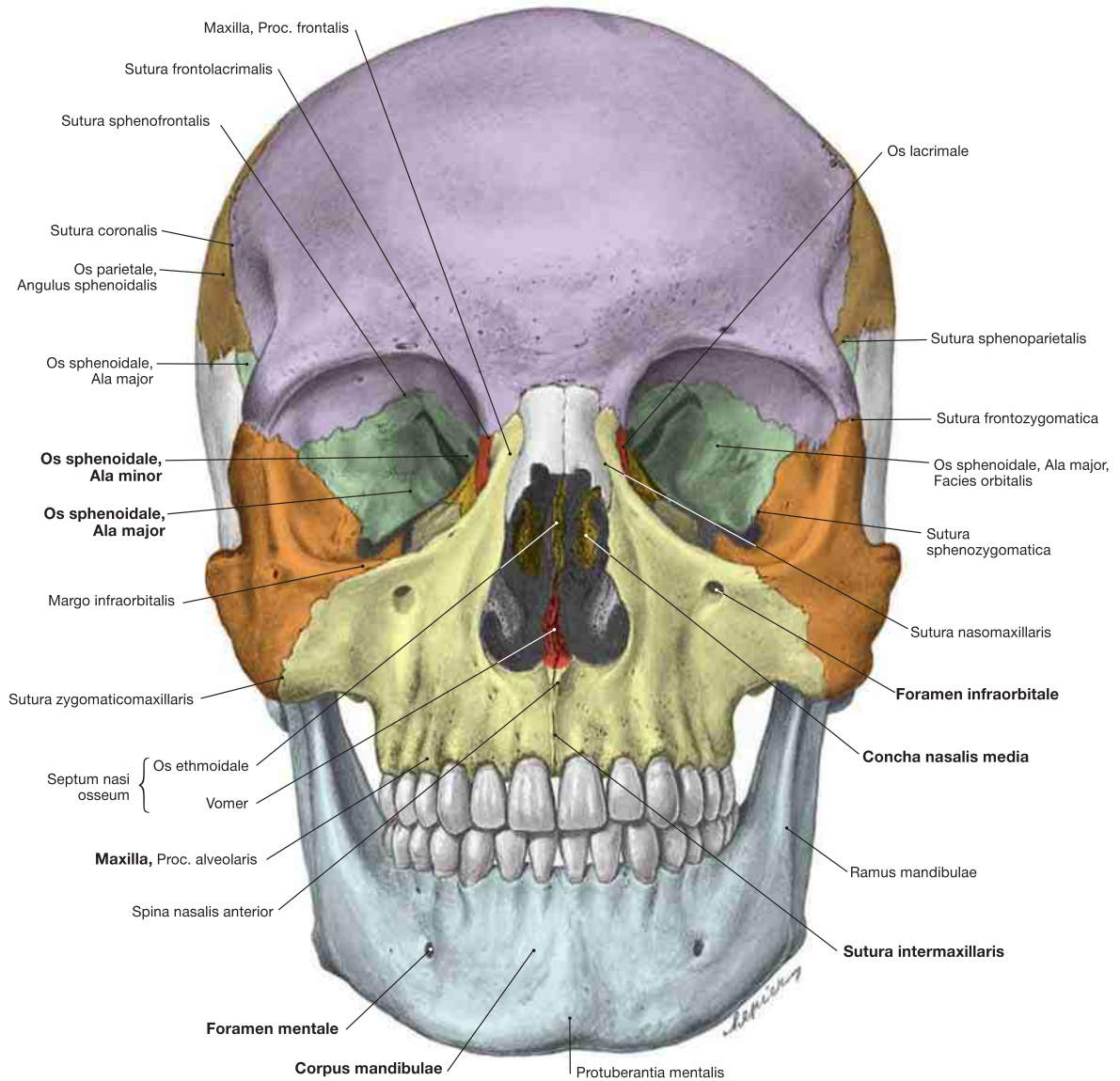
Car accidents are among the most frequent causes of midfacial fractures, which are classified according to LE FORT (→ Fig. 8.4):

- LE FORT I: horizontal fracture line with isolated detachment of the maxillary alveolar rim ("floating palate")

- LE FORT II: pyramidal fracture line involving the Maxilla in the region of the floor of the orbit; involvement of the ethmoidal bones, anterior skull base, and nasal bones is also possible
- LE FORT III: transverse fracture line with craniofacial dissociation



## Skull bones



**Fig. 8.5 Skull bones, Ossa cranii;** frontal view; colour chart see inside of the back cover of this volume.

The upper jaw or maxillary bone (**Maxilla**) is located between the orbit and the oral cavity. The maxilla participates in the formation of the lower and medial margins of the orbit and has a lateral border with the Os zygomaticum. The Proc. frontalis of the maxilla connects with the Os frontale. The Foramen infraorbitale is located below the lower margin of the orbit in the Corpus maxillae. The Spina nasalis anterior protrudes in the midline. The Proc. alveolaris creates the lower margin of the Maxil-

la and supports the teeth. In the orbit, the Maxilla creates the lower margin of the Fissura orbitalis inferior and, together with the Os zygomaticum, forms the lateral margin of the orbit.

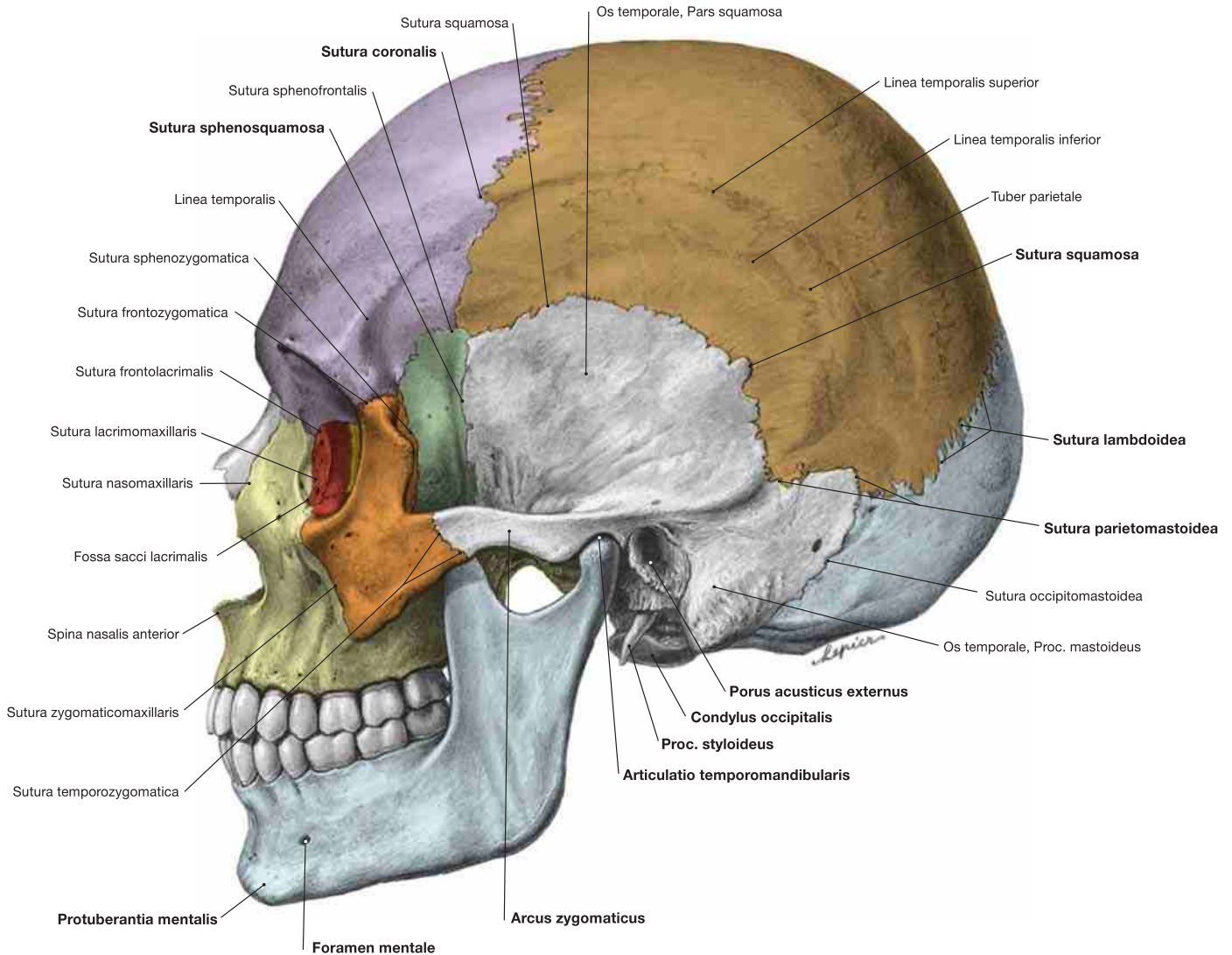
The lower jaw or mandible (**Mandibula**) consists of a Corpus and Rami mandibulae, which merge in the Angulus mandibulae. The Corpus mandibulae is composed of the Pars alveolaris with teeth and the Basis mandibulae beneath. The latter protrudes in the midline as Protuberantia mentalis. In addition, the Foramen mentale is shown.

### Clinical Remarks

**Fractures of the nasal bone and the supporting cartilaginous nasal framework** are among the most frequent fractures of the facial region. One can distinguish closed and open nasal fractures. Open fractures involve bony parts piercing through the skin and soft

tissue. The nasal septum and Conchae nasales can also be affected. Fractures of the nasal framework are typically a result of violent physical disputes, car accidents, martial arts like karate, boxing, and of a variety of team sports.

Skull bones



**Fig. 8.6 Skull bones, Ossa cranii;** lateral view; colour chart see inside of the back cover of this volume.

The lateral view displays parts of the Ossa frontale, parietale, occipitale, sphenoidale, and temporale, parts of the viscerocranium (Os nasale, Os lacrimale, Maxilla, and Os zygomaticum) as well as the lateral side of the lower jaw (Mandibula).

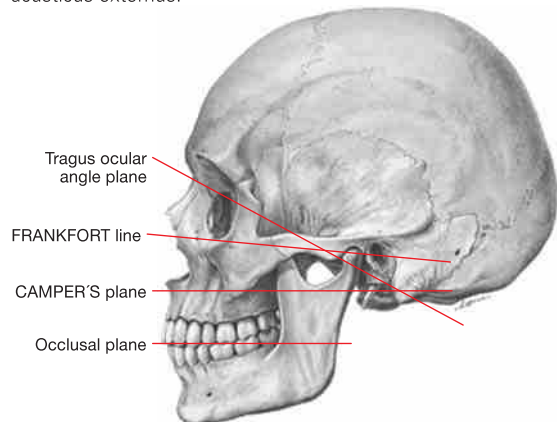
In the viscerocranium, the **Os nasale** has its cranial and posterior borders with the Os frontale and the Maxilla, respectively. The upper part of the lacrimal bone (**Os lacrimale**) forms the Fossa sacci lacrimalis between the **Maxilla** and the Os ethmoidale. The Proc. alveolaris of the Maxilla contains the upper teeth. The medial aspect of the Maxilla connects with the Os frontale, its lateral aspect contacts the Os zygomaticum. The Spina nasalis anterior protrudes in the anterior midline. The **Os zygomaticum** is responsible for the contour of the region of the cheek.

The head of the mandible (Caput mandibulae) articulates with the Os temporale in the temporomandibular joint (Articulatio temporomandibularis).

In its upper frontal aspect, the **Os frontale** is connected with the parietal bone (**Os parietale**) and the sphenoidal bone (**Os sphenoidale**) via the Sutura coronalis. The Os parietale connects with the occipital bone (Os occipitale) in the Sutura lambdoidea and with the Os sphenoidale in the Sutura shenoparietalis. The Os sphenoidale and the temporal bone (**Os temporale**) form the Sutura sphenosquamosa. Os temporale and Os occipitale connect in the posterior Sutura occipitomastoidea. The

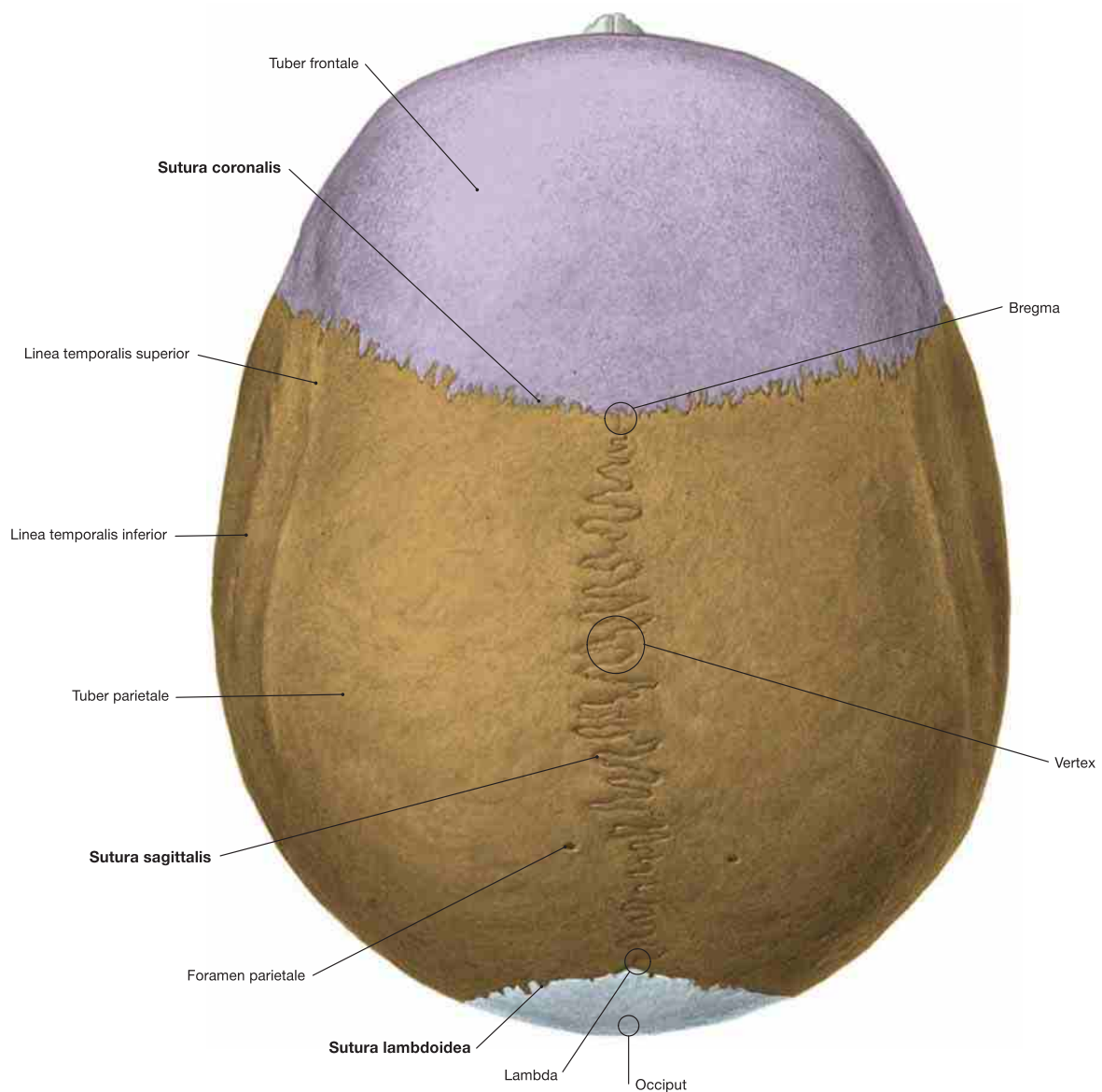
major part of the lateral wall of the skull is formed by the Pars squamosa of the Os temporale.

Os temporale and Os zygomaticum form the zygomatic arch (Arcus zygomaticus), which bridges the Fossa temporalis. The Pars tympanica of the Os temporale is located below the base of the Proc. zygomaticus and directly adjacent to the Pars squamosa. At its surface lies the Porus acusticus externus.



**Fig. 8.7 Reference lines for the teeth.**

## Skull bones



**Fig. 8.8 Skull bones, Ossa cranii;** superior view; colour chart see inside of the back cover of this volume.

A view on the upper part of the skull (skull cap, Calvaria) reveals the Os frontale, the Ossa parietalia, and the Os occipitale. Os frontale and Ossa parietalia are separated by the **coronal suture** (Sutura coronalis). Both Ossa parietalia meet at the **sagittal suture** (Sutura sagittalis). The Os occipitale connects with the two Ossa parietalia by the **lambdoid**

**suture** (Sutura lambdoidea). The contact point between the Suturae coronalis and sagittalis is called **Bregma**, the contact point of the Suturae sagittalis and lambdoidea is named **Lambda**. In the dorsal part of the Ossa parietalia and bilaterally in close proximity to the Sutura sagittalis are the paired Foramina parietalia for the passage of the Vv. emissariae.

### Clinical Remarks

Extensive external physical force can lead to skull fractures. **Skull fractures** are further differentiated into:

- **linear** fractures presenting with clear fracture lines
- **split** skull fractures with multiple bony fragments (impression fracture with inward pointing bony parts which can cause a compression or tear of the Dura mater as well as an injury to brain tissue)

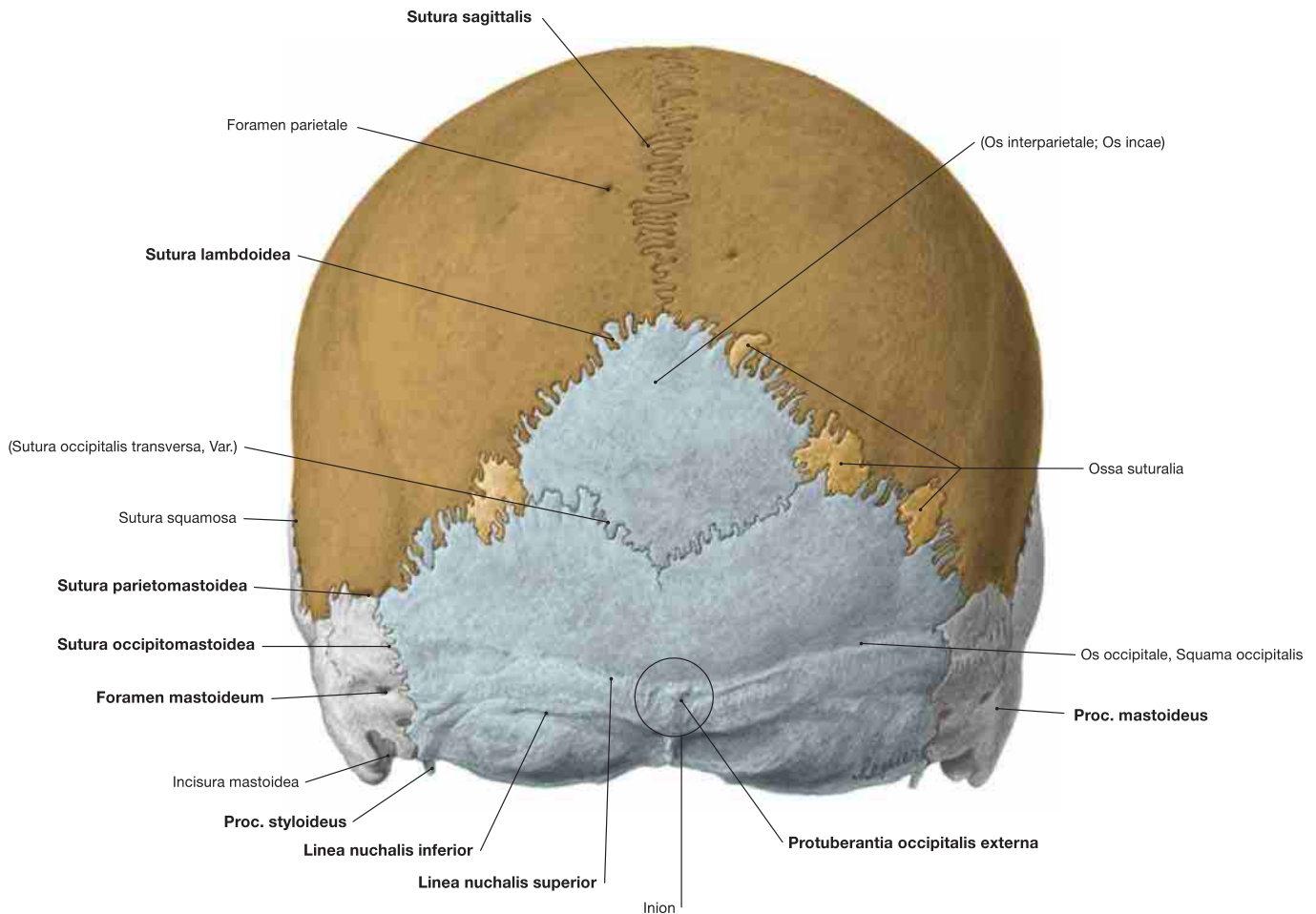
- **diastatic** fractures (with fracture lines including sutures and result in a widening of the suture)

- **basal skull fractures.**

All fractures associated with an open wound of the skin of the head and fractures involving the paranasal sinuses or the middle ear are considered to be open fractures with a risk of infection. They require a surgical intervention.



## Skull bones



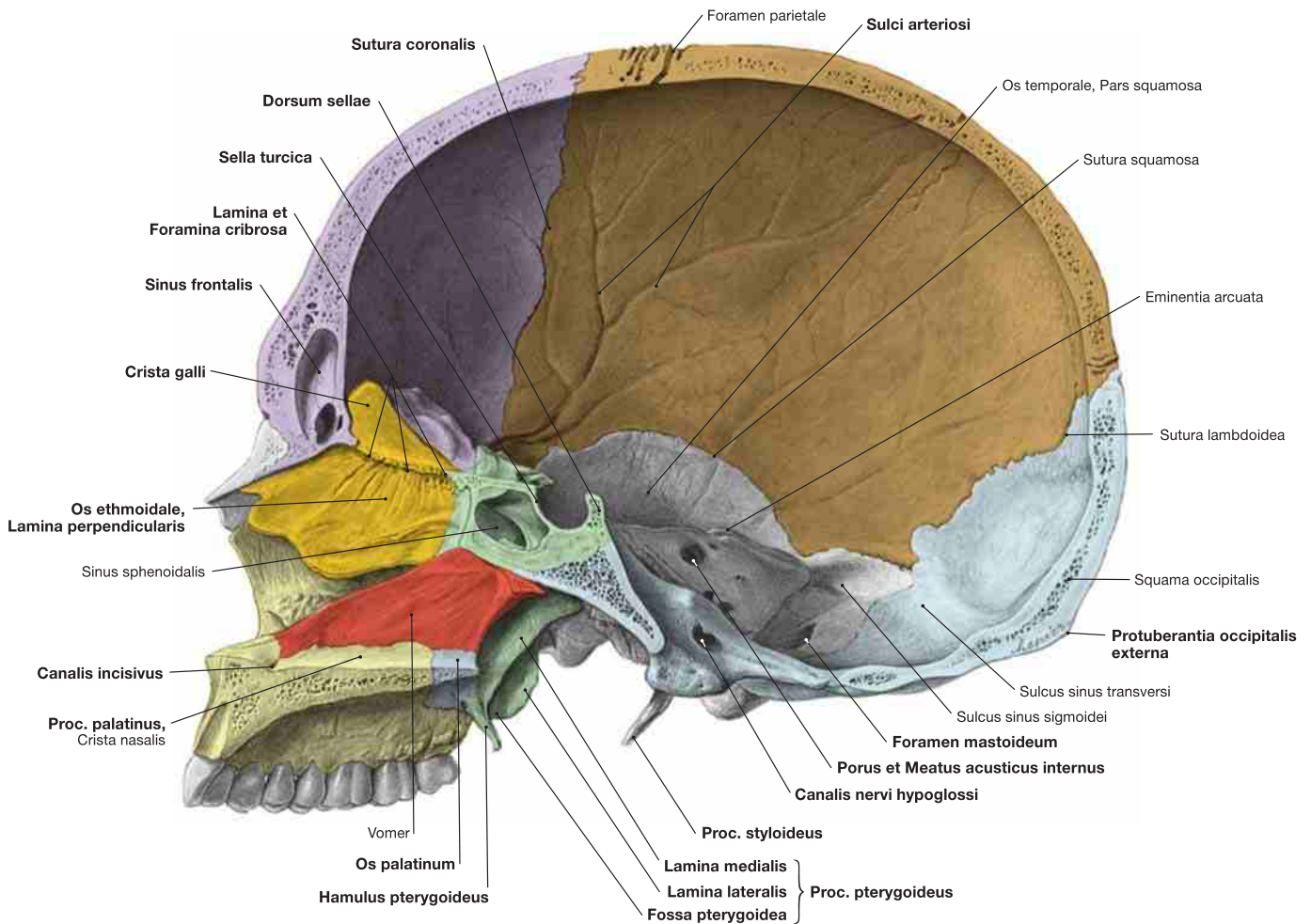
**Fig. 8.9 Skull bones, Ossa cranii;** posterior view; colour chart see inside of the back cover of this volume.

This view from the posterior side shows the Ossa temporalia, parietalia, and the Os occipitale. To both sides of the **Os temporale** the Proc. mastoideus is visible. At the lower medial margin of the Proc. mastoideus lies the Incisura mastoidea; this notch serves as attachment point for the Venter posterior of the M. digastricus.

Shown from posterior, both **Ossa parietalia** meet in the midline in the Sutura sagittalis, connect posteriorly with the Os occipitale in the Sutura lambdoidea, and are separated laterally from the Ossa temporalia by the Sutura parietomastoidea.

The **Os occipitale** occupies most of the posterior part of the skull. The central structure is the Squama occipitalis. Frequently, sutural bones (Ossa suturalia) are found along the Sutura lambdoidea. The Protuberantia occipitalis externa is an easily palpable bony reference point on the Os occipitale. Its most protruding point is the Inion. The Protuberantia extends bilaterally in an arch-shaped line as Linea nuchalis superior, a bony crest which serves for the attachment of the autochthonous (intrinsic) muscles of the back. At approximately 2–2.5 cm below the Protuberantia occipitalis externa, the Lineae nuchales inferiores run in a similar arch-shaped fashion, serving as additional attachment sites for muscles.

## Skull bones

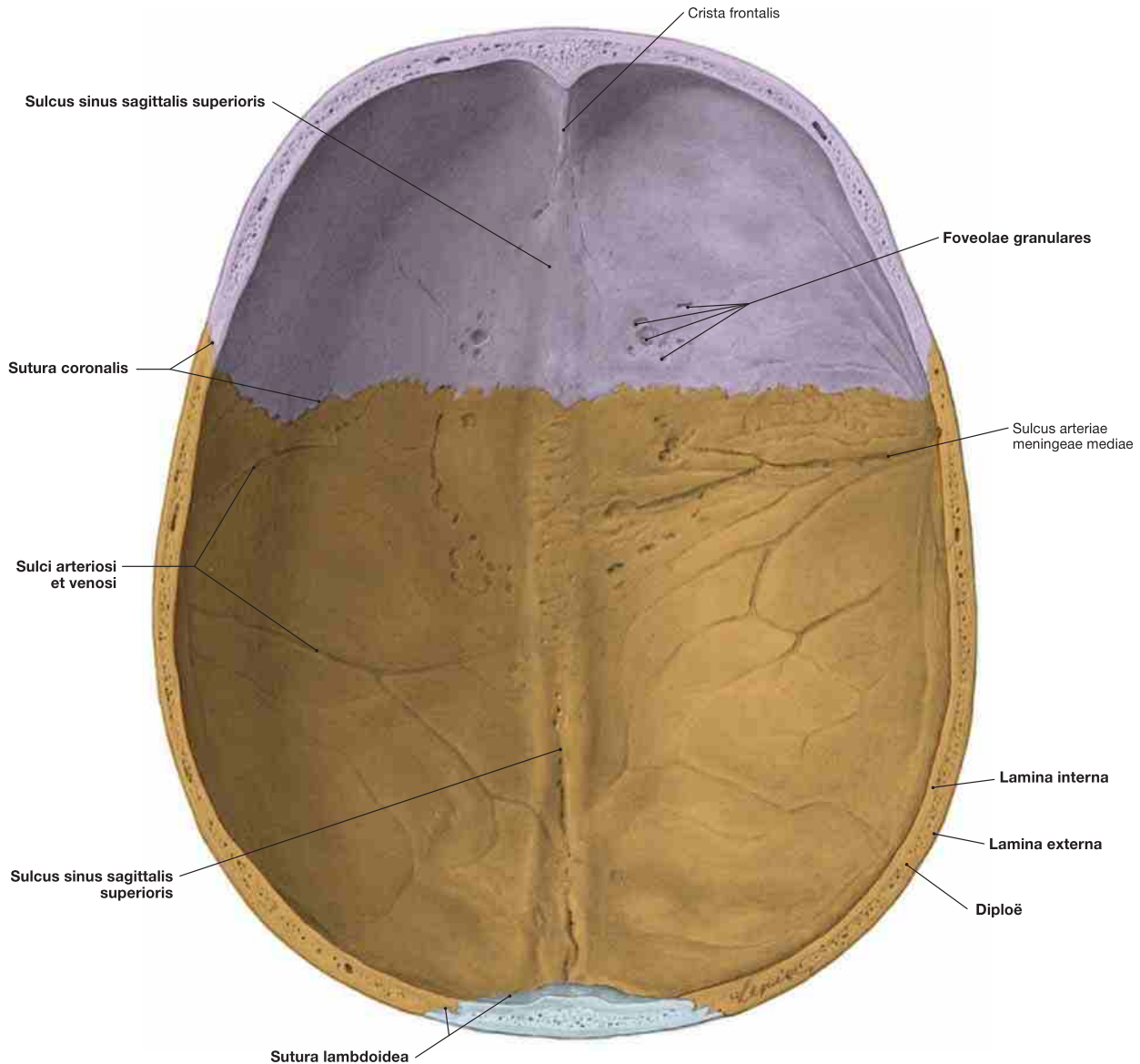


**Fig. 8.10 Skull bones, Ossa cranii, right side;** medial view; colour chart see inside of the back cover of this volume.

The cranial cavity includes the skull cap (Calvaria) and the base of the skull which is composed of the anterior, middle, and posterior cranial fossae. The cranial cavity surrounds the brain with its meninges and encloses the proximal portion of the cranial nerves, including the blood

vessels and the venous sinuses. On the inside of the cranial cavity, the pulsations of the A. meningea media have carved out Sulci arteriosi. The Lamina perpendicularis of the Os ethmoidale and the Vomer, the bony part of the nasal septum, are located at the transition region from Neurocranium to Viscerocranium. The Proc. palatinus of the Maxilla and the Os palatinum form the hard palate.

## Skull bones



**Fig. 8.11 Roof of the skull, Calvaria;** inner aspect; colour chart see inside of the back cover of this volume.

The inside of the skull cap reveals the Sutura coronalis between Ossa frontale and Ossa parietalia and the Sutura lambdoidea between Ossa parietalia and Os occipitale. Also visible at the inside of the Ossa frontale is the Crista frontalis which serves as an attachment for the Falx cerebri (duplication of the Dura mater composed of tough fibrous tissue; separates both cerebral hemispheres). The Crista frontalis transitions into the Sulcus sinus sagittalis superioris (location of the Sinus sagittalis superior) which becomes wider and deeper in its posterior part. It ex-

tends across the Sutura lambdoidea onto the Os occipitale.

Bilaterally and alongside the entire length of the Sulcus sinus sagittalis superioris, irregularly grouped small depressions (Foveolae granulares, location of the cauliflower-like Granulationes arachnoideae [PACCHIONIAN granulations]) are identified. The lateral part of the Calvaria contains multiple grooves (Sulci arteriosi et venosi).

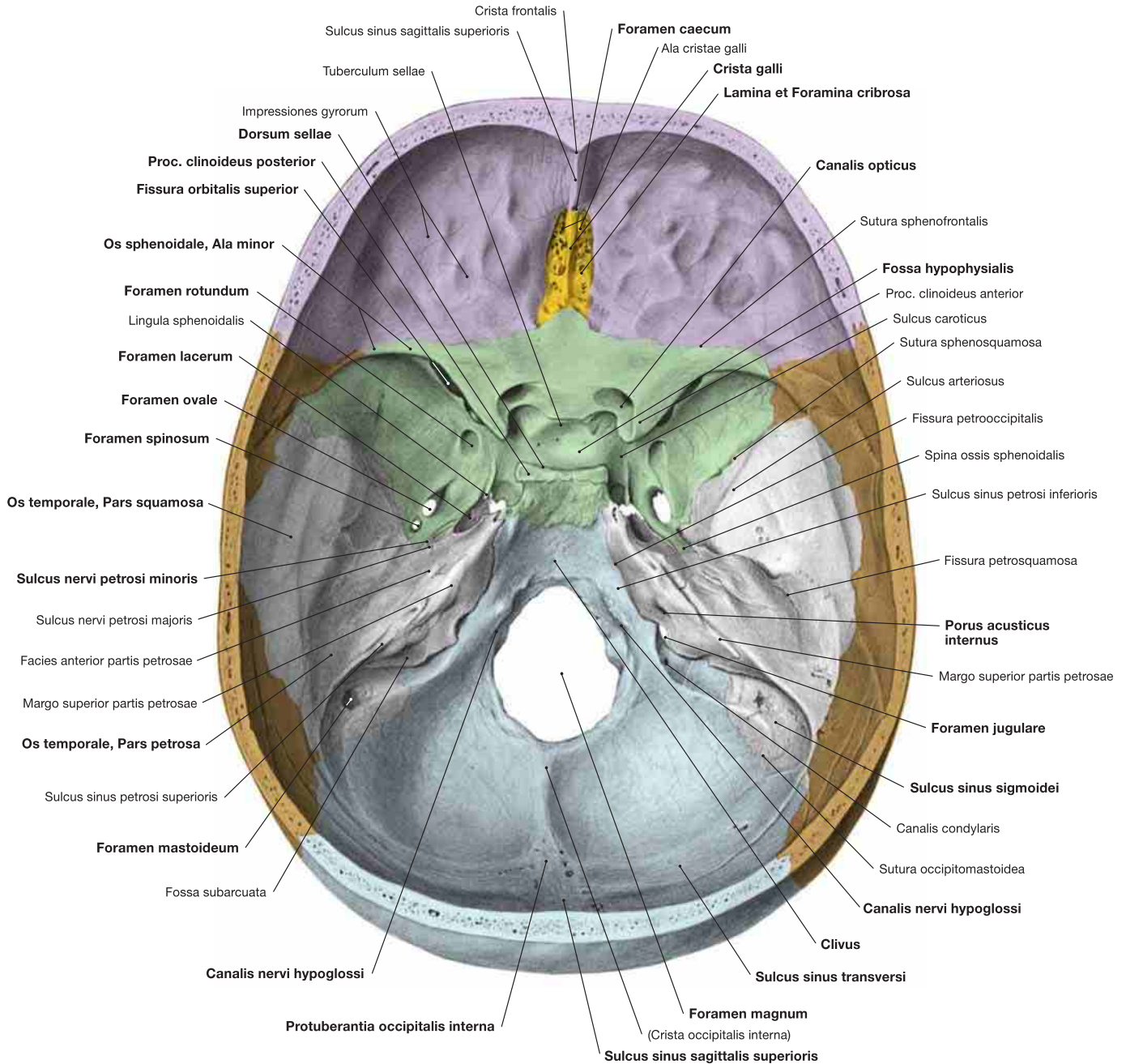
The **bones of the Calvaria** possess a special **structure**. They consist of a thick outer and thin inner compacta, named Lamina externa and Lamina interna (Lamina vitrea), and a thin layer of spongiosa, known as Diploë.

### Clinical Remarks

The Lamina interna of the calvarian bones is thin and can be easily damaged by **external forces** that result in a bending fracture of the Lamina. If thereby branches of the A. meningea media (which

course in the Sulcus arteriae meningae mediae of the Lamina interna) are injured, an **epidural haematoma** may occur (→ Fig. 12.11).

## Inner aspect of the base of the skull



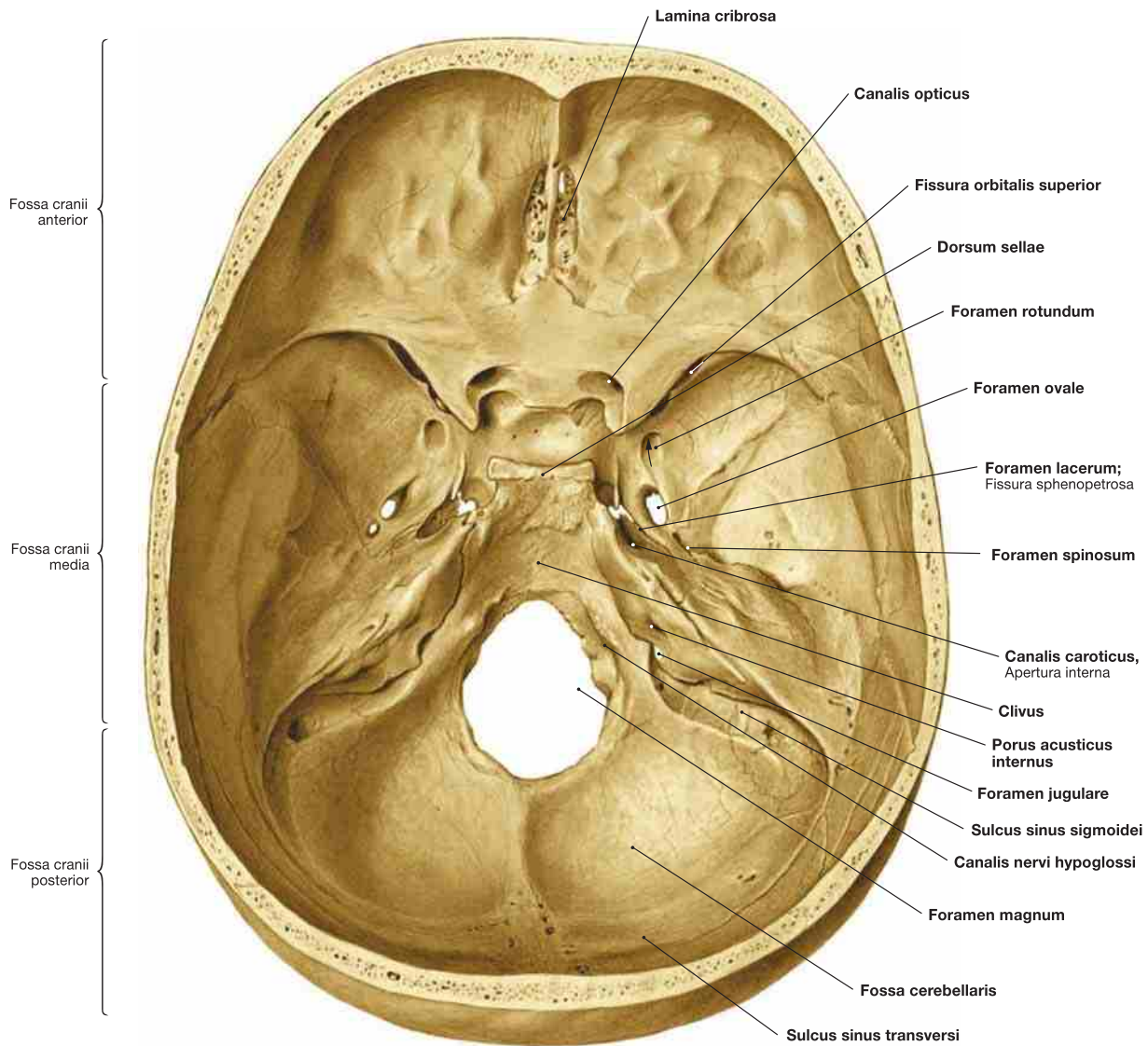
**Fig. 8.12 Inner aspect of the base of the skull, Basis cranii interna;** superior view; colour chart see inside of the back cover of this volume.

The anterior (Fossa cranii anterior), middle (Fossa cranii media), and posterior cranial fossae (Fossa cranii posterior) form the inner base of the skull. Ossa frontale, ethmoidalia, and sphenoidale participate in the structure of the **anterior cranial fossa**. The latter is located above the nasal cavity and orbit and contains the Foramen caecum, the Crista galli (attachment point for the Falx cerebri), and the bilateral Lamina cribrosa. Posterior to the Ossa frontale and Ossa ethmoidalia, the Corpus and the Alae minores of the Os sphenoidale form the base of the anterior cranial fossa. The Corpus also forms the border to the middle cranial fossa.

The **middle cranial fossa** is composed of the Ossa sphenoidale and temporalia. Its floor is elevated in the midline, and at this point it becomes part of the Corpus of the Os sphenoidale. The pit-shaped lateral portions are parts of the Ala major of the Os sphenoidale and the Pars squamosa of the Os temporale. Located in the middle cranial fossa are the saddle-shaped Sella turcica with the Fossa hypophysialis, and on both sides the Canalis opticus, the Fissura orbitalis superior, and the Foramina rotundum, ovale, spinosum, and lacerum. The Facies anterior partis petrosae demarcates the posterior aspect of the middle cranial fossa.



## Inner aspect of the base of the skull

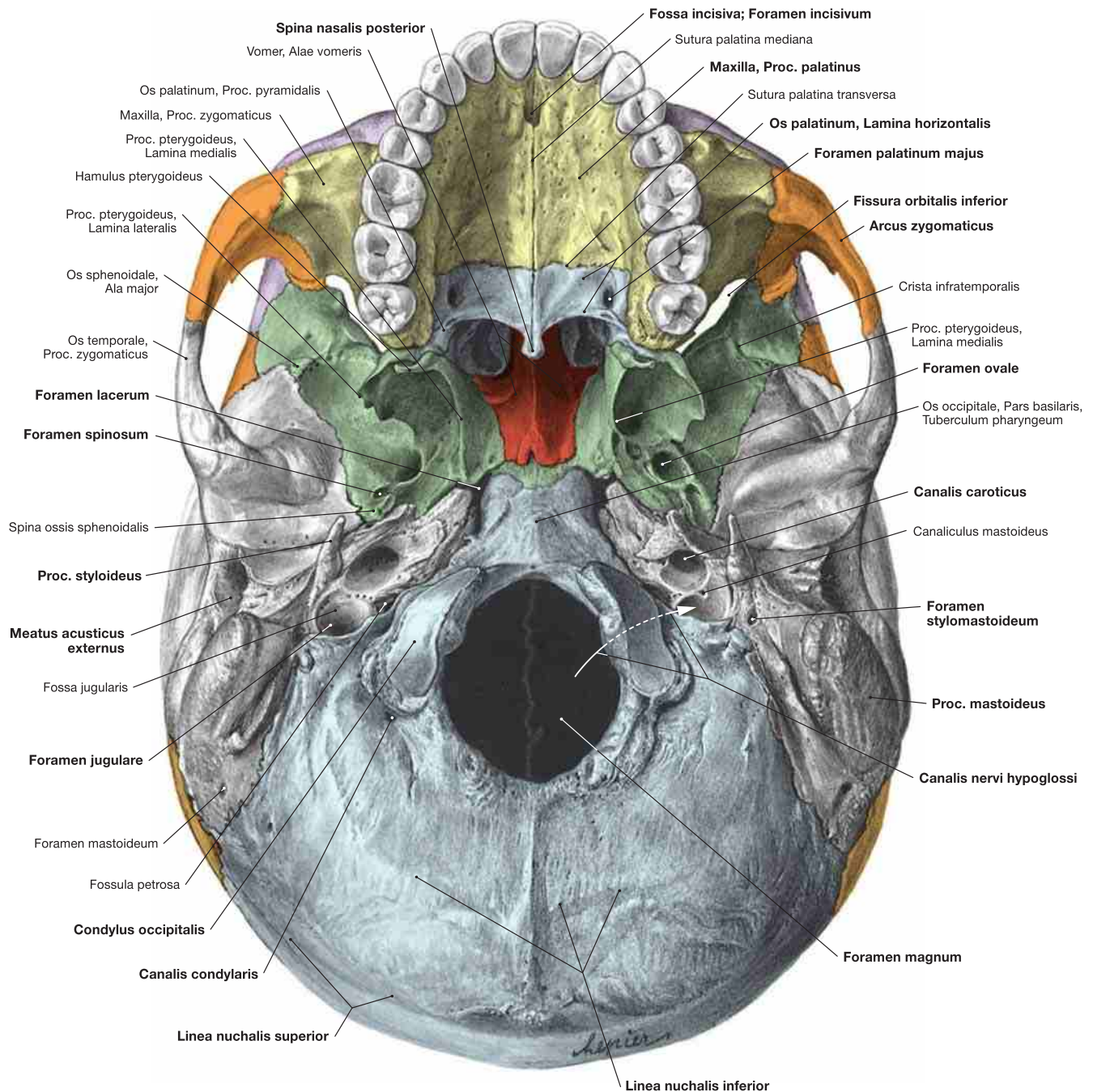


**Fig. 8.13 Inner aspect of the base of the skull, Basis cranii interna;** superior view.

Of the three cranial fossae, the **posterior cranial fossa** is the biggest. It is composed of the Ossa temporalia, the Os occipitale, and, to a smaller extent, of the Os sphenoidale and the Ossa parietalia. In the midline, its anterior margin is formed by the Dorsum sellae and the Clivus. The Clivus is an oblique bony rim, which creates a slope from the Dorsum sellae to the Foramen magnum. The Clivus is composed of parts of the Corpus of the Os sphenoidale and the Pars basi-

laris of the Os occipitale. The posterior aspect of the posterior cranial fossa consists mainly of the Sulcus sinus transversus. The Foramen magnum is the largest opening of the posterior cranial fossa. Additional structures of the posterior cranial fossa include the Canalis nervi hypoglossi, the Porus acusticus internus, and the Foramen jugulare. The Sulcus sinus sigmoidei approaches the Foramen jugulare from lateral. The central depression in the posterior cranial fossa is the Fossa cerebellaris.

## Outer aspect of the base of the skull



**Fig. 8.14 Outer aspect of the base of the skull, Basis cranii externa; inferior view.**

The cranial base extends to the middle incisors in the front, bilaterally to the Proc. mastoidei and the Arcus zygomatici, and to the Lineae nuchales superiores in the back. The cranial base divides into three compartments:

- anterior compartment with upper teeth and hard palate
- middle compartment posterior to the palate up to the anterior margin of the Foramen magnum
- posterior compartment from the anterior margin of the Foramen magnum to the Lineae nuchales superiores

**Anterior cranial base:** encompasses the palate (→ Fig. 8.26).

**Middle cranial base:** the anterior part of this middle compartment is

composed of the Vomer and the Os sphenoidale; the Ossa temporalia and the Os occipitale form the posterior part. The Vomer is located in the frontal part of the midline, rides on the Os sphenoidale, and constitutes the posterior part of the nasal septum.

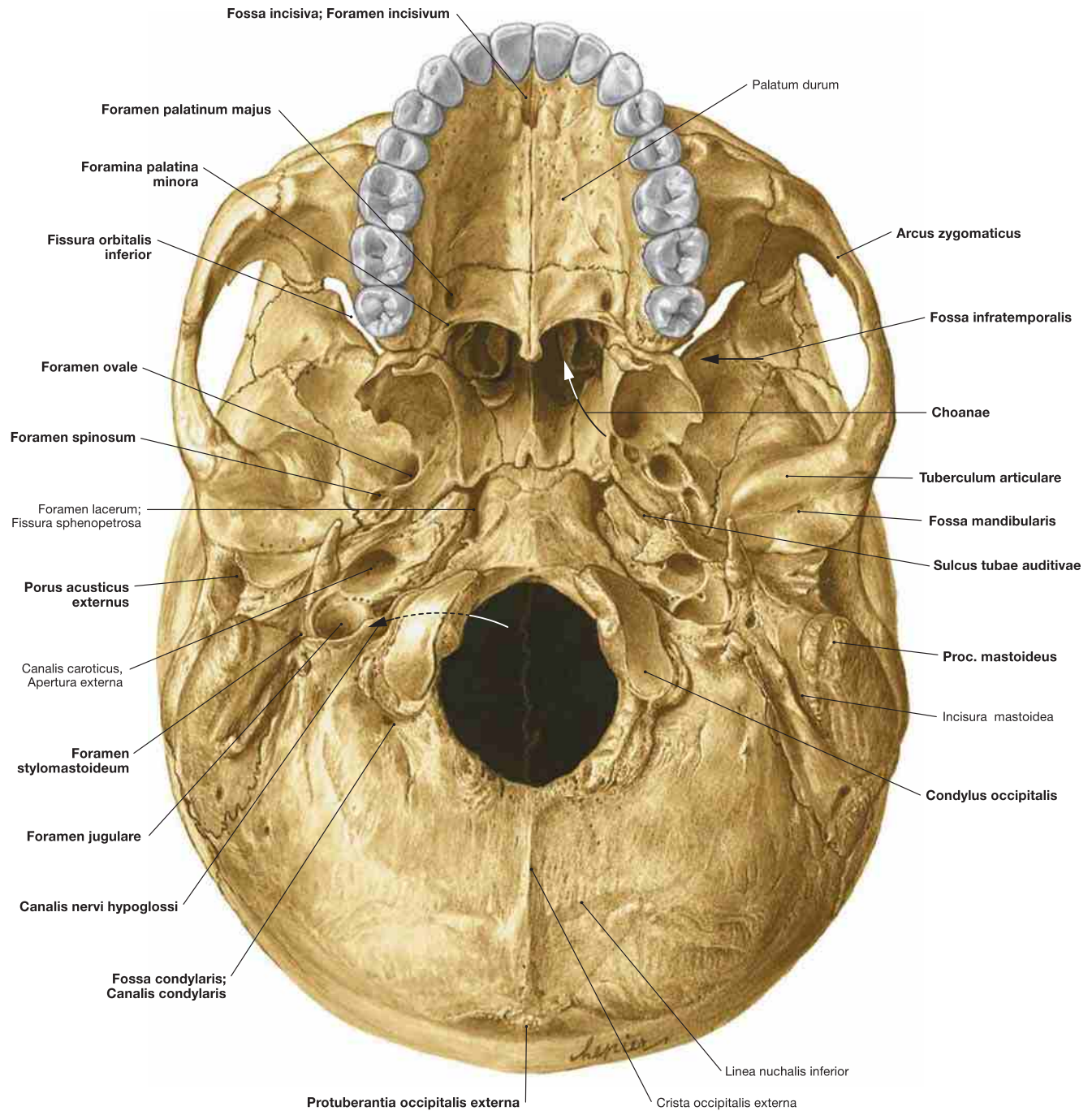
The Os sphenoidale is composed of a central Corpus and the paired Alae majores and Alae minores (not visible from below).

Following directly behind the Corpus of the Os sphenoidale is the Pars basilaris of the Os occipitale, which represents the beginning of the posterior cranial base. The Pars basilaris extends up to the Foramen magnum. Here, the Tuberculum pharyngeum protrudes. It constitutes the bony attachment point for parts of the Pharynx.

(continuation → Fig. 8.15)



Outer aspect of the base of the skull



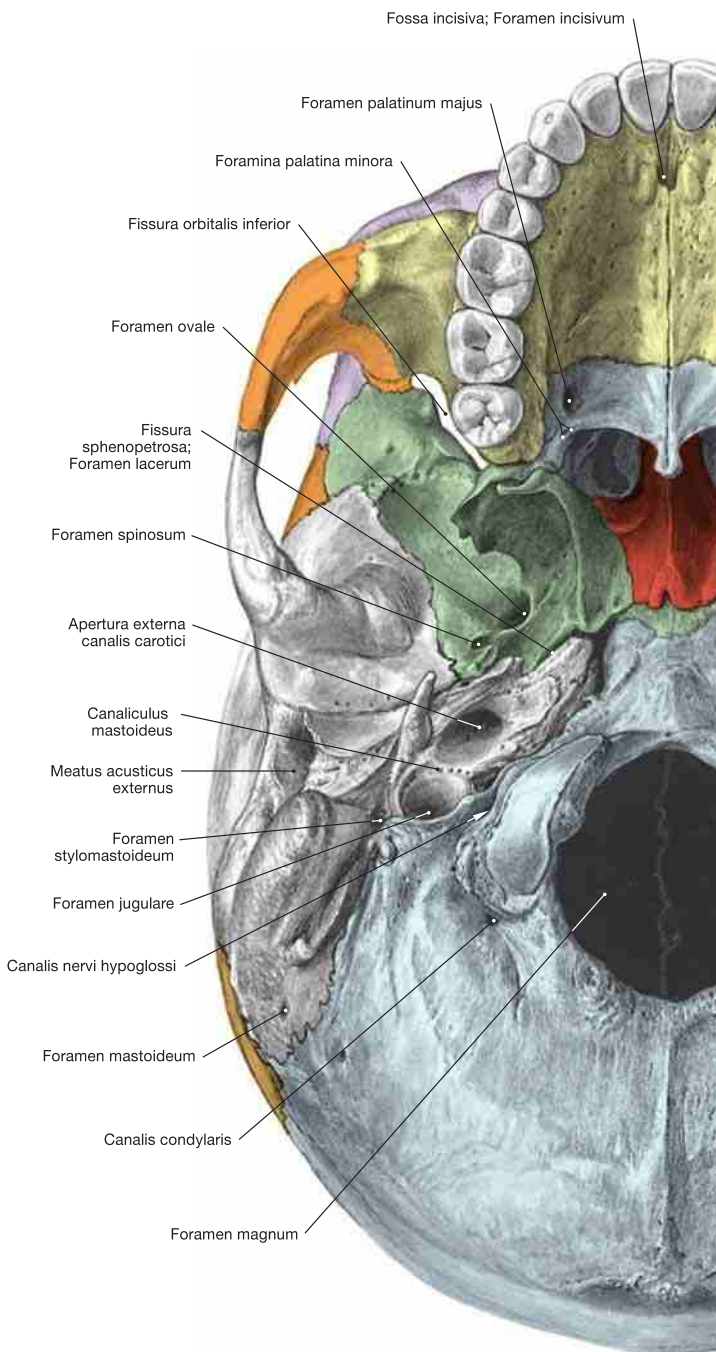
**Fig. 8.15 Outer aspect of the base of the skull, Basis cranii externa; inferior view.**

**Middle cranial base** (continuation of → Fig. 8.14): The Sulcus tubae auditivae is positioned at the border between The Ala major of the Os sphenoidale and the Pars petrosa of the Os temporale and represents the entrance into the bony part of the Tuba auditiva (→ p. 145). The bony canal continues through the Pars petrosa of the Os temporale to the tympanic cavity. Located laterally is the Pars squamosa of the Os temporale which is involved in the formation of the temporomandibular joint (Articulatio temporomandibularis). The Fossa mandibularis is part of the articular surface of the temporomandibular joint (→ pp. 36–39).

The Tuberculum articulare is located at the anterior margin of the Fossa mandibularis.

**Posterior cranial base:** The posterior compartment extends from the anterior margin of the Foramen magnum to the Lineae nuchales superiores and consists of parts of the Os occipitale and Ossa temporalia. Each of the paired Pars lateralis possesses a Condylus occipitalis for the articulation with the Atlas. Located behind the condyle is the Fossa condylaris, which contains the Canalis condylaris; anterior to the condyle the Canalis nervi hypoglossi is situated. Immediately lateral thereof lies the Foramen jugulare.

## Foramina of the outer base of the skull



**Fig. 8.16** Outer aspect of the base of the skull, *Basis cranii externa*, with Foramina; inferior view; colour chart see inside of the back cover of this volume.

### Clinical Remarks

In **basilar skull fractures** the fracture lines traverse the openings at the base of the skull. Thus, blood vessels and nerves passing through these openings can be injured with resulting nerve palsies and bleedings as frequent complications. In addition, basilar skull fractures can involve the frontal, sphenoidal, and ethmoidal sinuses (cerebrospinal fluid [CSF] and/or blood exiting through the nose). Lateral basilar skull fractures often involve the petrous bone (CSF exiting from the outer ear canal).

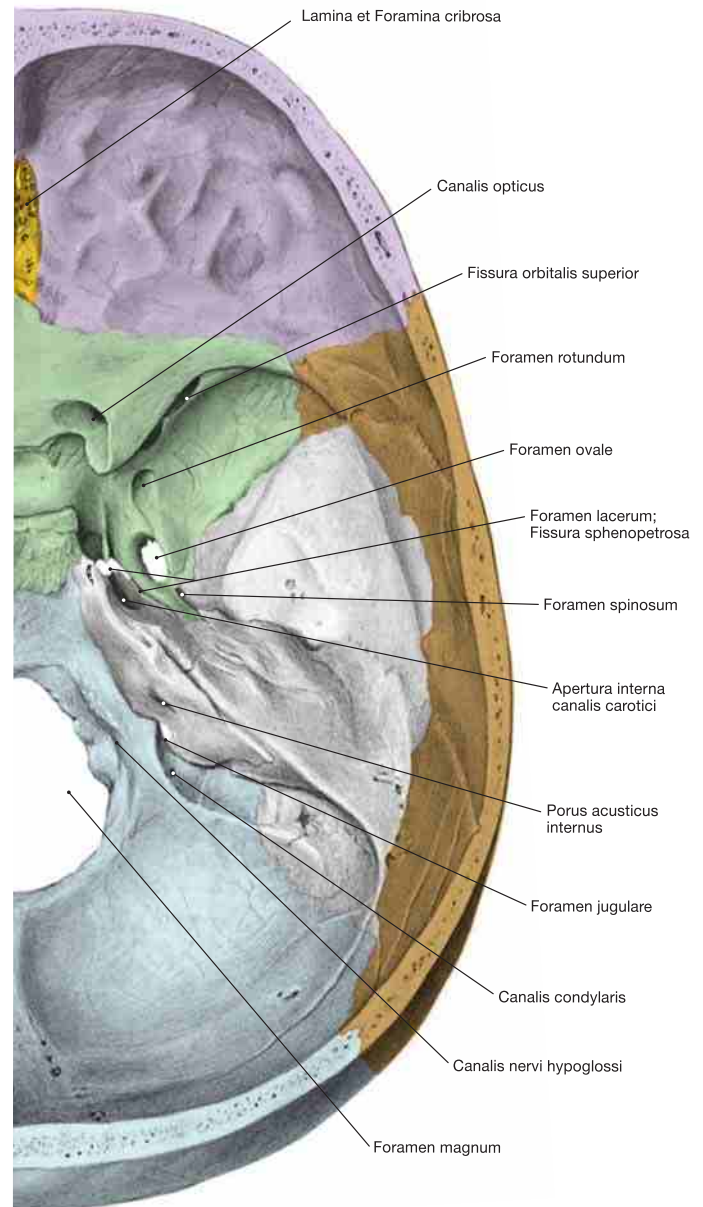
### Foramina of the Outer Base of the Skull and their Content

Foramina	Content
<b>Foramen incisivum</b>	<ul style="list-style-type: none"> <li>N. nasopalatinus (N. maxillaris [V/2])</li> </ul>
<b>Foramen palatinum majus</b>	<ul style="list-style-type: none"> <li>N. palatinus major (N. maxillaris [V/2])</li> <li>A. palatina major (A. palatina descendens)</li> </ul>
<b>Foramina palatina minora</b>	<ul style="list-style-type: none"> <li>Nn. palatini minores (N. maxillaris [V/2])</li> <li>Aa. palatinae minores (A. palatina descendens)</li> </ul>
<b>Fissura orbitalis inferior</b>	<ul style="list-style-type: none"> <li>A. infraorbitalis (A. maxillaris)</li> <li>V. ophthalmica inferior</li> <li>N. infraorbitalis (N. maxillaris [V/2])</li> <li>N. zygomaticus (N. maxillaris [V/2])</li> </ul>
<b>Foramen rotundum</b> (→ p. 12)	<ul style="list-style-type: none"> <li>N. maxillaris [V/2]</li> </ul>
<b>Foramen ovale</b>	<ul style="list-style-type: none"> <li>N. mandibularis [V/3]</li> <li>Plexus venosus foraminis ovalis</li> </ul>
<b>Foramen spinosum</b>	<ul style="list-style-type: none"> <li>R. meningeus (N. mandibularis [V/3])</li> <li>A. meningea media (A. maxillaris)</li> </ul>
<b>Fissura sphenopetrosa, Foramen lacerum</b>	<ul style="list-style-type: none"> <li>N. petrosus minor (N. glossopharyngeus [IX])</li> <li>N. petrosus major (N. facialis [VII])</li> <li>N. petrosus profundus (Plexus caroticus internus)</li> </ul>
<b>Apertura externa canalis carotici and Canalis carotici</b>	<ul style="list-style-type: none"> <li>A. carotis interna, Pars petrosa</li> <li>Plexus venosus caroticus internus</li> <li>Plexus caroticus internus (Truncus sympathicus, Ganglion cervicale superius)</li> </ul>
<b>Foramen stylo-mastoideum</b>	<ul style="list-style-type: none"> <li>N. facialis [VII]</li> </ul>
<b>Foramen jugulare</b>	<p>anterior part:</p> <ul style="list-style-type: none"> <li>Sinus petrosus inferior</li> <li>N. glossopharyngeus [IX]</li> </ul> <p>posterior part:</p> <ul style="list-style-type: none"> <li>A. meningea posterior (A. pharyngea ascendens)</li> <li>Sinus sigmoideus (Bulbus superior venae jugularis)</li> <li>N. vagus [X]</li> <li>R. meningeus (N. vagus [X])</li> <li>N. accessorius [XI]</li> </ul>
<b>Canaliculus mastoideus</b>	<ul style="list-style-type: none"> <li>R. auricularis nervi vagi (N. vagus [X])</li> </ul>
<b>Canalis nervi hypoglossi</b>	<ul style="list-style-type: none"> <li>N. hypoglossus [XII]</li> <li>Plexus venosus canalis nervi hypoglossi</li> </ul>
<b>Canalis condylaris</b>	<ul style="list-style-type: none"> <li>V. emissaria condylaris</li> </ul>
<b>Foramen magnum</b>	<ul style="list-style-type: none"> <li>Meninges</li> <li>Plexus venosus vertebralis internus (Sinus marginalis)</li> <li>Aa. vertebrales (Aa. subclaviae)</li> <li>A. spinalis anterior (Aa. vertebrales)</li> <li>Medulla oblongata/Medulla spinalis</li> <li>Radices spinales (N. accessorius [XI])</li> </ul>



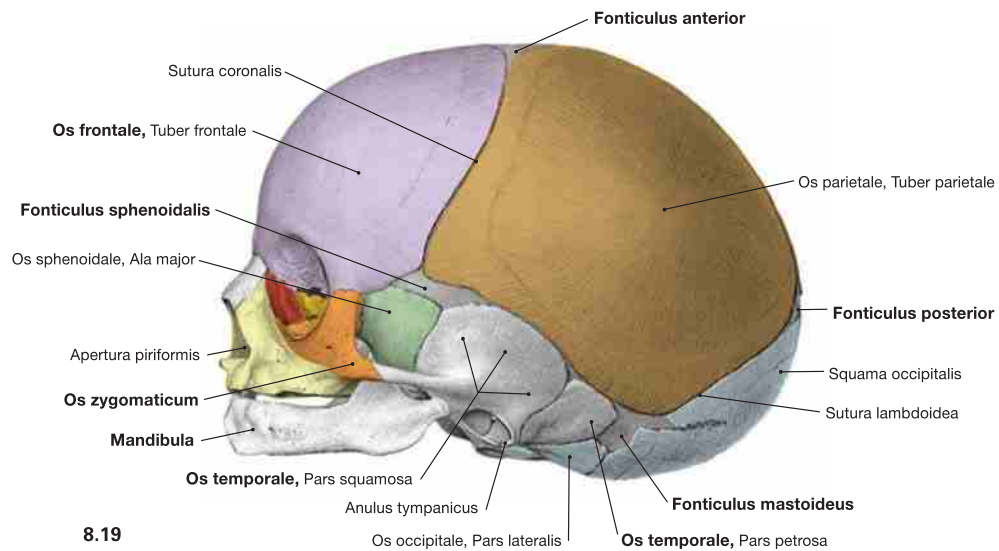
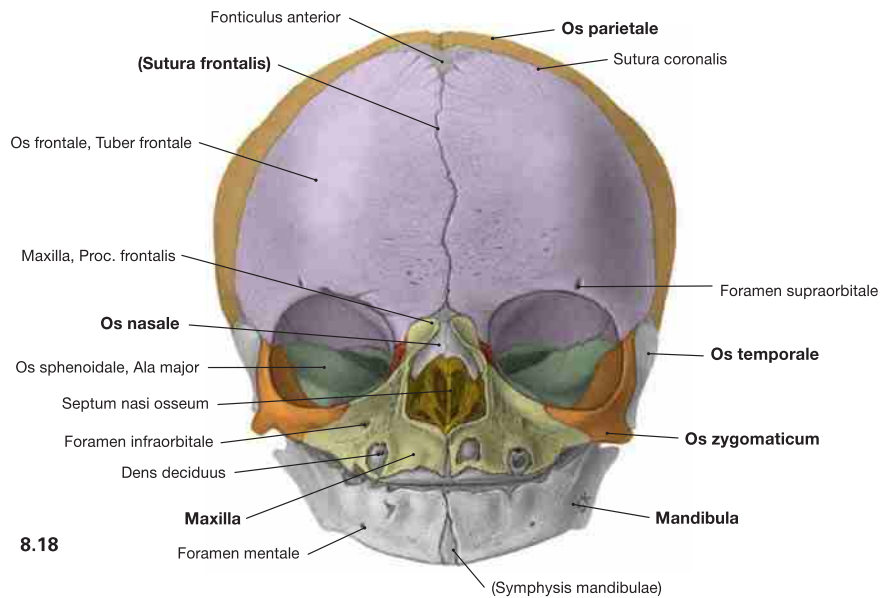
Foramina of the inner base of the skull

Foramina of the Inner Aspect of the Base of the Skull and their Content	
Foramina	Content
<b>Lamina cribrosa</b>	<ul style="list-style-type: none"> <li>Nn. olfactorii [I]</li> <li>A. ethmoidalis anterior (A. ophthalmica)</li> </ul>
<b>Canalis opticus</b>	<ul style="list-style-type: none"> <li>N. opticus [II]</li> <li>A. ophthalmica (A. carotis interna)</li> <li>Meninges; Vaginae nervi optici</li> </ul>
<b>Fissura orbitalis superior</b>	middle part: <ul style="list-style-type: none"> <li>N. nasociliaris (N. ophthalmicus [V/1])</li> <li>N. oculomotorius [III]</li> <li>N. abducens [VI]</li> </ul> lateral part: <ul style="list-style-type: none"> <li>N. trochlearis [IV]</li> </ul> mutual origin of: <ul style="list-style-type: none"> <li>N. frontalis (N. ophthalmicus [V/1])</li> <li>N. lacrimalis (N. ophthalmicus [V/1])</li> </ul> <ul style="list-style-type: none"> <li>R. orbitalis (A. meningea media)</li> <li>V. ophthalmica superior</li> </ul>
<b>Foramen rotundum</b>	<ul style="list-style-type: none"> <li>N. maxillaris [V/2]</li> </ul>
<b>Foramen ovale</b>	<ul style="list-style-type: none"> <li>N. mandibularis [V/3]</li> <li>Plexus venosus foraminis ovalis</li> </ul>
<b>Foramen spinosum</b>	<ul style="list-style-type: none"> <li>R. meningeus (N. mandibularis [V/3])</li> <li>A. meningea media (A. maxillaris)</li> </ul>
<b>Fissura sphenopetrosa, Foramen lacerum</b>	<ul style="list-style-type: none"> <li>N. petrosus minor (N. glossopharyngeus [IX])</li> <li>N. petrosus major (N. facialis [VII])</li> <li>N. petrosus profundus (Plexus caroticus internus)</li> </ul>
<b>Apertura interna canalis carotici and Canalis caroticus</b>	<ul style="list-style-type: none"> <li>A. carotis interna, Pars petrosa</li> <li>Plexus venosus caroticus internus</li> <li>Plexus caroticus internus (Truncus sympathicus, Ganglion cervicale superius)</li> </ul>
<b>Porus and Meatus acusticus internus</b>	<ul style="list-style-type: none"> <li>N. facialis [VII]</li> <li>N. vestibulocochlearis [VIII]</li> <li>A. labyrinthi (A. basilaris)</li> <li>Vv. labyrinthi</li> </ul>
<b>Foramen jugulare</b>	anterior part: <ul style="list-style-type: none"> <li>Sinus petrosus inferior</li> <li>N. glossopharyngeus [IX]</li> </ul> posterior part: <ul style="list-style-type: none"> <li>A. meningea posterior (A. pharyngea ascendens)</li> <li>Sinus sigmoideus (Bulbus superior venae jugularis)</li> <li>N. vagus [X]</li> <li>N. accessorius [XI]</li> <li>R. meningeus (N. vagus [X])</li> </ul>
<b>Canalis nervi hypoglossi</b>	<ul style="list-style-type: none"> <li>N. hypoglossus [XII]</li> <li>Plexus venosus canalis nervi hypoglossi</li> </ul>
<b>Canalis condylaris</b>	<ul style="list-style-type: none"> <li>V. emissaria condylaris</li> </ul>
<b>Foramen magnum</b>	<ul style="list-style-type: none"> <li>Meninges</li> <li>Plexus venosus vertebralis internus (Sinus marginalis)</li> <li>Aa. vertebrales (Aa. subclaviae)</li> <li>A. spinalis anterior (Aa. vertebrales)</li> <li>Medulla oblongata/Medulla spinalis</li> <li>Radices spinales (N. accessorius [XI])</li> </ul>



**Fig. 8.17 Inner aspect of the base of the skull, Basis cranii externa, with Foramina;** superior view; colour chart see inside of the back cover of this volume.

## Development of the skull



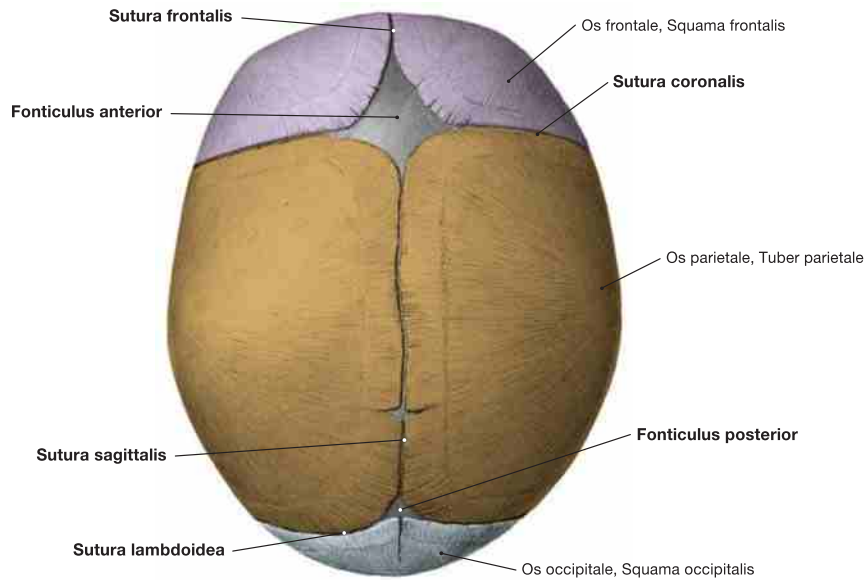
**Fig. 8.18 and Fig. 8.19** Skull, Cranium, of a newborn; frontal (→ Fig. 8.18) and lateral (→ Fig. 8.19) views; colour chart see inside of the back cover of this volume.

At birth, the newborn has six fontanelles, two unpaired (Fonticuli anterior and posterior) and two paired (Fonticuli sphenoidales and mastoidei). During **delivery**, sutures and fontanelles serve as reference structures to assess the location and position of the foetal head. Shortly

before birth, the Fonticulus posterior becomes the leading part of the head in the case of a normal cephalic presentation.

In concert with the sutures (Suturae), the fontanelles allow a limited deformation of the foetal skull during delivery. The remarkable postnatal growth results in the fontanelles becoming rapidly smaller, and complete closure will occur by the end of the third year of life.

Development of the skull

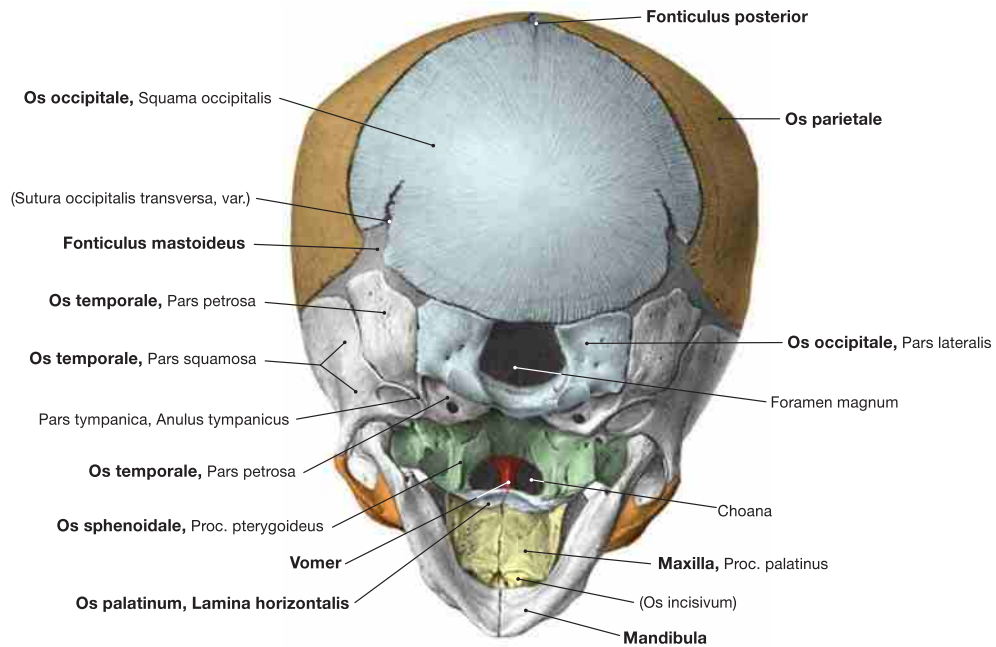


**Fig. 8.20 Skull, Cranium, of a newborn;** superior view; colour chart see inside of the back cover of this volume.  
 At birth, the bony plates of the skull cap (Calvaria) are still separated by the interstitial tissue located in the cranial sutures. The sutures are widened to fontanelles (Fonticuli) in regions where more than two bones meet. During life, most sutures, fontanelles (Fonticuli), and

synchondroses ossify. Important sutures include the Suturae lambdoidea (**lambdoid suture**), frontalis (**frontal suture**), sagittalis (**sagittal suture**), and coronalis (**coronal suture**) which gradually fuse up to about 50 years of age (the frontal suture already between the first and second year of life).

Fontanelles		
Fontanelle	Number	Closure [month of life]
Fonticulus anterior (large fontanelle)	1	approx. 36
Fonticulus posterior (small fontanelle)	1	approx. 3
Fonticulus sphenoidalis (anterior lateral fontanelle)	paired	approx. 6
Fonticulus mastoideus (posterior lateral fontanelle)	paired	approx. 18

## Development of the skull



**Fig. 8.21 Skull, Cranium, of a newborn;** posterior inferior view; colour chart see inside of the back cover of this volume. The development of the skull involves a desmal and an enchondral ossification mode (→ table). The mesenchyme of the head is the pri-

mordial building material that derives from the prechordal mesoderm, the occipital somites, and the neural crest. At the time of birth, some cranial bones are linked by cartilaginous joints (Articulationes cartilagineae; Synchrondroses cranii).

Ossification Mode of the Skull Bones			
	Viscerocranium	Neurocranium	Ossicles
<b>Desmal</b>	Mandibula except for Proc. condylaris, Maxilla, Os zygomaticum, Os palatinum, Os nasale, Vomer, Os lacrimale	Lamina medialis of the Proc. pterygoideus of the Os sphenoidale, Pars squamosa of the Os temporale, Squama occipitalis, Os frontale, Os parietale	
<b>Chondral</b>	Proc. condylaris of the Mandibula, Os ethmoidale, Concha nasalis inferior	Os sphenoidale except for Lamina medialis of the Proc. pterygoideus, Pars petrosa and Pars tympanica of the Os temporale, Pars lateralis and Pars basilaris of the Os occipitale	
<b>MECKEL's cartilage</b>			Malleus, Incus
<b>REICHERT's cartilage</b>		Proc. styloideus of the Os temporale	Stapes