

Bone:

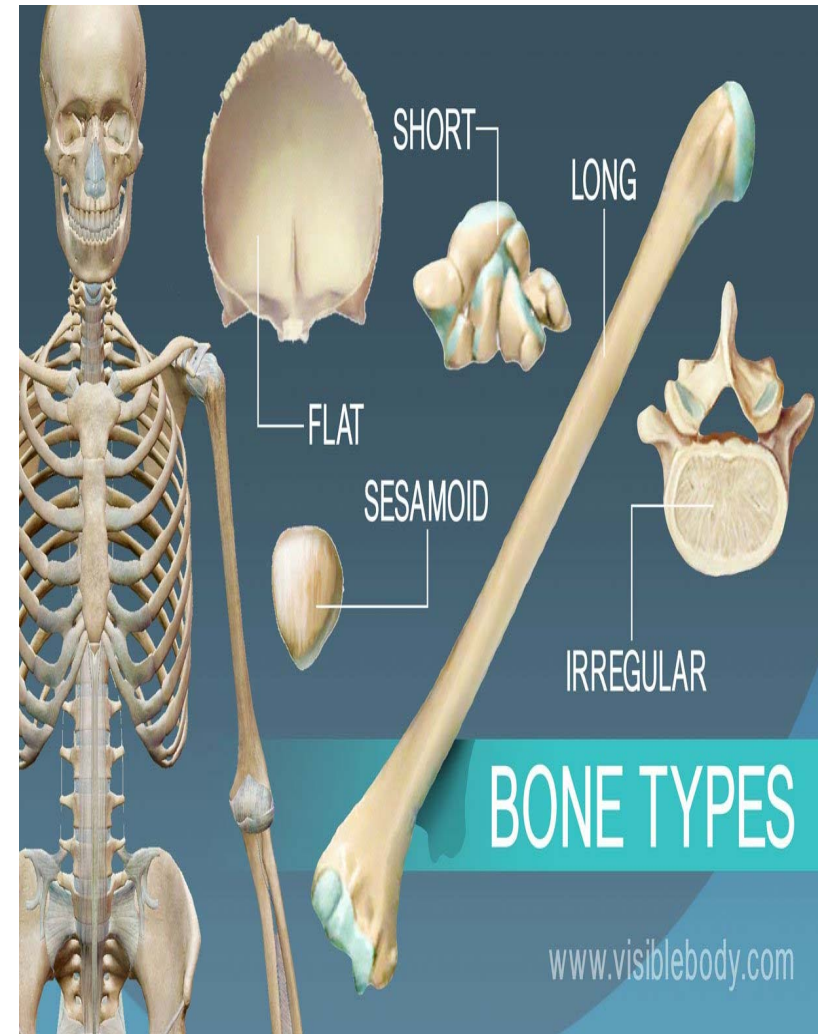
is a strong and durable type of connective tissue. It consists of:

- water (25%)
- organic constituents including osteoid and bone cells (25%)
- inorganic constituents, mainly calcium phosphate (50%)

Types of bones:

Bones are classified as long, short, irregular, flat and sesamoid.

- ❑ **Long bones:** these consist of a shaft and two extremities. As the name suggests the length is much greater than the width. Examples include the femur, tibia and fibula.
- ❑ **Short, irregular, flat and sesamoid bones:** these have no shafts or extremities and are diverse in shape and size. Examples include:
 - ❖ **short bones** — carpals (wrist)
 - ❖ **irregular bones**—vertebrae and pelvis (pubis, ilium, and ischium)
 - ❖ **flat bones** — sternum, ribs and most skull bones (occipital, parietal, frontal, nasal, lacrimal, and vomer)
 - ❖ **sesamoid bones** — patella (anterior to the knee joint within the tendon of the quadriceps femoris muscle)



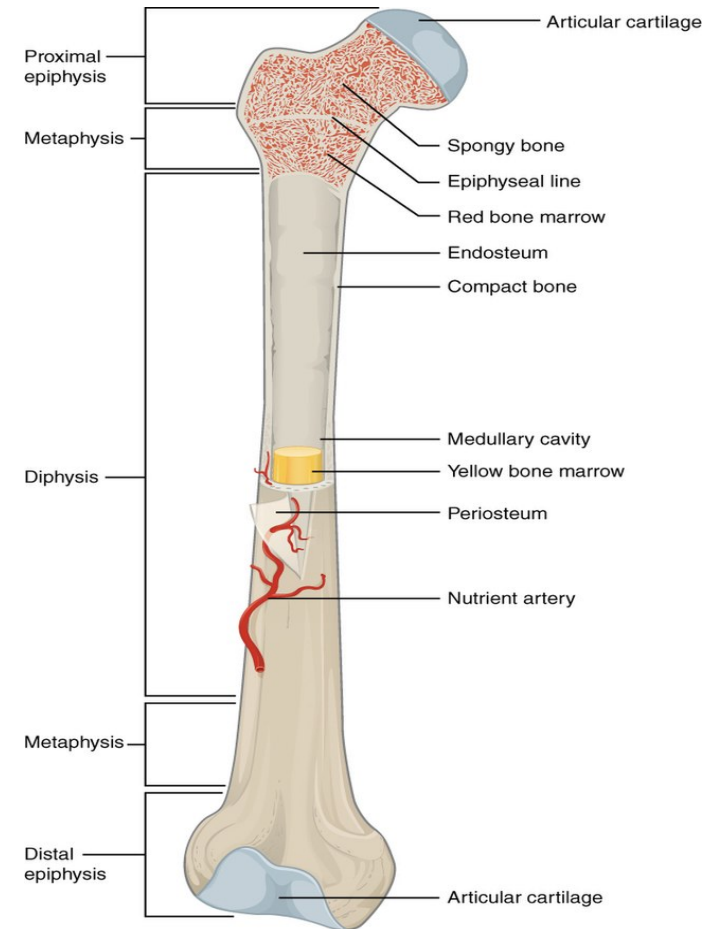
Bone structure:

General structure of a long bone:

- These have a **diaphysis** or shaft and two **epiphyses**.
- The diaphysis is composed of compact bone with a central medullary canal, containing fatty yellow bone marrow.
- The epiphyses consist of an outer covering of compact bone with cancellous bone inside.
- The diaphysis and epiphyses are separated by epiphyseal cartilages, which ossify when growth is complete.
- Long bones are almost completely covered by a vascular membrane, the **periosteum**. The outer layer is fibrous and the inner layer is osteogenic containing osteoblasts (bone-forming cells) and osteoclasts (bone-destroying cells), which are involved in maintenance and remodeling of bones.
- Hyaline cartilage replaces periosteum on the articular surfaces of bones forming synovial joints.

Structure of short, irregular, flat and sesamoid bones:

These have a relatively thin outer layer of compact bone with cancellous bone inside containing red bone marrow.



Anatomy of a Long Bone: A typical long bone showing gross anatomical features.

Functions of bones:

- ❑ provide the structure of the body
- ❑ give attachment to muscles and tendons
- ❑ permit movement of the body as a whole and of parts of the body, by forming joints that are moved by muscles
- ❑ contain red bone marrow in which blood cells develop: haematopoiesis
- ❑ provide a reservoir of minerals, especially calcium phosphate

Structure of bone Tissue

- ❑ There are two types of bone tissue: compact and spongy bone.
- ❑ There are three types of cells that contribute to bone homeostasis.
 - ❖ Osteoblasts are bone-forming cell,
 - ❖ osteoclasts resorb or break down bone.
 - ❖ osteocytes are mature bone cells.

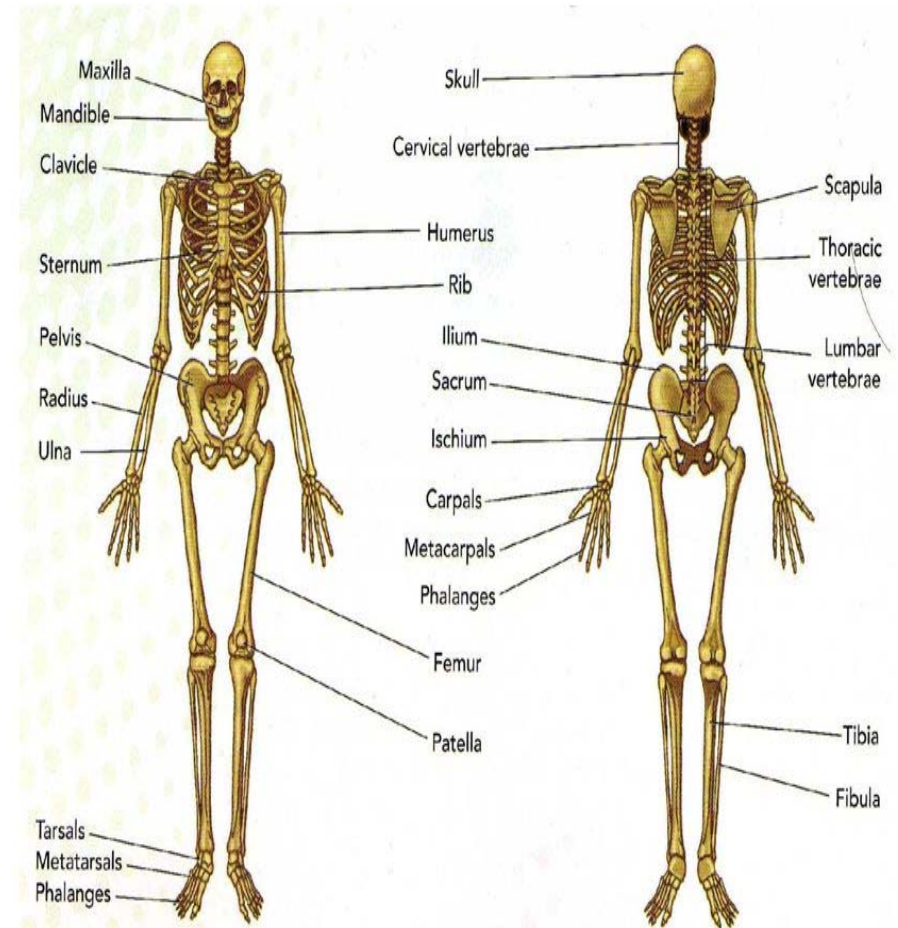


Figure 1.1: Bones of the human skeleton

Microscopic structure of bone

Compact Bone

The microscopic structural unit of compact bone is called an osteon, or haversian system. Each osteon is composed of :

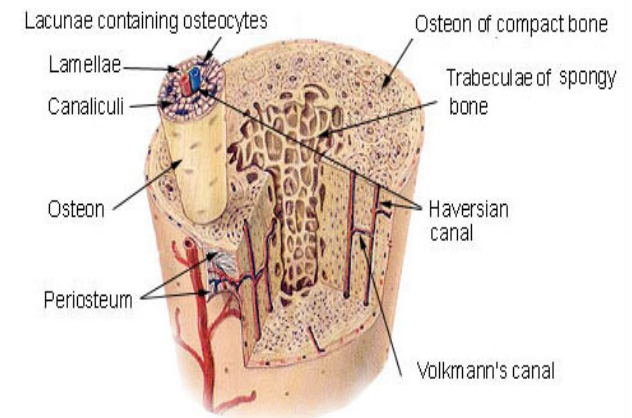
- central canal called the osteon (haversian) canal, containing blood and lymph vessels and nerves which is surrounded by concentric rings (lamellae) of matrix.
- Between the rings of matrix, the bone cells (osteocytes) are located in spaces called lacunae.
- Small channels (canaliculi) radiate from the lacunae and link the lacunae with each other and with the central Haversian canal

Cancellous (trabecular, spongy) bone To the naked eye, cancellous bone looks like a honeycomb.

Microscopic examination reveals a framework formed from **trabeculae** (meaning 'little beams'), which consist of a few lamellae and osteocytes interconnected by canaliculi. The spaces between the trabeculae contain red bone marrow that nourishes the osteocytes.

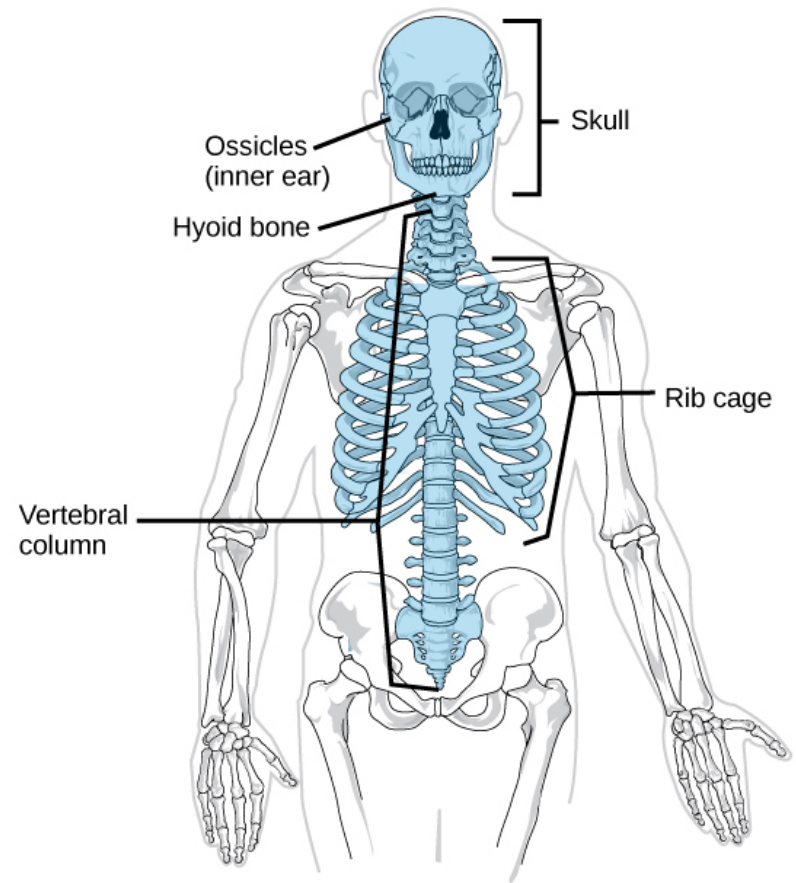


Compact Bone & Spongy (Cancellous Bone)



The bones of the skeleton are divided into two groups :

- ❖ Axial skeleton, which forms the axis of the body, which consists of the skull, vertebral column and rib cage.
- ❖ Appendicular skeleton, the bones of the arms, legs, shoulder and pelvic girdles make up the appendicular skeleton



Axial skeleton

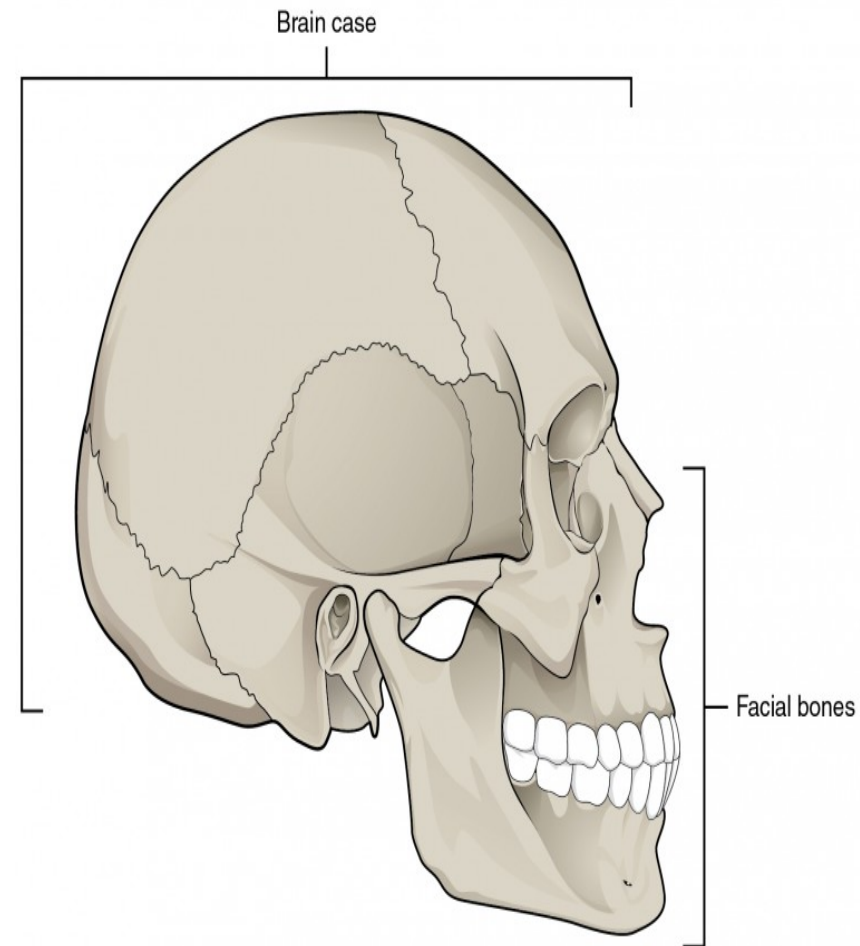
❖ Skull:

The skull rests on the upper end of the vertebral column and its bony structure is divided into two parts: the cranium and the face.

The cranium is formed by a number of flat and irregular bones that provide a bony protection for the brain and houses the middle and inner ear structures.

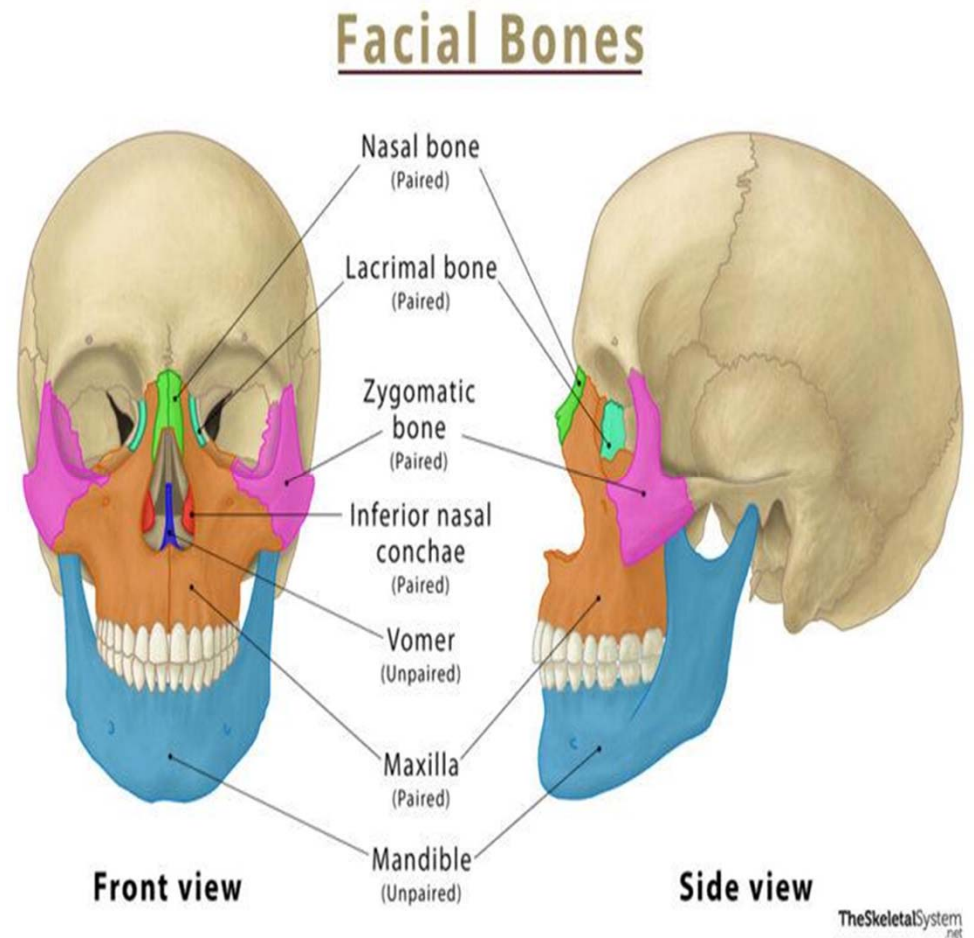
Facial bones: underlie the facial structures, form the nasal cavity, enclose the eyeballs, and support the teeth of the upper and lower jaws.

In the adult, the skull consists of 22 individual bones, 21 of which are immovable and united into a single unit. Only one bone moveable is the mandible (lower jaw).



❑ **Facial bones:** which are fourteen facial bones form the front portion of the skull, known as the facial skeleton or viscerocranium.

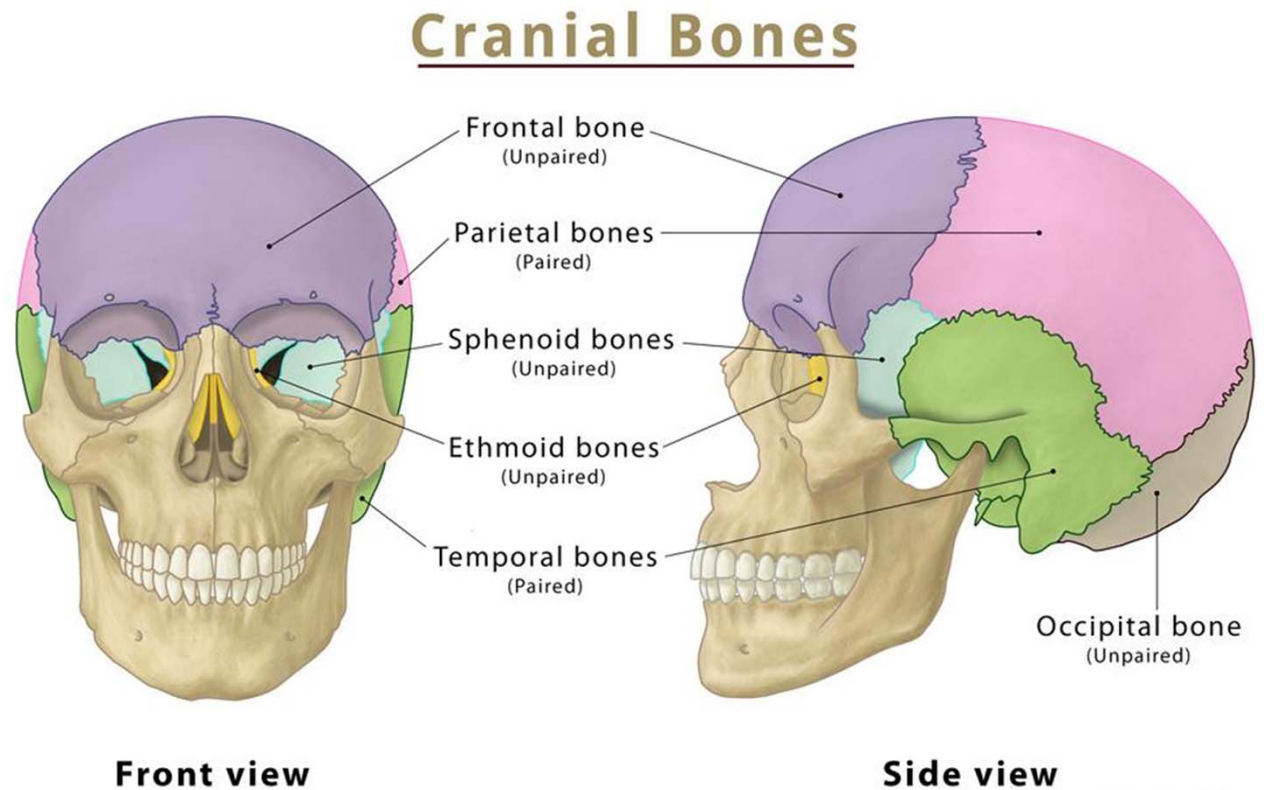
- ❑ **Zygomatic bone (2)**
- ❑ **Lacrimal bone (2)**
- ❑ **Inferior nasal conchae (2)**
- ❑ **Nasal bone (2)**
- ❑ **Palatine bone (2)**
- ❑ **Maxilla (paired, but fused)**
- ❑ **Vomer (1)**
- ❑ **Mandible (paired, but fused)**



The cranial bones

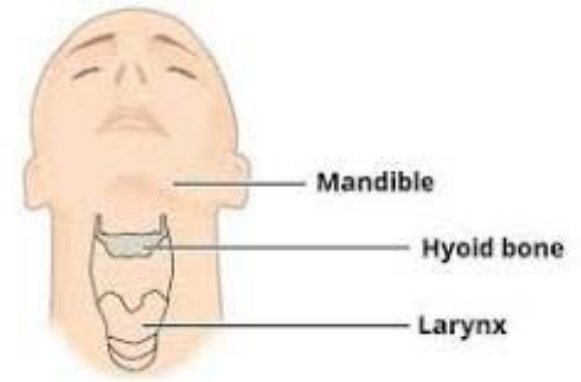
Encloses and protects the brain, eyes, and ears. Its eight bones.

- Frontal bone (1)
- Parietal bone (2)
- Temporal bone (2)
- Occipital bone (1)
- Sphenoid bone (1)
- Ethmoid bone (1)



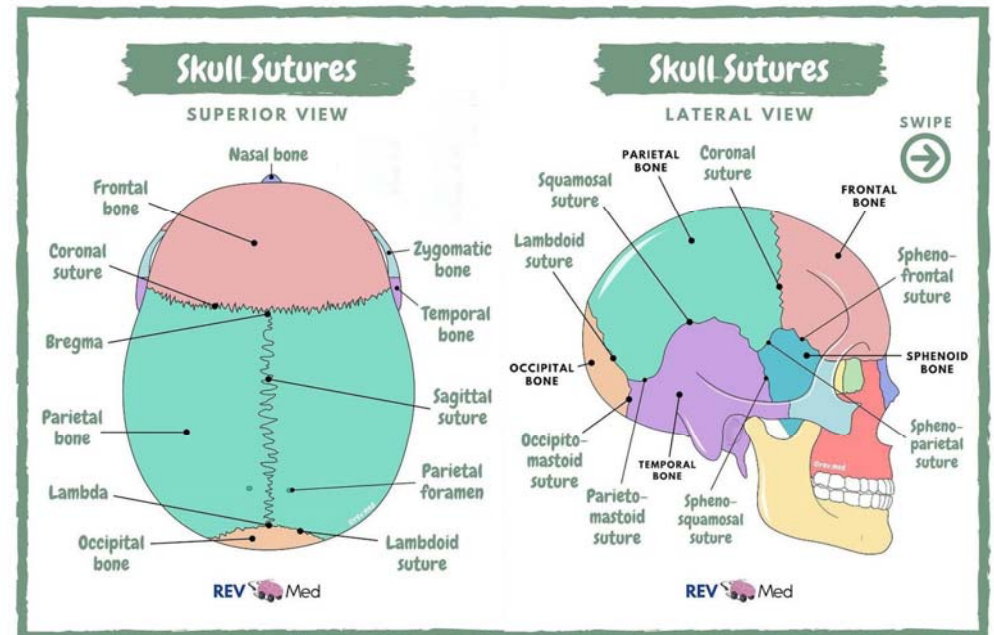
Hyoid bone

is an isolated small U-shaped horse-shoe-shaped bone lying in the soft tissues of the neck just above the larynx and below the mandible. It does not articulate with any other bone. It gives attachment to the base of the tongue



Skull sutures:

The sutures of the skull, also referred to as the cranial sutures, are fibrous joints that connect the bones of the skull. They appear as intricate thin lines that mark the adherence between the bones and the growth and closure of the cranial fontanelles.



Functions of the skull:

The various parts of the skull have specific and different functions:

- ❑ The cranium protects the delicate tissues of the brain.
- ❑ The bony eye sockets provide the eyes with some protection against injury and give attachment to the muscles which move the eyes.
- ❑ The temporal bone protects the delicate structures of the ear.
- ❑ Some bones of the face and the base of the skull give resonance to the voice because they have cavities called sinuses, containing air. The sinuses have tiny openings into the nasal cavity.
- ❑ The bones of the face form the walls of the posterior part of the nasal cavities.
They keep the air passage open, facilitating breathing.
- ❑ The maxilla and the mandible provide alveolar ridges in which the teeth are embedded.
- ❑ The mandible is the only movable bone of the skull and chewing food is the result of raising and lowering the mandible by contracting and relaxing some muscles of the face, the muscles of mastication

Thoracic cage:

The thoracic cage is formed by the vertebral column behind, the ribs and intercostal spaces on either side and the sternum and costal cartilages in front.

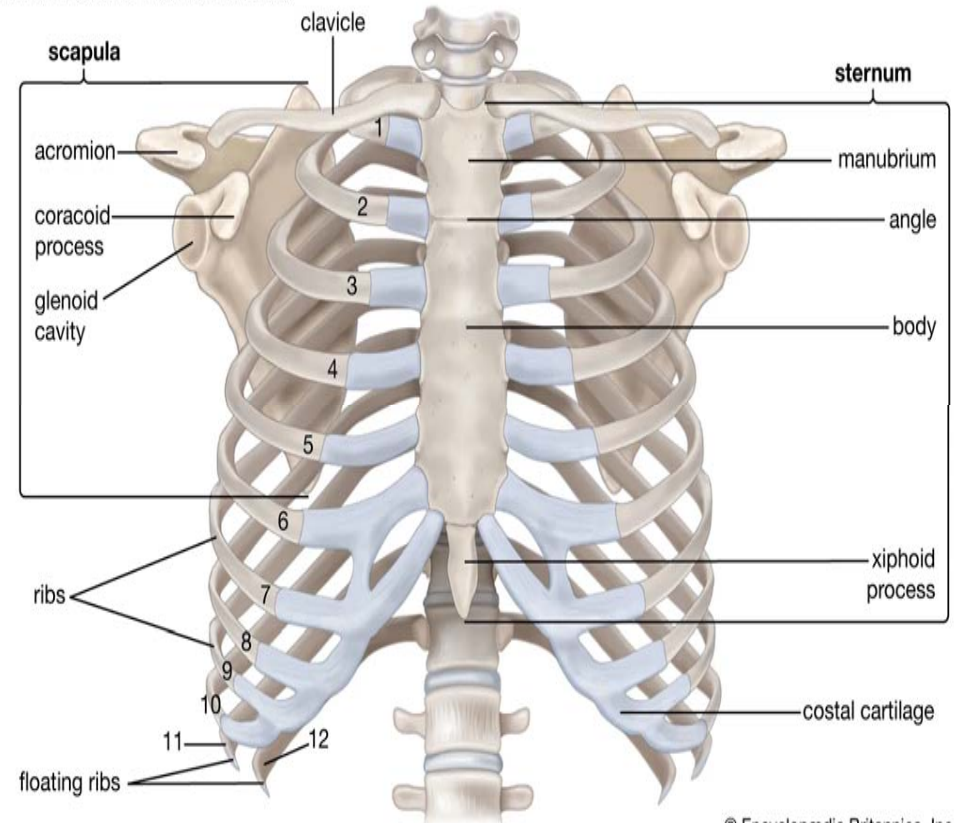
Functions of the thoracic cage:

- ❖ It protects the thoracic organs heart, lungs, large blood vessels and other structures.
- ❖ It forms joints between the upper limbs and the axial skeleton.
- ❖ It gives attachment to the muscles of respiration

Thoracic cage is formed by:

- ❖ sternum or breastbone
- ❖ 12 pairs of ribs
- ❖ 12 thoracic vertebrae

Bones of the human thorax



Sternum:

commonly called breastbone, is a flat bone located in the midline of the chest, making up the anterior thoracic wall. As it lies superficially, it is easily palpable below the skin of the chest in the midline.

Consist of three parts:

1. Manubrium

The manubrium is the uppermost section and articulates with the clavicles at the sternoclavicular joints and with the first two pairs of ribs.

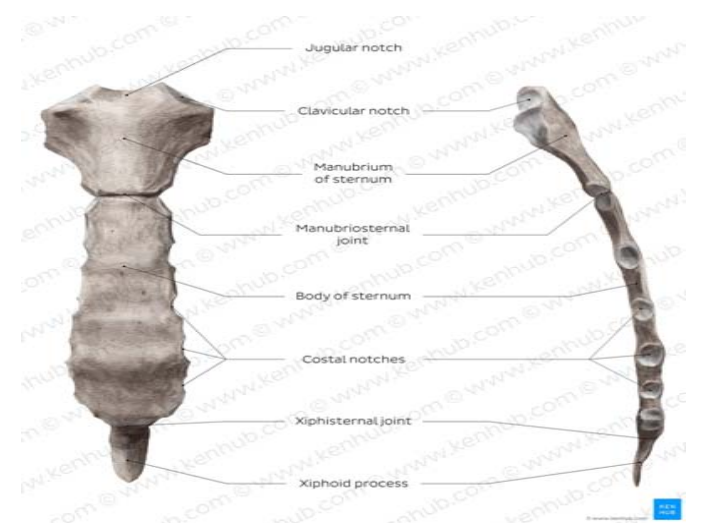
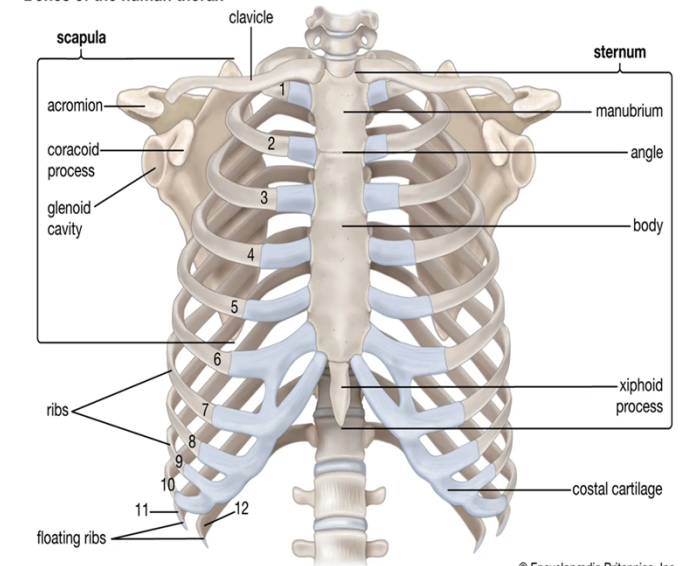
2. Body (gladiolus)

It is flat and elongated, articulating with the manubrium superiorly forming manubriosternal joint and the xiphoid process inferiorly, forming the xiphisternal joint. Its lateral borders which articulate with the costal cartilages of the thoracic 2nd - 7th

3. Xiphoid process

It is the most inferior and smallest part of the sternum. It is usually pointed and largely cartilaginous in structure.

Bones of the human thorax



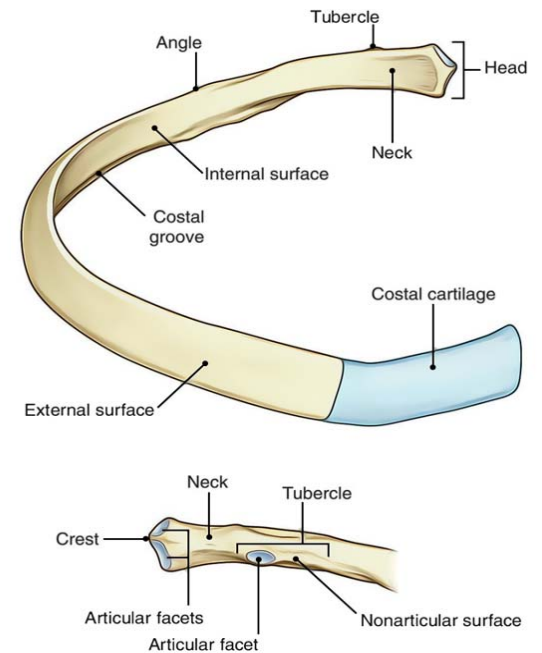
Ribs:

There are 12 pairs of ribs which form the bony lateral walls of the thoracic cage and articulate posteriorly with the thoracic vertebrae.

- ❖ The first seven pairs are attached directly to the sternum by costal cartilages and are called **true ribs**.
- ❖ The 8th, 9th, and 10th pairs do not join the sternum directly but are connected to the 7th rib by cartilage called **false ribs**.
- ❖ The 11th and 12th pairs **floating ribs**.

Anatomy of typical rib: Each typical rib has:

- ❖ A head bearing two articular facets.
- ❖ A neck
- ❖ A tubercle with a rough non-articular portion and a smooth facet, for articulation with the transverse process of the vertebra.
- ❖ Angle
- ❖ Costal groove



The following are the significant features of the ‘atypical’ ribs.

- ❑ **1st rib:** This is flattened from above downwards, shortest and most curvaceous of all the ribs
- ❑ has a prominent tubercle

- ❑ **The 2nd rib:** is much less curved and longer than the 1st.
- ❑ **The 10th rib** has only one articular facet on the head.
- ❑ **The 11th and 12th ribs :**
 - Short
 - have no tubercles
 - only a single facet on the head.
 - The 11th rib has a slight angle and a shallow subcostal groove; the 12th has neither of these features.

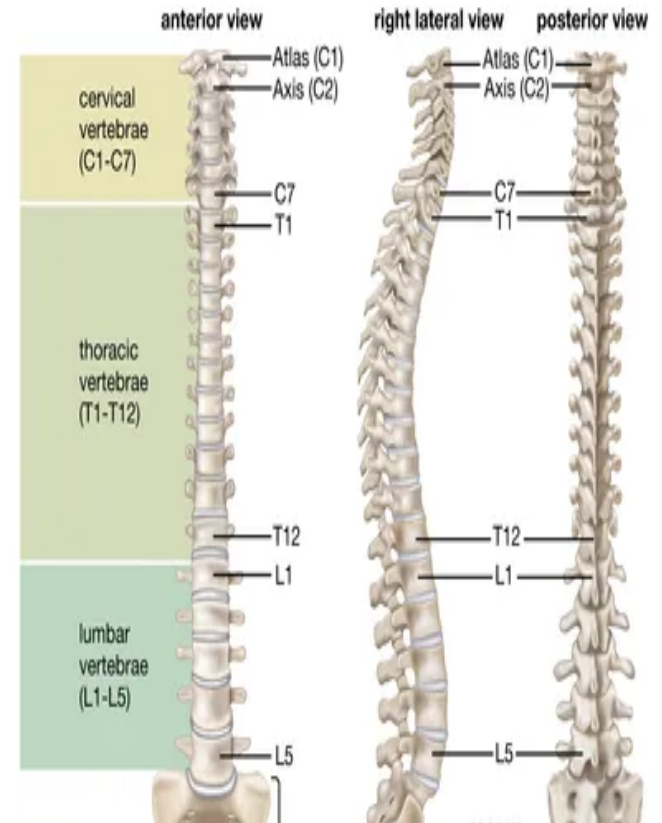
Costal cartilages:

These bars of **hyaline cartilage** serve to connect the upper seven ribs directly to the side of the sternum and the 8th, 9th and 10th ribs to the cartilage immediately above. The cartilages of the 11th and 12th ribs merely join the tapered extremities of these ribs and end in the abdominal musculature

Vertebral column

The vertebral column (spinal column or backbone) is made of individual bones called vertebrae. The names of vertebrae indicate their location along the length of the spinal column. There are several regions:

- ❑ **7 cervical vertebrae**, are located within the neck. The first vertebra is called the atlas, which articulates with the occipital bone to support the skull and the second cervical vertebra called axis. The remaining five cervical vertebrae do not have individual names
- ❑ **12 thoracic**, articulate (form joints) with the ribs on the posterior side of the trunk.
- ❑ **5 lumbar**, the largest and strongest bones of the spine, are found in the small of the back
- ❑ **5 sacral fused into 1 sacrum**, permits the articulation of the two hip bones
- ❑ **4 small coccygeal fused into 1 coccyx**, commonly known as the tailbone, is below the sacrum.



In adults, its show normal four curves:

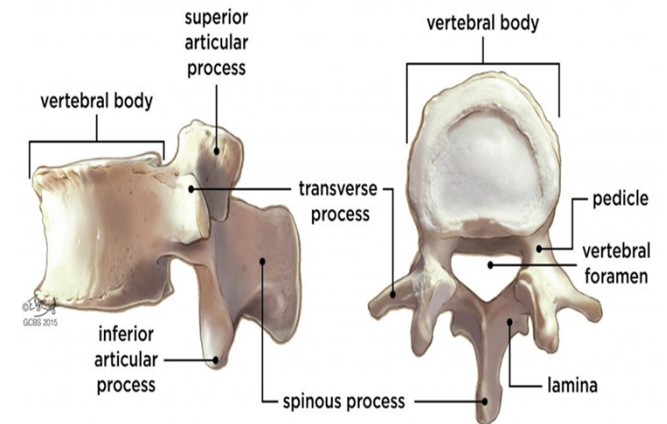
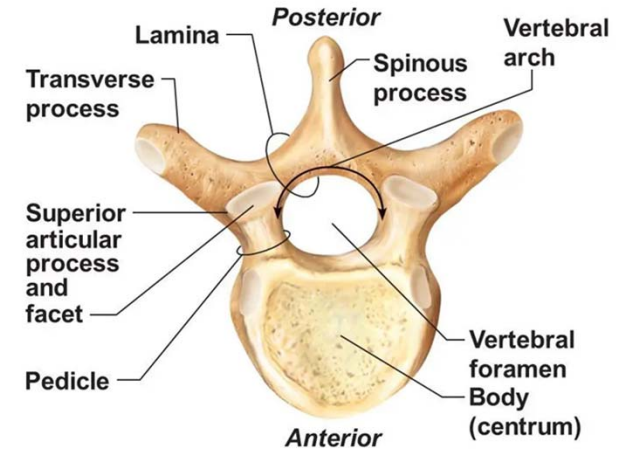
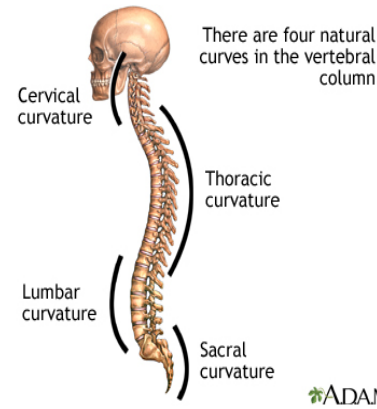
- ❑ Cervical and lumbar curve are convex (lordotic)
- ❑ Thoracic and sacral curve are concave (Kyphotic).

Functions of the Vertebral or Spinal Column

- ❑ Protection of the spinal cord and nerve root
- ❑ Base for attachment of ligaments, tendons, muscles
- ❑ In the thoracic region the ribs articulate with the vertebrae forming joints which move during respiration.
- ❑ Structural support for the head, shoulders, chest
- ❑ Connects upper and lower body for balance and weight distribution
- ❑ Flexibility and mobility in four dimensions
- ❑ The intervertebral discs act as shock absorbers and protecting the brain.

Typical vertebrae consist of:

- ❑ A body
- ❑ A vertebral arch (pedicles and lamina)
- ❑ vertebral foramen which contains the spinal cord
- ❑ Seven processes (two transverse processes, one spinous process and four articular processes)



Cervical vertebrae :

C1, C2 and C7- Atypical vertebrae

C3-C6 – have similarities- typical characterized by:

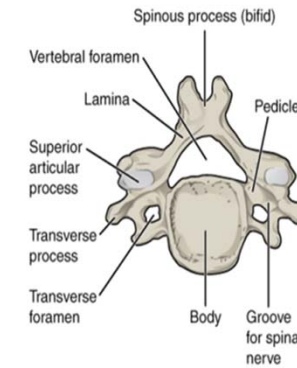
- ❖ Smaller bodies
- ❖ Large vertebral arch- larger vertebral foramen
- ❖ Transverse process consist of transverse foramina
- ❖ Spinous process short and bifid

C1- (Atlas)

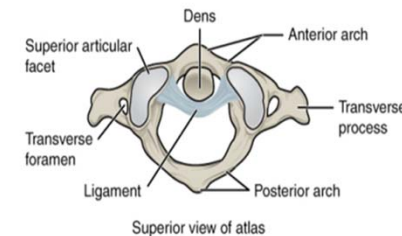
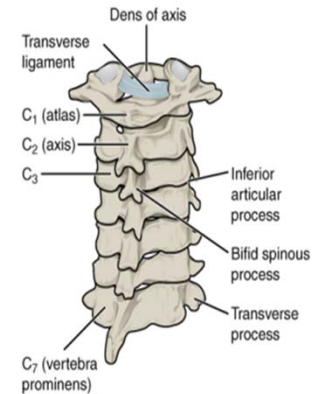
Is the 1st cervical vertebra and it consists simply of a ring of bone with two short transverse processes. The anterior part of the large vertebral foramen is occupied by the odontoid process of the axis, which is held in position by a transverse ligament Thus the odontoid process forms the body of the atlas. The posterior part is the true vertebral foramen and is occupied by the spinal cord

C2- (Axis)

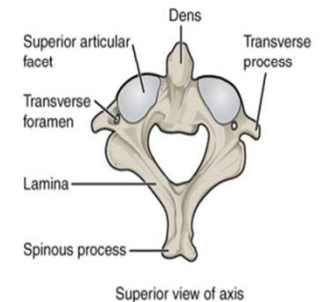
Is the 2nd cervical vertebra. The body is small and has the upward projecting odontoid process or dens that articulates with the first cervical vertebra, the atlas. The movement at this joint is turning the head from side to side.



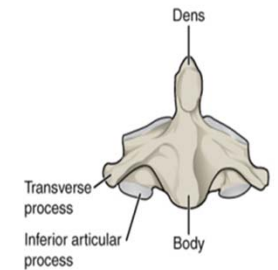
Structure of a typical cervical vertebra



Superior view of atlas



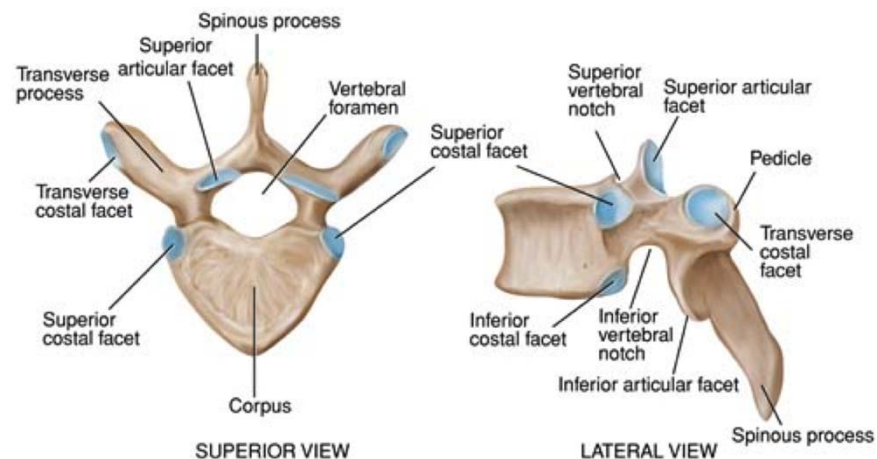
Superior view of axis



Anterior view of axis

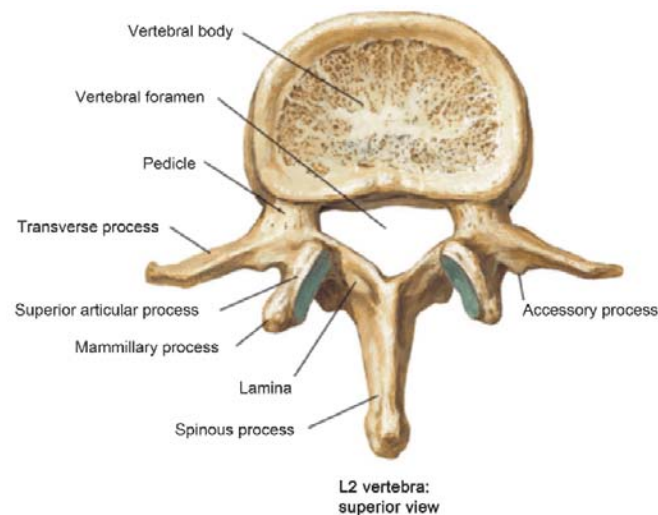
Thoracic vertebrae :

- ❖ A typical thoracic vertebra is distinguished by large body and the spinous process, which is long and projects downward to overlap the next inferior vertebra.
- ❖ It also has articulation sites (facets) on the vertebral body and a transverse process for rib attachment.



Lumbar vertebrae

- ❖ Carry the greatest amount of body weight.
- ❖ large size and thickness of the vertebral body.
- ❖ Short transverse processes
- ❖ Short, blunt spinous process.
- ❖ Articular processes are large, with the superior process facing medially and the inferior facing laterally.

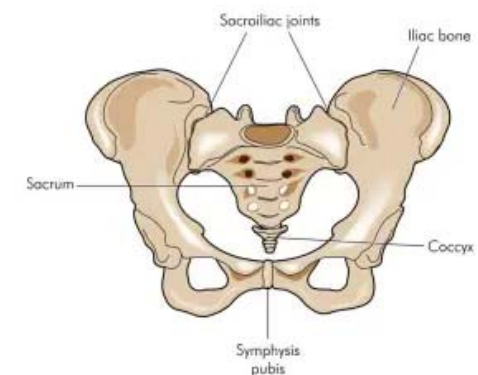
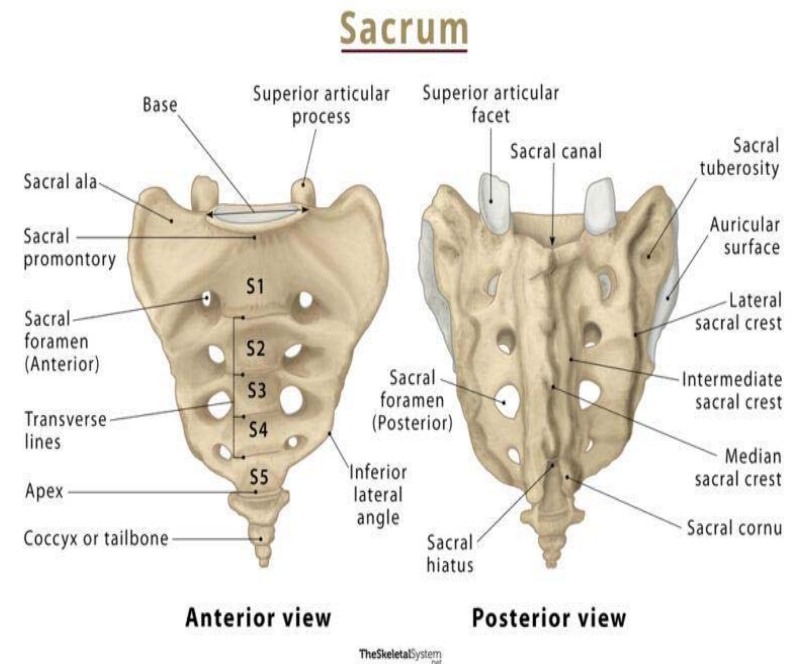


The sacrum:

This consists of five rudimentary vertebrae fused to form a triangular bone. The upper part, or base, articulates with the 5th lumbar vertebra. On each side it articulates with the ilium to form a sacroiliac joint, and at its inferior tip it articulates with the coccyx. The anterior edge of the base, the promontory, protrudes into the pelvic cavity. On each side of the bone there is a series of foramina for the passage of nerves.

Coccygeal vertebrae

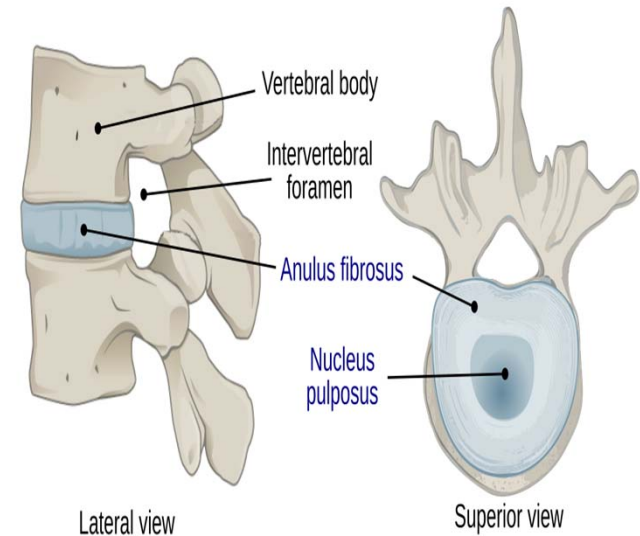
It articulates with the inferior tip of the sacrum. It is not weight bearing in the standing position, but may receive some body weight when sitting.



Features of the vertebral column

Intervertebral discs:

The bodies of adjacent vertebrae are separated by intervertebral discs, consisting of an outer rim of fibrocartilage (annulus fibrosus) and a central core of soft gelatinous material (nucleus pulposus). They are thinnest in the cervical region and become progressively thicker towards the lumbar region. They have a shock-absorbing function and the cartilaginous joints they form contribute to the flexibility of the vertebral column as a whole.



Movements of the vertebral column:

Flexion (bending forward).

Extension (bending backward)

Lateral flexion (bending to the side)

Rotation.

