

## 1. SKELETON OF HEAD (SKULL)

### CRANIUM

Skull serves as compact, and at the same time as a flexible box for the brain and sensual organs, which the skull protects. Skull of a human consists of 22 bones, from which is 21 bones joined together, so that they can be separated only with great difficulty. Only mandibula is joined with remaining bones by articulation. Eight skull bones are unpaired, and five of them are paired. Skull bones are of various shapes, they consist of flat bones, pneumatic bones and irregular bones. Most flat skull bones (or their parts), border various holes and excavations, where the brain (together with its meninges), important sensual organs, head parts of gastrointestinal and respiratory tract are located. On skull bones, there are also many openings, holes and channels, through which many blood vessels and nerves run. Usually we divide the skull into two segments – neurocranium (cranial part) and splanchnocranium (facial part). Marginal line between neurocranium and splanchnocranium runs approximately from orbital roof in direction towards meatus acusticus externus osseus.

**Neurocranial skull bones**, collectively called neurocranium, encircling the skull cavity (cavitas seu cavum cranii), represent solid protection for the brain. A vestibulo-auditory apparatus is located here. The upper part of neurocranium is called vault of cranium (calvaria cranii), lower part of neurocranium creates skull basis (basis cranii). Neurocranium is constructed from four unpaired bones (os occipitale – occipital bone, os sphenoidale – sphenoid bone, os frontale – frontal bone) and two paired bones (os parietale – parietal bone and os temporale – temporal bone).

**Splanchnocranial skull bones**, collectively called viscerocranium (splanchnocranium), together with some neurocranial bone compartments encircle cavities, in which visual and olfactory apparatus, apparatus of respiratory and gastrointestinal system are located (demarcate the orbits, the nasal cavity and incompletely also the oral cavity). Viscerocranial part of skull is formed by sixteen bones, from which: upper jaw (maxilla), nasal bone (os nasale), lachrymal bone (os lacrimale), facial bone (os zygomaticum), palatum bone (os palatinum) and lower nasal concha (concha nasalis inferior) are paired, ethmoid bone (os ethmoidale), vomer (vomer), lower jaw, mandible, mandibula and hyoid bone (os hyoideum) are unpaired bones.

## Occipital bone – Os occipitale

Os occipitale creates the basis of occiput, and serves for insertion of nuchal muscles. It consists of three parts.

**Pars basilaris ossis occipitalis** (basal part) connects occipital bone ventrally with os sphenoidale. On intracranial plane there is a shallow pit – clivus, on which a brain stem lies. From external side, there is a tubercle on the basal part – tuberculum pharyngeum. In adult humans ventrally from this formation, on the interface of occipital and sphenoid bone, there is synostosis sphenoccipitalis, a fissure, which is during growth period (about 20 years) filled in with cartilage – synchondrosis sphenoccipitalis.

**Partes laterales ossis occipitalis** (lateral parts), where condyli occipitales for joining with atlas are apparent. Above each condyle there is canalis hypoglossi for penetration of XII. brain nerve. Just behind condyle are fossa condylaris and canalis condylaris. Laterally from condyles, there is an incisure – incisura jugularis, which together with similar incisure on temporal bone create foramen jugulare. This opening serves for penetration of vena jugularis interna and some of head nerves.

**Squama occipitalis** (occipital squama) – from external side there are lines for attachment of nuchal muscles – protuberantia occipitalis externa, crista occipitalis externa, linea nuchae suprema, linea nuchae superior and linea nuchae inferior. Inner side of occipital squama is deepened into fossae for brain occipital lobes – fossae cerebrales and fossae for cerebellar hemispheres – fossae cerebellares. These holes (fossae) are separated by transversal running of sulcus sinus transversi. In the middle plane there is crista occipitalis interna. From parietal bones, groove for attachment a venous sinus – sulcus sinus sagittalis superioris reaches here – in site of its crossing with sulcus sinus transversi, protuberantia occipitalis interna is vaulting inwards, and both connecting structures together create eminentia cruciformis. Squama occipitalis and partes laterales encircle a big occipital foramen – foramen magnum.

## Sphenoid bone – Os sphenoidale

Sphenoid bone is „sphenoidly inserted” into the middle of skull basis, and is in tight contact with almost all skull bones. It consists of four parts: body (corpus), greater wings (alae majores), lesser wings (alae minores) and pterygoideal processus (processus pterygoidei).

**Corpus** is of approximately cuboidal form. It includes paired sinus (sinus sphenoidalis),

volume of this sinus is quite variable. Sinus sphenoidalis is divided by osseous septum (septum sinuum sphenoidalium) into two compartments. From the frontal side of corpus, which is connected with ethmoidal bone, a margin protrudes - crista sphenoidalis, which is grown together with lamina perpendicularis ossis ethmoidalis. On the lower part of body, there is a sharp margin (rostrum sphenoidale); alae vomeris are adjoining rostrum (for detailed description, see vomer). Frontal wall of sphenoid sinus is created by relatively thin concha sphenoidalis, separating sinus from the nasal cavity. Sinuses lead into the nasal cavity through two aperturae sinus sphenoidalis. Cranial side of corpus ossis sphenoidalis is inverted into the skull cavity. Frontal side is connected with lamina cribrosa ossis ethmoidalis in sutura sphenoethmoidalis. In vicinity there is a relative shallow groove (sulcus praechiasmaticus), where crossing of optical nerves (chiasma nervorum opticorum) lies. Formations of cranial side, conditioned by location of hypophysis is found dorsally from here. They remind us a turkey saddle (sella turcica). Frontally, in middle plane, there is an apparent tubercle (tuberculum sellae), which is laterally (along sides) elongated into a short paired projection (processus clinoides medius). Cranial wall is deepened into fossa (fossa hypophysialis), in which hypophysis is located. Dorsal side of fossa hypophysialis is formed by a pronounced edge (dorsum sellae), which protrudes laterally into two projections (processus clinoides posteriores). Behind dorsum sellae, corpus ossis sphenoidalis is smooth and it's declining dorsocaudally and together with pars basilaris ossis occipitalis are grown together. On their common dorsal side they create clivus. On both lateral sides of sella turcica there is a pronounced groove (sulcus caroticus). This sulcus is dorsolaterally defined by a small osseous lingular process (lingula sphenoidalis).

**Alae minores** come off from the sphenoid bone dorsally. Alae minores are relatively thin triangular plates; dorsomedially protrudes into processus clinoides anterior. Medial edge of alae minores is grown together with corpus ossis sphenoidalis, their frontal margin is medially connected with lamina cribrosa ossis ethmoidalis in sutura sphenoethmoidalis, lateral are grown together with pars orbitalis ossis frontalis in sutura sphenofrontalis. Dorsolateral margin is free. Free dorsolateral margin together with free edge of facies orbitalis alae majoris define a significant fissure, fissura orbitalis superior, which leads from skull cavity directly into the eye socket. Canalis opticus runs through the site of division alae minores from corpus ossis sphenoidalis

**Alae majores** are bigger and more structured than alae minores. Their division from corpus has a relative wide basis, and forms a disk, inverted by its concavity into the skull cavity.

Dorsomedially, ala major approaches the anterior margin of pyramis ossis temporalis. Both bones (os temporale, os sphenoidale) are not fully connecting here, but a narrow fissura (fissura sphenopetrosa) exists between them. Ventromedially it proceeds in foramen lacerum. On non macerated skull, it is filled by fibrous cartilage, forming synchondrosis sphenopetrosa. Foramen lacerum is filled by fibrocartilago basialis. Alae majores, together with adjacent bones, define two fissures. Ventromedially, together with dorsal margin of ala minor, it forms a fissure (fissura orbitalis superior) (see description of ala minor). Ventrocaudally, together with facies orbitalis maxillae, it forms another fissure (fissura orbitalis inferior), connecting orbita with fossa pterygopalatina.

On ala major we distinguish five surfaces:

- facies interna (*cerebralis*) is concave and inverted into the skull cavity. It has an apparent impressions of cerebral folds (impressiones gyrorum), impressions of branches of meningeal arteries (sulci arteriosi) and projections (juga cerebralia), which are being inserting into cerebral fissures.
- facies ventrokranialis (*orbitalis*) is flat and approximately quadrangular. It is inverted into orbita and forms a significant part of its lateral side.
- facies ventrocaudalis (*facies maxillaris*) is basically a rounded area of relatively small size. It defines fossa pterygopalatina from above (cranially). Foramen rotundum ends in here.
- facies laterocranialis (*temporalis*) is inverted into fossa temporalis.
- facies laterocaudalis (*infratemporalis*) is inverted into fossa infratemporalis. Marginal line between facies temporalis and infratemporalis is an obvious edge (crista infratemporalis). From the dorsal corner of facies infratemporalis, there is a thorn (spina ossis sphenoidalis) running off, from which lig. sphenomandibulare runs off.

In ala major we find three significantl openings:

1. *foramen rotundum*, lies anteriorly at the division of ala major from corpus ossis sphenoidalis. It opens on facies maxillaris in fossa pterygopalatina
2. *foramen ovale* lies dorsolaterally from foramen rotundum. Its orificium is on estuary of facies infratemporalis into fossa infratemporalis
3. *foramen spinosum* lies even more dorsolaterally, in narrow vicinity of spina ossis sphenoidalis. It also leads into fossa infratemporalis

**Processus pterygoideus** is a paired projection, originating in the site of connection of corpus

ossis sphenoidalis and ala major. It is oriented caudally. In the site of its division, a canal (canalis pterygoideus), which orifice ends into fossa pterygopalatina, penetrates through the bone from front to back. Processus pterygoideus consists of two lamellas, wide lamina lateralis and narrow lamina medialis. Anterior margins of both lamellas meet together in a sharp angle, opened into dorsal direction. A relatively spacious fossa; fossa pterygoidea arises, between both lamellas. Lower ends of both lamellas are separated by significant notch (incisura pterygoidea), into this notch processus pyramidalis ossis palatini is inserted. Dorsocranial edge of lamina medialis, in site division from body, is enlarged into longitudinal fossa, fossa scaphoidea. Lower end of lamina medialis is curved into a hook, and it is called hamulus pterygoideus. Anterior margin of processus pterygoideus, where both lamellas are connected, are leaning onto the maxilla and palatal bone. On this margin, sulcus pterygopalatinus runs in craniocaudal direction, which on the dorsal side of maxilla, together with sulcus pterygopalatinus ossis palatini forms a little canal (canalis palatinus major).

### **Frontal bone – Os frontale**

Os frontale forms the major background of frons and of orbital roof. It consists of three parts.

**Squama frontalis** (frontal squame) has frontal tubers (tubera frontalia) from the external side. On superior orbital margin (margo orbitalis superior, margo supraorbitalis), there is medially incisura frontalis or foramen frontale, laterally incisura supraorbitalis resp. foramen supraorbitale. Above these formations, there are supraorbital arches (arcus superciliares). Between both of them, in the middle plane there is significant anthropometrical point – glabella. Faciens endocranialis (facies interna) is concave. In the middle plane, there is a vertical sulcus sinus sagittalis superioris running from above. The sulcus arrives here from parietal bones. On fissural sides small cavities are present (foveolae granulares). Frontally sulcus sinus sagittalis superioris runs through the edge (crista frontalis). Crista frontalis is frontally terminated by a blind foramen (foramen caecum). Analogically as on the endocranial plane of other neurocranial bones, impressiones gyrorum, juga cerebrialia and sulci arteriosi are also present here.

**Pars orbitalis** (orbital part) is paired, forms the frontal part of orbital roof. On lateral part of orbital roof, there is a shallow fossa for lacrimal gland – fossa glandulae lacrimalis, on medial side, there is fovea – fovea trochlearis – where cartilaginous trochlea is fixated. In frontoethmoidal suture, on medial orbital side, foramen ethmoidale anterius and foramen ethmoidale posterius are opening.

**Pars nasalis** (nasal part) is U-shaped, and is connected with os ethmoidale, ossa nasalia and maxilla. Inside, there is a paired frontal sinus (sinus frontalis) divided by septum sinuum frontaliu into two, mostly asymmetrical spaces. Ostium sinus frontalis ends into apertura sinus frontalis into nasal cavity.

Ossification:

The bone is originally paired; sutura frontalis between the right and the left part ceases to exist within about the first two years of age. In case it persists into adulthood, we call it sutura metopica. Sutura metopica occurs about in 8% of our population.

### **Parietal bone – Os parietale**

Os parietale, paired bone, forms the main part of vault of cranium. Ventrally, both parietal bones are connected with frontal bone, through sutura coronalis, dorsally with occipital bone through sutura lambdoidea, and laterocaudally with temporal bones (sutura squamosa). Both parietal bones are connected through sutura sagittalis. In its vicinity, in the dorsal third, there is a variable foramen parietale. Sometimes this foramen can reach enormous size. On the external surface are, predominantly in women and children, apparent tubera parietalia (centers of bone ossification), laterally there are two rough lines running for the attachment of fascia and muscle bundles of temporal muscle (linea temporalis superior et inferior). On endocranial plane of sagittal suture there is an apparent part of sulcus sinus sagittalis superioris for equally named venous sinus. Laterally from here in lamina interna, small foveolae granulares often occur. Sulci arteriae meningeae mediae originate on frontal inferior angle. In the area of angulus mastoideus a deep sulcus, sulcus sinus sigmoidei, is on endocranial plane. It is continuation of sulcus sinus transversi on squama occipitalis, and it turns on the temporal bone. It is designed for venous sinus.

### **Temporal bone – Os temporale**

Os temporale is paired bone, lying dorsolaterally from sphenoidal bone, and dorsally from pars basilaris ossis occipitalis. It participates on the structure of the middle compartment of skull basis, and forms lateral parts of vault of cranium (calvaria cranii). Naturally, it is bone of a very complicated structure, where inner ear is embedded, and in addition to that many

significant canals and foramina run through here. Temporal bone consists of some originally independent bones, which are aggregated around foramen acusticum externum. Squama temporalis (pars squamosa) lies over this meatus. Behind it and partly below it there is pars mastoidea. Pars petrosa is located ventromedially, pars tympanica in front of it, and finally below to pars petrosa - pars hyoidea is attached, represented by processus styloideus.

### **Pars petrosa (pyramis)**

Is formed by triquetral pyramid, inserted between occipital and sphenoidal bone – pyramis ossis temporalis. It is very massive and it forms a capsula for the middle and inner ear. Pyramis has four walls; its apex is oriented ventromedially.

- *Facies anterior pyramidis* is converted into fossa cranii media. At pyramidal apex (apex pyramidis), there is a shallow pit for ganglion nervi trigemini – impressio trigemini. Approximately in the middle of the frontal plane, there are two parallel running notches and openings (sulcus n. petrosi majoris et minoris) arising from hiatus canalis nervi petrosi majoris et minoris. In the dorsal part there is a projection – eminentia arcuata, laterally there is a thin roof of cavum tympani (tegmen tympani). At apex there is an internal aperture for canalis caroticus opening (apertura interna canalis carotici).
- *Facies posterior pyramidis* is situated nearly vertically, and is directed into fossa cranii posterior. From the anterior plane of the pyramis, it is separated by distinct margin, margo superior pyramidis, on which sulcus sinus petrosi superioris runs. The most apparent formation here is the internal auditory entrance (porus acusticus internus), which proceeds as a blind canal – meatus acusticus internus. Its basis is called fundus meatus acustici interni. Fundus is divided by a horizontal margin – crista transversa into cranial and caudal half, when in cranial ventral quadrant there is an entry into canalis nervi facialis. Dorsally from porus acusticus internus, in apertura externa aquaeductus vestibuli. Dorsally in tight vicinity there is a little depression – fossa subarcuata. At caudal margin of pyramis, there is sulcus sinus petrosi inferioris for sinus venosus. Below porus acusticus internus there is apertura externa canaliculi cochleae. Incisura jugularis is also located here, which together with incisura jugularis ossis occipitalis form foramen jugulare.
- *Facies inferior pyramidis* is turned over onto basis cranii externa. Approximately in middle of the plane, there is a little oval opening – apertura externa canalis carotici. Fossa jugularis is located dorsally, on its anterior part there is an entry into canaliculus mastoideus. At interface of both great openings (apertura externa canalis carotici and

foramen jugulare) there is fossula petrosa, into which apertura externa canaliculi tympanici is opening.

- Facies ventrobasis (base of pyramis) is visible only after removing pars tympanica ossis temporalis, and this relatively complicated wall will be studied together with other structures of auditory apparatus.

### **Pars squamosa**

From a part of squama ossis temporalis processus zygomaticus protrudes ventrally, which after sutural connection with processus zygomaticus ossis zygomatici forms arcus zygomaticus. Below the origin of processus zygomaticus, there is a fossa for articulation with caput mandibulae (fossa mandibularis). Its anterior edge forms a transversal ridge tuberculum articulare.

### **Pars mastoidea**

is dorsally linked to pars squamosa. Dorsal margin, margo occipitalis, is connected to squama occipitalis (sutura occipitomastoidea). Inside of this suture, or ventrally from it, there is foramen mastoideum, through which venous sinus runs. Margo tympanicus is attached to pars tympanica into the anterior margin, both parts are together separated by a narrow fissure, fissura tympanomastoidea, in which canaliculus mastoideus leads. Main part of pars mastoidea is bulky conical processus mastoideus, descending caudally serving for attachment of cervical muscles. On the medial side of processus mastoideus there are two incisures: deeper incisura mastoidea (origin of venter posterior m. digastrici) and laterally from it there is a shallower sulcus arteriae occipitalis. Processus mastoideus belongs to pneumatic bones; because it contains many small cavities (cellulae mastoideae). Processus mastoideus starts to develop only after birth; it is only outlined on the skull of a newborn. Bone pneumatization starts in childhood. On the inner plane of pars mastoidea there is an apparent formation, deep notch, sulcus sinus sigmoidei. It represents a continuation of sulcus sinus transversi on oss occipitale, and is directed into foramen jugulare.

### **Pars tympanica**

is slim, conical, and convoluted plate, attached to pars petrosa and pars squamosa ossis temporalis. For the most part it encircles the external auditory canal, and helps to close up cavum tympani (it has frontal and dorsal lamella, connecting caudally together). Cranial part of this cone is not closed (incisura tympanica). Medially it creates a circular sulcus (sulcus tympanicus), into which the ear drum (membrana tympani) is inserted. Cranial margin of pars



tympanica is directed against petrosal bone, and it is separated from it by two fissures – fissura petrotympanica medially and fissura petrosquamosa laterally.

### **Pars hyoidea**

Processus styloideus serving as place of origin of some ligaments and muscles. Its length can go up to 5 cm. From there, some ligaments and muscles begin. Dorsally from this process, there is an opening – foramen stylomastoideum, in which canalis n. facialis enters the skull surface.

### Canals in os temporale

1. **Canalis caroticus.** Canalis caroticus is of an inverted J-shape. It starts on facies inferior pyramidis as apertura externa canalis carotici and terminates on apex pyramidis in apertura interna canalis carotici.
2. **Canalis nervi facialis** – small canal that has a relatively complicated course. We distinguish three main divisions. It starts in area nervi facialis in fundus meatus acustici interni and at the beginning it runs in ventrolateral direction, which means it runs in horizontal plane in right angle to the longitudinal axis of pyramis, up until hiatus canalis nervi petrosi majoris on anterior plane of pyramis (the 1st. section ). Here the canal suddenly breaks, and changes its direction in a way, that it now runs dorsolaterally, and parallelly with longitudinal axis of pyramis, on medial side of cavum tympani, where his run causes a projection, prominentia canalis facialis (the 2nd section). Last, third section of the course: canaliculus descends caudally on dorsal side of cavum tympani, and leads into skull surface, on inferior plane of pyramis, in foramen stylomastoideum.
3. **Canaliculus chordae tympani** arises from the III. section of canalis n. facialis and runs from the skull through fissura petrotympanica into fossa infratemporalis.
4. **Canalis musculotubarius** – begins on external side of the skull basis in incision between pyramis and squama temporalis, at frontal end of fissura petrosquamosa, and runs from here into the middle ear cavity. Horizontally directed osseous septum divides and separates it into cranial and caudal section.
5. **Canaliculus mastoideus** – starts on anterior side of fossa jugularis, and leaves from skull through fissura tympanomastoidea.
6. **Canaliculus tympanicus** – starts on facies inferior pyramidis (apertura externa canaliculi

tympanici) and comes into middle ear cavity in fossula petrosa.

7. **Canaliculus (aqueductus) vestibuli.** It opens up in the inner ear, and leaves through apertura externa aqueductus vestibuli on facies posterior pyramidis.
8. **Canaliculus cochleae.** It begins in the inner ear, and leaves through apertura externa canaliculi cochleae below porus acusticus internus on crista inferior pyramidis.

## Upper jaw – Maxilla

Maxilla is osseous basis of ventral part of the face. It consists of maxillar body (corpus maxillae), from which four processes protrude (processus frontalis, zygomaticus, palatinus et alveolaris).

**Corpus maxillae.** We distinguish four planes on maxillar body:

- *Facies orbitalis maxillae* forms (together with facies orbitalis ossis zygomatici) an orbital floor. Here is the beginning of sulcus infraorbitalis, which is deepened into canalis infraorbitalis, its opening is on the anterior plane of the bone.
- *Facies anterior* – on facies anterior there is the foramen of mentioned canalis infraorbitalis in foramen infraorbitale. In the course of canalis infraorbitalis, canales alveolares anteriores with neurovascular bundles divide themselves in the direction towards the roots of anterior teeth. Over root canine there is a variously deep fossa – fossa canina. Facies anterior is dorsally terminated by a round margin – crista infrazygomatica, which is proceeding from the margo processus zygomatici into alveolus of the 1st molar. Facies anterior is medially terminated with a sharp edge – incisura nasalis, which together with incisura nasalis of contralateral bone demarcates the entry into the nasal cavity (apertura piriformis nasi) and in the middle line (over incisor roots) protrudes into a short thorn – spina nasalis anterior.
- *Facies infratemporalis.* There is an apparent tuber maxillae, on it there are small canals, leading in the direction of molar roots – canales alveolares posteriores. Inside the nasal cavity, at facies nasalis, there is a great opening – hiatus (sinus) maxillaris, leading into big cavity in maxillar body – sinus maxillaris. It is the biggest cavity from all paranasal sinuses. It fills in practically the whole maxillar body, and it also reaches into processus maxillae. It is typically being compared to a hollow pyramid of triangular shape, with round margins, and apex directed towards processus zygomaticus. The basis is formed by

area nasalis of corpus maxillaris. A significant part of it is taken by opening hiatus (sinus) maxillaris, which is diminished by surrounding bones. Cranial side, created by facies orbitalis corporis maxillae, is thin and translucent. Dorsal side is concave and oriented towards tuber maxillae. Frontal side is usually quite thicker, and it is created by facies anterior maxillae. In male sinus maxillaris is more spacious, than in female.

**Processus frontalis maxillae** has crista lacrimalis anterior on its dorsal margin. On the plane area, inverted into the nasal cavity, there are two additional transversal margins, from which the frontal one is designed for connection with concha nasalis media – crista ethmoidalis, and the caudal margin is designed for connection with concha nasalis inferior – crista conchalis.

**Processus zygomaticus maxillae** is short, trilateral and crista infrazygomata runs off it.

**Processus alveolaris maxillae** is located on the inferior edge of upper jaw, in a form of a half of a horseshoe. It represents functional extension of a bone, conditioned by the presence of teeth. After losing of teeth, processus alveolaris maxillae is re-absorbing and diminishing. On the external side of processus alveolaris maxillae, the contours of margin – juga alveolaria – mark the position of alveoli dentales (roots of teeth). On caudal side of alveolar processus are alveoli dentales, separated by septa interalveolaria, single alveoli dentales contain many roots isolated by septa intraalveolaria (interradicularia).

**Processus palatini maxillae** of both upper jaws, form anterior 3/4 of palatum durum. Palatinal processes are connected together (sutura palatina mediana). The bone mass protrudes there sometimes in common torus palatinus. On dorsolateral side of processus palatinus sulci palatini run conditioned by presence of palatal vessels and nerves. In the ventral part of sutura palatina mediana is intermaxillar foramen incisivum. Maxillar part, lying ventrally from foramen incisivum ossifies independently (os incisivum, praemaxilla), and it is separated by suture, running between outer incisor and canine. Facies cranialis processus palatini is an integral part of the bottom of nasal cavity.

### **Nasal bone – Os nasale**

Os nasale is paired thin osseous plate. Ossa nasalia are connected by sutures with frontal bone, with processus frontales maxillarum, and mutually in middle plane together into sutura internasalis. Their lower margin is in living humans supported by a cartilage.

### Lachrymal bone – Os lacrimale

Os lacrimale is a paired bone, which is located between processus frontalis maxillae and lamina orbitalis ossis ethmoidalis forms part of medial orbital wall. Facies interna ossis lacrimalis is connected to anterior part of cellulae ethmoidales ossis ethmoidalis. On facies orbitalis ossis lacrimalis, there is a vertical crista lacrimalis posterior and ventrally from it there is sulcus lacrimalis, enlarged into fossa sacci lacrimalis. This fossa proceeds caudally from the pit as canalis nasolacrimalis, which serves for tear derivation into meatus nasalis inferior. Margo inferior ossis lacrimalis protrudes forward into hamulus lacrimalis, overlapping incisura lacrimalis maxillae, and is connected with processus lacrimalis conchae nasalis inferioris. It completes one side of canalis nasolacrimalis, which runs from fossa sacci lacrimalis in the orbital side into the nasal cavity.

### Facial bone – Os zygomaticum

Os zygomaticum is a paired bone, participating on demarcation of orbital floor and lateral part of orbit. Its shape and position can influence configuration of the face. It consists of corpus and three projections (processus).

**Corpus ossis zygomatici:** we differentiate *facies orbitalis*, *lateralis* and *facies temporalis*. On orbital plane, there is a tiny opening foramen zygomaticoorbitale, leading into a tiny canal. The canal divides inside the bone, and it leads onto facial plane as foramen zygomaticofaciale, on temporal plane as foramen zygomaticotemporale

#### **Processus ossis zygomatici:**

- *frontalis* – running cranially, it is connected with frontal bone and ala major ossis sphenoidalis
- *maxillaris* – running ventromedially, it is connected with processus zygomaticus maxillae
- *temporalis* – running dorsally, it is connected with processus zygomaticus ossis temporalis, and together with processus zygomaticus ossis temporalis forms arcus zygomaticus

### Palatal bone – Os palatinum

Os palatinum is a paired bone, participating on formation of dorsal part of palatum durum, and complementation of lateral side of nasal cavity. It has a shape of a letter L.

**Lamina horizontalis** of right and left side form dorsal  $\frac{1}{4}$  of hard palate. Ventrally both horizontal plates are connected with palatal processes of both upper jaws, into variably shaped sutura palatina transversa. Both laminae meet together in the mediosagittal plane through sutura palatina mediana. This suture protrudes cranially in crista nasalis, to which vomer is attached. Crista nasalis protrudes dorsally as spina nasalis posterior. On the oral area of lamina horizontalis, there are two openings – foramen palatinum majus and foramina palatina minora (serving for penetration of palatal vessels and nerves, supplying hard and soft palate). Laterodorsally, where horizontal plate meets vertical plate, we find processus pyramidalis, which is wedged into a notch (incisura pterygoidea) of processus pterygoideus ossis sphenoidalis.

**Lamina perpendicularis** – vertical plate – is overlapping dorsal edge of hiatus sinus maxillaris and reduces it. Its lateral surface forms the medial wall of fossa pterygopalatina. On the internal (nasal) side of this plate, there are two horizontal margins for attachment of concha nasalis media and inferior – crista ethmoidalis and crista conchalis. Lamina perpendicularis cranially protrudes into processus orbitalis and sphenoidalis, which run into the orbita and to the sphenoidal bone. Between processes there is incisura sphenopalatina. After being connected with adjacent bones, an opening arises here – foramen sphenopalatinum, serving for communication of nasal cavity with fossa pterygopalatina.

### **Concha nasalis inferior – Concha nasalis inferior**

Concha nasalis inferior is a paired bone, participating on completing the lateral side of the nasal cavity. It is adjoining to crista conchalis maxillae and crista conchalis ossis palatini. Concha nasalis inferior has **three processus**:

- *processus maxillaris*, the largest of them is hang on the caudal edge of hiatus sinus maxillaris
- *processus lacrimalis*, there is a running off ventrally in ventral direction, from cranial margin of concha to the lachrymal bone
- *processus ethmoidalis*, there is a running off dorsally, serving for connection with processus uncinatus conchae nasalis mediae

### **Ethmoidal bone – Os ethmoidale**

Os ethmoidale is an unpaired bone, planted between both orbits. It participates on forming of

orbital roof, and partially also on forming of lateral wall of nasal cavity, it consists of three elementary parts:

**lamina perpendicularis** – unpaired vertical plate, forming cranial part of nasal septum (septum nasi osseum). Into the skull cavity (into fossa cranii anterior) it protrudes as crista galli. Foramen caecum is found in front of crista galli

**lamina cribrosa** – perforated plate of ethmoidal bone, forms basis for the roof of nasal cavity, and serves for penetration of fibres of olfactory nerve

**labyrinthus ethmoidalis** – system of small cavities, in lateral side of the nasal cavity (cellulae ethmoidales), bulla ethmoidalis is the biggest of them. On the medial side of labyrinth, there are two conchae – concha nasalis superior et media running in the direction of nasal cavity. Anterior and posterior part of concha nasalis media is attached to crista ethmoidalis maxillae and the same one of palatal bone. From concha nasalis media, in the dorsal direction to concha inferior, processus uncinatus protrudes, which together with other bones, participates on reduction of hiatus maxillaris. The bordering line between labyrinthus olfactorius and paries medialis orbitae, is formed by paper-thin lamina orbitalis (lamina papyracea). On the upper margin, through which lamina orbitalis is connected with pars nasalis ossis frontalis, there are two openings for penetration of equally named nerves and vessels – foramen ethmoidale anterius et posterius.

### **Vomer – Vomer**

Vomer is sagittally oriented, unpaired splanchnocranial bone, which forms the dorsocaudal part of bone nasal septum. Margo superior vomeris is attached by two diastased lamellas (alae vomeris) to corpus ossis sphenoidalis from below. The caudal end of vomer, is attached onto crista nasalis on palatum durum. Ventrocranially the vomer is connected with lamina perpendicularis ossis ethmoidalis. Dorsal vomer edge is free, and it separates both choanae.

### **Mandible. Lower jaw – Mandibula**

Mandibula is an unpaired bone, which forms the osseous basis of the lower part of the face. It is the only skull bone, which is connected with the remaining skull skeleton using articulation, through temporomandibular joint (articulatio temporomandibularis). The bone consists of unpaired corpus mandibulae and paired ramus mandibulae. The area, where corpus mandibulae meets with ramus mandibulae, is called angulus mandibulae.

**Corpus mandibulae** is thickened along its whole lower margin, predominantly in the chin area, where it forms a triangular projection – trigonum mandibulae. In the middle line, protuberantia mentalis protrudes from this triangle, along its sides there is a variably created tuberculum mentale. On the inner plane of chin part of mandible, in middle plane, there is spina mentalis. Laterocaudally from spina, there is a shallow pit – fossa digastrica on each side. Along cranial edge of mandibular body (similar as with maxilla), processus alveolaris is divided into dental alveoles (alveoli dentales), with, septa interalveolaria and septa intraalveolaria (interradicularia) and juga alveolaria anteriorly. On the inner side of the body, an oblique margin (linea mylohyoidea) passes. Above it, somewhat ventrally, there is a shallow pit – fovea sublingualis, below linea mylohyoidea there is next cavity – fovea submandibularis. Both cavities have equally named salivary glands running over to them. From the external side of corpus mandibulae (usually below the second premolar) there is an opening – foramen mentale, through which the estuary of canalis mandibulae passes.

**Ramus mandibulae** is attached to corpus mandibulae in a reflex angle. It protrudes ventrally into processus coronoideus and dorsally into processus condylaris. On it, there is an apparent cranial enlargement – caput mandibulae, below it, there is a narrowed neck – collum mandibulae with central depression – fovea pterygoidea. Between both processus there is an incisure – incisura mandibulae. From frontal edge of processus coronoideus, on the external side of processus alveolaris, oblique margin – linea obliqua protrudes caudally. Another margin (crista buccinatoria) runs on the inner side of processus alveolaris (this margin is palpable from the oral cavity). Between both margins and behind last molar, there is a triangular pit trigonum retromolare. On the inner side of ramus mandibulae, there is foramen mandibulae, through which neurovascular bundle passes into above mentioned canalis mandibulae. Foramen mandibulae is from the central side demarcated by thin osseous plate – lingula mandibulae, sideways forward a narrow sulcus mylohyoideus protrudes. On the external and internal side of the mandibular angle, there are tuberosities for attachment of masticatory muscles: external – tuberositas masseterica, internal – tuberositas pterygoidea.

### **Hyoid bone. Tongue bone – Os hyoideum**

Os hyoideum is an unpaired splanchnocranial bone, hanged on the skull basis on ligaments and muscles between the chin and larynx. Hyoid bone itself, is the site of beginning and of attachment of many cervical muscles (suprahyoidal and infrahyoidal), tongue muscles, and a larynx hangs on it as well. It consists of three parts.

**Corpus ossis hyoidei**, with the shape of transversally positioned plate, with convex anterior

and concave posterior bone plane.

**Cornua minora** are short, cylinder-shaped, and are running dorsocranially.

**Cornua majora** lie nearly in the elongation of corpus ossis hyoidei, and is pestle-shaped enlarged at the ends.

## SKULL AS A WHOLE

### Dimensions of skull

For evaluation of the size of neurocranium, skull capacity (volumen) is critical, conditioned predominantly by brain development. The average skull capacity is about 1450 cm<sup>3</sup> in male, 1350 cm<sup>3</sup> in female (differences are given by generally greater size of a male body). Skull capacity depends on range variations. If the capacity doesn't reach 1100 cm<sup>3</sup>, we talk about **microcephaly**. If the capacity is greater than 1800 cm<sup>3</sup>, we talk about **macrocephaly**.

### Newborn skull

The size of skull is in certain relation to the remaining skeleton. Mutual relation of the head size and the size of rest of the body changes in the course of development. Newborn's is body length equals 4 times the height of his head, in 2nd year 5 times, in 6th year 6 times, and in adulthood 8 times the height of his head. That means, that a newborn is born with a relatively big head. In the postnatal period, the head growth is much slower, than the growth of remaining parts of the body. Splanchnocranial formation is depending on the development of teeth and the entire masticatory apparatus (jaws and masticatory muscles). Face of a toothless newborn or an old man is therefore much lower, than the face of a middle-aged individual, with normally developed dentition.

Newborn skull has many differences from the skull of adult humans. Skull of a newborn baby is relatively big in comparison with postcranial skeleton. After comparison of both skull parts, the facial part in comparison with cranial part is relatively small (ratio of 1:8 at newborn, 1:2 at adults). The facial part is greatly dependent on the development of masticatory apparatus. The most important factors influencing development of splanchnocranium, are predominantly teeth eruption, changes connected with functional use of jaws (at suction, later at mastication and manducation), development of masticatory muscles and pneumatization of maxilla.



Neurocranial bones aren't connected by sutures yet, but by narrow fibrous bands, which in some places (where more bones meet together) are spatially enlarged, and forms fonticuli. Stated connection type between flat bones of vault of cranium enables its mutual mobility and shifting during childbirth (passage of foetal head through narrow birth canal) and enables configuration of newborn head. In newborn skull, we can differentiate six main fonticuli. Two impair ones (fonticulus major et minor) situated in the midsagittal plane (these two fonticuli have practical and diagnostic significance) and two paired ones situated on lateral sides of the skull (fonticulus sphenoidalis et mastoideus). Fonticulus major et minor are well palpable under the skin of newborn head, and they have a great significance in obstetrics (can enable orientation of position of head in the birth canal during childbirth) and in paediatrics (assessment of body development of an infant is based on the extent and speed of closing fonticuli, their changes on the head surface can indicate dehydration of an organism or increasing of intracranial pressure).

- *Fonticulus anterior seu major* lies in the crossing site of sutura sagittalis, coronalis and frontalis. It has rhomboidal shape, with its longest cusp directed frontally. The length of fonticulus fluctuates between 3 - 4 cm; its width is almost 1 cm less. The fonticulus fades away (ossifies) between the 1st and 2nd year. On its site, an independent ossicle (os bregmaticum) can usually be created and it belongs to skeletal varieties.
- *Fonticulus posterior seu minor* lies in the crossing site of sutura sagittalis and sutura lambdoidea. It has three cusps, and it closes relatively soon after birth (after the 3rd month it is typically not apparent).

Two other fonticuli (fonticulus sphenoidalis et mastoideus) are overlapped by muscles and therefore aren't palpable. They fade away between the 6th – 12th month. Premature obliteration (ossification) of sutures can lead to skull deformities.

### Gender differences on skull

Characteristic	Male skull	Female skull
Capacity (average)	1450 cm <sup>3</sup>	1350 cm <sup>3</sup>
General structure	Massive	Gracile
Neurocranium	Relative long and wide	Relative short and narrow

Squama frontalis	Fluently vaulted, fluent transition into vertex	Steep forehead, transition into vertex is angular
Glabella and arcus superciliares	Strongly developed	Weakly developed
Margo supraorbitalis	Curved	Sharp
Tubera frontalia, parietalia	More weakly developed	More strongly developed
Protuberantia occipitalis externa	Strong prominence	Only indicated
Processus mastoidei	Bigger, skull placed on a support leans against them	Small, skull placed on a support doesn't lean against them
<b>Splanchnokranium</b>	Generally bigger	Generally smaller
Position of processus alveolares in incissor area	Vertical	Alveolar prognathia
Facies	Higher	Lower
Mandible in site of symphysis	High	Low
Dental arch	Bigger, rounded	Smaller, more pointed
Tuberosities for muscle attachments	Strongly developed	Weakly developed
Nasal radix – nasofrontal transition	Angular curve	Fluent transition

Above mentioned characters must be complexly assessed, not all of them are always created. Not each male skull must have all male characteristics, and on the other hand female skull doesn't have all female characteristics, even a skilled morphologist is able to correctly determine the gender identity in only 80-90 % cases.

## Skull cavity – *Cavitas (cavum) cranii*

Bones of the cranial part of the skull form a firm case, which encircles the skull cavity – **cavitas cranii**. On it we distinguish vault of cranium – **calvaria** and skull basis – **basis cranii**. The borderline between both parts is only artificial; it is determined by the section, which leads from supraorbital arches to protuberantia occipitalis externa. While the vault of cranium is organised relatively simply and it is compact, the structure of the skull basis is very complicated. Here various firm bone structures are alternating here, and many canals, openings and notchs pass through it, enable direct communication with skull superficium, or with various splanchnocranial spaces. takes place via these canals, openings and slits.

## Vault of cranium – *Calvaria cranii*

External plane of vault of cranium (*facies externa calvariae*) is not only in transversal, but also in longitudinal direction convex; its surface is generally smooth. The shape depends on the general shape of it, most often it is oval. We divide calvaria into three sections: forehead (*frons*), vertex (*vertex*) and occiput (*occiput*). Frontally the skull is created by squama frontalis, in the middle section medially by both parietal bones, laterally by squamae temporales, dorsally by squama occipitalis. The above mentioned bones are connected together by various sutures, which run either sagittally (*sutura sagittalis*, *sutura squamosa*, in case of metopism also *sutura frontalis seu metopica*), or frontally (*sutura coronalis*, *sutura lambdoidea*).

On the lateral side of vault of cranium there are two arch-shaped lines, *linea temporalis superior et inferior*. *Planum temporale* lying below *linea temporalis inferior* represents medial side of *fossa temporalis* (*fossa temporalis*).

Frontally, the fornix is recessed into a forehead (*frons*). On it, two differently accentuated frontal tubers (*tubera frontalia*) are protruding. In vertex area (*vertex*) there are parietal tubers (*tubera parietalia*). Medially from these tubers there is a paired foramen (*foramen parietale*) at *sutura sagittalis*. Dorsal part is vaulting into an occiput (*occiput*). Its basis is formed by the surrounding of *protuberantia occipitalis externa*, below it; vault of cranium borders the skull basis.

The internal plane of vault of cranium (*facies interna calvariae*) is concave, and is compared with deep bowl. Here we find a row of unevenness, such as *impressiones gyrorum*, *juga cerebralia*, which are caused by brain relief. *Ramus* of *a. meningea media* form fissures (*sulci*

arteriosi). In the middle plane there is a significant impression of venous sinus (sulcus sinus sagittalis superioris), along both sides of sulcus there are usually several small foveolae granulares. The sulcus sinus sagittalis superior frontally turns into crista frontalis. Dorsally, there are two horizontally running sulci transversi.

### **Skull basis – Basis cranii**

On the skull basis, we distinguish the internal plane – **basis cranii interna** and the external plane – **basis cranii externa**.

#### **Basis cranii interna**

The internal plane of the skull basis has approximately an ovoid shape, and it is concave. We distinguish three sections on it: anterior, middle and posterior skull fossa – **fossa cranii anterior, media et posterior**. Mentioned holes are located subsequently in a way that fossa anterior is the highest and fossa posterior is the lowest. The holes can fluently transit into vault of cranium, with the exception of fossa cranii posterior.

#### **Fossa cranii anterior**

Fossa cranii anterior is relatively shallow. It is somewhat deeper in the middle; laterally it is flat and almost convex. It is formed by partes orbitales ossis frontalis, lamina cribrosa with crista galli ossis ethmoidalis, alae minores ossis sphenoidalis, and frontal part of the superior plane corpus ossis sphenoidalis (inclusive of sulcus praechiasmaticus). Frontally and laterally it passes into calva, against fossa cranii media it is bordered by dorsal margin of alae minores ossis sphenoidalis. The main content of fossa anterior are the frontal lobes of brain hemispheres. Some openings and canals run from fossa anterior:

- *canalis opticus* leads into orbita
- *canalis ethmoidalis anterior*
- *openings in lamina cribrosa* ossis ethmoidalis run into the nasal cavity

#### **Fossa cranii media**

Fossa cranii media lies dorsally from fossa cranii anterior, and it is much deeper. Dorsally it is bordered, in the middle by dorsum sellae, laterally by margo superior of both pyramids. It consists of three parts. The middle part is unpaired (pars sellaris), it is relatively narrow, and

lies at the highest point. Its basis is formed by sella turcica. Laterally, the fossa cranii media is widening into both sides, and is deepening into a bowl-like shape. Its basis is formed by alae majores, squamae temporales and facies anteriores of pyramids. Significant structures here are impressions of a. meningea media (sulci a. meningeae mediae). The content of fossa media are hypophysis, sinus cavernosus, both aa. carotis int. and the temporal lobes of brain hemispheres. In fossa cranii media there are many significant openings and canals.

- *fissura orbitalis superior* leads into orbita.
- *foramen rotundum* leads into fossa pterygopalatina
- *foramen ovale* opens into fossa infratemporalis
- *foramen spinosum* leads into fossa infratemporalis
- *foramen lacerum* is filled by cartilage (synchondrosis sphenopetrosa)
- *apertura interna canalis carotici* opens on the apex of the pyramidis
- *hiatus canalis n. petrosi majoris et minoris* lie on facies anterior pyramidis, and continue to foramen lacerum as sulcus n. petrosi majoris and minoris

### **Fossa cranii posterior**

Fossa cranii posterior is the lowest lying fossa amongst all three fossae cranii; it is the deepest and most spacious. Its walls are formed by dorsum sellae, clivus, facies posteriores of both pyramids and os occipitale (dorsally after protuberantia occipitalis interna). Content of fossa posterior is predominantly brain stem (lies on clivus), in partes laterales there are cerebellar hemispheres. In fossa cranii posterior, a number of openings and canals start:

- foramen magnum represents the connection between neurocranial cavity and spinal canal
- porus acusticus internus leads into meatus acusticus internus
- apertura externa aquaeductus vestibuli represents a passage canal for ductus endolymphaticus, leading from labyrinthus membranaceus of the inner ear
- foramen jugulare represents connection with facies exocranialis of basis cranii
- foramen mastoideum contains venous emissarium
- canalis hypoglossi leads onto the lower side of skull basis

## **Basis cranii externa**

The whole facies inferior basis cranii can be viewed through only after removal of splanchnocranial bones. We divide it into **frontal, middle and dorsal sections**.

**Frontal section** dorsally reaches to the line running from processus pterygoideus along fissura orbitalis inferior. It is formed by lamina cribrosa ossis ethmoidalis, pars nasalis and partes orbitales ossis frontalis.

**Middle section** dorsally reaches to the line running from margo anterior of foramen magnum over condyli occipitales to processus mastoidei. The basis of the middle section is corpus ossis sphenoidalis, pars basilaris ossis occipitalis, in lateral sections there are alae majores ossis sphenoidalis, partes petrosae, squamae and partes tympanicae of temporal bones. In middle section there are many significant openings, canals and fissures, leading predominantly into the skull cavity (canalis hypoglossi, foramen jugulare, apertura externa canaliculi tympanici, apertura externa canaliculi cochleae, apertura externa canalis carotici, canalis musculotubarius, foramen spinosum, foramen ovale, foramen rotundum, foramen stylomastoideum, foramen lacerum, fissura petrooccipitalis et fissura sphenopetrosa, porus acusticus externus, fissura petrosquamosa, fissura petrotympanica, canalis pterygoideus).

**Dorsal section** is formed predominantly by occipital bone; laterally it is completed about processus mastoidei of temporal bones. In this section there are foramen magnum and canales condylares.

## **Lateral skull holes**

On the lateral side of a skull (predominantly in the splanchnocranial area) there is a system of holes gradually connected together: fossa temporalis, infratemporalis and pterygopalatina.

### **Fossa temporalis**

Fossa temporalis lies most laterally, and it is most spacious. Its osseous bordering is incomplete. Arcus zygomaticus is the lateral bordering; medial side is formed by a part of os parietale, squama temporalis and facies temporalis alae majoris ossis sphenoidalis. Medial side is cranially bordered with linea temporalis superior, caudally with crista infratemporalis alae majoris ossis sphenoidalis. Anterior side of fossa temporalis is formed by processus frontalis ossis zygomatici. There is foramen zygomaticotemporale, through which passes nervus zygomaticotemporalis. Cranial, dorsal and inferior sides are missing, and fossa

temporalis fluently continues into fossa infratemporalis below crista infratemporalis alae majoris ossis sphenoidalis. The content of fossa temporalis is made of m. temporalis and various vessels and nerves.

### **Fossa infratemporalis**

Fossa infratemporalis is cranially and laterally connected fluently with fossa temporalis. Its osseous boundaries are also incomplete. The cranial side is facies infratemporalis alae majoris ossis sphenoidalis, frontal side is facies infratemporalis maxillae, medial side is lamina lateralis processus pterygoidei. The lateral side is formed by ramus mandibulae. Dorsal and caudal side are not created on the bone skeleton. A number of foramens and fissurae open into fossa infratemporalis (foramen ovale, foramen spinosum, foramina alveolaria superiora posteriora, foramen mandibulae, fissura orbitalis inferior). On the medial side there is a notch, through which fossa pterygopalatina fluently connects with fossa infratemporalis. Content of fossa infratemporalis is made of mm. pterygoidei and various vessels and nerves.

### **Fossa pterygopalatina**

Slit - shaped fossa pterygopalatina represents a medial continuation of fossa infratemporalis, and forms its deepest part. It is located between facies dorsalis of corporis maxillae, and facies anterior of processus pterygoideus. Fossa pterygopalatina has the shape of quadrangular pyramid, with its base directing cranially. It is formed by facies inferior of corpus ossis sphenoidalis, and facies maxillaris of alae majoris of ossis sphenoidalis. Foramen rotundum opens in this fossa. Apex of pyramidis runs caudally, and passes into canalis palatinus major. Medial side is formed by lamina perpendicularis ossis palatini, foramen sphenopalatinum opens here, and by means of which fossa pterygopalatina communicates with the nasal cavity. Facies anterior is formed by facies infratemporalis corporis maxillae. In facies anterior there is pars posterior of fissura orbitalis inferior, which communicates with orbita. Facies dorsalis of pterygopalatinal fossa is formed by facies anterior of processus pterygoideus ossis sphenoidalis, and through this processus canalis pterygoideus passes. The lateral side of pterygopalatinal fossa is practically missing on bone skeleton, and here the fossa communicates with fossa infratemporalis. In fossa pterygopalatina there is a terminal section of a. maxillaris and n. maxillaris and ganglion pterygopalatinum. Through fissura orbitalis inferior various vessels and nerves pass through into the orbita, nasal cavity and oral cavity.

## **Orbita**

Orbita (eye-socket) is a deep hole, situated in the cranial section of skull splanchnocranium, and inside it there is ocular apparatus. Orbita has quadrangular pyramid shape; its **base** is opened, and inverted frontally (aditus orbitae). **Apex** orbitae is directed dorsally, below the skull basis. Both orbital axes (lines connecting centre of aditus orbita with apex orbitae) are diverging frontally, and they are intersecting dorsally approximately over sella turcica. **Aditus orbitae** has mostly quadrangular shape; its margin is cranially formed by margo supraorbitalis of os frontalis, medially processus frontalis maxillae, laterally os zygomaticum, and caudally corpus maxillae and os zygomaticum (margo infraorbitalis). Cranial and caudal margin (margo supraorbitalis et infraorbitalis) and margo lateralis are sharp and well palpable margins. Margo medialis is round, and poorly palpable. In margo supraorbitalis there are various fissures (incisura frontalis et incisura supraorbitalis), which can be transformed into equal named foramens (foramen frontale et supraorbitale). Apex orbitae is a part of os sphenoidale. Canalis opticus opens up in it and leads into the skull cavity.

**Medial side** has a sagittal position (medial sides of both orbits are parallel) and is formed by: processus frontalis maxillae, os lacrimale (both bones bordering fossa sacci lacrimalis, which runs into the nasal cavity as canalis nasolacrimalis), lamina orbitalis ossis ethmoidalis, processus orbitalis ossis palatini and ala minor ossis sphenoidalis. In medial side there are two foramens (foramen ethmoidale anterius et posterius, through which equal named vessels and nerves pass).

**Lateral side** is frontally formed by os zygomaticum (foramen zygomaticoorbitale opens here) and facies orbitalis alae majoris ossis sphenoidalis.

**Cranial side** is formed by pars orbitalis ossis frontalis (fossa glandulae lacrimalis is on the bone laterally and fovea trochlearis medially) and ala minor ossis sphenoidalis.

**Caudal side** is predominantly formed by facies orbitalis corporis maxillae (sulcus infraorbitalis runs here and it passes cranially into canalis infraorbitalis), in the lateral part, it is bordered by os zygomaticum.

Between cranial and lateral side there is a fissure (**fissura orbitalis superior**), running into fossa cranii media. Between caudal and lateral side there is a fissure (**fissura orbitalis inferior**), which opens in fossa infratemporalis.



## **Cavitas nasalis ossea**

The bone nasal cavity (usually 3 - 4 cm tall and 2 -3 cm wide) frontally opens through an impar pear-shaped apertura – **apertura piriformis**, which is demarcated cranially by ossa nasalia, caudally by corpora maxillarum, and their processus frontales. Bone nasal cavity is divided by septum (**septum nasi osseum**) into two halves. In dorsal direction, both nasal cavities separated by posterior margin of septum (choanae) open. **Choanae** (about 2 cm tall and about 1 cm wide) have approximately ovoid shape, and are separated from each other by dorsal edge of vomer. Choanae are demarcated cranially by corpus ossis sphenoidalis, caudally by lamina horizontalis ossis palatini, laterally by lamina medialis processus pterygoidei and medially by vomer. In the nasal cavity, we can differentiate floor, roof, medial and lateral side.

**Floor of the nasal cavity** is formed by a hard palate. Ventrally these are processus palatini maxillarum (frontally at nasal septum foramen incisivum opens), in the dorsal third laminae horizontales ossis palatini are located.

**Roof of nasal cavity** is formed by ossa nasalia, pars nasalis ossis frontalis, lamina cribrosa ossis ethmoidalis and corpus ossis sphenoidalis.

**Medial side** is formed by septum nasi osseum. Vomer and lamina perpendicularis ossis ethmoidalis participate on its structure.

**Lateral side** is structurally the most complicated one. Bones, forming its basis, are organised into three layers:

- lateral layer: processus frontalis maxillae, facies nasalis corporis maxillae (there is a big hiatus - hiatus sinus maxillaris is opening here) and dorsally there is lamina medialis processus pterygoidei ossis sphenoidalis
- middle layer: os lacrimale in the frontal part, and lamina perpendicularis ossis palatini in the dorsal part. This forms a partial close connection with fossa pterygopalatina; in the cranial part there is foramen sphenopalatinum. Lamina perpendicularis ossis palatini participates on diminishing of the dorsal part, and os lacrimale on the diminishing of the frontal part of hiatus sinus maxillaris.
- medial layer is formed cranially by labyrinthus ossis ethmoidalis, caudally by concha nasalis inferior. Both bones further diminish hiatus sinus maxillaris, and transform it into

split-shaped hiatus semilunaris.

From lateral side three conchae are protruding into nasal cavity (concha nasalis superior et media which are dividing from labyrinthus ethmoidalis, concha nasalis inferior is an independent bone) and form the boundary of nasal meatus (**meatus nasi**).

- Meatus nasi superior lies above concha nasalis media (small concha nasalis superior protrudes into this space, and does not represent its cranial bordering!). Cellulae ethmoidales posteriores open into meatus nasi superior, and sinus sphenoidalis opens dorsally.
- Meatus nasi medius is longer, and more spacious, it lies between concha nasalis inferior and concha nasalis media. Inside it there are openings of cellulae ethmoidales anteriores et mediae, sinus maxillaris and sinus frontalis. Orificium of all above named sinuses (infundibulum ethmoidale) is opening into hiatus semilunaris.
- Meatus nasi inferior lies below concha nasalis inferior. Canalis nasolacrimalis opens in this meatus.
- Meatus nasopharyngeus lies behind margo dorsales of all conchae, and reaches to choanae.
- Meatus nasi communis is a space between conchal margins and nasal septum.

## **Cavitas oris**

Oral cavity is demarcated quite insufficiently on the bone skeleton. It has only cranial side (palatum durum) and lateral and frontal sides (processus alveolares maxillarum and processus alveolaris mandibulae, and corpus mandibulae).

**Cranial side** is formed by hard palate (palatum durum). Basis of palatum durum is in the frontal two thirds represented by processus palatini maxillarum, dorsally laminae horizontales of both palatina bones and their processus pyramidales. In the anterior part, foramen incisivum opens in the middle. Dorsally and laterally foramen palatinum majus opens, On processus pyramidalis there are openings of foramina palatina minora.