Skeleton of the trunk and limbs

Human Anatomy Department

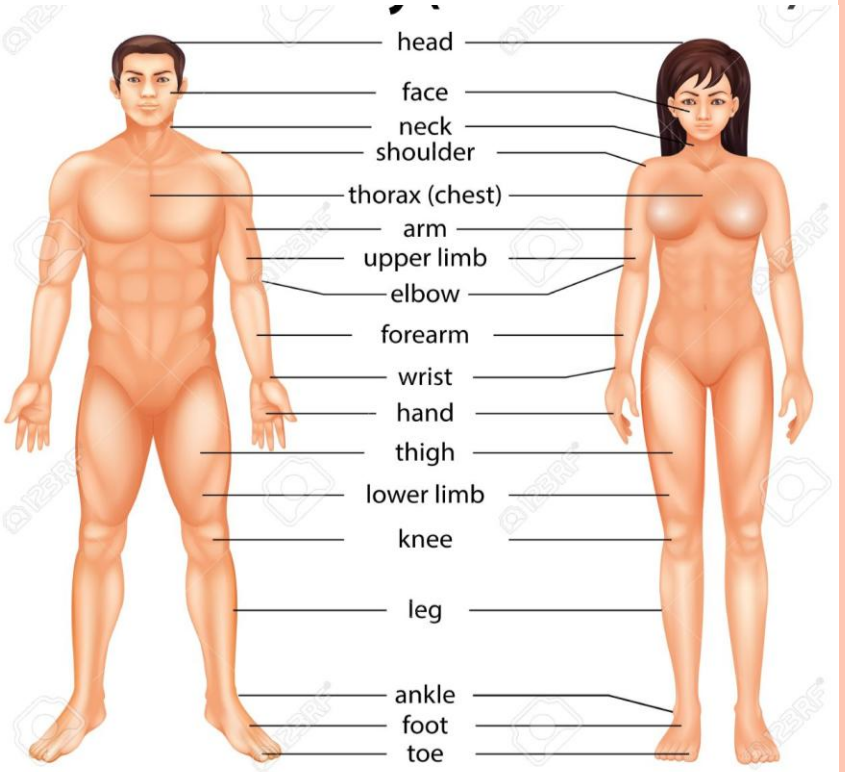
Dr. Anastasia Bendelic

1. **Skeleton of the trunk** – components
   a. ***Vertebral column as a whole***, curvatures
   b. Vertebrae, development, anomalies
   c. ***Thorax as a whole***, apertures
   d. Sternum and ribs, development and anomalies
2. **Skeleton of the limbs** – components
   a. ***Pelvis as a whole***, compartments, apertures
   b. ***Foot as a whole***, arches of the foot
   c. Development and anomalies of the limbs

Parts of the human body

Human body consists of:

- **head**,
- **trunk,**
- 2 pairs of **limbs** (or extremities).



Classification of bones

- According to their topography:

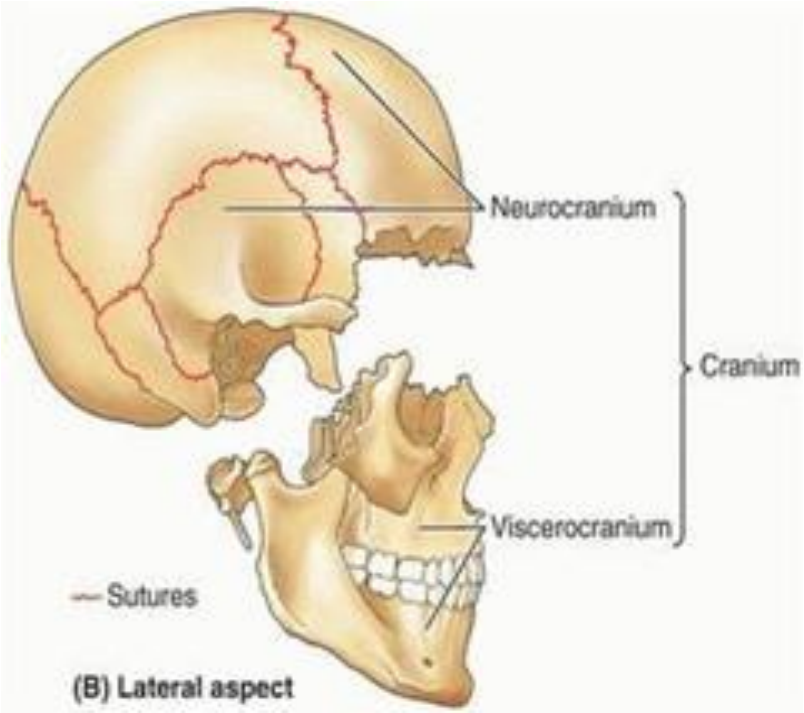
1. Bones of the **skull** (or cranium);
2. Bones of the **trunk**;
3. Bones of the **limbs:**

a) bones of the girdles;

b) bones of the free part of limbs.

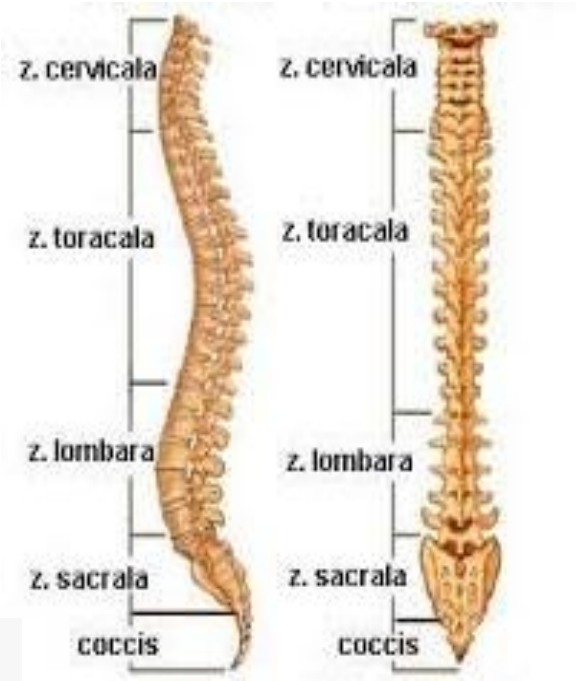
Two parts of skull (or cranium)

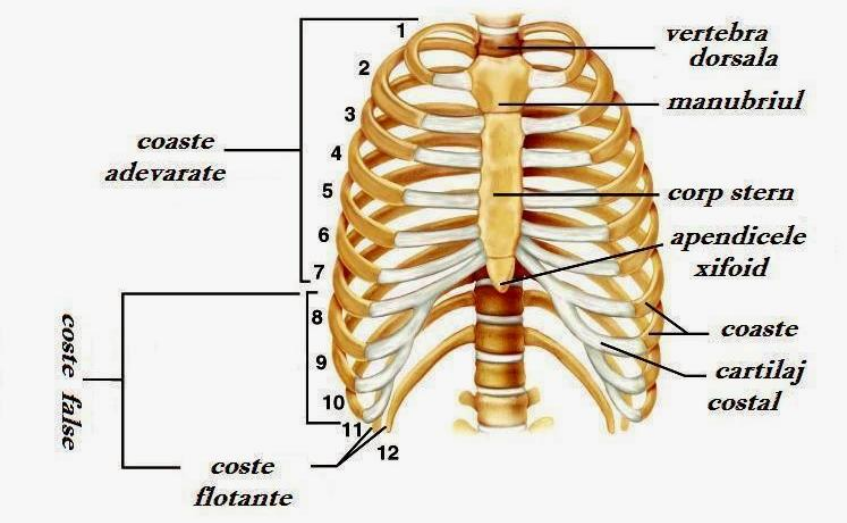
- **Neurocranium** (or *brain box*) forms a protective case around the brain.
- **Viscerocranium** (or *facial skeleton*) forms the skeleton of the face.



Bones of the trunk

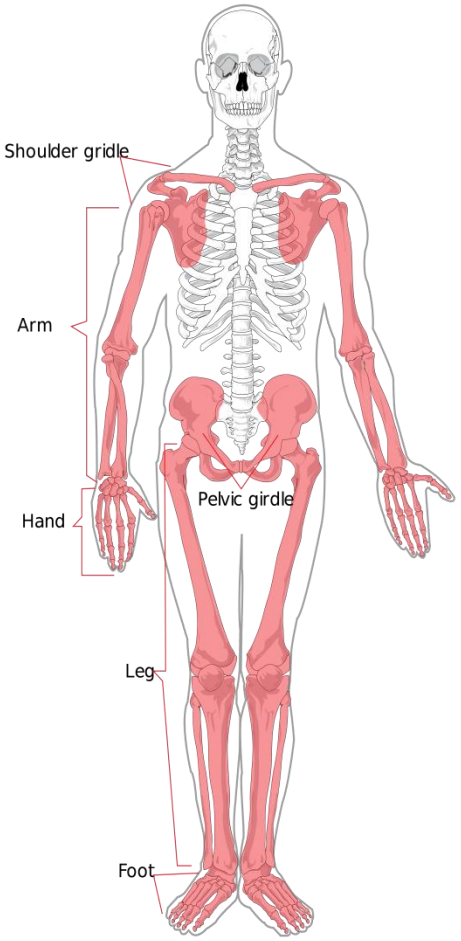
- **Vertebrae** (form the vertebral column or spine);
- **Sternum**;
- **Ribs**.





Bones of the limbs

- **Skeleton of the girdles:**
  - ✓ shoulder/pectoral girdle;
  - ✓ pelvic girdle;
- **Skeleton of the free part of limbs.**



Vertebral column

- Encloses and protects the spinal cord.
- Supports the skull.
- Supports the weight of the head, neck and trunk.
- Transfers the weight to the lower limbs.
- Helps to maintain the upright position of the body.

Vertebral column

Vertebral column as a whole is formed by 33-34 vertebrae:

1. ***Cervical vertebrae – 7*** (CI-CVII);
2. ***Thoracic vertebrae -12*** (TI-TXII);
3. ***Lumbar vertebrae – 5*** (LI-LV);
4. ***Sacral vertebrae – 5*** (SI-SV);
5. ***Coccygeal vertebrae - 4-5*** (C_0I-C_0IV).

Vertebral column consists of 33-34 vertebrae (or 26 bones).

- 24 vertebrae are **true vertebrae** (*cervical, thoracic and lumbar*) – vertebrae which remain unfused throughout life.
- 9-10 vertebrae are **false vertebrae** (*sacral and coccygeal*) – vertebrae which fuse to each other and form two bones (*sacrum* and *coccyx*).

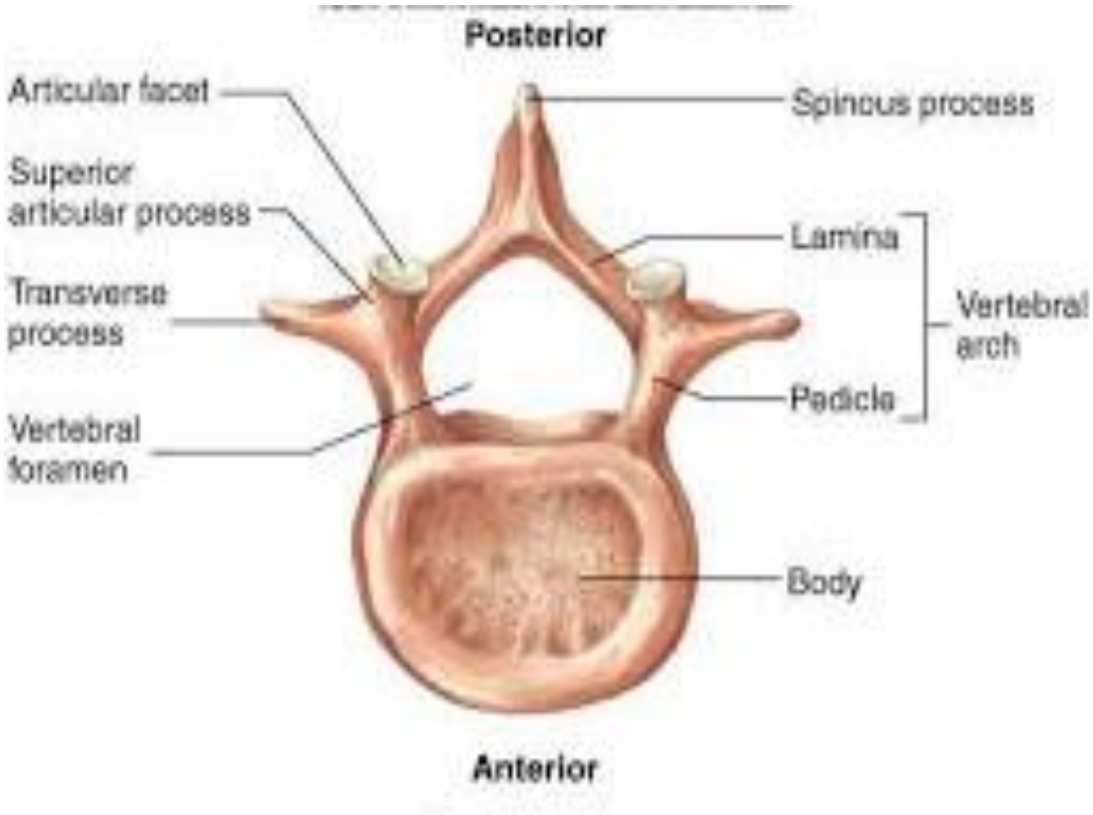
Common features of the true vertebra

1. Anterior part – **body** (*corpus vertebrae*);
2. Posterior part – **arch** (*arcus vertebrae*):

a) 2 pedicles (*pediculi arcus vertebrae*),
b) 2 laminae (*laminae arcus vertebrae),*
c) 7 processes:

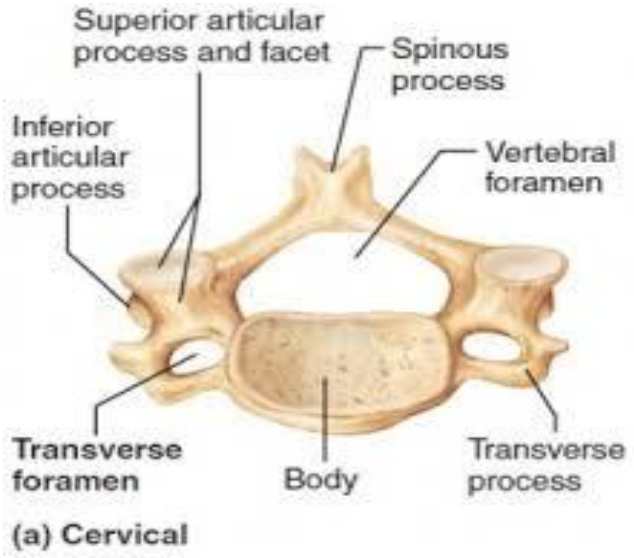
- spinous process (1),
- transverse processes (2),
- articular processes (4).

Common features of the true vertebrae



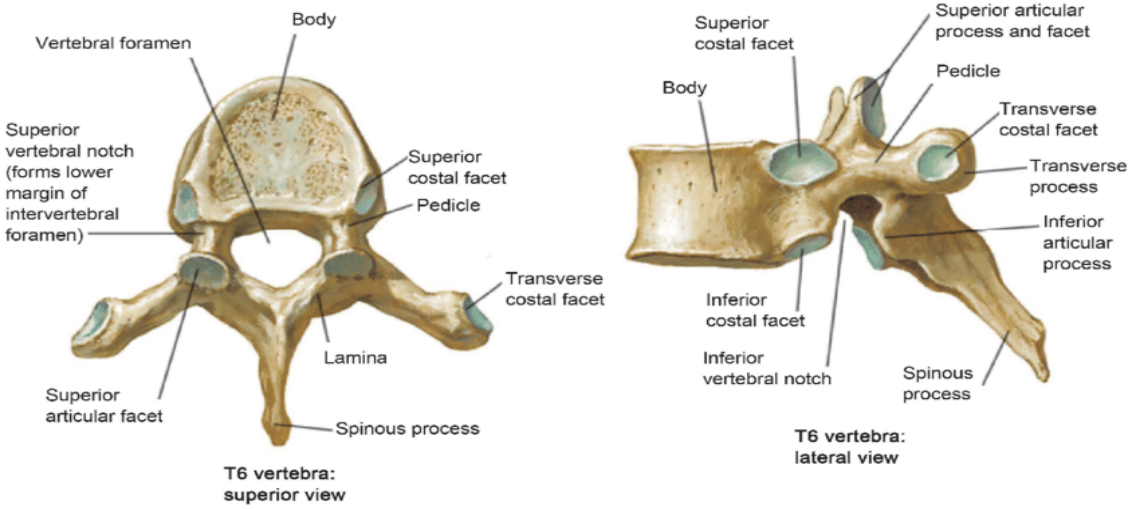
Regional features of the vertebrae

- **Cervical vertebrae**
- ✓ *identified by* the presence of foramen in the transverse process,
- ✓ small bodies,
- ✓ large and triangular vertebral foramen,
- ✓ small bifid spinous process.



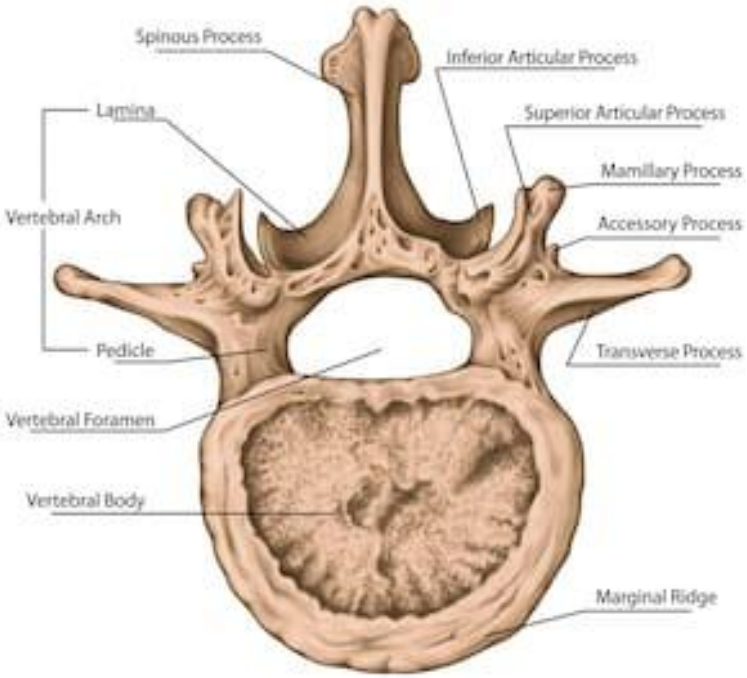
Regional features of the vertebrae

- **Thoracic vertebrae**
- ✓ *identified by* the presence of *costal facets* for articulation with the ribs,
- ✓ heart shaped bodies,
- ✓ circular and small vertebral foramen,
- ✓ long, slope postero-inferiorly spinous process.



Regional features of the vertebrae

- **Lumbar vertebrae**
- ✓ *identified by* large bodies,
- ✓ accessory and mammillary processes.
- **Sacral vertebrae** fused to form the sacrum.
- **Coccygeal vertebrae** fused to form coccyx**.**



The position and shape of vertebral column is determined by the upright position of man.

There are 4 curvatures in sagittal plane:

- **Lordoses** – curvatures convex anteriorly:

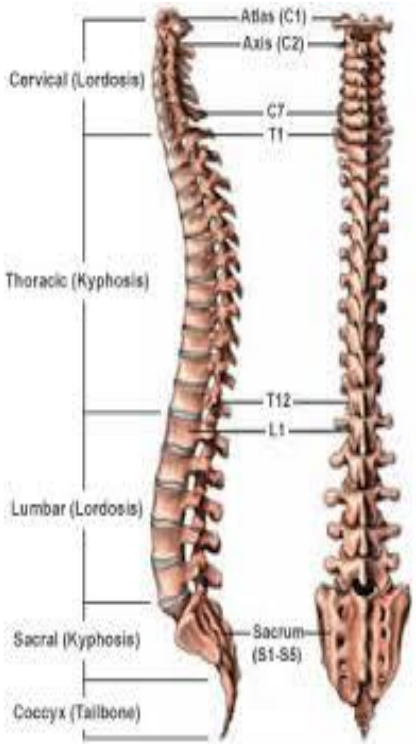
a. cervical lordosis;

b. lumbar lordosis.

- **Kyphoses** – curvatures convex posteriorly:

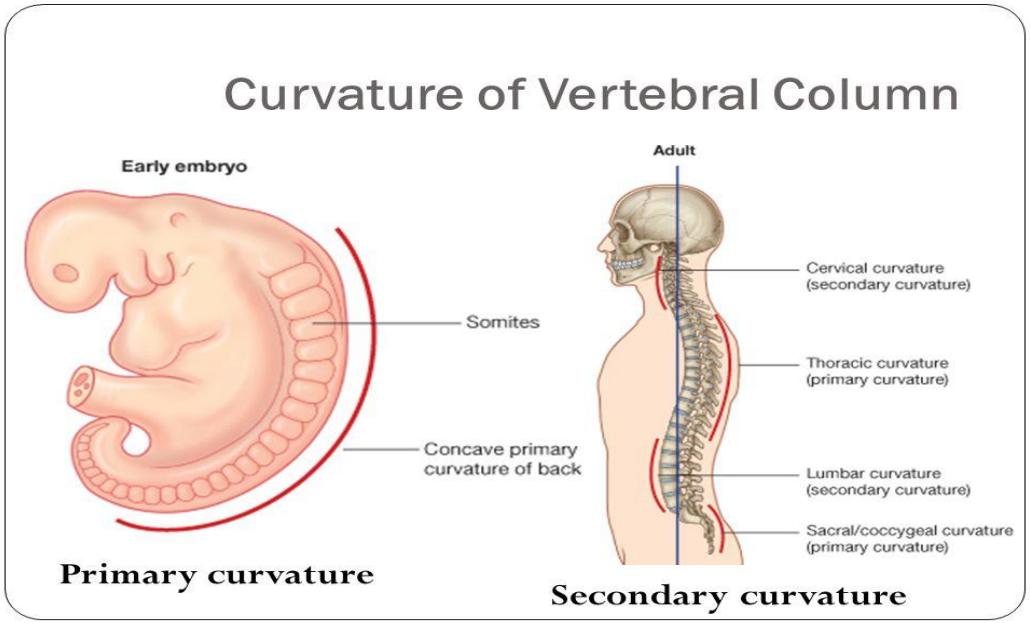
a. thoracic kyphosis;

b. sacral kyphosis.



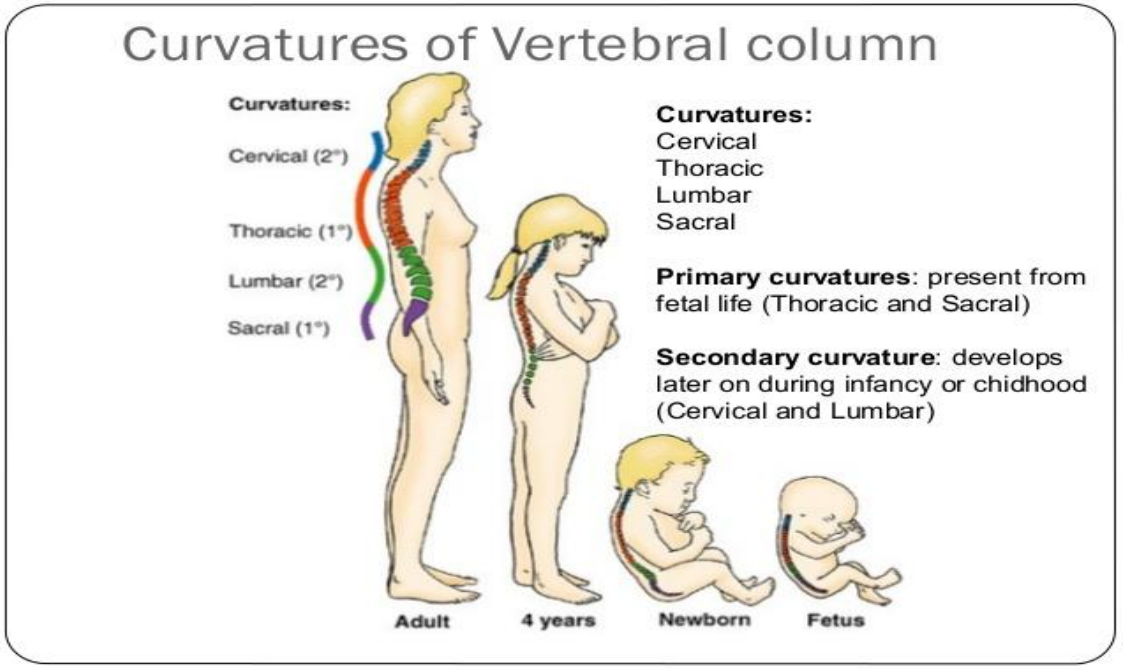
Curvatures in the sagittal plane

- The thoracic and sacral curvatures termed **primary,** appear during the prenatal period of life.
- The cervical and lumbar curvatures, termed **secondary,** appear later.



Curvatures in the sagittal plane

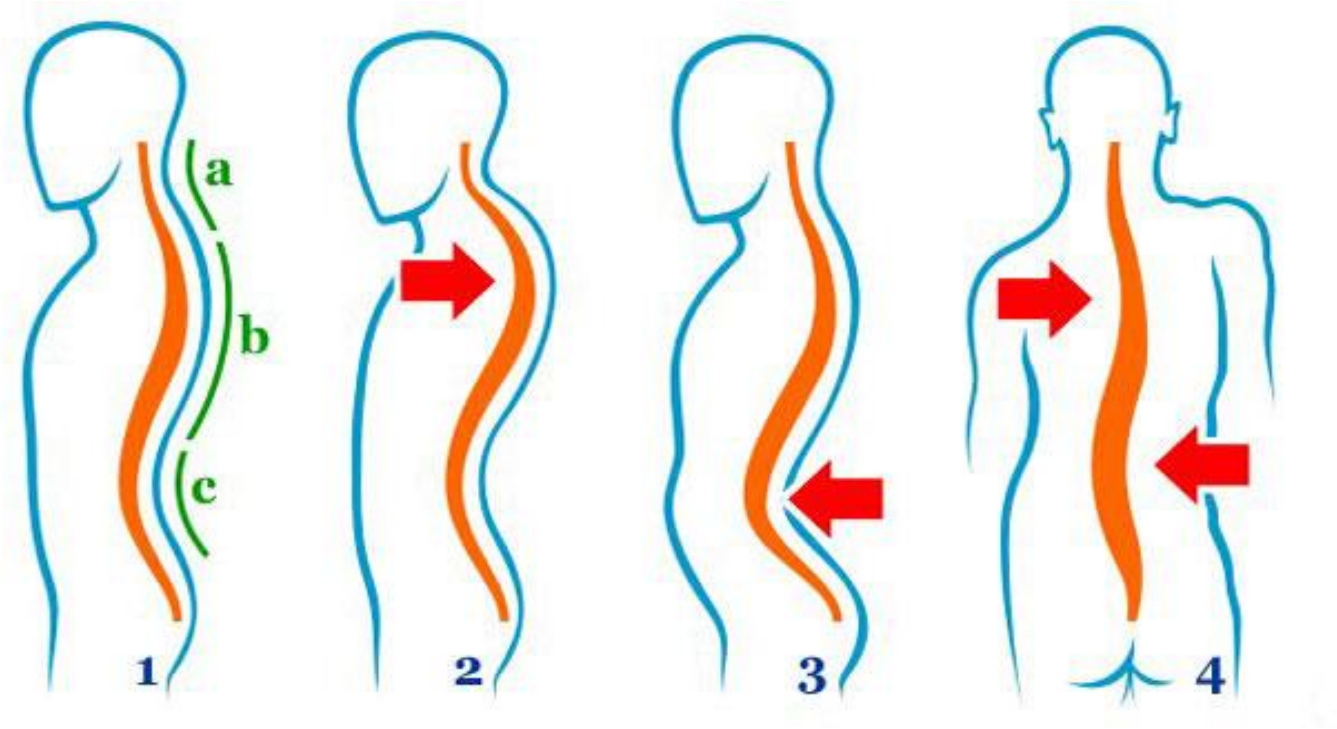
- When the infant begins to rise his head, the **cervical lordosis** forms.
- When the child learns to stand and walk, the **lumbar lordosis** forms.



Curvatures in the frontal plane

- The lateral curvature, more frequently convex to the right, is called **scoliosis**.
- Scoliosis is the most common abnormal curvature, occuring in 0,5% of the population.

Normal (1) and abnormal (2,3,4) curvatures of the vertebral column



Abnormal curvatures of the vertebral column

- **Excess thoracic kyphosis** is an exagerated khyphotic curvature in the thoracic region, also called *hyperkyphosis*.
- **Excess lumbar lordosis** is an exagerated lordotic curvature of the lumbar region, also known as *hyperlordosis*.
- **Scoliosis,** abnormal lateral curvature, is more common among females.

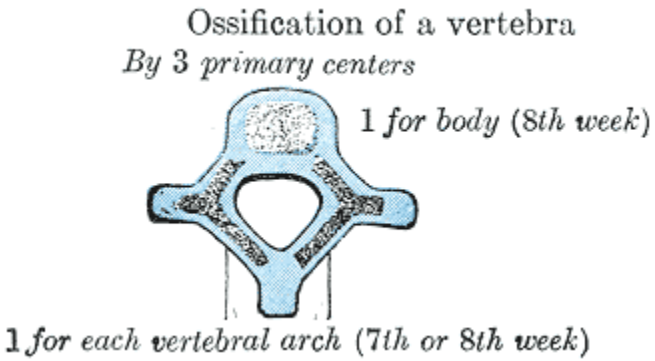
Development of the vertebrae (3 stages)

- Vertebrae develop during the embryonic period as mesenchymal condesations around the notochord (***membranous stage***).
- Later these mesenchymal bone models chondrify and cartilaginous vertebrae form (***cartilaginous stage***).
- Vertebrae begin to ossify toward the end of embryonic period (8th week), with three *primary ossification centers* (***bony stage***).

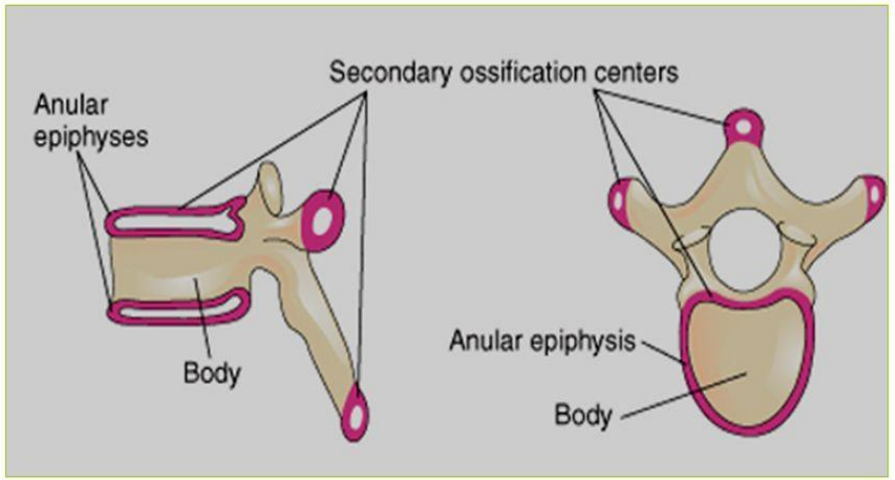
Ossification centers of the vertebra

- **Primary ossification centers** (3 in number): *one endochondral centrum* in the body of vertebra, two *endochondral centers* in each half of the vertebral arch.
- **Secondary ossification centers** (5 in number) develop during the puberty: one in the spinous process, one in each transverse process, one on the inferior and one on the superior edges of vertebral body.

Ossification centers of the vertebra



- 5 **secondary ossification centers** appear in the vertebrae after puberty:



VARIATIONS IN THE VERTEBRAE

- The number of cervical vertebrae (seven) is remarkably constant (even giraffes and snakes have seven cervical vertebrae).

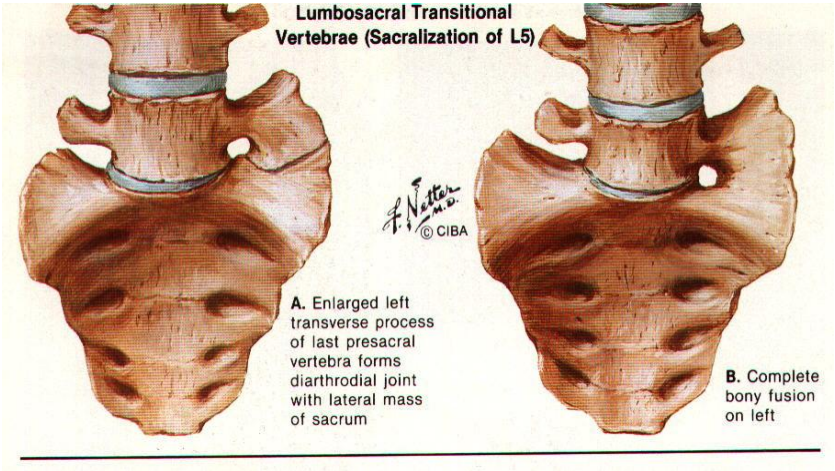
a) ***Occipitalization of the atlas*** is the congenital synostosis of the atlas to the occipital bone.

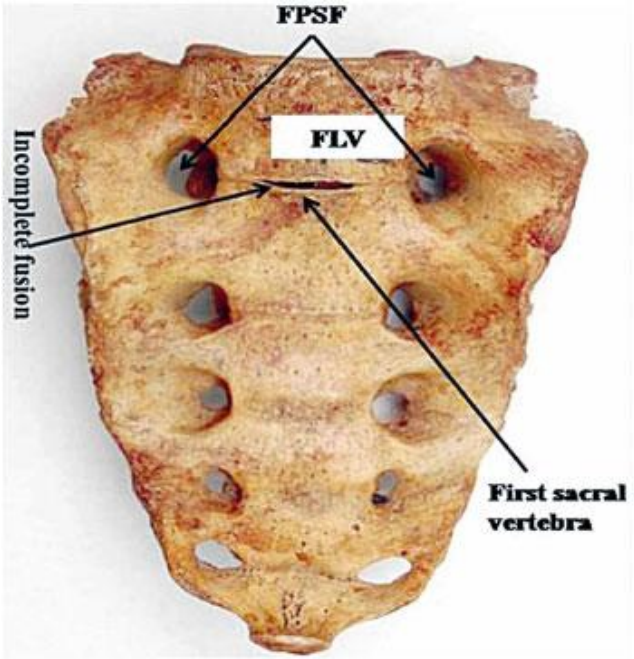
- Variations in the number of vertebrae occur more often in the presacral region:

a. ***Sacralization*** *of the LV vertebra*;

b. ***Lumbarization*** *of the SI vertebra*.

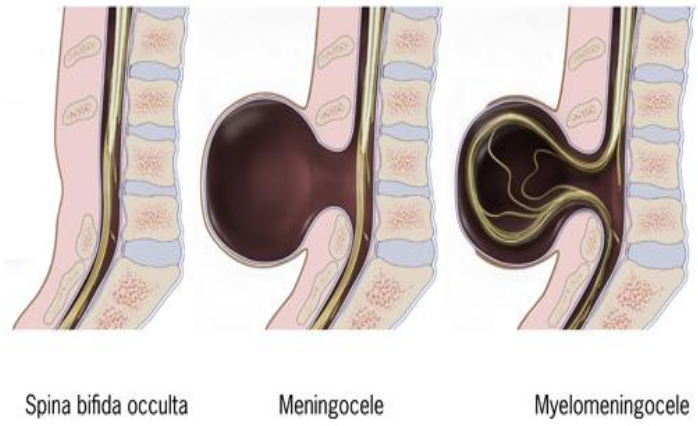
Sacralization of LV vertebra

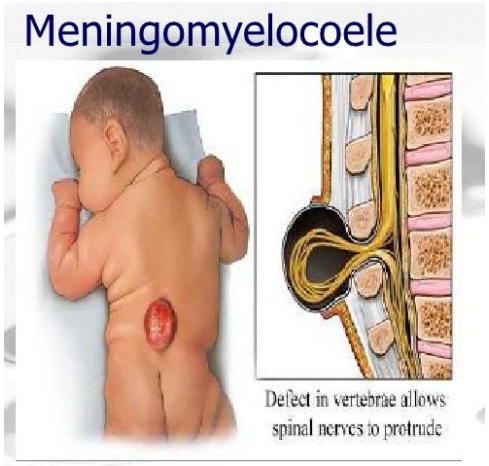




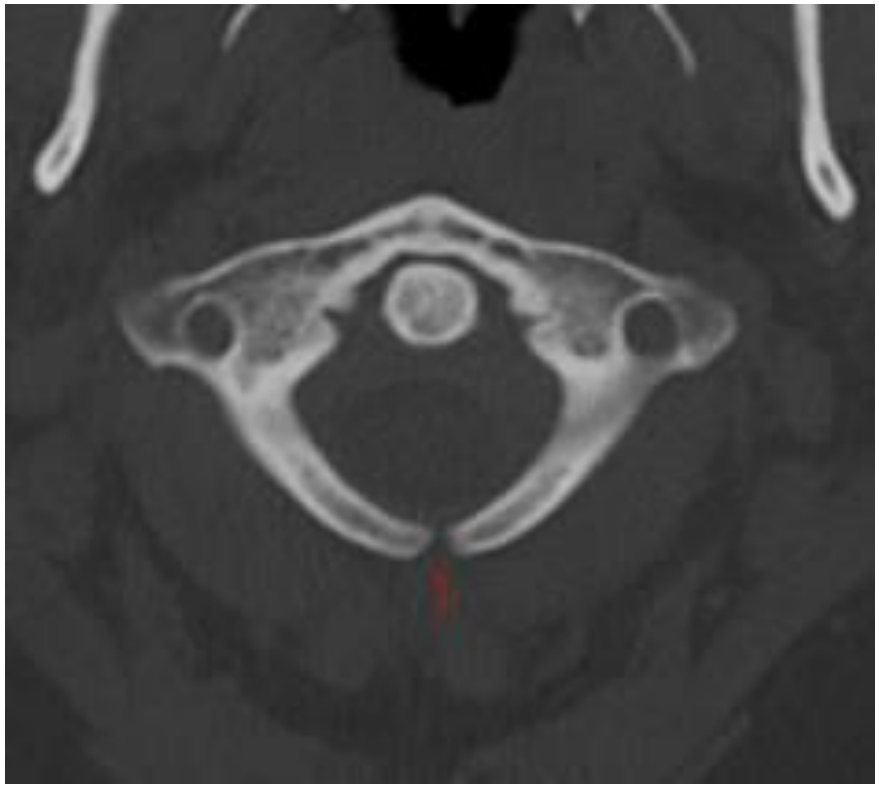
Anomalies of the vertebrae

- **Spina bifida occulta** (hidden, no opening of the back) when the laminae of the vertebral arches fail to fuse.
- **Spina bifida cystica** is associated with herniation of the meninges (*meningocele*) and the spinal cord (*meningomyelocele*).





Spina bifida atlantis



Thorax (thoracic cage) as a whole

The **thorax** (thoracic cage) is formed by:

- sternum
- 12 pairs of ribs,
- 12 thoracic vertebrae.

It is open superiorly and inferiorly.

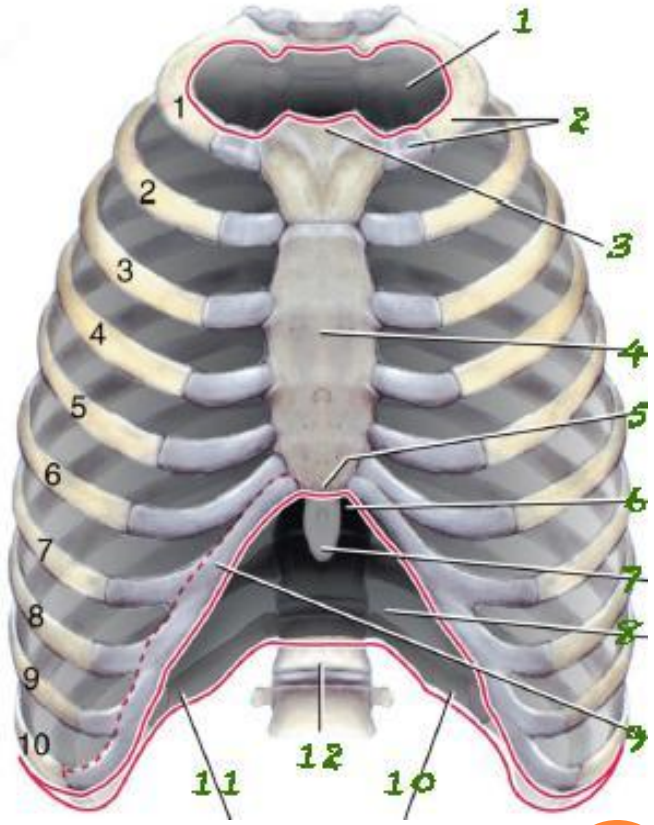
The superior opening (***superior thoracic aperture***) is a passageway that allows communication with the neck and upper limbs.

The inferior opening (***inferior thoracic aperture***) provides the origin of the diaphragm, which separates the thoracic and abdominal cavities.

Thoracic inlet

- **Superior thoracic aperture** (anatomical *thoracic inlet*) is bounded, as follows:

a. posteriorly by 1st thoracic vertebra;
b. laterally by 1st pair of ribs;
c. anteriorly by manubrium of sternum.



Thoracic outlet

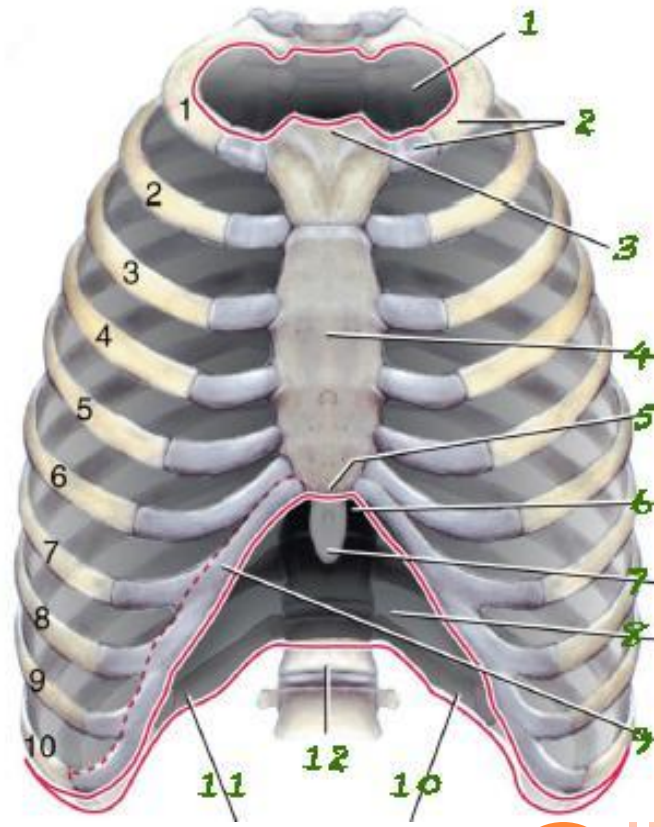
- **Inferior thoracic aperture** (anatomical *thoracic outlet*) is bounded, as follows:

a. posteriorly by 12th thoracic vertebra;

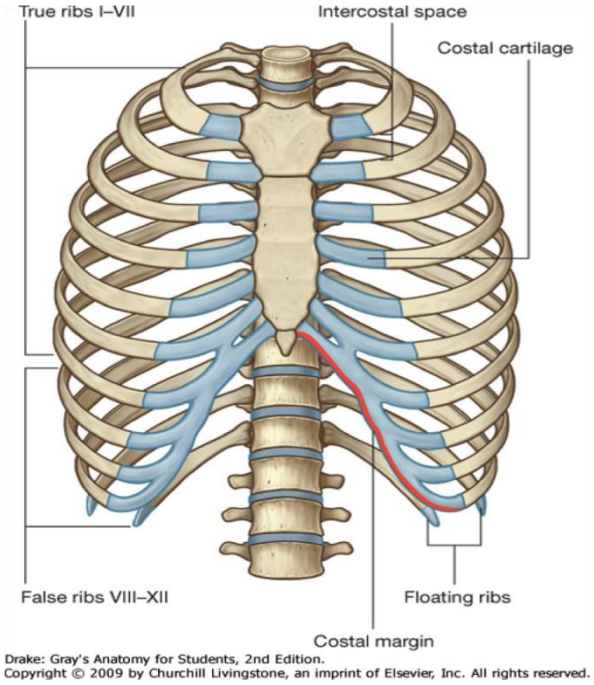
b. posterolaterally by 12th and 11th pairs of ribs;

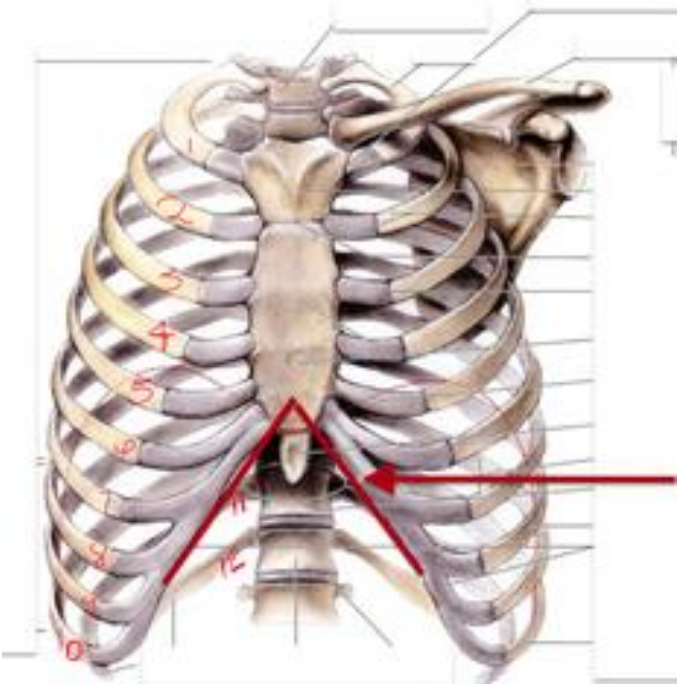
c. anterolaterally by ***costal arch*** or ***costal margin*** (formed by costal cartilages of 7th-10th ribs);

d. anteriorly by xiphoid process.



Costal arch (or costal margin) and infrasternal angle





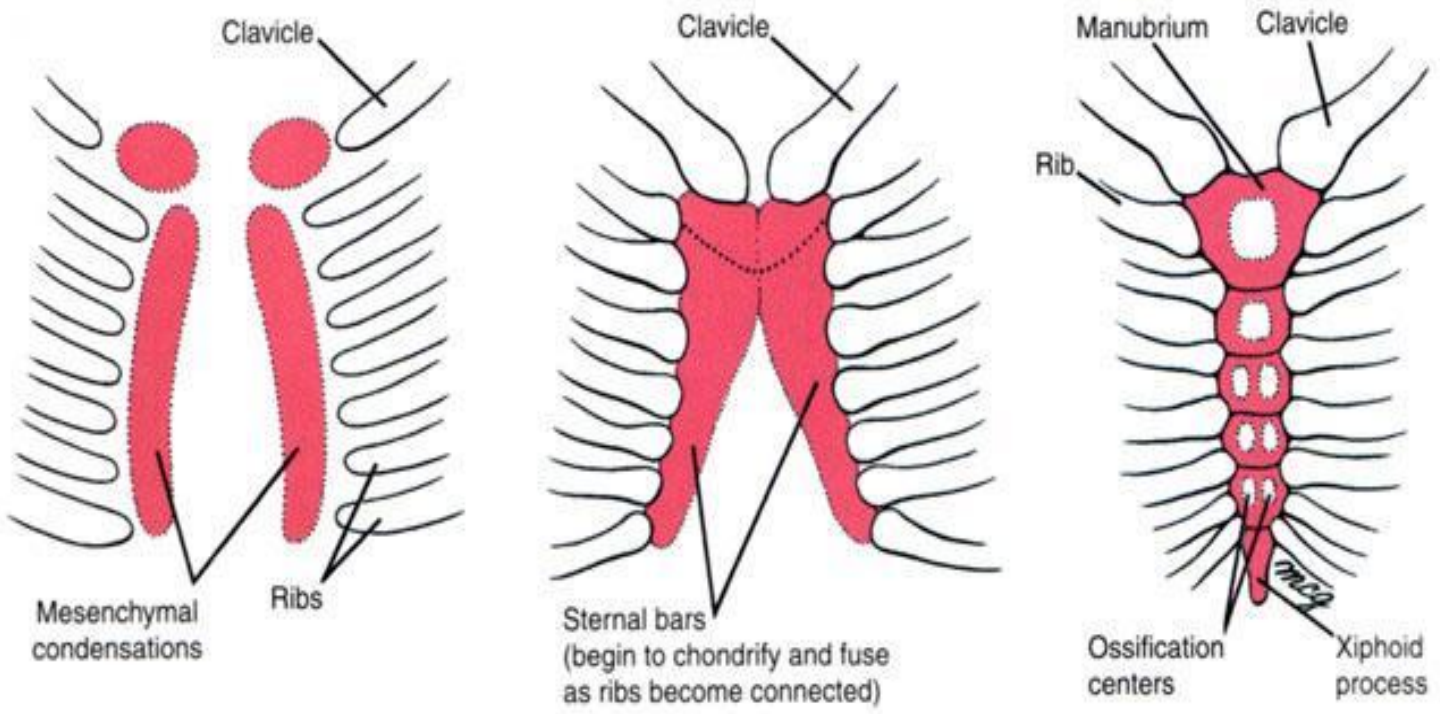
Sternum

Sternum consists of three parts:

- **manubrium,**
- **body,**
- **xiphoid process**.

Sternum develops from a pair of **sternal bars** (or *sternal plates*), which fuse craniocaudally, in the median plane.

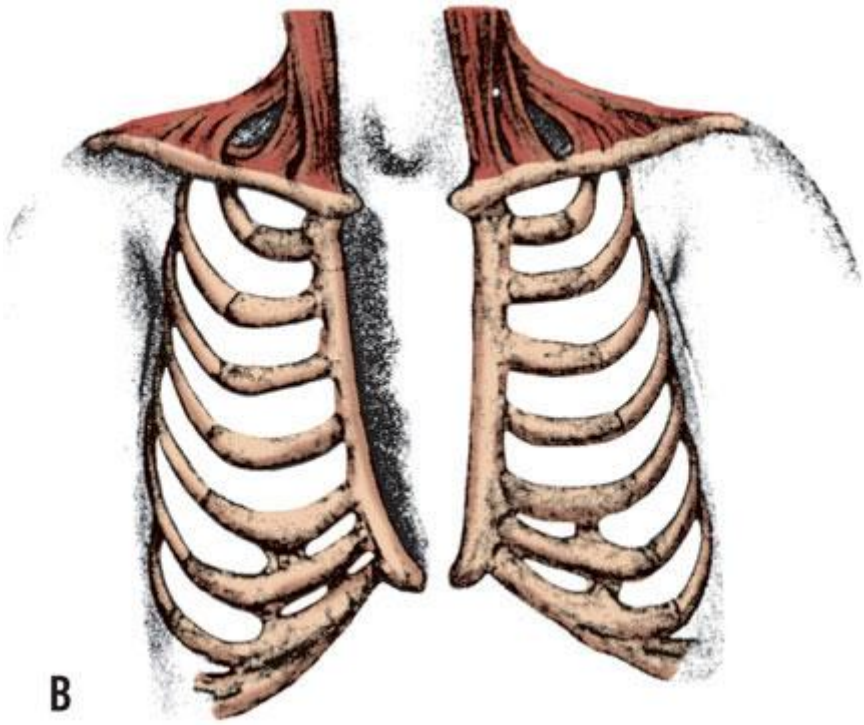
Development of the sternum



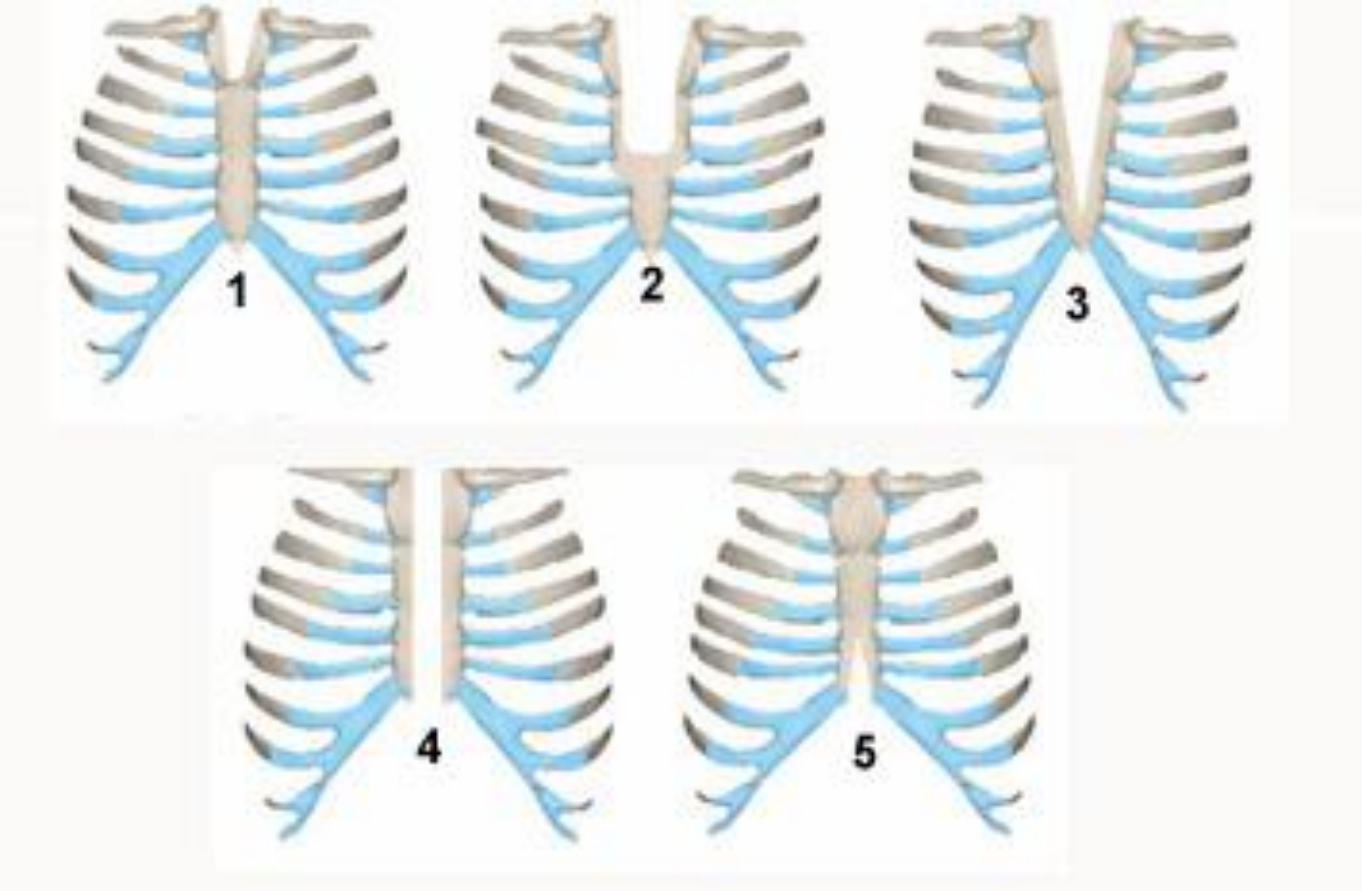
Sternal anomalies

- **Complete sternal cleft**;
- **V- or U-shaped sternal clefts** (involving the manubrium and superior part of the body);
- **Sternal foramen** – a perforation in the sternal body;
- **Perforated xiphoid process**.

Complete sternal cleft



V- or U-shaped sternal clefts



Ribs

- **True ribs** (1^{st}-7^{th}) – attach directly to the sternum.
- **False ribs** (8^{th}-12^{th}) – do not attach to the sternum.
- ✓ **Floating (free) ribs** (11^{th}, 12^{th}) have no anterior attachment, they end in the abdominal musculature.

Ribs (*costae*)

Each rib consists of two parts:

1. anterior, cartilaginous part or **costal cartilage** (*cartilago costale*);
2. posterior, bony part or **rib** (*costa*).

Rib *(costa)* has the following components:

a. head (*caput costae*);
b. neck (*collum costae*);
c. body (*corpus costae*).

There are typical (3^{th} – 10^{th}) and atypical (1^{st}, 2^{nd}, 11^{th}, 12^{th}) ribs.

Development and anomalies of ribs

Ribs develop from **costal processes** of the thoracic vertebrae.

Anomalies:

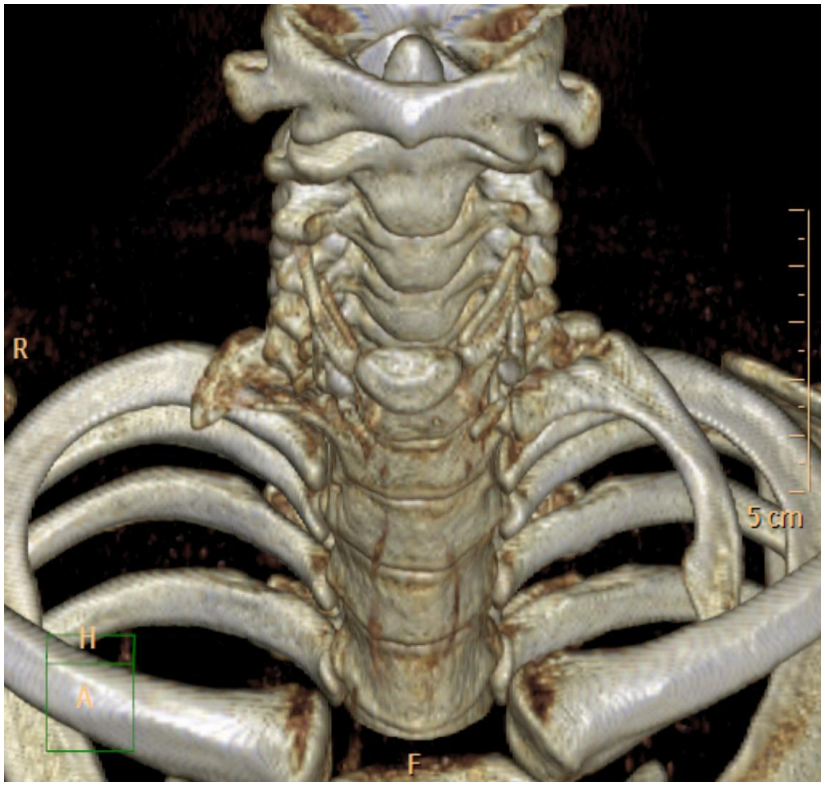
- **Supernumerary (extra) ribs**:

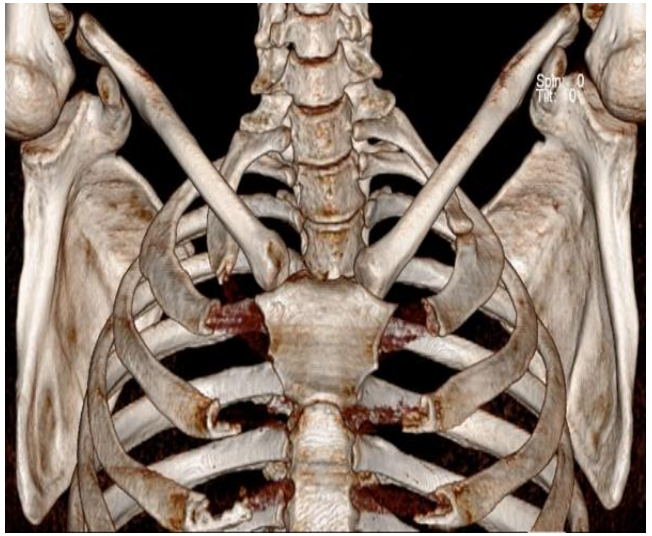
a. cervical ribs;

b. lumbar ribs.

- **Congenital absence of ribs**;
- **Fused ribs.**

Cervical ribs and elongated transverse process on C7



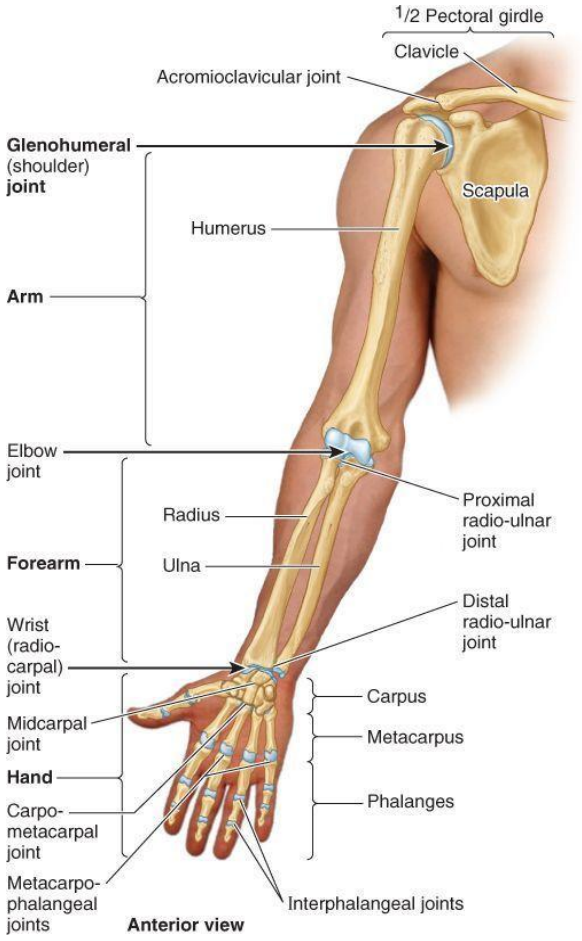


Upper limb consists of 4 segments:

- **Shoulder** is built by the *shoulder (or pectoral) girdle*, formed by scapula and clavicle.
- **Arm** *(L. brachium)* contains the humerus;
- **Forearm** (***L.*** *antebrachium*) that contains the ulna and radius;
- **Hand** *(L. manus)* is formed by carpal bones, metacarpals (I-V) and phalanges.

Skeleton of the upper limb

- **Shoulder (**or **pectoral) girdle**: clavicle and scapula;
- **Skeleton of the free part of upper limb**: humerus, ulna, radius, carpal bones, metacarpals and phalanges.

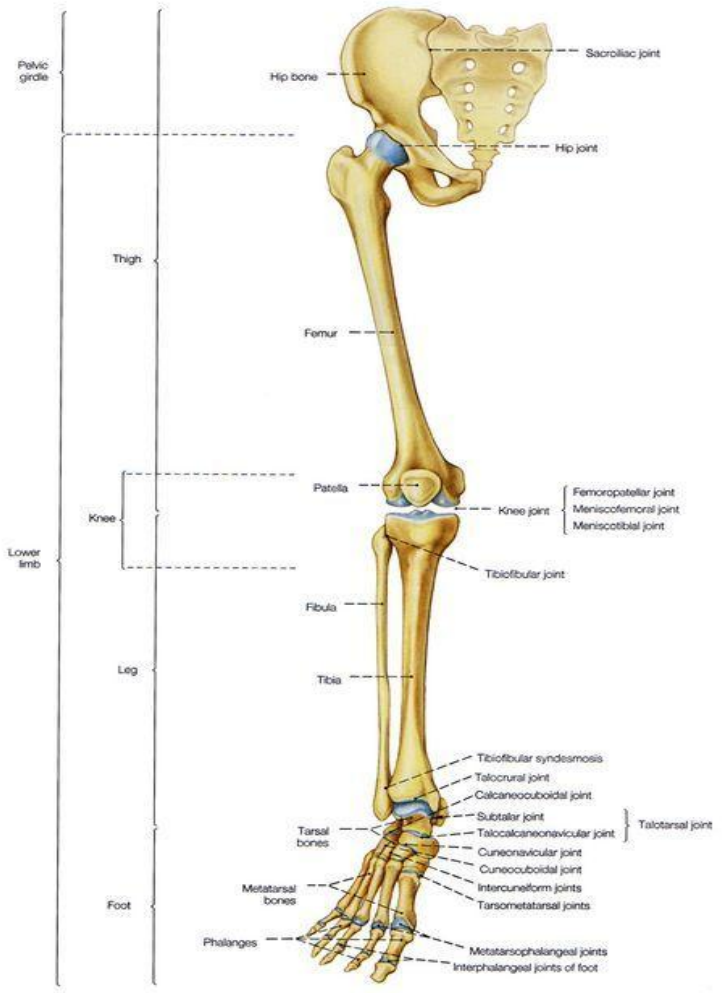


Lower limb consists of 4 parts:

- **Hip region** is built by the *pelvic girdle*, formed by hip or coxal bone (***L***. *os coxae*);
- **Thigh** (***L***. *femur*) that contains the femur;
- **Leg** (***L***. *crus*) contains the tibia and fibula.
- **Foot** (***L***. *pes*) is formed by tarsal bones, metatarsals (I-V) and phalanges.

Skeleton of the lower limb

- **Pelvic girdle**: hip or coxal bone;
- **Skeleton of the free part of lower limb**: femur, tibia, fibula, tarsal bones, metatarsals and phalanges.

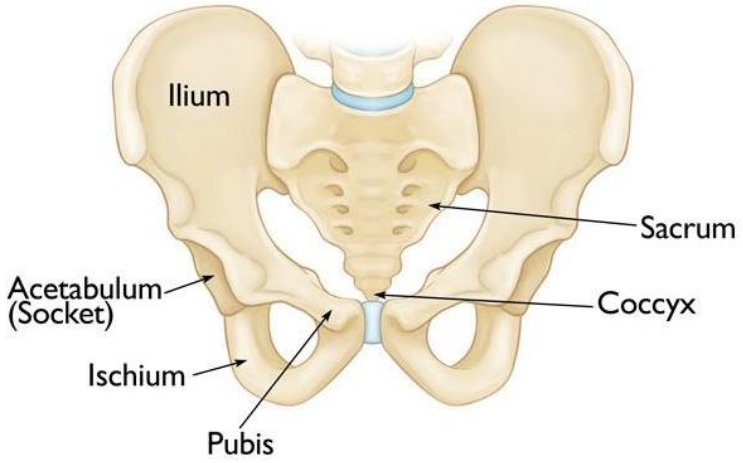


Pelvis as a whole

Bony ring, named **pelvis** is formed by:

- 2 hip (or coxal) bones,
- sacrum,
- coccyx.

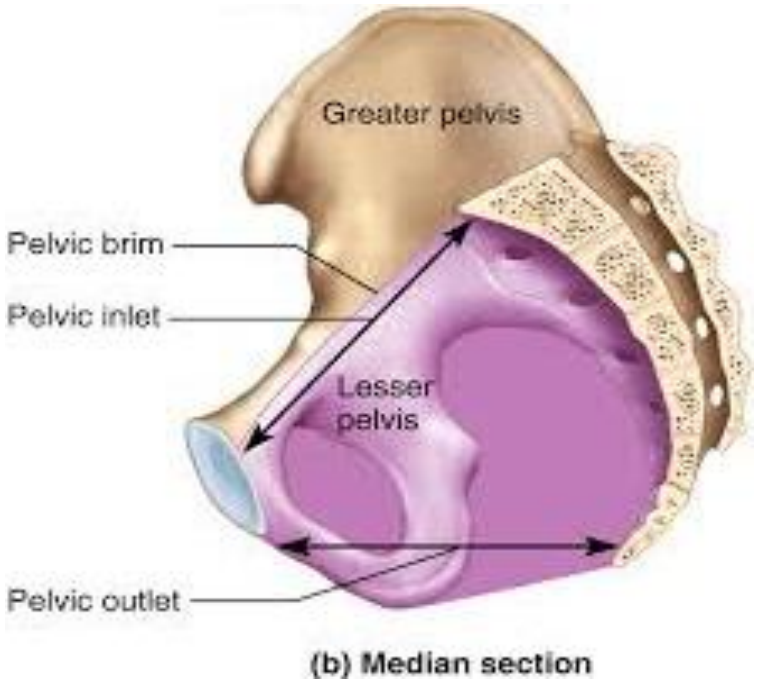
The gap enclosed by bony pelvis is called the **pelvic cavity**.



Pelvis, compartments

There are two compartments of the pelvis:

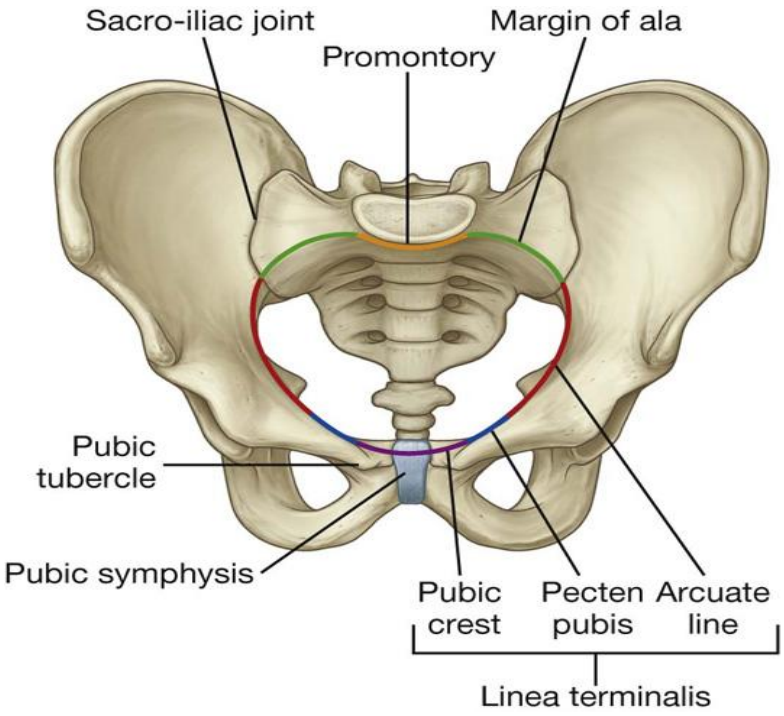
- **greater**, or **false pelvis** (*pelvis major*),
- **lesser**, or **true pelvis** (*pelvis minor*).



Linia terminalis (pelvic brim)

These two compartments are separated by ***linia terminalis*** (pelvic brim)**,** formed by:

- promontory,
- ala of sacrum,
- arcuate line of ilium,
- pecten pubis,
- superior border of pubic symphysis.



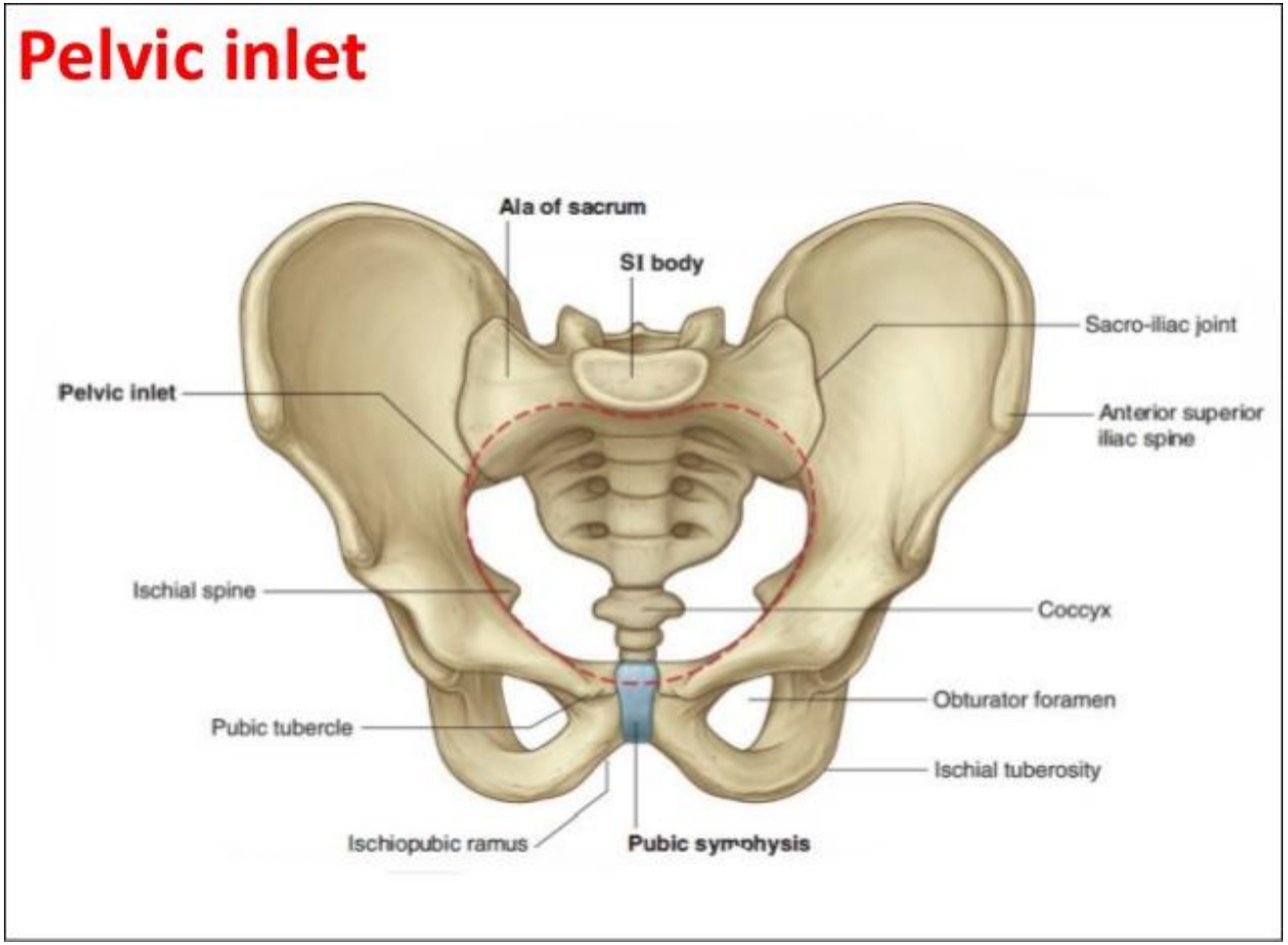
Lesser or true pelvis

Lesser pelvis has two openings:

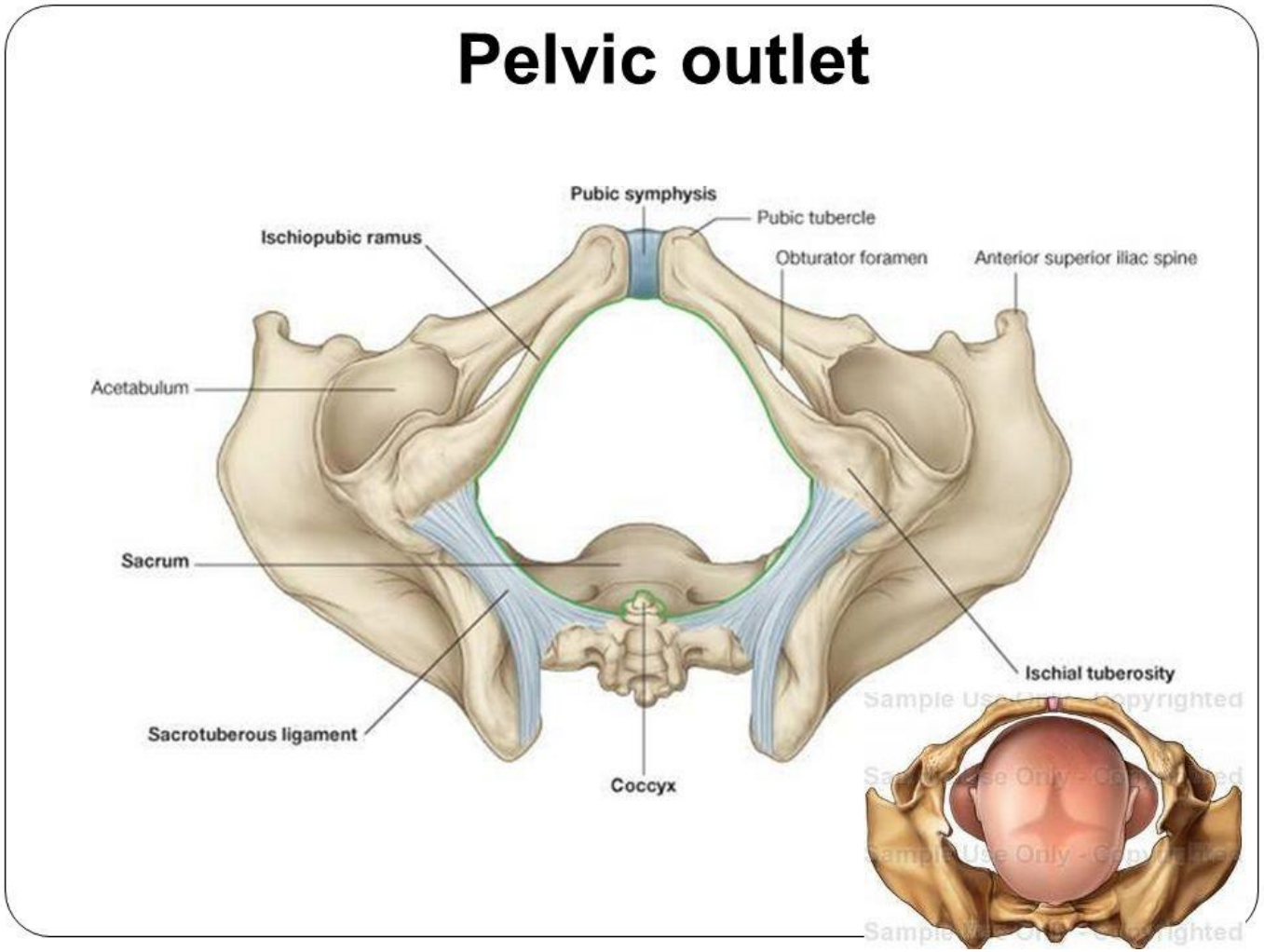
- **apertura pelvis superior** (*pelvic inlet*) corresponds with *linia terminalis*;
- **apertura pelvis inferior** (*pelvic outlet*) is bounded by:

- ✓ coccyx,
- ✓ sacrotuberous ligament,
- ✓ ischial tuberosity,
- ✓ ischiopubic ramus,
- ✓ inferior border of pubic symphysis.

Pelvic inlet = *linia terminalis*

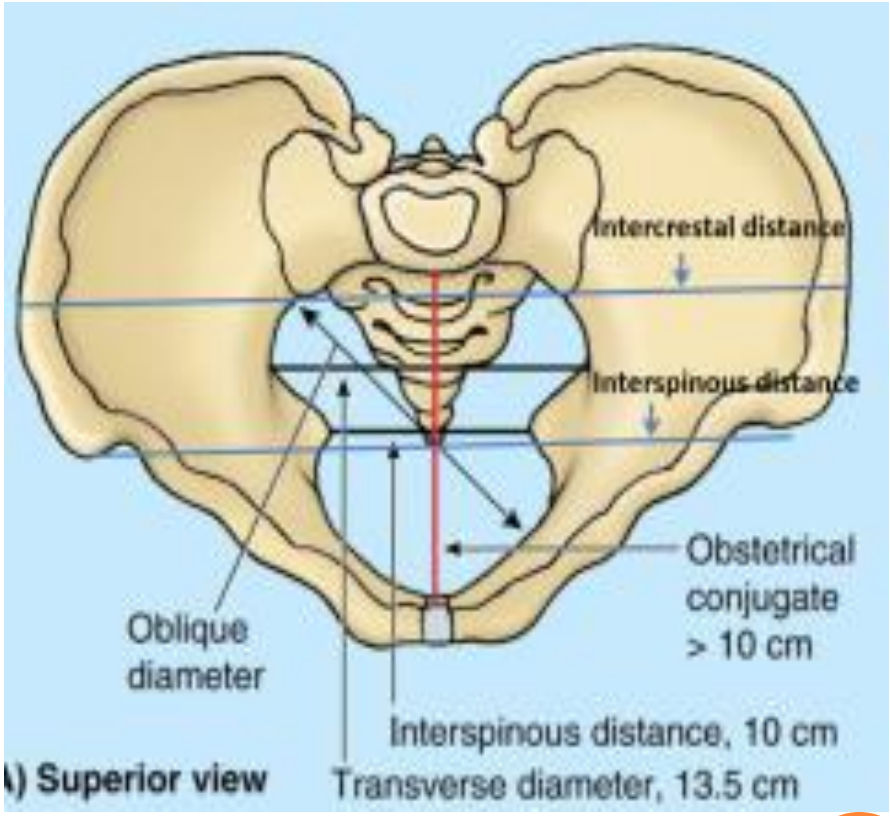


Pelvic outlet



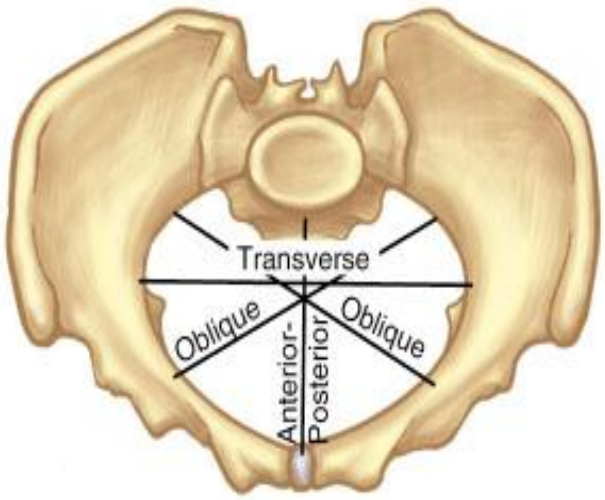
Diameters of greater pelvis

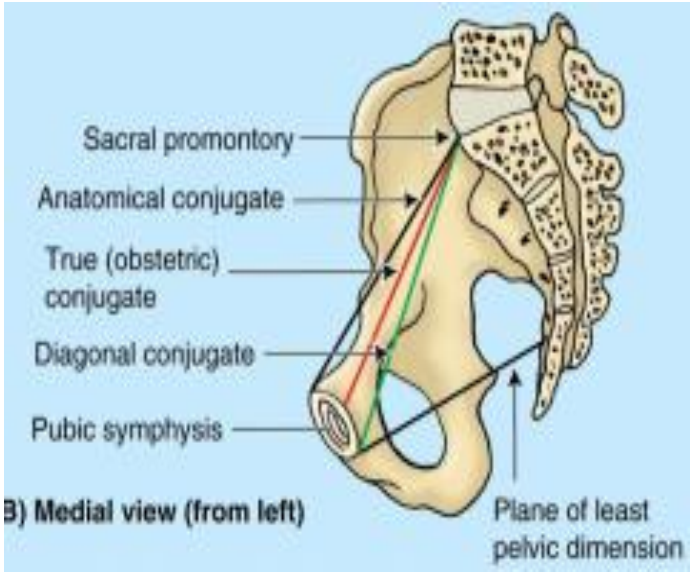
- **Interspinous distance** (diameter) = 25-27 cm.
- **Intercristal distance** (diameter) = 28-29 cm.
- **Intertrochanteric distance** (diameter) = 30-32 cm.
- **External conjugate** = 20-21 cm.



Diameters of pelvic inlet

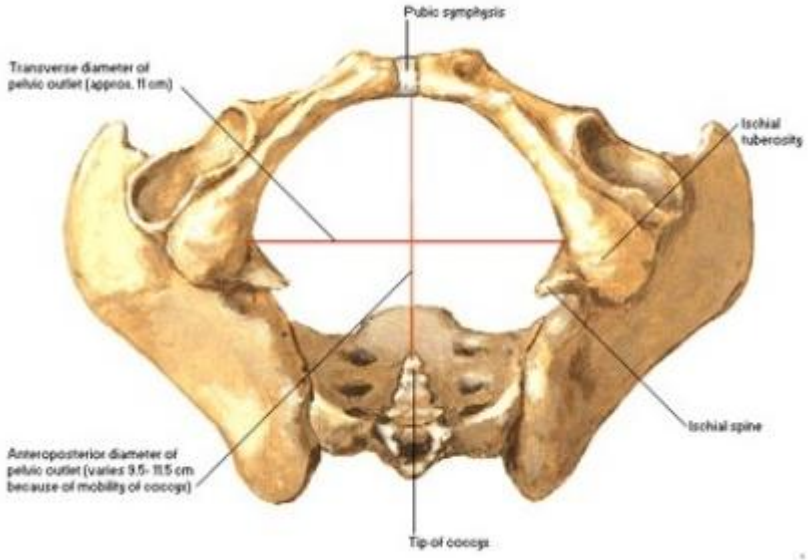
- **Transverse diameter** = 13 cm
- **Oblique diameter** = 12 cm
- **Anteroposterior diameter**:
  - ✓ *Anatomical conjugate* = 11.5 cm
  - ✓ *True (obstetric) conjugate* = 11 cm
  - ✓ *Diagonal conjugate* = 12 cm



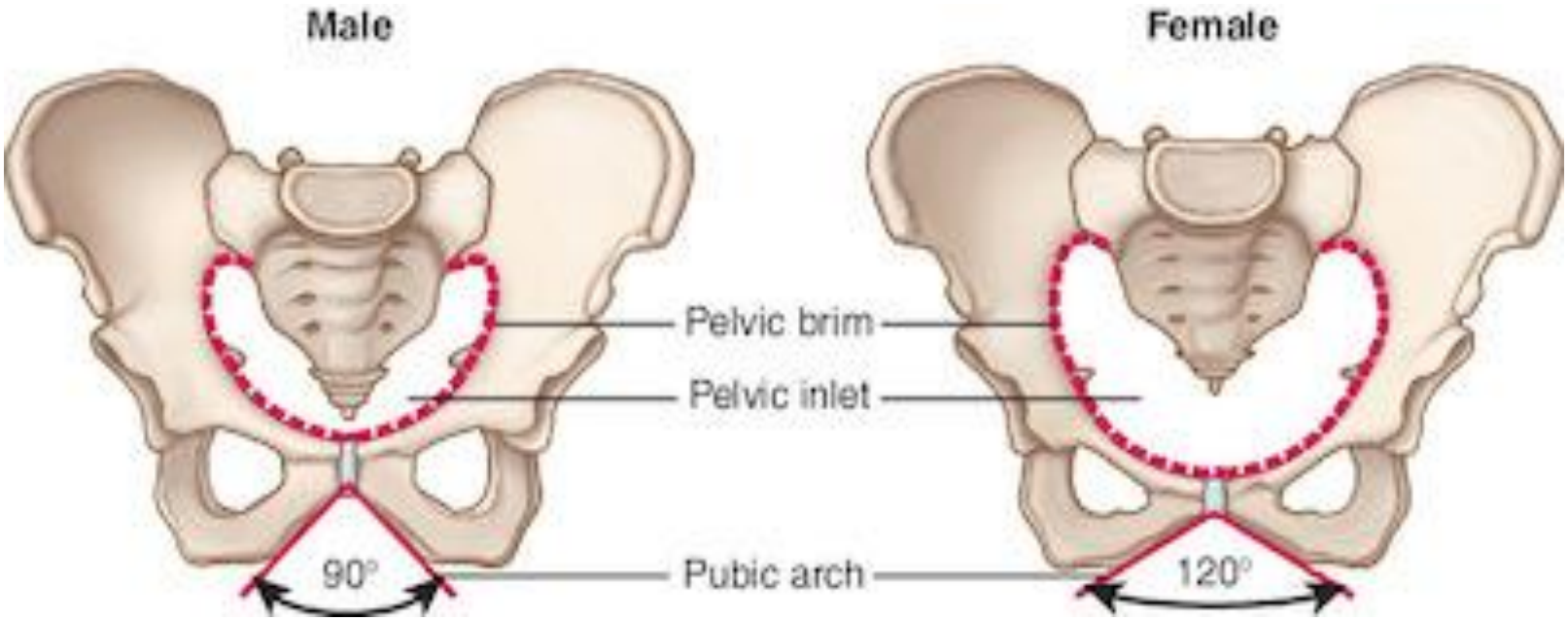


Diameters of pelvic outlet

- **Transverse diameter** = 11 cm.
- **Anteroposterior diameter** (*straight conjugate*) = 9.5-11.5 cm.



Gender differences of pelvis



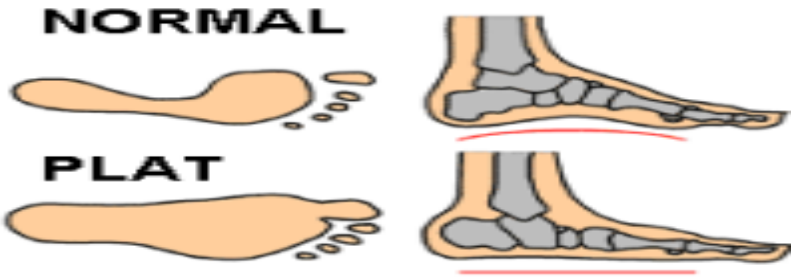
Foot as a whole

The skeleton of the foot is **arched**, both longitudinally and transversely.

The presence of arches makes the sole concave both anteroposteriorly and transversely.

During the standing position, the weight of the body is spread among **three points**:

- ✓ **calcaneal tuberosity,**
- ✓ **head of first metatarsal,**
- ✓ **head of fifth metatarsal**.

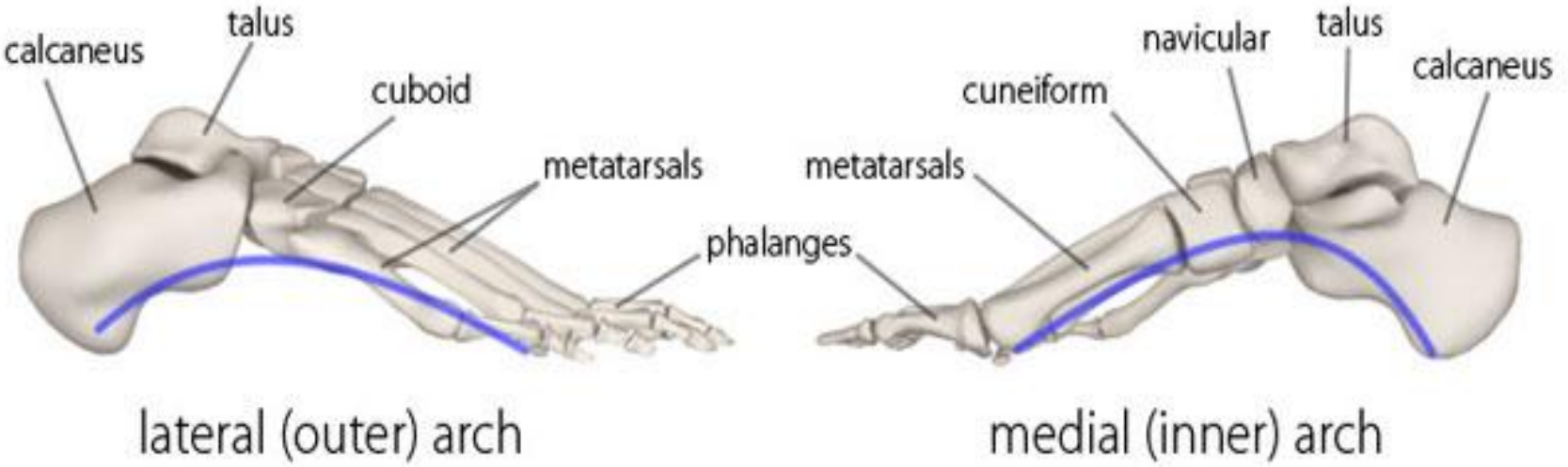


Foot as a whole

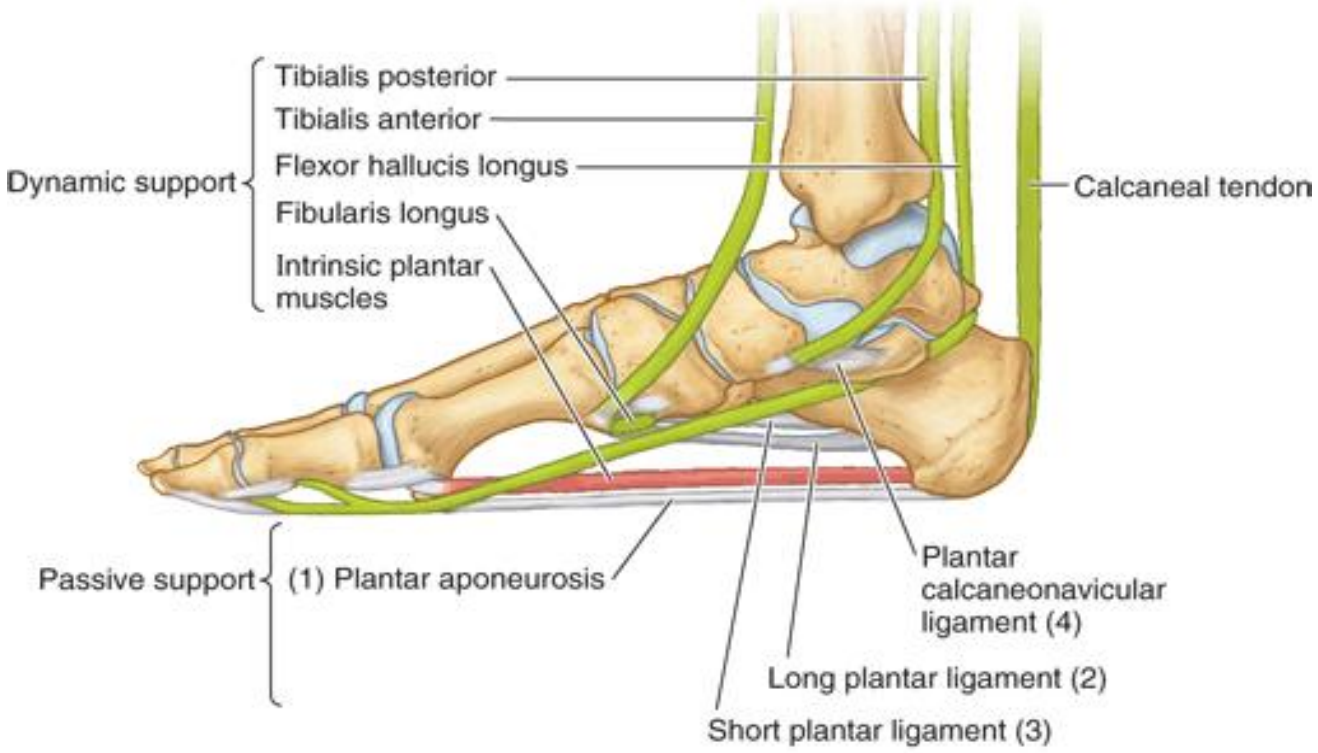
Arches of the foot are formed by ***tarsal*** and ***metatarsal bones***, strengthened by ***ligaments*** and ***tendons***.

- **Longitudinal arch of foot** has two parts (arches):
- ***Medial part*** (higher and more important), formed by calcaneus, talus, navicular, three cuneiforms, and first three metatarsals.
- ***Lateral part*** (flatter and rests on the ground in the standing position), formed by calcaneus, cuboid, and last two metatarsals.

Longitudinal arches of foot



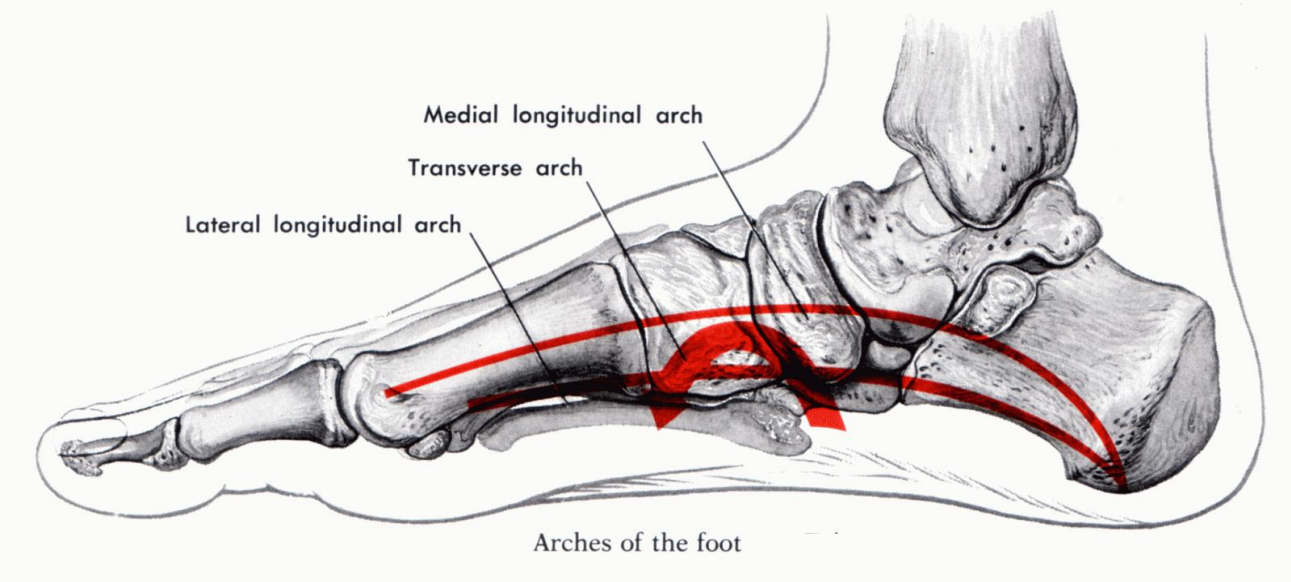
Support of longitudinal arches of foot



(E) Medial longitudinal arch (medial view)

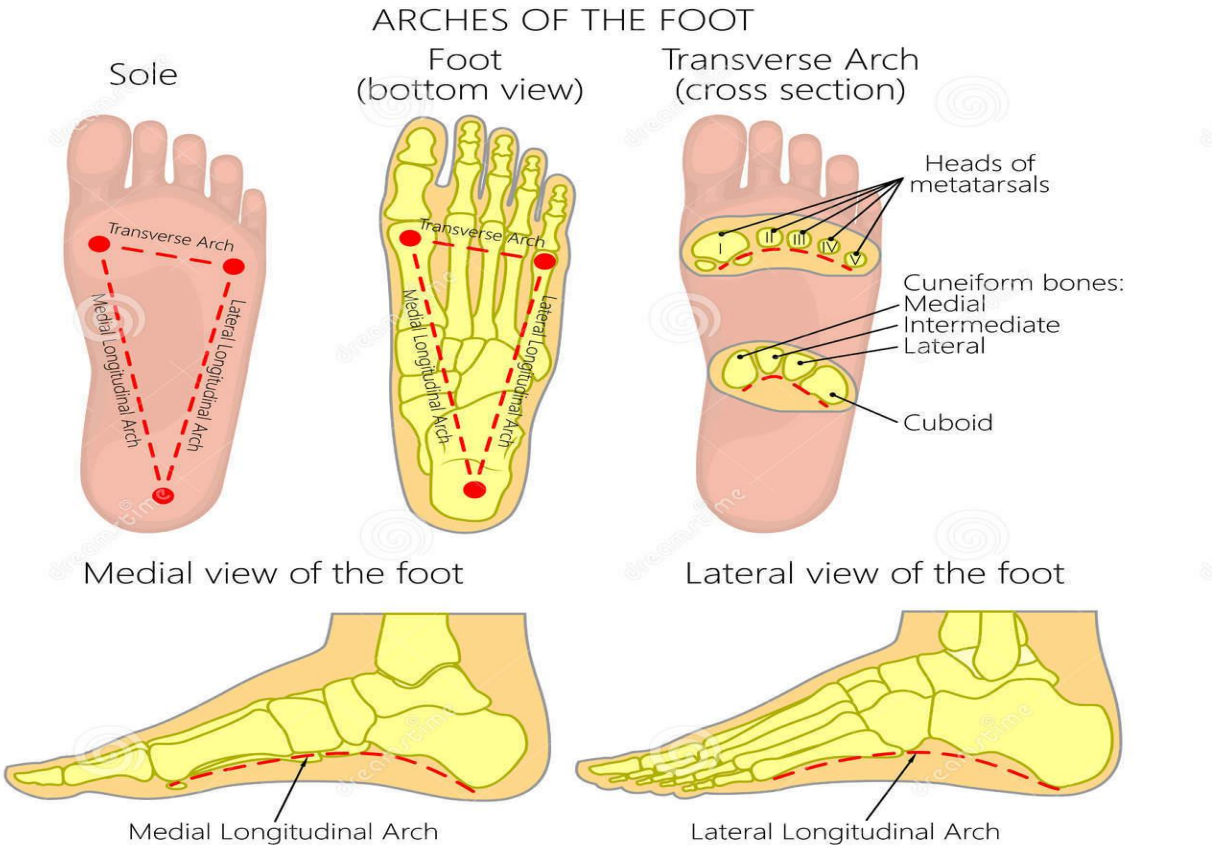
Transverse arches of foot

- **Proximal transverse arch of foot** formed by cuboid and three cuneiforms.
- **Distal transverse arch of foot** corresponds with heads of metatarsals.



Arches of the foot

Arches of the foot



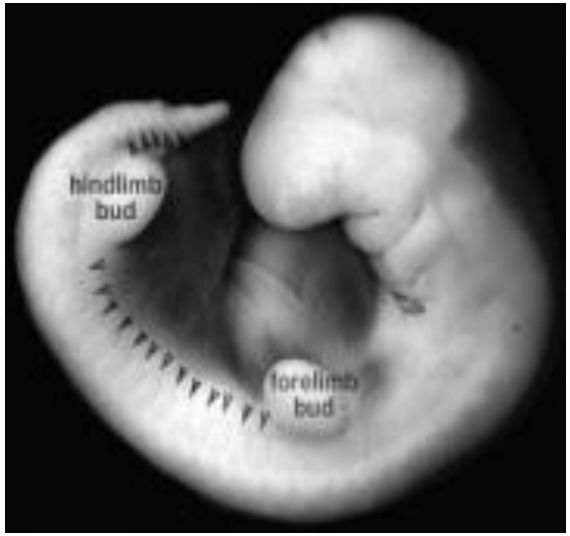
Development of the bones of the limbs

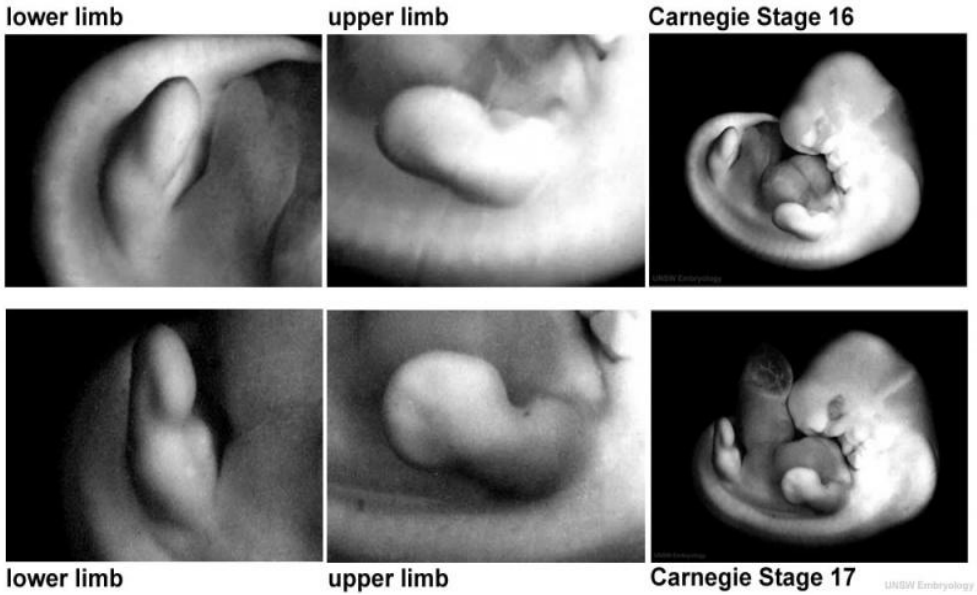
- The bones of the limbs are ***secondary*** or ***chondral bones*** (except, the clavicle). They pass through 3 stages of development: *membranous, cartilaginous* and *bony (*or *osseous) stages*. They ossify by *endochondral osteogenesis*.
- The clavicle is a ***mixed*** or ***chondro-desmal bone.***

Development of the limbs

- The ***limb bud*** primordia appear at the end of ***4th week*** as a small elevations of the ventrolateral body wall.
- Each bud is a mass of mesenchyme (from lateral mesoderm of the somatopleure) covered by ectoderm.

Development of the limbs



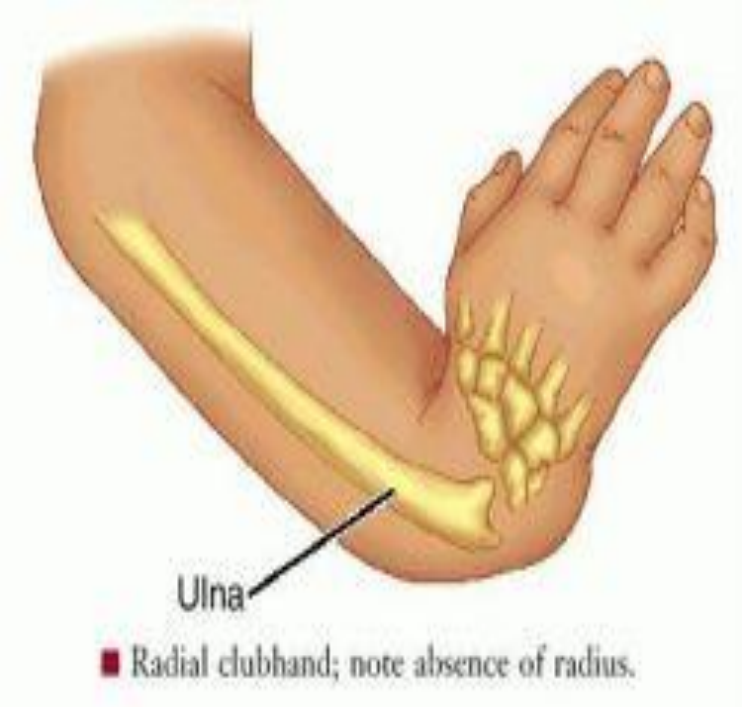


Anomalies of the limbs

- **Amelia** – one or both extremities are absent;
- **Cleft hand or cleft foot** (lobster-claw deformities);
- **Club hand** or congenital absence of radius;
- **Club foot** or talipes equinovarus;

CLEFT HAND OR CLEFT FOOT (LOBSTER-CLAW DEFORMITIES)

Club hand



Radial clubhand; note absence of radius.

Club foot

Anomalies of the limbs

- **Polimelia** or supernumerary limbs;
- **Polydactyly** or supernumerary digits;

Anomalies of the limbs

- **Sirenomelia** (or symelia) – fused lower limbs;
- **Sympodia** – fused foot;
- **Syndactyly** – fused digits.

Sirenomelia – fused lower limbs

Syndactyly – fused digits

Thank you!