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**OSTEOLOGY**  
**ОСТЕОЛОГИЯ**

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## OSTEOLOGY

A study of the skeleton is called *osteology*.

The bones of the skeleton provide:

- a base for the tissue attachment (muscles, ligaments);
- ability to move;
- protection to internal organs;
- haematopoiesis.

The human skeleton may be divided into:

- ***the axial skeleton (skeleton axiale)*** consisting of the bones of the head (cranium), neck and trunk (vertebral column, sternum, ribs);
- ***the appendicular skeleton (skeleton appendiculare)*** consisting of the bones of the limbs.

### THE VERTEBRAL COLUMN (**columna vertebralis**)

- The vertebral column is also called the spine, the spinal column or back bone.
- It is the central axis of the body. It supports the body weight and transmits it to the ground through the lower limbs.
- The vertebral column is made up of 32-34 vertebrae: 7 cervical (C1-C7), 12 thoracic (T1-T12), 5 lumbar (L1-L5), 5 sacral (S1-S5) and 3-5 coccygeal (Co).

### Parts of a typical vertebra

Each *vertebra (vertebra)* has body, arch and seven processes.

- ***The vertebral body (corpus vertebrae)*** lies anteriorly. It is shaped like a short cylinder, being rounded from side to side and having flat upper and lower surfaces that are attached to those of adjoining vertebrae by the intervertebral discs.
- ***The vertebral arch (arcus vertebrae)*** lies posteriorly. It is connected with the body by the right and left ***pedicles (pediculus arcus vertebrae)***. The posterior part of the arch is called ***the laminae (lamina arcus vertebrae)***.
- ***The vertebral foramen (foramen vertebrale)*** – is in between the body of the vertebra and the arch. Each vertebral foramen forms a short segment of ***the ver-***

*tebral canal* (**canalis vertebralis**) that runs through the whole length of the vertebral column and lodges *the spinal cord*.

- Passing backwards from the posterior surface of the arch there is *the spine* or *spinous process* (**processus spinosus**).
- Passing laterally from the lateral surfaces of the arch there are *the transverse processes* (**processus transversus**).
- Projecting upwards and downwards from the lateral sides of the arch there are *superior* and *inferior articular processes* (**processus articularis superior et inferior**). Each articular process has *superior* or *inferior articular facet* (**facies articularis superior, inferior**) respectively. The superior facet of one vertebra articulates with the inferior facet of the vertebra above it.
- The pedicles are much narrower than the body and are attached to its upper border. As a result there are pair of large *inferior vertebral notches* (**incisura vertebralis inferior**) below the pedicles. Above the pedicles there are two much smaller *superior vertebral notches* (**incisura vertebralis superior**).
- The superior and inferior vertebral notches of adjoining vertebrae form *the intervertebral foramen* (**foramen intervertebrale**) which gives passage to the spinal nerves.

### **Side determination**

1. The vertebral body lies anteriorly.
2. The inferior vertebral notch is larger than the superior vertebral notch.

### **The cervical vertebrae (vertebrae cervicales)**

- The transverse process of a cervical vertebra is pierced by a foramen called the *foramen transversarium* (**foramen transversarium**). The vertebral artery passes through this foramen.
- Each transverse process has *the anterior* and *posterior tubercles* (**tuberculum anterius et posterius**).

- The anterior tubercle of the sixth cervical vertebra is larger than the others and is called *the carotid tubercle* (**tuberculum caroticum**) because the common carotid artery can be compressed against it in case of bleeding.
- *The groove for spinal nerve* (**sulcus nervi spinalis**) lies on the superior surface of the transverse process.
- The spine is short and bifid.

### The first cervical vertebra

- It is called *the atlas* (**atlas**).
- It is ring shaped.
- It has no body, but it has *anterior and posterior arches* (**arcus anterior et posterior atlantis**) and right and left *lateral masses* (**massa lateralis atlantis**) laterally.
- The anterior arch is marked by a median *anterior tubercle* (**tuberculum anterius**) on its anterior surface. Its posterior surface bears an oval *facet for dens* (**fovea dentis**) which articulates with the dens of the second cervical vertebra to form the median atlanto-axial joint.
- The posterior arch has a median *posterior tubercle* (**tuberculum posterius**) on its posterior surface. The upper surface is marked by *a groove for vertebral artery* (**sulcus arteriae vertebralis**).
- Superior surface of the lateral mass bears *the superior articular surface* (**facies articularis superior**). This facet is elongated and concave. It articulates with the corresponding condyle of the occipital bone to form the atlanto-occipital joint.
- The lower surface is marked by *the inferior articular surface* (**facies articularis inferior**). This facet is nearly circular, more or less flat. It articulates with the corresponding facet on the axis vertebra to form the lateral atlanto-axial joint.
- It has no spine.

### The second cervical vertebra

- It is called *the axis* (**axis**).
- It has *the dens* (**dens axis**), which is a process projecting upwards from the body. The dens has *apex* (**apex dentis**).

- The anterior aspect of the dens bears an *anterior articular facet* (**facies articularis anterior**) for articulation with the anterior arch of the atlas, the posterior aspect of it shows a *posterior articular facet* (**facies articularis posterior**) for the transverse ligament of atlas.

### The seventh cervical vertebra

- It has a long thick spinous process. The tip of the process forms a projection, which can be felt on the back of the neck. That is why this vertebra is called *the vertebra prominens* (**vertebra prominens/выступающий позвонок**).

### The thoracic vertebrae (vertebrae thoracicae)

- The body of the thoracic vertebrae bears 2 costal demifacets.
  - *The superior costal facet* (**fovea costalis superior**) is larger and placed on the upper border of the body near the pedicle. It articulates with the head of the numerically corresponding rib.
  - *The inferior costal facet* (**fovea costalis inferior**) is placed on the lower border in front of the inferior vertebral notch. It articulates with the next lower rib.
- The transverse processes are large and they are directed laterally and backwards. The anterior surface of each process bears a *transverse costal facet* (**fovea costalis processus transversi**) near its tip for articulation with the tubercle of the corresponding rib.
- The superior costal facet on the body of the first thoracic vertebra is complete. It articulates with the head of the first rib. The inferior costal facet is a “demifacet” for the second rib.
- The body of the tenth thoracic vertebra has only the superior costal facets (for corresponding rib).
- The bodies of the eleventh and twelfth thoracic vertebrae have only single complete costal facets on each side. Transverse processes of these vertebrae do not have articular facets.
- The spine is long, and is directed downwards and backwards.

### **The lumbar vertebrae (vertebrae lumbales)**

- The body of the lumbar vertebra is larger than all the others.
- The spine is a vertical quadrilateral plate directed almost backwards.
- The transverse process is homologous to the ribs.
- The posterior surface of the base of each transverse process is marked by a small elevation, *the accessory process (processus accesorius)*. It is the true transverse process of these vertebrae.

### **The sacrum (os sacrum)**

The sacrum is a large, flattened, triangular bone formed by the fusion of five sacral vertebrae. It forms the posterior part of the bony pelvis, articulating on each side with the corresponding hip bone at the sacro-iliac joint. The sacrum transmits the body weight to the hip bones.

The sacrum has a base, an apex, pelvic and dorsal surfaces.

- *The base (basis ossis sacri)* is the upper massive part of the sacrum. It has *the superior articular processes (processus articularis superior)* which articulate with vertebra L5 to form the lumbosacral joint. The projecting anterior margin of this articulation is called *the promontory (promontorium)*.
- *The apex (apex ossis sacri)* bears a facet for articulation with the coccyx.
- *The pelvic surface (facies pelvica)* is smooth and concave.
  - The median area is marked by four *transverse ridges (lineae transversae)*, which indicate the lines of fusion of the bodies of five sacral vertebrae.
  - These ridges end on each side at the four *anterior sacral foramina (foramina sacralia anteriora)*, which communicate with *the sacral canal (canalis sacralis)*.
- *The dorsal surface (facies dorsalis)* is irregular and convex.
  - The midline is marked by *the median sacral crest (crista sacralis mediana)*, representing the fused spines of the upper four sacral vertebrae.
  - Laterally to the median sacral crest lies *the intermediate sacral crest (crista sacralis medialis)* formed by the fused articular processes.

- Laterally to the intermediate sacral crest there is *the lateral sacral crest (crista sacralis lateralis)* formed by the fused transverse processes.
- *The posterior sacral foramina (foramina sacralia posteriora)* lie between the intermediate and lateral sacral crests, they communicate with the sacral canal.
- The foramina separate *the lateral part (pars lateralis)* from the medial part of the bone.
- The lateral part has *the auricular surface (facies auricularis)* for articulation with the ilium, and *the sacral tuberosity (tuberositas ossis sacri)*.
- The inferior articular processes of the fifth sacral vertebra are free and form *the sacral cornua (cornu sacrale)*, which project downwards at the sides of *the sacral hiatus (hiatus sacralis)*.
- *The vertebral foramen* lies behind the body, and leads into the sacral canal. Inferiorly, the canal opens as the sacral hiatus.

### **The coccyx (os coccyges)**

The coccyx is a small triangular bone formed by fusion of 3-5 rudimentary coccygeal vertebrae.

- The upper surface of the body of the first coccygeal vertebra forms the base of the coccyx, which articulates with the apex of the sacrum.
- This vertebra has rudimentary articular processes called *the coccygeal cornua (cornu coccygeum)*, which articulate with the sacral cornua.

### **THE RIBS (costae)**

There are 12 pairs of ribs. The ribs are bony arches arranged one below the other. The space between the ribs is called *intercostal space (spatium intercostale)*.

- The first 7 ribs which are connected directly to the sternum by the cartilages are called *true ribs (costae verae)*.
- The remaining 5 are *false ribs (costae spuriae)*. Their cartilages are joined to the cartilage of the upper rib.
- The anterior ends of the 11<sup>th</sup> and 12<sup>th</sup> ribs are free and they are called *floating ribs (costae fluctuantes)*.

## Typical rib

Each rib has anterior and posterior ends, and a shaft with upper and lower borders, and outer and inner surfaces.

- The anterior end is oval and concave for articulation with its cartilage.
- The posterior end is made up of the following parts:
  - *the head (caput costae)* has *articular facet (facies articularis capitis costae)* that is separated by a *crest (crista capitis costae)*. The lower larger facet articulates with the body of the numerically corresponding vertebra. The upper facet articulates with the vertebra above.
  - *The neck (collum costae)* lies between the head and the shaft.
  - *The tubercle (tuberculum costae)* is placed on the outer surface of the rib at the junction of the neck and the shaft. Its medial part forms the costotransverse joint with the transverse process of the corresponding vertebra.
- *The shaft (corpus costae)* is flattened so that it has 2 surfaces (outer and inner) and 2 borders (upper and lower).
  - The lower border is sharp and the upper border is rounded.
  - *The costal groove (sulcus costae)* lies along the inferior border on the inner surface. It contains the posterior intercostal vessels and intercostal nerve.
  - The shaft is curved with its convexity outwards. It is bent at *the angle (angulus costae)* which is situated about 5 cm laterally to the tubercle.
  - The angle is marked by an oblique line on the outer surface directed downwards and laterally.

## Side determination

1. The anterior end bears a concave depression. The posterior end bears a head, a neck and a tubercle.
2. The shaft is convex outwards, there is a groove along the inner surface of its lower border.

## The first rib

- It is the shortest, broadest and most curved rib.
- Unlike the typical rib the shaft of the first rib is flattened from above downwards so that it has superior and inferior surfaces, and outer and inner borders.

- The lower surface of the shaft is smooth. The upper surface of the shaft is crossed anteriorly by *the groove for subclavian vein* (**sulcus venae subclaviae**), and *the groove for subclavian artery* (**sulcus arteriae subclaviae**) posteriorly.
- The grooves are separated by a ridge. The ridge lies at the inner border of the rib and it is called *the scalene tubercle* (**tuberculum musculi scaleni anterioris**).
- The head is small and rounded.
- The tubercle coincides with the angle of the rib.

#### Side determination

1. The anterior end is larger, thicker and pitted. The posterior end is small and rounded.
2. The outer border is convex.
3. The upper surface has the scalene anterior tubercle. The lower surface is smooth.

#### **The tenth rib**

It has only a single facet on the head for the body of the 10<sup>th</sup> thoracic vertebra.

#### **The eleventh and twelfth ribs**

These have pointed anterior ends. The necks and tubercles are absent.

### **THE STERNUM (sternum)**

The sternum is a flat bone. The upper part is the manubrium of sternum. The middle part is the body of sternum. The lowest tapering part is the xiphoid process.

#### *The manubrium of sternum* (**manubrium sterni**)

- The manubrium is the thickest and strongest part of the sternum.
- The manubrium makes a slight angle with the body, convex forwards, called *the sternal angle* (**angulus sterni**).
- The superior border is marked by *the jugular notch* (**incisura jugularis**) in the median part, and *the clavicular notch* (**incisura clavicularis**) on each side, that articulates with the medial end of the clavicle to form the sternoclavicular joint.
- The lateral borders bear *costal notches* (**incisurae costales**) for articulation with the 1<sup>st</sup> and upper end of the 2<sup>nd</sup> costal cartilages.

### ***The body of sternum (corpus sterni)***

- The anterior surface is marked by 3 transverse ridges, indicating the lines of fusion of the small segments.
- The lateral borders form costal notches for: the lower part of the 2<sup>nd</sup> costal cartilage; the 3<sup>rd</sup> to 6<sup>th</sup> costal cartilage; and the upper part of the 7<sup>th</sup> costal cartilage.

***The xiphoid process (processus xiphoideus)*** has the costal notches for the lower end of the 7<sup>th</sup> costal cartilage.

### **Applied anatomy**

1. Bone marrow for examination is usually obtained by sternal (manubrial) puncture.
2. Xiphoid process may be bifid or perforated.

## **BONES OF UPPER LIMB (ossa membri superioris)**

The skeleton of each upper limb consists of the following parts:

- ***pectoral (or shoulder) girdle (cingulum pectorale)*** - clavicle and scapula;
- ***free part of upper limb (pars libera membri superioris)***:
  - the bone of the arm is humerus,
  - two bones of the forearm are radius and ulna,
  - 8 carpal bones of the wrist,
  - 5 metacarpal bones of the palm,
  - phalanges (proximal, middle and distal), the thumb has only two phalanges.

## **THE CLAVICLE (clavicula)**

The clavicle is a long bone. It has a cylindrical part called the shaft, and two ends.

- ***The acromial (lateral) end (extremitas acromialis)*** is flattened from above downwards. It bears ***an acromial facet (facies articularis acromialis)*** that articulates with the acromion process of the scapula to form the acromioclavicular joint.
- ***The sternal (medial) end (extremitas sternalis)*** is quadrangular and has ***a sternal facet (facies articularis sternalis)*** that articulates with the clavicular notch of the manubrium of the sternum to form the sternoclavicular joint.

- **The shaft of the clavicle (corpus claviculae)** can be divided into the lateral one third and the medial two thirds.
  - The lateral one third is concave forwards. Its inferior surface presents an elevation called **the conoid tubercle (tuberculum conoideum)** and a ridge called **trapezoid line (linea trapezoidea)**. They give attachment to the coracoclavicular ligament.
  - The medial two thirds are convex forwards.

### **Side determination**

1. The lateral end is flat, and the medial end is large and quadrilateral.
2. The shaft is slightly curved, so that it is convex forwards in its medial 2/3, and concave forwards in its lateral 1/3.
3. The inferior surface is rough.

### **Applied anatomy**

The clavicle is commonly fractured by falling on the outstretched hand. The common site of the fracture is the junction between two curvatures of the bone (weakest point). The lateral fragment is displaced downwards by the weight of the limb.

## **THE SCAPULA (scapula)**

The scapula has two surfaces (costal and posterior), three borders (superior, lateral, medial), three angles (superior, inferior, lateral) and three processes (spine, acromion, coracoid process).

- The anterior **costal surface (facies costalis)** is concave and directed medially and forwards. It bears the **subscapular fossa (fossa subscapularis)**.
- **The posterior surface (facies posterior)** gives attachment to **the spine of scapula (spina scapulae)**. It is a triangular bony plate which divides the surface into a smaller **supraspinatus fossa (fossa supraspinata)** superiorly and a larger **infraspinatus fossa (fossa infraspinata)** inferiorly.
- **The acromion (acromion)** is a continuation of the lateral end of the spine. The medial border of the acromion has **a clavicular facet (facies articularis clavicu-**

**laris**) for articulation with the lateral end of the clavicle to form the acromioclavicular joint.

- **The superior border (margo superior)** is thin and short. Its lateral part bears *the coracoid process (processus coracoideus)*. **The suprascapular notch (incisura scapulae)** is located medially to the coracoids processus.
- **The lateral angle (angulus lateralis)** is broad and bears the **glenoid cavity (cavitas glenoidalis)** which is directed forwards, laterally and slightly upwards. Just below the cavity there is *the infraglenoid tubercle (tuberculum infraglenoidale)*, above the glenoid cavity there is *the supraglenoid tubercle (tuberculum supraglenoidale)*. Medial to the glenoid cavity there is a constriction which is called *the neck of scapulae (collum scapulae)*.

### **Side determination**

1. The lateral angle is large and bears the glenoid cavity.
2. The dorsal surface is convex and is divided by the triangular spine into the supraspinous and infraspinous fossae. The costal surface is concave to fit on the convex chest wall.
3. The lateral thickest border runs from the glenoid cavity above to the inferior angle below.

### **Applied anatomy**

Paralysis of the serratus anterior causes ‘winging’ of the scapula, the arm cannot be abducted.

## **THE HUMERUS (humerus)**

The humerus is a long bone. It has an upper end, a lower end and a shaft.

### **The upper end**

- **The head (caput humeri)** is directed medially, backwards and upwards. It articulates with the glenoid cavity of the scapula to form the shoulder joint.
- The line separating the head from the rest of the upper end is called *the anatomical neck (collum anatomicum)*.
- **The lesser tubercle (tuberculum minus)** is an elevation on the anterior aspect of the upper end.

- *The greater tubercle* (**tuberculum majus**) is an elevation that forms the lateral part of the upper end.
- *The intertubercular sulcus* (**sulcus intertubercularis**) separates the lesser tubercle (medially) from the greater tubercle (laterally). The sulcus has *medial* and *lateral lips* (**crista tuberculi minoris, majoris**) that represent prolongations of the lesser and greater tubercles downward.
- The line, separating the upper end of the humerus from the shaft is called *the surgical neck* (**collum chirurgicum**).

### **The shaft of humerus (corpus humeri)**

The shaft has three borders and three surfaces.

- *The lateral border* (**margo lateralis**) is prominent only at the lower end where it forms *the lateral supracondylar ridge* (**crista supracondylaris lateralis**).
- The upper part of *the medial border* (**margo medialis**) forms the medial lip of the intertubercular sulcus. The lower end forms *the medial supracondylar ridge* (**crista supracondylaris medialis**).
- The upper one third of the anterior border forms the lateral lip of the intertubercular sulcus. The lower half of the anterior border is smooth and rounded.
- *The anterolateral surface* (**facies anterolateralis**) lies between the anterior and lateral borders. A little above the middle it is marked by a V-shaped *deltoid tuberosity* (**tuberositas deltoidea**).
- *The anteromedial surface* (**facies anteromedialis**) lies between the anterior and medial borders. Its upper one third is narrow and forms the floor of the intertubercular sulcus.
- *The posterior surface* (**facies posterior**) lies between the medial and lateral borders. The middle one third is crossed by *the radial groove* (**sulcus nervi radialis**).

### **The lower end**

The lower end forms *the condyle of humerus* (**condylus humeri**), which has articular and nonarticular parts.

The articular part includes the following:

- *The capitulum (capitulum humeri)* is a rounded projection which articulates with the head of the radius, positioned laterally.
- *The trochlea (trochlea humeri)* is a pulley shaped surface, positioned medially. It articulates with the trochlear notch of the ulna.

The nonarticulate part includes the following:

- *The coronoid fossa (fossa coronoidea)* is a depression just above the anterior aspect of the trochlea. It accommodates the coronoid process of the ulna when the elbow is flexed.
- *The radial fossa (fossa radialis)* is present just above the anterior aspect of the capitulum. It accommodates the head of the radius when the elbow is flexed.
- *The olecranon fossa (fossa olecrani)* lies just above the posterior aspect of the trochlea. It accommodates the olecranon process of the ulna when the elbow is extended.
- *The medial epicondyle (epicondylus medialis)* is a prominent bony projection on the medial side of the lower end. There is *the groove for ulnar nerve (sulcus nervi ulnaris)* on the posterior aspect of the medial epicondyle.
- *The lateral epicondyle (epicondylus lateralis)* is a prominent bony projection on the lateral side of the lower end.

### Side determination

1. The upper end is rounded and forms the head.
2. The head is directed medially and backwards.
3. The capitulum is directed forwards and laterally.

### **Applied anatomy**

1. The common sites of fracture are the surgical neck, the shaft, and the supracondylar region.
2. Three nerves are directly related to the humerus and, therefore, are liable to injury: the axillary at the surgical neck, the radial at the radial groove, and the ulnar behind the medial epicondyle.

## **THE RADIUS (radius)**

The radius is the lateral bone of the forearm. It has an upper end, a lower end and a shaft.

## The upper end

- **The head (caput radii)** is disc shaped. It has a superior concave **articular facet (fovea articularis)** which articulates with the capitulum of the humerus at the elbow joint.
- **The articular circumference (circumferentia articularis)** of the head fits into a socket formed by the radial notch of the ulna and the annular ligament, thus forming the superior radioulnar joint.
- **The neck (collum radii)** is the constricted region just below the head.
- **The radial tuberosity (tuberositas radii)** lies just below the medial part of the neck.

## The shaft (corpus radii)

It has three borders and three surfaces.

- **The anterior border (margo anterior)** extends from the anterior margin of the radial tuberosity to the radial styloid process.
- **The posterior border (margo posterior)** is the mirror image of the anterior border (it is clearly defined only in its middle one third).
- The medial **interosseus border (margo interosseus)** is the sharpest of the three borders.
- **The anterior surface (facies anterior)** lies between the anterior and interosseus borders. It is smooth.
- **The posterior surface (facies posterior)** lies between the posterior and interosseus borders. It is rough.
- **The lateral surface (facies lateralis)** lies between the anterior and posterior borders.

## The lower end

The lower end is the widest part of the bone.

- The anterior surface is plane, the posterior surface presents **the grooves for extensor muscle tendons (sulci tendinum musculorum extensorum)**.
- The medial surface is occupied by **the ulnar notch (incisura ulnaris)** for the head of the ulna.
- The lateral surface is prolonged downwards to form **the radial styloid process (processus styloideus radii)**.

- The inferior surface bears *the carpal articular surface (facies articularis carpalis)* for both the scaphoid and the lunate bones. So, this surface takes part in formation of the wrist joint.

### **Side determination**

1. The upper end forms the head with the circumference, the lower end has the styloid process.
2. The anterior surface of the lower end is plane, the posterior surface is rough.
3. The sharp interosseus border is directed medially.

### **Applied anatomy**

1. Common fracture of the radius is about 2 cm above its lower end. This fracture is usually a result of falling on outstretched hand. In this case the distal fragment of the bone is displaced upwards and backwards.
2. Congenital absence of the radius is a rare anomaly. The thumb is often absent also.
3. A sudden powerful jerk on the hand of a child may dislodge the head of the radius from the grip of the annular ligament. This is known as subluxation of the head of the radius.

## **THE ULNA (ulna)**

The ulna is the medial bone of the forearm. It has an upper and a lower end and a shaft.

### **The upper end**

- *The olecranon (olecranon)* projects upwards from the shaft.
- *The coronoid process (processus coronoideus)* projects forwards from the shaft just below the olecranon.
- *The radial notch (incisura radialis)* is on the lateral surface of the coronoid process, it articulates with the head of the radius to form the superior radioulnar joint.
- The lower part of the anterior surface of the coronoid process forms *the tuberosity of ulna (tuberositas ulnae)*.
- *The trochlear notch (incisura trochlearis)* is in between the olecranon and coronoid process. It has an articular surface that articulates with the trochlea of the humerus to form the elbow joint.

## **The shaft**

The shaft has three borders and three surfaces.

- The lateral *interosseus border* (**margo interosseus**) is the sharpest one.
- *The anterior border* (**margo anterior**) is thick and rounded. It begins on the medial side of the ulnar tuberosity and terminates on the medial side of the styloid process.
- *The posterior border* (**margo posterior**) begins at the back of the olecranon and terminates at the base of the styloid process.
- *The anterior surface* (**facies anterior**) lies between the anterior and interosseus borders. It is smooth.
- *The medial surface* (**facies medialis**) lies between the anterior and posterior borders.
- *The posterior surface* (**facies posterior**) lies between the posterior and interosseus borders. It is rough.

## **The lower end**

It is made up of the head and the styloid process.

- *The head* (**caput ulnae**) has *the articular circumference* (**circumferentia articularis**) that articulates with the ulnar notch of the radius to form the inferior radioulnar joint. It is separated from the wrist joint by the articular disc.
- *The ulnar styloid process* (**processus styloideus ulnae**) projects downwards from the posteromedial side of the lower end of the ulna.
- Posteriorly, between the head and the styloid process there is a groove for the extensor muscle tendon.

## **Side determination**

1. The upper end is hook-like, with its concavity directed forwards.
2. The lateral border of the shaft is sharp and crest-like.
3. The posterior surface of the lower end has a groove for the extensor tendons.

## **Applied anatomy**

1. The ulna is the stabilizing bone of the forearm with its trochlear notch gripping the lower end of the humerus. Thus, the radius can pronate and supinate for efficient work of the upper limb.
2. The shaft of the ulna may fracture either alone or along with the radius.

3. Dislocation of the elbow happens after a fall off on the outstretched hand with the elbow slightly flexed. The olecranon shifts posteriorly and the elbow is fixed in slight flexion.
4. Fracture of the olecranon is common and is caused by a fall off on the point of the elbow.

### **THE CARPAL BONES (ossa carpi)**

The carpus is made up of 8 carpal bones, which are arranged in two rows.

1. The proximal row contains (from lateral to medial side):
  - *scaphoid* (**os scaphoideum**). It has a *tubercle* (**tuberculum ossis scaphoidei**) on its lateral side.
  - *lunate* (**os lunatum**).
  - *triquetral* (**os triquetrum**).
  - *pisiform* (**os pisiforme**).
2. The distal row contains in the same order:
  - *trapezium* (**os trapezium**). It has a *tubercle* (**tuberculum ossis trapezii**) on its lateral side.
  - *trapezoid* (**os trapezoideum**).
  - *capitate* (**os capitatum**).
  - *hamate* (**os hamatum**). It has a *hook* (**hamulus ossis hamati**) near its base.

*The carpal groove (sulcus carpi)* is limited: laterally by the tubercles of the scaphoid and trapezium; medially by the pisiform and the hook of the hamate.

### **Applied anatomy**

1. Fracture of the scaphoid is quite common. It is caused by a fall on the outstretched hand or on the tips of the fingers. It is important that this fracture often does not heal. Avascular necrosis of the body of the bone happens in this case.
2. Dislocation of the lunate after the fracture often causes carpal tunnel syndrom.

### **THE METACARPALS (ossa metacarpi)**

These are 5 miniature long bones, which are numbered from lateral to the medial side. Each bone has a head (placed distally), a shaft and a base (at the proximal end).

- **The head (caput ossis metacarpi)** is rounded. It has an articular surface for the base of the proximal phalange.
- **The shaft (corpus ossis metacarpi)** is concave on the palmar surface.
- **The base (basis ossis metacarpi)** is irregularly expanded. It has articular surface(s) for the carpal bone(s). The metacarpal bones I-IV have articular surfaces for the neighboring bones on lateral and/or medial sides of their bases.

**The metacarpal I** is the shortest and stoutest of all metacarpal bones. The base is occupied by an articular surface for the trapezium.

### Applied anatomy

1. Fracture of the base of the first metacarpal is caused by a force along its long axis. The thumb is forced into a semiflexed position and cannot be opposed. Other metacarpals may also be fractured.
2. When the thumb possesses three phalanges, the first metacarpal has two epiphyses, one at each end. Occasionally, the first metacarpal bifurcates distally. Then the medial branch has no distal epiphysis, and has only two phalanges. The lateral branch has a distal epiphysis and three phalanges.

## THE PHALANGES (ossa digitorum)

The hand has 5 fingers:

- **thumb (pollex)**,
- **index finger (index)**,
- **middle finger (digitus medius)**,
- **ring finger (digitus annularis)**,
- **little finger (digitus minimus)**.
- There are 14 phalanges in each hand, 3 for each finger - **proximal phalanx (phalanx proximalis)**, **middle phalanx (phalanx media)**, **distal phalanx (phalanx distalis)**, and 2 for the thumb (*proximal and distal*).
- Each phalanx has **a base of phalanx (basis phalangis)**, **a shaft of phalanx (corpus phalangis)** and **a head of phalanx (caput phalangis)**.

- *The base* is marked by the facet for articulation with the head of the metacarpal bone (proximal phalanx) or other phalanx (middle or distal phalanges).
- In the proximal and middle phalanges *the head* has a pulley shaped articular surface.
- In distal phalanges *the head* is marked anteriorly by a rough horse-shoe-shaped **tuberosity of distal phalanx** (**tuberositas phalangis distalis**) which supports the sensitive pulp of the finger tip.

### **BONES OF LOWER LIMB (ossa membri inferioris)**

The skeleton of each lower limb consists of:

- **pelvic girdle (cingulum pelvicum)** - hip bone;
- **free part of lower limb (pars libera membri inferioris)**:
  - the bone of the thigh is femur,
  - two bones of the leg are tibia and fibula,
  - bones of the foot are 7 tarsal, 5 metatarsal and phalanges (proximal, middle and distal), the great toe has only two phalanges.

### **THE HIP BONE (os coxae)**

This is a large irregular bone. It is made up of three elements – ilium, pubis and ischium – which are fused by their bodies at the acetabulum.

#### **The ilium (os ilium)**

The ilium forms the upper expanded plate like part of the hip bone. A lower part of this bone is called *the body of ilium (corpus ossis ilii)*, it is fused with the pubis and the ischium at the acetabulum. An upper part of ilium is called *the ala of ilium (ala ossis ilii)*. The arcuate line lies between the body and the ala.

- The upper border of the ala forms a broad ridge that is convex upwards. This ridge is called *the iliac crest (crista iliaca)*.
- The anterior end of the iliac crest projects forwards as *the anterior superior iliac spine (spina iliaca anterior superior)*.
- The posterior end of the crest also forms a projection called *the posterior superior iliac spine (spina iliaca posterior superior)*.

- A few centimeters below these spines there are *the anterior inferior iliac spine* (**spina iliaca anterior inferior**) and *the posterior inferior iliac spine* (**spina iliaca posterior inferior**) respectively.
- The iliac crest has *the inner* and *outer lips* (**labium internum et externum**). *The intermediate zone* (**linea intermedia**) lies between the lips.
- The smooth and concave *iliac fossa* (**fossa iliaca**) occupies the anterior part of the inner surface of the ala.
- *The iliac tuberosity* (**tuberositas iliaca**) above and *the auricular surface* (**facies auricularis**) below occupy the posterior part of the inner surface of the ala. The auricular surface articulates with the sacrum to form the sacroiliac joint.
- The sharp border separates the iliac fossa from the auricular surface. Its lower part forms *the arcuate line* (**linea arcuata**). The lower end of the arcuate line reaches the junction of the ilium and pubis, which is called *the iliopubic eminence* (**eminentia iliopubica**).
- The outer surface of the ala is marked by three ridges called:
  - *the anterior gluteal line* (**linea glutea anterior**) - convex line which begins about 2,5 cm behind the anterior superior spine, runs backwards and downwards and ends at the middle of the upper border of the greater sciatic notch,
  - *the posterior gluteal line* (**linea glutea posterior**) - vertical line passing from the iliac crest to the posterior inferior iliac spine,
  - *the inferior gluteal line* (**linea glutea inferior**) - horizontal line which begins a little above the anterior inferior spine, runs backwards and downwards and ends near the apex of the greater sciatic notch.

### **The ischium (ischium)**

The ischium consists of a main part called *the body* (**corpus ossis ischii**), and a projection called *the ramus* (**ramus ossis ischii**).

- The upper end of the body forms the inferior part of the acetabulum.
- The lower part of the body forms *the ischial tuberosity* (**tuber ischiadicum**).
- There is *the ischial spine* (**spina ischiadica**) above the ischial tuberosity. It separates the greater and the lesser sciatic notches:

- *The greater sciatic notch* (**incisura ischiadica major**) is between the ischial spine and the posterior inferior iliac spine.
- *The lesser sciatic notch* (**incisura ischiadica minor**) is between the ischial spine and the ischial tuberosity.
- The ramus of the ischium connects with the inferior ramus of the pubis.

### **The pubis (os pubis)**

The pubis has a body, a superior ramus and an inferior ramus. *The body* (**corpus ossis pubis**) forms the anterior part of the acetabulum.

- *The superior pubic ramus* (**ramus superior ossis pubis**) connects with *the inferior pubic ramus* (**ramus inferior ossis pubis**) medially. There is *the symphyseal surface* (**facies symphysialis**), which articulates with the opposite pubis to form the pubic symphysis.
- *The pubic crest* (**pecten ossis pubis**) begins from the iliopubic eminence and ends at *the pubic tubercle* (**tuberculum pubicum**). It is the continuation of the arcuate line. The pecten pubis and the arcuate line form *the terminal line* (**linea terminalis**), that separates the greater and lesser pelvises.
- *The obturator groove* (**crista obturatoria**) crosses the lower surface of the superior ramus.
- *The inferior ramus* extends from the symphysis to the ramus of the ischium.

### **The acetabulum (acetabulum)**

- It is a deep cup-shaped hemispherical cavity on the lateral aspect of the hip bone.
- *The acetabular notch* (**incisura acetabuli**) is on the margin of the acetabulum. It is bridged by the transverse ligament.
- The nonarticular floor is called *the acetabular fossa* (**fossa acetabuli**).
- A horseshoe shaped articular surface is called *the lunate surface* (**facies lunata**). It articulates with the head of the femur to form the hip joint.

### **The obturator foramen (foramen obturatum)**

- It is bounded by the rami of the pubis, the ramus of the ischium, the bodies of the pubis and ischium.
- In the upper part of the obturator foramen there is a deep *obturator groove* (**sulcus obturatorius**).

- The obturator groove is converted into the *obturator canal* (**canalis obturatorius**) by the connective tissue *obturator membrane* (**membrana obturatoria**).

### Side determination

1. The acetabulum is directed laterally.
2. The flat, expanded ilium forms the upper part of the bone, above the acetabulum.
3. The obturator foramen lies below the acetabulum. It is bounded anteriorly by the thin pubis, and posteriorly by thick and strong ischium.

## THE FEMUR (femur)

The femur is the longest and strongest bone of the body. It has two ends and a shaft.

### The upper end

- *The head* (**caput femoris**) forms more than half a sphere, and is directed medially, upwards and slightly forwards.
- The head articulates with the acetabulum to form the hip joint.
- A roughened pit is situated just below and behind the center of the head. It is called *the fovea for ligament of head* (**fovea capitis femoris**).
- *The neck* (**collum femoris**) connects the head with the shaft. It makes an angle with the shaft. Its anterior surface is flat and meets the shaft at *the intertrochanteric line* (**linea intertrochanterica**). The posterior surface meets the shaft at *the intertrochanteric crest* (**crista intertrochanterica**).
- *The greater trochanter* (**trochanter major**) is a large quadrangular prominence located at the upper part of the junction of the neck with the shaft. The medial surface presents a deep *trochanteric fossa* (**fossa trochanterica**).
- *The lesser trochanter* (**trochanter minor**) is a conical eminence directed medially and backwards from the junction of the neck and the shaft.

### The shaft of femur (corpus femoris)

- It is convex forwards.
- The medial and lateral borders are rounded, but the posterior border is in the form of a broad ridge, called *the linea aspera* (**linea aspera**).
- The linea aspera has distinct *medial and lateral lips* (**labium mediale et laterale**).

- Medial and lateral lips of the linea aspera diverge in the upper one third of the shaft. The medial lip is called **linea pectinea**, the lateral lip ends near *the gluteal tuberosity* (**tuberositas glutea**). It is a broad roughened ridge on the posterolateral surface of the upper part of the shaft.
- Two lips of the linea aspera diverge in the lower one third of the shaft forming *the popliteal surface* (**facies popliteae**).

### **The lower end**

- The lower end is widely expanded to form two *large condyles*, one *medial* and one *lateral* (**condylus medialis et lateralis**).
- Anteriorly, two condyles are united to form *the patellar surface* (**facies patellaris**).
- Posteriorly, the condyles are separated by a deep gap - *the intercondylar fossa* (**fossa intercondylaris**) and project backwards much beyond the plane of the popliteal surface.
- *The lateral* and *medial epicondyles* (**epicondylus lateralis et medialis**) present above the lateral and medial condyles respectively.

### **Side determination**

1. The upper end bears a rounded head, the lower end is widely expanded to form two large condyles.
2. The head is directed medially.
3. The cylindrical shaft is convex forwards.

### **Applied anatomy**

Tripping over minor obstruction, or other accidents, causing forced medial rotation of the thigh and leg results in:

1. spiral fracture of the shaft of the femur in persons below the age of 16 years;
2. fracture of the neck of the femur over the age of 60 years.

## **PATELLA (patella)**

The patella is the largest sesamoid bone in the body, developed in the tendon of the quadriceps femoris.

- *The base of patella* (**basis patellae**) is superior broad part.

- *The apex of patella* (**apex patellae**) is directed downwards, and lies about 1 cm above the knee joint.
- *The anterior surface* (**facies anterior**) is convex and is covered by an expansion from the tendon of the rectus femoris.
- The posterior surface is *articular surface* (**facies articularis**). The articular area is divided by a vertical ridge into a larger lateral and a smaller medial portion.

### Applied anatomy

1. The patella probably improves the leverage of the quadriceps femoris by increasing the angulation of the line of pull on the leg.
2. Fracture of the patella should be differentiated from a bipartite or tripartite patella.

## THE TIBIA (*tibia*)

The tibia is the medial and larger bone of the leg. That long bone has an upper end, a shaft and a lower end.

### The upper end

- The upper end is markedly expanded from side to side, to form two large *condyles –medial and lateral* (**condylus medialis et lateralis**).
- *The superior articular surface* (**facies articularis superior**) of the medial and lateral condyles articulates with the respective condyle of the femur.
- *The intercondylar eminence* (**eminentia intercondylaris**) lies between the articular surfaces of the two condyles. It is flanked by *the medial* and *lateral intercondylar tubercles* (**tuberculum intercondylare mediale et laterale**).
- *The anterior intercondylar area* (**area intercondylaris anterior**) lies in front of the intercondylar eminence, *the posterior intercondylar area* (**area intercondylaris posterior**) lies behind it.
- The posterolateral aspect of the lateral condyle has *the fibular articular facet* (**facies articularis fibularis**) for the head of the fibula.
- *The tuberosity of the tibia* (**tuberositas tibiae**) is a prominence located on the anterior aspect of the upper end of the tibia.

### **The shaft (corpus tibiae)**

- **The anterior border (margo anterior)** is sharp. It extends from the tibial tuberosity above, to the anterior border of the medial malleolus below.
- **The medial border (margo medialis)** is rounded. It extends from the medial condyle above, to the posterior border of the medial malleolus below.
- The lateral **interosseus border (margo interosseus)** extends from the lateral condyle a little below and in front of the fibular facet, to the anterior border of the fibular notch.
- **The lateral surface (facies lateralis)** lies between the anterior and interosseus borders.
- **The posterior surface (facies posterior)** lies between the medial and interosseus borders. Its upper part is crossed obliquely by a rough ridge called **the soleal line (linea musculi solei)**. It begins just behind the fibular facet, runs downwards and medially, and terminates by joining the medial border at the junction of its upper and middle third.
- **The medial surface (facies medialis)** lies between the anterior and medial borders.

### **The lower end**

- Medially the lower end is prolonged downwards as **the medial malleolus (malleolus medialis)**.
- The lateral aspect of the lower end presents a triangular **fibular notch (incisura fibularis)** to which the lower end of the fibula is attached.
- The inferior surface of the lower end is **the inferior articular surface (facies articularis inferior)**. It articulates with the superior trochlear surface of the talus and thus takes part in forming the ankle joint. Medially the articular surface extends on to the medial malleolus as **an articular facet (facies articularis malleoli medialis)**.

### **Side determination**

1. The upper end is much larger than the lower end.
2. The medial side of the lower end projects downwards beyond the rest of the bone. The projection is called the medial malleolus.
3. The anterior aspect of the upper end has the tuberosity of the tibia.

## Applied anatomy

1. The upper end of the tibia is one of the commonest sites for acute osteomyelitis. The knee joint remains safe because the capsule is attached near the articular margins of the tibia, proximal to the epiphyseal line.
2. The tibia is commonly fractured at the junction of the upper two thirds and the lower one third of the shaft. Such fracture heals very slow, since the blood supply to this part of the bone is poor.
3. Sometimes a surgeon takes a piece of bone and uses it to repair a defect in some other bone. The pieces of bone are easily obtained from the subcutaneous medial aspect of the tibia.

## THE FIBULA (fibula)

The fibula is the lateral and smaller bone of the leg. It has an upper end, a shaft and a lower end.

### The upper end

- It is slightly expanded in all directions.
- The superior surface bears a circular *articular facet* (**facies articularis capitis fibulae**) which articulates with the lateral condyle of the tibia.
- *The apex of head* (**apex capitis fibulae**) projects upwards from its posterolateral aspect.
- The constriction immediately below the head is called *the neck* (**collum fibulae**).

**The shaft** has 3 borders – *anterior, posterior and interosseus* (**margo anterior, posterior et interosseus**), and 3 surfaces – *medial, lateral and posterior* (**facies medialis, lateralis et posterior**).

### The lower end

- It is *the lateral malleolus* (**malleolus lateralis**).
- The medial surface of the lateral malleolus bears a triangular *articular facet* (**facies articularis malleoli lateralis**) for the talus (anteriorly) and *the malleolar fossa* (**fossa malleoli lateralis**) posteriorly.

### **Side determination**

1. The upper end is slightly expanded in all directions. The lower end is expanded anteroposteriorly and is flattened from side to side.
2. The medial side of the lower end bears an articular facet anteriorly, and a deep fossa posteriorly.

### **Applied anatomy**

1. The common peroneal nerve can be rolled against the neck of the fibula. This nerve is commonly injured here.
2. The fibula is an ideal spare bone for a bone graft.
3. Though it does not bear any weight, the lateral malleolus and the ligaments attached to it are very important in maintaining stability at the ankle joint.

### **THE TARSAL BONES (ossa tarsi)**

- The tarsus is made up of seven tarsal bones, arranged in two rows.
- In the proximal row there are the talus above, and the calcaneus below.
- In the distal row there are four tarsal bones lying side by side. From medial to lateral side they are: the medial cuneiform, intermediate cuneiform, lateral cuneiform and cuboid.
- Another bone, the navicular, is interposed between the talus and the three cuneiform bones.

### **The talus (talus)**

The talus is the second largest tarsal bone. It lies between the tibia above and the calcaneus below, gripped on the sides by the two malleoli. It has a head, a neck and a body.

### **The head**

- **The head (caput tali)** is directed forwards.
- Its anterior surface is convex. It is called **the navicular articular surface (facies articularis navicularis)** and articulates with the posterior surface of the navicular bone.
- The inferior surface bears **the anterior facet for calcaneus (facies articularis calcanea anterior)**.

### **The neck (*collum tali*)**

- It is the constricted part of the bone between the head and the body.
- Its inferior surface has *the middle facet for calcaneus* (**facies articularis calcanea media**).

### **The body (*corpus tali*)**

- The body forms *the trochlea of talus* (**trochlea tali**)
- The superior surface of the trochlea bears *a superior facet* (**facies superior**) which articulates with the inferior articular surface of the tibia to form the ankle joint.
- The medial surface of the trochlea has *a medial malleolar facet* (**facies malleolaris medialis**) that articulates with the medial malleolus.
- The lateral surface of the trochlea forms *the lateral process* (**processus lateralis tali**), and this surface has *a lateral malleolar facet* (**facies malleolaris lateralis**) for the lateral malleolus.
- The posterior surface forms *the posterior process* (**processus posterior tali**), that is marked by an oblique *groove for tendon of flexor hallucis longus* (**sulcus tendinis musculi flexoris hallucis longi**). The groove is bounded by *medial* and *lateral tubercles* (**tuberculum mediale, laterale**).
- The inferior surface bears *the posterior calcaneal articular facet* (**facies articularis calcanea posterior**).

Three facets for calcaneus (anterior, middle and posterior) articulate with corresponding facets on the upper surface of the calcaneus. *The sulcus tali* (**sulcus tali**) lies between the middle and posterior facets for calcaneus. It forms *the tarsal sinus* (**sinus tarsi**) along with the sulcus calcanei.

### Side determination

1. The head is directed forwards.
2. The trochlear articular surface of the body is directed upwards, and concave articular surface is directed downwards.
3. The lateral surface of the body has the lateral process.

### **The calcaneus (*calcaneus*)**

The calcaneus is the largest tarsal bone. It forms the prominence of the heel. The body of this bone has 6 surfaces.

- The anterior surface is small. It has a concavoconvex *articular surface for cuboid* (**facies articularis cuboidea**).
- The posterior surface forms *the calcaneal tuberosity* (**tuber calcanei**).
- The medial surface has a prominence of bone called *the sustentaculum tali* (**sustentaculum tali**). Its inferior surface has *the groove for tendon of flexor hallucis longus* (**sulcus tendinis musculi flexoris hallucis longi**).
- The lateral surface is rough and almost flat. There is a small elevation termed *the peroneal trochlea* (**trochlea fibularis**). *The groove for tendon of peroneus longus* (**sulcus tendinis musculi fibularis longi**) lies just below it.
- The superior surface bears *three talar articular facets* (anterior, middle and posterior) (**facies articularis talaris anterior, media et posterior**) that articulate with corresponding facets on the talus. The middle facet is separated from the posterior facet by a deep groove called *the calcaneal sulcus* (**sulcus calcanei**). It comes into opposition with the sulcus tali to form the sinus tarsi.
- The inferior surface is rough.

#### Side determination

1. The anterior surface is small and bears an articular facet. The posterior surface is large and rough.
2. The upper surface bears a large articular surface in the middle.
3. The lateral surface is flat, the medial surface bears the sustentaculum tali.

#### **The navicular (os naviculare)**

The navicular bone is boat-shaped. It is situated on the medial side of the foot, in front of the head of the talus, and behind the three cuneiform bones.

- The anterior surface is convex, and is divided into 3 facets for the three cuneiform bones.
- The posterior surface is concave and oval for articulation with the head of the talus.
- The lateral surface bears a facet for the cuboid.
- The medial surface has a prominent *tuberosity* (**tuberositas ossis navicularis**), directed downwards.

### **The cuneiform bones (ossa cuneiformia)**

There are three cuneiform bones: medial, intermediate and lateral. The medial cuneiform is the largest and the intermediate cuneiform is the smallest. They are situated in front of the navicular bone and behind the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> metatarsal bones.

### **The cuboid (os cuboideum)**

The cuboid is the lateral bone of the distal row of the tarsus, situated in front of the calcaneus and behind the 4<sup>th</sup> and 5<sup>th</sup> metatarsal bones.

## **THE METATARSAL BONES (ossa metatarsi)**

The metatarsus is made up of 5 metatarsal bones, which are numbered from medial to lateral side. Each metatarsal is a miniature long bone, and has *a shaft (corpus ossis metatarsi)*, *a base (basis ossis metatarsi)* or proximal end, and *a head (caput ossis metatarsi)* or distal end. The metatarsal bones are similar in structure to the metacarpal bones.

- The shaft is slightly convex dorsally.
- The first metatarsal is the shortest, thickest and stoutest of all metatarsal bones.
- The second metatarsal is the longest. The lateral side of the base of the 5<sup>th</sup> metatarsal has a large *tuberosity of fifth metatarsal bone (tuberositas ossis metatarsi quinti)* projecting backwards and laterally.

## **THE PHALANGES (ossa digitorum)**

The foot has 5 fingers: *great toe (hallux)*, *second toe (digitus secundus)*, *third toe (digitus tertius)*, *fourth toe (digitus quartus)*, *little toe (digitus minimus)*.

The phalanges of the foot are arranged on a pattern similar to that in the hand. There are 14 phalanges in each foot – 2 for the great toe and 3 for each of the rest toes. These bones are similar in shape to those of the hand, but are much shorter and thinner.

## BONES OF CRANIUM (*ossa cranii*)

The skeleton of the head consists of several bones that are joined together to form the cranium. The cranium can be divided into two main parts:

1. ***The neurocranium (neurocranium)*** is the upper part of the cranium which encloses brain. It has paired parietal and temporal bones, and unpaired frontal, occipital, sphenoid and ethmoid bones.
2. ***The facial skeleton (viscerocranium)*** is composed of paired maxilla, zygomatic, nasal, lacrimal, palatine, inferior nasal concha, and unpaired mandible and vomer.

## THE OCCIPITAL BONE (*os occipitale*)

The occipital bone forms the posterior and inferior walls of the brain case and it has the basilar part anteriorly, two lateral parts and the squamous part posteriorly. ***The foramen magnum (foramen magnum)*** is limited by these parts.

### The basilar part (*pars basilaris*)

- ***The groove for inferior petrosal sinus (sulcus sinus petrosi inferioris)*** is seen on the lateral edges of the basilar part.
- The inferior surface is a component of the superior pharyngeal wall and it bears ***the pharyngeal tubercle (tuberculum pharyngeum)***.
- The basilar part fuses with the sphenoid bone by the age 18. The superior surfaces of basilar part and the body of sphenoid bone form ***the clivus (clivus)***.

### The lateral part (*pars lateralis*)

- The inferior surface of lateral part bears ***the occipital condyle (condylus occipitale)*** for articulation with the lateral mass of atlas.
- The basis of the occipital condyle is pierced by ***the hypoglossal canal (canalis nervi hypoglossi)***.
- Behind the condyle is the condylar fossa. Sometimes it is penetrated by ***the condylar canal (canalis condylaris)*** for condylar emissary vein.
- ***The jugular process (processus jugularis)*** projects laterally to the condyle. This process limits ***the jugular notch (incisura jugularis)*** posteriorly. The jugular

notch of occipital bone and the jugular notch of temporal bone form the jugular foramen (**foramen jugulare**).

- *The groove for sigmoid sinus (sulcus sinus sigmoidei)* lies on the superior surface of lateral part.

#### **The squamous part of occipital bone (squama occipitalis)**

- It has a convex external surface and a concave internal surface.
- *The external occipital protuberance (protuberantia occipitalis externa)* is in the center of the external surface.
- *The external occipital crest (crista occipitalis externa)* extends from the occipital protuberance on the midline to the posterior border of the foramen magnum.
- *The superior nuchal line (linea nuchalis superior)* passes laterally from the protuberance on each side.
- *The inferior nuchal line (linea nuchalis inferior)* passes laterally from the middle of the external occipital crest on each side.
- *The internal occipital protuberance (protuberantia occipitalis interna)* is in the center of the internal surface called *the cruciate eminence (eminentia cruciformis)*.
- *The internal occipital crest (crista occipitalis interna)* extends from the internal protuberance on the midline to the posterior border of the foramen magnum.
- *The groove for transverse sinus (sulcus sinus transversi)* passes laterally from the internal protuberance on each side.
- *The groove for superior sagittal sinus (sulcus sinus sagittalis superioris)* passes upwards from the internal protuberance.

#### **THE PARIETAL BONE (os parietale)**

The parietal bone is a paired bone forming the middle part of the brain case. This bone is a quadriangular plate with convex external and concave internal surfaces. It has 4 borders and 4 angles.

- The anterior *frontal border (margo frontalis/лобный край)* articulates with the frontal bone.

- The posterior *occipital border* (**margo occipitalis**/затылочный край) articulates with the occipital bone.
- The medial *sagittal border* (**margo sagittalis**/сагиттальный край) articulates with the contralateral parietal bone. *The groove for superior sagittal sinus* (**sulcus sinus sagittalis superioris**/борозда верхнего сагиттального синуса) passes along this border on internal surface. *The granular foveolae* (**foveolae granulares**/ямочки грануляций) are seen on either side of the sulcus.
- The lateral *squamosal border* (**margo squamosus**) articulates with the temporal bone.
- *The frontal angle* (**angulus frontalis**) unites with the frontal bone.
- *The occipital angle* (**angulus occipitalis**) unites with the occipital bone.
- *The mastoid angle* (**angulus mastoideus**) unites with the mastoid process of the temporal bone. Its inner surface is marked by *the groove for sigmoid sinus* (**sulcus sinus sigmoidei**).
- *The sphenoidal angle* (**angulus sphenoidalis**) unites with the sphenoid bone. This angle is narrow.
- In the center of *external surface* (**facies externa**) there is *the parietal tuber* (**tuber parietale**).
- Below the parietal tuber there are two curved *temporal lines* (**linea temporalis superior et inferior**).
- *The internal surface* (**facies interna**) is marked by *the groove for middle meningeal artery* (**sulcus arteriae meningae mediae**). It passes from the sphenoidal angle to the occipital angle.

### Side determination

1. The lateral border is squamosal.
2. The anterolateral (sphenoidal) angle is narrow. The posterolateral (mastoid) angle has the groove for sigmoid sinus.
3. The groove for middle meningeal artery passes from the sphenoidal angle to the occipital angle.

## THE FRONTAL BONE (*os frontale*)

The frontal bone is an unpaired bone forming the anterior part of the brain case. This bone has the squamous part, two orbital parts and the nasal part.

### The squamous part (*squama frontalis*)

- It has convex external surface and concave internal surface.
- *The external surface (facies externa)* is marked by two *frontal tubers (tuber frontale)*.
- The inferior border of the squama is called *the supraorbital margin (margo supraorbitalis)*.
- *The supraorbital notch (incisura supraorbitalis)* is in the medial part of this border. It transforms sometimes into *the supraorbital foramen (foramen supraorbitale)*.
- Medially to the supraorbital notch there is *the frontal notch (or foramen) (incisura (foramen) frontalis)*.
- The lateral end of the supraorbital border forms *the zygomatic process (processus zygomaticus)* that articulates with the zygomatic bone. *The temporal line (linea temporalis)* extends upwards from the process and limits *the temporal surface (facies temporalis)* of the squama.
- *The superciliary arch (arcus superciliaris)* lies just above the supraorbital border.
- *The glabella (glabella)* lies between two superciliary arches.
- *The groove for superior sagittal sinus (sulcus sinus sagittalis superioris)* passes vertically on the midline of *the internal surface (facies interna)*. Inferiorly this groove turns into *the frontal crest (crista frontalis)*.
- *The foramen caecum (foramen caecum)* lies near the lower end of the frontal crest.

### The orbital part (*pars orbitali*)

- The orbital parts are two horizontal plates. They are separated by *the ethmoidal notch (incisura ethmoidalis)*, which is filled by the ethmoid bone.
- The concave inferior surface is called *the orbital surface (facies orbitalis)*. It forms the superior orbital wall and bears marks of adjacent accessories of the eye:

- *The lacrimal fossa (fossa glandulae lacrimalis)* lies near the zygomatic process.
- *The trochlear fovea (fovea trochlearis)* and *the trochlear spine (spina trochlearis)* lie near the frontal notch.
- The superior surface faces the cranial cavity. This surface has *the impressions of cerebral gyri (impressiones gyrorum)*.
- The posterior border articulates with the sphenoid bone.

#### **The nasal part (pars nasalis)**

- The nasal part surrounds the ethmoidal notch.
- *The nasal spine (spina nasalis)* lies anteriorly and it is directed downwards.
- On the left and on the right of the nasal spine there is *the opening of frontal sinus (apertura sinus frontalis)*. This opening leads into *the frontal sinus (sinus frontalis)* located in the thickness of the bone to the back of the superciliary arch.
- The frontal sinus contains air and is separated by *the septum of frontal sinuses (septum sinuum frontaliu)* into two parts.

### **THE SPHENOID BONE (os sphenoidale)**

This bone has complex structure and consists of the body and three paired processes – the greater wings, the lesser wings and the pterygoid processes. *The superior orbital fissure (fissura orbitalis superior)* lies between the lesser and greater wings. The III, IV, VI cranial nerves and the first branch of the trigeminal nerve (V) pass through it.

#### **The body (corpus)**

- The superior surface of the body has a depression called *the sella turcica (sella turcica)*.
- *The hypophysial fossa (fossa hypophysialis)* lies on the floor of the sella turcica.
- *The tuberculum sellae (tuberculum sellae)* limits the sella turcica anteriorly.
- *The prechiasmatic sulcus (sulcus prechiasmaticus)* lies in front of the tuberculum sellae.
- *The dorsum sellae (dorsum sellae)* limits the sella turcica posteriorly. The lateral parts of the dorsum project forwards and are called *the posterior clinoid processes (processus clinoides posterior)*.

- *The carotid sulcus (sulcus caroticus)* for the internal carotid artery passes on each lateral surface of the body.
- The posterior surface of the body fuses with the basilar part of occipital bone and forms the clivus.
- *The sphenoidal crest (crista sphenoidalis)* is seen on the anterior surface of the body. The crest continues down to become *the sphenoidal rostrum (rostrum sphenoidale)*. The rostrum penetrates into the space between the wings of the vomer. The crest connects with the perpendicular plate of the ethmoid bone.
- *The openings of sphenoidal sinus (apertura sinus sphenoidalis)* are seen to the sides of the crest. They pierce *the sphenoidal concha (concha sphenoidalis)* and lead into *the sphenoidal sinus (sinus sphenoidalis)*. The sphenoidal sinus is divided by *a septum of sphenoidal sinus (septum sinuum sphenoidalium)* into two parts.

#### **The greater wing (ala major)**

- The greater wings have four surfaces:
  - *The cerebral surface (facies cerebralis)* has *the impressions of cerebral gyri (impressiones gyrorum)*.
  - *The orbital surface (facies orbitalis)* forms the lateral wall of the orbit.
  - *The maxillary surface (facies maxillaris)* is directed to the maxillary tuber.
  - *The temporal surface (facies temporalis)* forms the medial wall of the temporal fossa.

There is *the infratemporal crest (crista infratemporalis)*. It separates *the infratemporal surface (facies infratemporalis)* that forms the medial wall of infratemporal fossa.

- There are three openings at the base of greater wing:
  - *The foramen rotundum (foramen rotundum)* lies anteriorly. The second branch of the trigeminal nerve passes through it.
  - *The foramen ovale (foramen ovale)* for the third branch of the trigeminal nerve.
  - *The foramen spinosum (foramen spinosum)* for the middle meningeal artery, passing through it. Near this foramen the wing has a projection called *the spine of sphenoid bone (spina ossis sphenoidalis)*.

### **The lesser wing (ala minor)**

- The lesser wings arise by two roots from the body of the sphenoid bone and extend forwards and laterally.
- *The optic canals (canalis opticus)* are located between two roots of the lesser wings. The optic nerve passes through it.
- The posterior borders of the lesser wings are free and carry on *the anterior clinoid processes (processus clinoides anterior)*.

### **The pterygoid process (processus pterygoideus)**

- The pterygoid processes are directed downwards from the junction of the greater wings and the body of the sphenoid bone.
- Their base is pierced by *the pterygoid canal (canalis pterygoideus)*, which transmits the pterygoid nerve and vessels. Its anterior opening communicates with the pterygopalatine fossa.
- Each process is made up of *medial* and *lateral plates (lamina medialis et lateralis)*, between which *the pterygoid fossa (fossa pterygoidea)* is located posteriorly.
- The inferior portion of the pterygoid fossa is continuous with *the pterygoid notch (incisura pterygoidea)*. The pyramidal process of the palatine bone penetrates into this notch.
- The anterior surface of the pterygoid process is marked by *the greater palatine groove (sulcus palatinus major)*.
- The inferior part of the medial plate forms the hook-like process called *the pterygoideus hamulus (hamulus pterygoideus)*. The tendon of m. tensor palatini passes around the hamulus pterygoideus.

### **THE ETHMOID BONE (os ethmoidale)**

The ethmoid bone is located centrally between the bones of the face and comes in contact with most of them to form the nasal cavity and orbit.

The ethmoid bone has three parts: vertical *perpendicular plate (lamina perpendicularis)*, horizontal *cribriform plate (lamina cribrosa)* and *two ethmoidal labyrinths (labyrinthus ethmoidalis)*.

**The perpendicular plate** is a part of the nasal septum.

- *The crista galli (crista galli)* projects upwards from the midline of the cribriform plate (for attachment of the dura mater).

**The cribriform plate** is a rectangular plate fitting into the ethmoid notch of the frontal bone. It is perforated by many small openings like a sieve. The perforations transmit the branches of the olfactory nerve.

**The ethmoidal labyrinths** hang on either side of the perpendicular plate.

- The labyrinths are made up of bony air cells: *anterior, middle* and *posterior ethmoidal cells (cellulae ethmoidales anteriores, mediae et posteriores)*.
- The ethmoidal cells are covered laterally by a thin *orbital plate (lamina orbitalis)*, which takes part in formation of the medial wall of the orbit.
- The ethmoidal cells form *the ethmoidal infundibulum (infundibulum ethmoidale)*. The frontal sinus communicates with the nasal cavity through this infundibulum.
- On the medial surface of the labyrinth there are two *nasal concha (concha nasalis superior et media)* which cover the ethmoidal cells.

### **THE TEMPORAL BONE (os temporale)**

The temporal bone is a paired bone. It forms part of the lateral wall and base of the brain case and houses the organs of hearing and equilibrium.

The temporal bone has three parts: *squamous part (pars squamosa)*, *tympanic part (pars tympanica)* and *petrous part (pars petrosa)*.

#### **The petrous part**

- This part is also called the pyramid because it is shaped like a trihedral pyramid with the base facing externally and *the apex of petrous part (apex partis petrosae)* facing anteriorly and internally towards the sphenoid bone.
- *The internal opening of carotid canal (apertura interna canalis carotici)* lies at the apex of petrous part.
- The pyramid has three surfaces: anterior, posterior and inferior.

- *The petrosquamous fissure* (**fissura petrosquamosa**) separates the squamous and petrous parts.
- *The anterior surface of petrous part* (**facies anterior partis petrosae**) is part of the floor of the middle cranial fossa.
  - The anterior surface of the petrous part has a small depression near its apex. This is *the trigeminal impression* (**impressio trigeminalis**), which lodges the ganglion of the trigeminal nerve.
  - Lateral to the trigeminal impression two small grooves pass: a medial *groove for greater petrosal nerve* (**sulcus nervi petrosi majoris**) and lateral *groove for lesser petrosal nerve* (**sulcus nervi petrosi minoris**). They lead to two openings of the same name, a medial *hiatus for greater petrosal nerve* (**hiatus nervi petrosi majoris**), and a lateral *hiatus for lesser petrosal nerve* (**hiatus nervi petrosi minoris**).
  - *The arcuate eminence* (**eminentia arcuata**) is lateral to these openings. It is formed by the prominence of the superior semicircular canal of the equilibrium organ.
  - The bone surface between the petrosquamous fissure and the arcuate eminence forms *the tegmen tympani* (**tegmen tympani**).
- *The posterior surface of the petrous part* (**facies posterior partis petrosae**) has *the internal acoustic opening* (**porus acusticus internus**) leading into *the internal acoustic meatus* (**meatus acusticus internus**).
- *The inferior surface of the petrous part* (**facies inferior partis petrosae**) faces the base of the cranium.
  - This surface gives off a slender tapering *styloid process* (**processus styloideus**) for attachment of the muscles and ligaments.
  - Thick *mastoid process* (**processus mastoideus**) lies posteriorly. This process contains air *mastoid cells* (**cellulae mastoideae**) separated by a bony trabeculae. They receive air from the tympanic cavity with which they communicate by means of *the mastoid antrum* (**antrum mastoideum**). The outside surface of the mastoid process bears a deep *mastoid notch* (**incisura mastoidea**). *The oc-*

*occipital groove* (**sulcus arteriae occipitalis**) lies medially. A deep *groove for sigmoid sinus* (**sulcus sinus sigmoidei**) is on the inner surface of mastoid process.

- *The stylomastoid foramen* (**foramen stylomastoideus**) is in between the styloid and mastoid processes. It transmits the facial nerve.
- The deep *jugular fossa* (**fossa jugularis**) lies medially to the styloid process.
- *The external opening of carotid canal* (**apertura externa canalis carotici**) is in front of the jugular fossa and this opening is separated from it by a sharp ridge. This ridge has small *petrosal fossa* (**fossula petrosa**).

The petrous part has three borders: anterior, posterior and superior.

- *The anterior border* (**margo anterior**) forms a sharp angle with the squama. **The musculotubal canal** (**canalis musculotubarius**), leading into the tympanic cavity, passes along the anterior border. The canal is divided into two parts by a septum. The upper *canal for tensor tympani* (**semicanalis muscoli tensoris tympani**) lodges the tensor tympani muscle. The lower *canal for auditory tube* (**semicanalis tubae auditivae**) is the bony part of the auditory tube for the conduction of air from the pharynx to the tympanic cavity.
- *The superior border* (**margo superior**) separates the anterior and posterior surfaces. It bears *the groove for superior petrosal sinus* (**sulcus sinus petrosi superioris**).
- The posterior border joins the basilar part of occipital bone and together they form *the groove for inferior petrosal sinus* (**sulcus sinus petrosi inferioris**).

### The squamous part

- *The cerebral surface* (**facies cerebralis**) of the squamous part is marked by *the impressions of cerebral gyri* (**impressiones gyrorum**) and an ascending groove for middle meningeal artery.
- The external surface is called *the temporal surface* (**facies temporalis**). It gives rise to *the zygomatic process* (**processus zygomaticus**), which articulates with the zygomatic bone.

- Just below the zygomatic process there is *the articular fossa* (**fossa mandibularis**) for articulation with the mandible. *The articular tubercle* (**tuberculum articulare**) is in front of the articular fossa.

### **The tympanic part**

- This part fuses with the mastoid process posteriorly and with the petrous part anteriorly.
- It forms *the external acoustic opening* (**porus acusticus externus**) leading into *the external acoustic meatus* (**meatus acusticus externus**).
- *The tympanosquamous fissure* (**fissura tympanosquamosa**) separates the tympanic and squamous parts. This fissure is divided by the process of the petrous part into two parts: *petrosquamous fissure* (**fissura petrosquamosa**) anteriorly and *petrotympanic fissure* (**fissura petrotympanica**) posteriorly.
- *The tympanomastoid fissure* (**fissura tympanomastoidea**) separates the tympanic part from the mastoid process.

### **The canals of the temporal bone**

1. *The carotid canal* (**canalis caroticus**) transmits the internal carotid artery. It begins as the external opening of carotid canal on the inferior surface of the petrous part, then ascends and opens by the internal opening of carotid canal at the apex of petrous part medially to the musculotubal canal.
2. *The facial canal* (**canalis nervi facialis**) begins in the depth of porus acoustic internus and passes forwards and laterally to the hiatus for greater petrosal nerve. There the canal turns to the right and forms *the geniculum of facial canal* (**geniculum canalis nervi facialis**) and then it passes laterally and backwards. The canal ends up as the stylomastoid foramen on the inferior surface of petrous part.

## **THE MAXILLA (maxilla)**

The maxilla is a paired bone of a complex structure. It takes part in the formation of the orbit, the nasal cavity and the septum between the nasal and oral cavities.

The maxilla consists of a body and four processes.

### **The body of maxilla (corpus maxillae)**

- The body has a large air *maxillary sinus* (**sinus maxillaris** seu antrum Highmori), which communicates with the nasal cavity by a wide opening called *the maxillary hiatus* (**hiatus maxillaris**).
- The body has four surfaces - anterior, infratemporal, nasal and orbital.

### **The anterior surface (facies anterior)**

- The anterior surface is concave. In the center of this surface there is *the canine fossa* (**fossa canina**).
- The anterior surface is separated from the orbital surface by *the infraorbital margin* (**margo infraorbitalis**) and from the infratemporal surface by the zygomatic process.
- Just below the infraorbital margin is *the infraorbital foramen* (**foramen infraorbitale**) through which the infraorbital nerve and artery leave the orbit.
- The medial border of the anterior surface is formed by *the nasal notch* (**incisura nasalis**). The notch forms *the anterior nasal spine* (**spina nasalis anterior**) inferiorly.

### **The infratemporal surface (facies infratemporalis)**

- The infratemporal surface bears *the maxillary tuberosity* (**tuber maxillae**).
- The maxillary tuber has several small *alveolar foramen* (**foramina alveolaria**) leading into *alveolar canals* (**canales alveolares**) transmitting the nerves and vessels to the upper teeth.
- The inner surface of the tuber bears *the greater palatine groove* (**sulcus palatinus major**).

### **The nasal surface (facies nasalis)**

- The maxillary hiatus is seen on this surface.
- *The lacrimal groove* (**sulcus lacrimalis**) is between the maxillary hiatus and the base of frontal process.
- *The conchal crest* (**crista conchalis**) lies in front of the nasolacrimal groove. It connects with the inferior nasal concha.

### **The orbital surface (facies orbitalis)**

- *The infraorbital groove (sulcus infraorbitalis)* originates near the posterior border of the orbital surface and turns into *the infraorbital canal (canalis infraorbitalis)* anteriorly. The infraorbital canal opens by the infraorbital foramen on the anterior surface of the maxilla.
- *The alveolar canals (canales alveolares)* arise from the infraorbital canal. They transmit nerves and vessels to the anterior teeth.

#### **The frontal process (processus frontalis)**

- The frontal process projects upwards and joins the nasal part of the frontal bone.
- Its lateral surface bears vertical *anterior lacrimal crest (crista lacrimalis anterior)*.
- The medial surface bears *the ethmoidal crest (crista ethmoidalis)* for attachment of the middle nasal concha.

#### **The alveolar process (processus alveolaris)**

- The alveolar process bears *alveolar arch (arcus alveolaris)* on its inferior border.
- The arch has *dental alveoli (alveoli dentales)* for the eight upper teeth.
- The alveoli are separated by *interalveolar septa (septa interalveolaria)*.

#### **The palatine process (processus palatinus)**

- This process forms most of *the bony palate (palatum osseum)* by joining the contralateral process in the midline.
- Where the processes meet, *the nasal crest (crista nasalis)* rises on the superior surface. It faces the nasal cavity and articulates with the inferior border of the vomer.

**The zygomatic process (processus zygomaticus)** articulates with the zygomatic bone.

### **THE PALATINE BONE (os palatinum)**

The palatine bone takes part in the formation of the nasal and oral cavities, orbit and the pterygopalatine fossa. The bone consists of two plates and three processes.

#### **The horizontal plate (lamina horizontalis)**

- This part of the palatine bone together with the maxillary palatine process forms the bony palate.

- The medial border of the horizontal plate meets the medial border of the contralateral bone to form *the nasal crest (crista nasalis)*.
- *The greater palatine foramen (foramen palatinum majus)* is on the inferior surface of the horizontal plate. Palatine vessels and nerves leave *the greater palatine canal (canalis palatinus major)* through this foramen.

#### **The perpendicular plate (lamina perpendicularis)**

- This plate adjoins the nasal surface of the maxilla.
- The medial surface has upper *ethmoidal crest (crista ethmoidalis)* for the middle nasal concha and lower *conchal crest (crista conchalis)* for the inferior nasal concha.
- *The greater palatine groove (sulcus palatinus major)* is on the lateral surface of the perpendicular plate. This groove together with the same named grooves of the maxilla and the pterygoid process of the sphenoid bone form *the greater palatine canal (canalis palatinus major)*.

#### **Pyramidal process (processus pyramidalis)**

- It projects backwards and laterally from the junction of the horizontal and perpendicular plates.
- Nerves and vessels penetrate the process vertically through *the lesser palatine canals (canales palatini minores)*.

#### **The orbital process (processus orbitalis)**

- It projects from the anterior end of the superior border of the perpendicular plate.
- The process forms the posterior part of the inferior orbital wall.

#### **The sphenoidal process (processus sphenoidalis)**

- It projects from the posterior end of the superior border of the perpendicular plate.
- The process adjoins the inferior surface of the body of the sphenoid bone.

*The sphenopalatine notch (incisura sphenopalatina)* lies between the orbital and sphenoidal processes.

### **THE INFERIOR NASAL CONCHA (concha nasalis inferior)**

It is an independent bone. It is a thin bony plate which upper end is attached to the conchal crest of the maxilla and palatine bone. Its inferior border is free.

### **THE NASAL BONE (os nasale)**

The nasal bone joins the contralateral bone to form the ridge of the nose at its root. It connects with the nasal part of frontal bone (superiorly) and the frontal process of the maxilla (laterally).

### **THE LACRIMAL BONE (os lacrimale)**

- This bone is a thin plate found in the medial orbital wall behind the frontal process of the maxilla.
- Its lateral surface bears *the posterior lacrimal crest (crista lacrymalis posterior)*.
- *The lacrimal groove (sulcus lacrymalis)* lies in front of the crest.
- The groove meets the lacrimal groove of the maxilla to form *the fossa for lacrimal sac (fossa sacci lacrymalis)*.

### **THE VOMER (vomer)**

- The vomer forms part of the bony nasal septum.
- Its superior border has two wings - *ala of vomer (ala vomeris)*, which fit over the rostrum of the sphenoid bone.
- The upper half of the anterior border articulates with the perpendicular plate of the ethmoid bone.
- The inferior border articulates with the nasal crest of the maxilla and palatine bone.
- The posterior border separates the posterior openings of the nasal cavity called *choanae*.

### **THE ZYGOMATIC BONE (os zygomaticum)**

The zygomatic bone connects the frontal and temporal bones and the maxilla by articulating with their zygomatic processes. It has three surfaces and three processes.

- *The orbital surface (facies orbitalis)* takes part in the formation of the orbital wall.
- The smooth posterior surface faces the temporal fossa and is called *the temporal surface (facies temporalis)*.
- *The lateral surface (facies lateralis)* is shaped like a fourpoint star and bulges slightly.
- *The zygomatico-orbital foramen (foramen zygomaticoorbitale)* is on orbital surface. The foramen leads into canal that is divided into two. These canals open on the lateral surface by *the zygomaticofacial foramen (foramen zygomaticofaciale)* and on the temporal surface by *the zygomaticotemporal foramen (foramen zygomatico-temporale)*.
- The superior *frontal process (processus frontalis)* articulates with the zygomatic process of the frontal bone and the greater wing of the sphenoid bone.
- The lateral *temporal process (processus temporalis)* articulates with the zygomatic process of the temporal bone to form *the zygomatic arch (arcus zygomaticus)*.

### THE MANDIBLE (**mandibula**)

The mandible is the only movable bone of the cranium. This bone consists of a horizontal part called the body of mandible and two vertical parts called rami of mandible. The body and the ramus meet at the angle called the angle of mandible.

#### **The body of mandible (corpus mandibulae)**

- The upper *alveolar part (pars alveolaris)* of the body bears *alveolar arch (arcus alveolaris)* on its superior border.
  - The arch has *dental alveoli (alveoli dentales)* for lower teeth.
  - The alveoli are separated by *interalveolar septa (septa interalveolaria)*.
- The rounded massive inferior border of the body forms *the base of mandible (basis mandibulae)*.
- *The mental protuberance (protuberantia mentalis)* lies on the midline of the outer surface of the base.
- *The mental tubercle (tuberculum mentale)* is on each side of this protuberance.

- *The mental foramen* (**foramen mentale**) is on the lateral surface of the body. It is the opening of *the mandibular canal* (**canalis mandibulae**), transmitting nerve and vessels.
- *The oblique line* (**linea obliqua**) runs to the back and upwards from the mental tubercle.
- *The mental spine* (**spina mentalis**) projects from the midline of the inner surface of the body.
- *The sublingual fossa* (**fovea sublingualis**) lies on each side of the mental spine.
- *The digastric fossa* (**fossa digastrica**) is on both sides of the mental spine close to the inferior border of the mandible. Further to the back *the mylohyoid line* (**linea mylohyoidea**) runs backwards and upwards.
- Just below the mylohyoid line there is *the submandibular fossa* (**fovea submandibularis**).

#### **The ramus of mandible (ramus mandibulae)**

- *The mandibular foramen* (**foramen mandibulae**) is on its inner surface leading into mandibular canal.
- The medial border of this foramen projects as *the lingula* (**lingula mandibulae**).
- *The mylohyoid groove* (**sulcus mylohyoideus**) originates behind the lingula and runs downwards and forwards. It lodges the nerve and vessels.
- Superiorly the ramus of the mandible terminates as two processes, anterior *coronoid process* (**processus coronoideus**) and posterior *condylar process* (**processus condylaris**).
- *The crest for buccinator muscle* (**crista buccinatoria**) runs on the inner surface of the ramus upwards from the surface of the alveoli of the last molars towards the coronoid process.
- The condylar process has *the head of mandible* (**caput mandibulae**) that articulates with the articular fossa of the temporal bone to form the temporomandibular joint.

- Just below the head there is *the neck of mandible* (**collum mandibulae**). On the anterior surface of the neck there is *the pterygoid fovea* (**fovea pterygoidea**).

*The angle of mandible* (**angulus mandibulae**) bears on its inner surface *the pterygoid tuberosity* (**tuberositas pterygoidea**) and on outer surface *the masseteric tuberosity* (**tuberositas masseterica**) for the attachment of the chewing muscles.

### THE HYOID BONE (**os hyoideum**)

This bone is situated at the base of the tongue, between the mandible and the larynx.

It consists of *the body of hyoid bone* (**corpus ossis hyoidei**) and two pairs of horns.

- *The greater horns* (**cornua majora**) project from the ends of the body backwards and laterally.
- *The lesser horns* (**cornua minora**) project from the junction of the body and the greater horns upwards and backwards.

### THE CRANIUM AS A WHOLE

The conditional line separates *the calvaria* (**calvaria**) and *the cranial base* (**basis cranii**). The line passes through the external occipital protuberance, the superior nuchal line, the base of mastoid process, superior border of the external acoustic opening, the zygomatic arch and the infratemporal crest of the greater wing of the sphenoid bone, the supraorbital margin of the frontal bone and the glabella.

- *The external surface of cranial base* (**basis cranii externa**) is made up of the inferior surface of the viscerocranium (without the mandible) and the neurocranium.
- *The internal surface of cranial base* (**basis cranii interna**) is separated into three parts. The posterior borders of the lesser wings of the sphenoid bone are the borderline between the anterior and middle fossae. The superior borders of the petrous parts of the temporal bones are the borderline between the middle and posterior fossae.
  - *The anterior cranial fossa* (**fossa cranii anterior**) is formed by the orbital part of the frontal bone, the cribriform plate of the ethmoid bone and the lesser wings of the sphenoid bone.

- ***The middle cranial fossa (fossa cranii media)***. Its medial part is formed by the sella turcica. The lateral parts are formed by the greater wings of the sphenoid bone, the squamous parts of the temporal bones and the anterior surfaces of the petrous parts.
- ***The posterior cranial fossa (fossa cranii posterior)*** is formed by the occipital bone, the posterior part of the body of the sphenoid bone, the petrous parts of the temporal bones and the mastoid angles of the parietal bones.

### **FORAMINA OF THE CRANIUM**

- The lower end of *the medulla oblongata* passes through *the foramen magnum* to become continuous with the spinal cord.
- *The internal carotid artery* enters the cranium by passing through *the carotid canal*.
- Nerve fibres of *olfactory nerve (I)* pass through *aperturæ in the cribriform plate of the ethmoid bone*.
- *The optic nerve (II)* passes from the orbit into the middle cranial fossa through *the optic canal*.
- *The oculomotor (III), trochlear (IV) and abducent (VI) nerves* enter the orbit through *the superior orbital fissure*.
- The trigeminal nerve (V) has three divisions each of which leaves the middle cranial fossa through a different foramen. *The ophthalmic division (1)* enters the orbit through *the superior orbital fissure*. *The maxillary division (2)* passes into *the foramen rotundum* to reach the pterygopalatine fossa. *The mandibular division (3)* passes through *the foramen ovale* to reach the infratemporal region.
- *The facial nerve (VII)* leaves the posterior cranial fossa by passing into *the internal acoustic meatus*, and it emerges through *the stylomastoid foramen*.
- *The vestibulocochlear nerve (VIII)* leaves the posterior cranial fossa by passing through *the internal acoustic meatus*, to reach the internal ear which lies inside of the petrous part of the temporal bone.

- *The jugular vein, the glossopharyngeal (IX), vagus (X) and accessory (XI) nerves* leave the posterior cranial fossa through *the jugular foramen*
- *The hypoglossal nerve (XII)* leaves the posterior cranial fossa through *the hypoglossal canal*.
- *The foramen lacerum (foramen lacerum/рваное отверстие)* lies in the site of connection of the apex of petrous part of the temporal bone, the base of the occipital bone and the body of sphenoid bone. The internal opening of the carotid canal, musculotubal and pterygoid canals open in this region.

### **THE ORBIT (orbita)**

The orbit has a shape of four-sided pyramid and contains the organ of vision. The base of the pyramid corresponds with the entrance to the orbital cavity – *the orbital opening (aditus orbitalis)*. The apex is directed backwards and medially. The orbit has four walls.

#### **The medial wall (paries medialis)**

- This wall is formed by the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoidal bone, the body of the sphenoid bone and the medial part of the orbital surface of the frontal bone.
- The fossa for lacrimal sac is in the anterior part of the medial wall. It leads into *the nasolacrimal canal (canalis nasolacrimalis)* which opens into the inferior nasal meatus of the nasal cavity.
- *The anterior and posterior ethmoidal foramina (foramina ethmoidale anterius et posterius)* are in the suture between the frontal and ethmoidal bones. They transmit the anterior and posterior ethmoidal nerves and vessels and lead into the nasal cavity.

#### **The roof (paries superior)**

- This wall is formed by the orbital surface of the frontal bone and the lesser wing of the sphenoid bone.

### **The lateral wall (*paries lateralis*)**

- This wall is formed by the orbital surface of the zygomatic bone and the greater wing of the sphenoid bone.

### **The floor (*paries inferior*)**

- This wall is formed by the orbital surfaces of the zygomatic bone and maxilla and in the posterior portion by the orbital process of the palatine bone.

*The superior orbital fissure* and *the optic canal* open at the apex of the pyramid. These openings communicate orbit with the cranial cavity.

*The inferior orbital fissure* is between the lateral and inferior walls. Its posterior end leads into the pterygopalatine fossa, and the anterior end into the infratemporal fossa.

## **THE BONY NASAL CAVITY (*cavitas nasalis ossea*)**

The nasal cavity is the initial part of the respiratory tract and lodges the olfactory organ.

- *The piriform aperture (*apertura piriformis*)* is the entrance into the cavity.
- *The choanae (*choanae*)* - paired openings at the back, make an exit from the nasal cavity and lead into the pharynx.
- *The bony nasal septum (*septum nasi osseum*)* divides the nasal cavity into two halves.
- Each half of the nasal cavity has four walls.

### **The lateral wall**

It is formed by the following bones (from front to back): the nasal bone, the nasal surface of the body and frontal process of the maxilla, the lacrimal bone, the ethmoidal labyrinth and the inferior nasal concha, the perpendicular plate of the palatine bone, and the medial plate of the pterygoid process of the sphenoid bone.

### **The medial wall or the bony nasal septum**

It is formed by the perpendicular plate of the ethmoid bone and the vomer superiorly, the nasal crest of the maxilla and the palatine bone inferiorly.

### **The superior wall**

It is formed by the nasal bone, nasal part of the frontal bone, cribriform plate of the ethmoidal bone and the body of the sphenoid bone.

### **The inferior wall**

It is formed by the palatine process of the maxilla and the horizontal plate of the palatine bone which make up *the bony palate* (**palatum osseum**); the opening of *the incisive canal* (**canalis incisivus**) is seen in its front part.

### **The nasal meatus**

Three nasal conchae project downwards into the nasal cavity from the lateral wall. They separate the three nasal meatus – superior, middle and inferior.

#### ***The superior nasal meatus* (meatus nasi superior)**

- It is between the superior and middle conchae of the ethmoid bone. It is found only in the posterior part of the nasal cavity.
- This meatus communicates with:
  - the sphenoidal sinus;
  - the posterior ethmoidal cells.

#### ***The middle nasal meatus* (meatus nasi medius)**

- It is between the middle and inferior nasal conchae.
- This meatus communicates with:
  - the anterior and middle ethmoidal cells;
  - the maxillary sinus through maxillary hiatus;
  - the frontal sinus through the ethmoidal infundibulum;
  - the pterygopalatine fossa through the sphenopalatine foramen.

#### ***The inferior nasal meatus* (meatus nasi inferior)**

- It is between the inferior nasal concha and the inferior wall of the nasal cavity.
- The nasolacrimal canal opens into its anterior part.

***The common nasal meatus* (meatus nasi communis)** is the space between three nasal conchae laterally and the nasal septum medially.

## THE TEMPORAL FOSSA (*fossa temporalis*)

The temporal fossa lodges the temporal muscle.

- ***The medial wall*** is formed by the frontal and parietal bones, the greater wing of the sphenoid bone, the squamous part of the temporal bone.
- ***The anterior wall*** is formed by the temporal surface of the zygomatic bone.
- ***The lateral wall*** is formed by the zygomatic arch.
- The temporal fossa is bounded superiorly by the temporal line, inferiorly by the infratemporal crest of the greater wing of the sphenoid bone.

## THE INFRATEMPORAL FOSSA (*fossa infratemporalis*)

- ***The medial wall*** is formed by the lateral plate of the pterygoid process of the sphenoid bone.
- ***The anterior wall*** is formed by the infratemporal surface of the maxilla and the temporal surface of the zygomatic bone.
- ***The superior wall*** is formed by the inferior surface of the greater wing of the sphenoid bone and squamous part of the temporal bone. It is bounded superiorly by the infratemporal crest of the greater wing of the sphenoid bone also.
- The temporal fossa communicates with
  - the orbit through the inferior orbital fissure;
  - the pterygopalatine fossa through ***the pterygomaxillary fissure (fissura pterygomaxillaris)***.

## THE PTERYGOPALATINE FOSSA (*fossa pterygopalatina*)

- ***The anterior wall*** is formed by the tuber of maxilla.
- ***The medial wall*** is formed by the perpendicular plate of the palatine bone.
- ***The posterior wall*** is formed by the pterygoid process of the sphenoid bone and the pyramidal process of the palatine bone.
- The fossa communicates with:
  - the nasal cavity (middle nasal meatus) through the sphenopalatine foramen;
  - the orbit through the inferior orbital fissure;

- the infratemporal fossa through the pterygomaxillary fissure;
- the middle cranial fossa through the foramen rotundum;
- the external surface of the cranial base through the pterygoid canal;
- the oral cavity through the greater palatine canal.

These openings and canals transmit vessels and nerves.

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