

# *Skeletal System*

## Axial & Appendicular

### **The Skeletal System**

- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments (bone to bone)(tendon=bone to muscle)
- Divided into two divisions
  - Axial skeleton
  - Appendicular skeleton – limbs and girdle

## **By the end of today's PPT presentation in Class at 12.00 Noon, you will be able to:**

- Discuss the functions of the skeletal system
- Distinguish between the axial skeleton and appendicular skeleton
- Define the axial skeleton and its components
- Define the appendicular skeleton and its components

The skeletal system includes all of the bones, cartilages, and ligaments of the body that support and give shape to the body and body structures. The skeleton consists of the bones of the body. For adults, there are 206 bones in the skeleton. Younger individuals have higher numbers of bones because some bones fuse together during childhood and adolescence to form an adult bone. The primary functions of the skeleton are to provide a rigid, internal structure that can support the weight of the body against the force of gravity, and to provide a structure upon which muscles can act to produce movements of the body. The lower portion of the skeleton is specialized for stability during walking or running. In contrast, the upper skeleton has greater mobility and ranges of motion, features that allow you to lift and carry objects or turn your head and trunk. In addition to providing for support and movements of the body, the skeleton has protective and storage functions. It protects the internal organs, including the brain, spinal cord, heart, lungs, and pelvic organs. The bones of the skeleton serve as the primary storage site for important minerals such as calcium and phosphate. The bone marrow found within bones stores fat and houses the blood-cell producing tissue of the body.

The skeleton is subdivided into two major divisions—the axial and appendicular.

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Date: 06/02/2019

Note: Text in parts have been adopted from website sources.

# Bones

- Cellular structures whereby the extracellular fluid environment of the cell is surrounded by a rigid, calcified frame.
- Framework of one bone, when combined with all the other bones of the body comprise the skeleton .
- Skeleton gives an identifiable form to an animal and provides protection for the cranial, thoracic, abdominal and pelvic viscera.
- Medullary cavity of the bones is the principal location of blood formation.

# Bones

- Calcified regions of bone act as a “sink” and a “source” for many of the required minerals (cations and anions) of the body.
- Because of attachment of muscles to bone many body parts can be moved.
- Bones are dynamic structures that are capable of accommodating to different loads and stresses by remodeling.
- Function can be restored to broken bones by the process of bone repair.



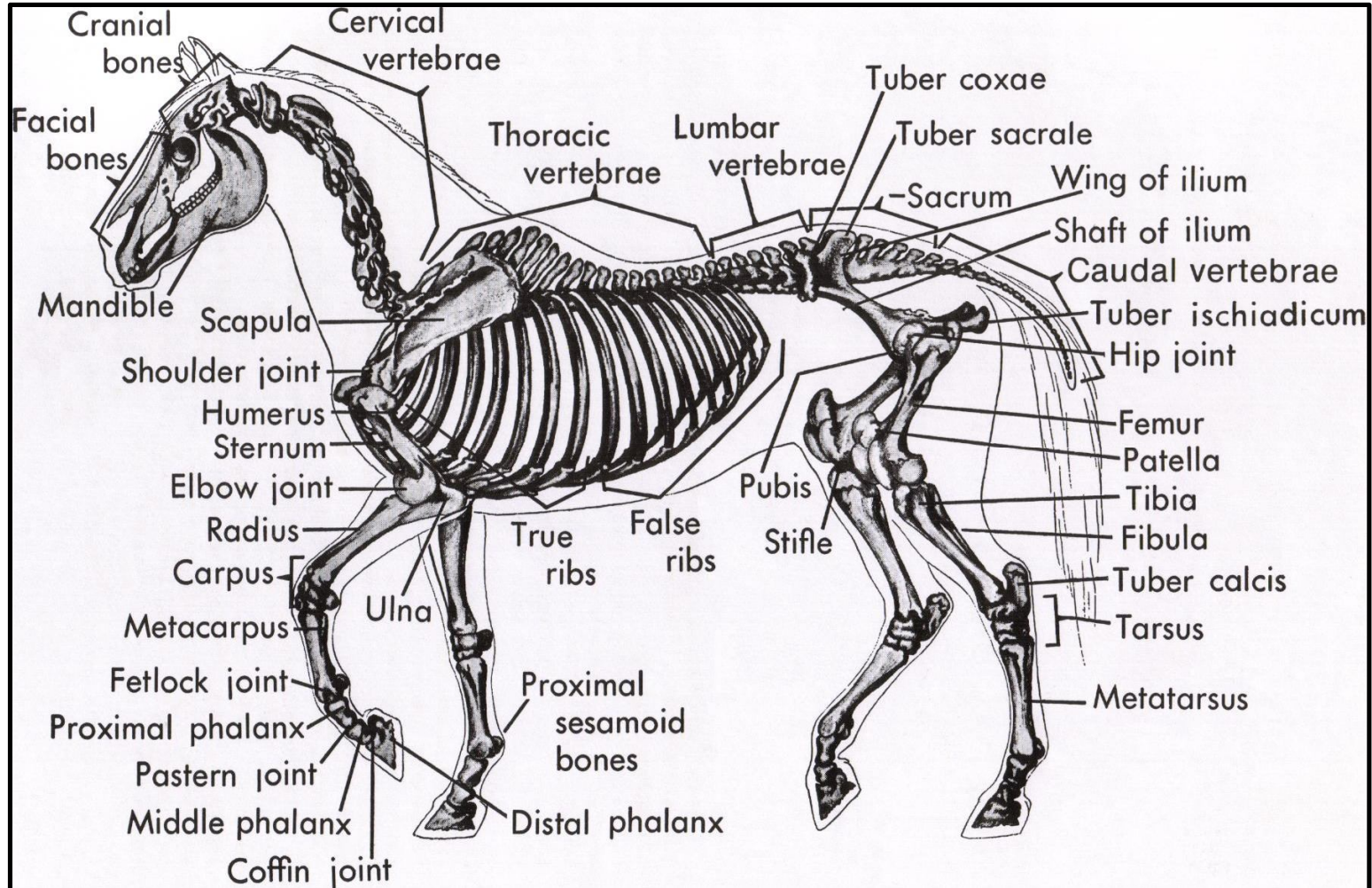
# Structure and Function

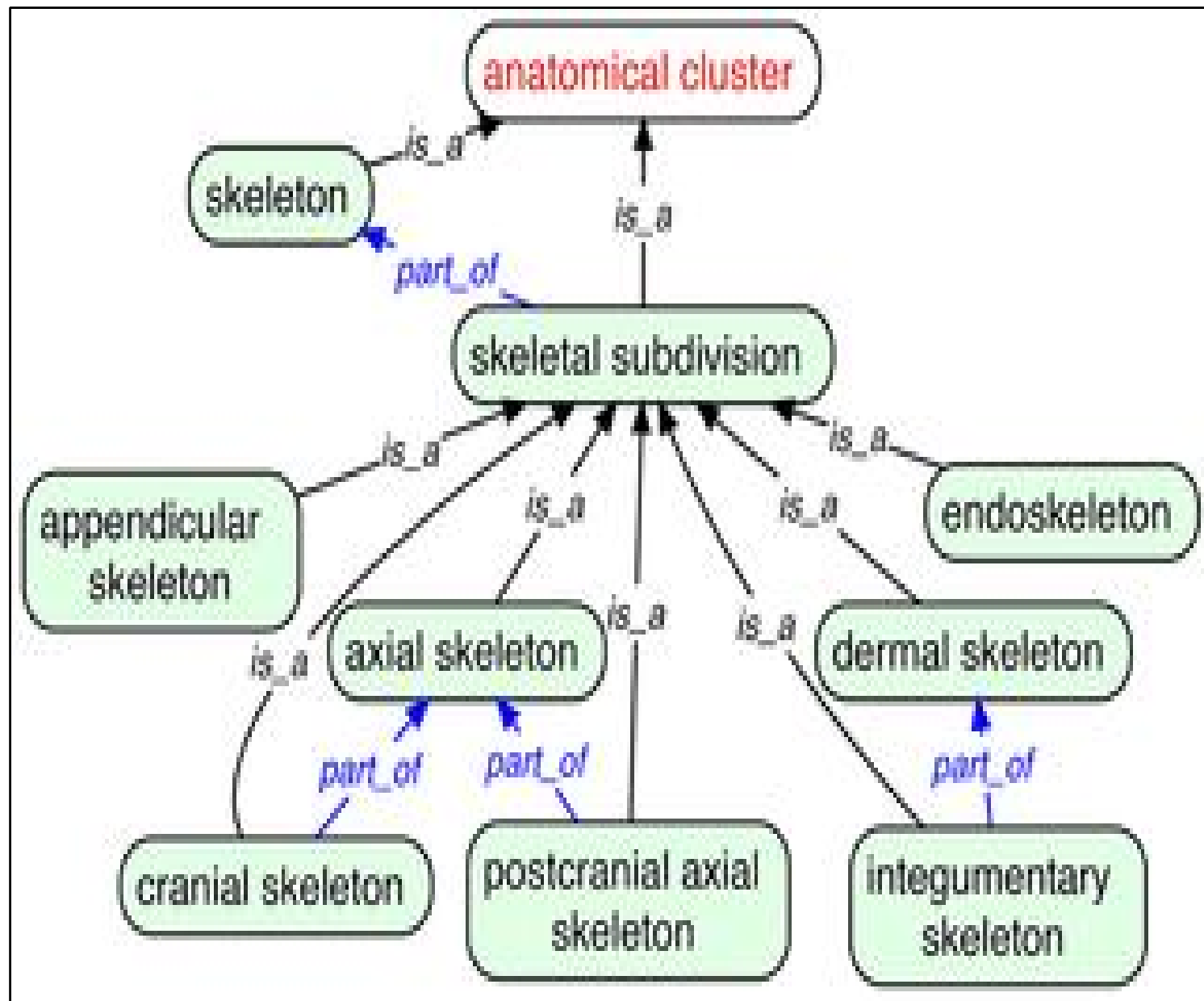
- Bones of the body are basically similar among animals, but vary according to size, shape, and number.
- Bones of the skeleton are classified as belonging to either the axial skeleton or appendicular skeleton.
  - Axial skeleton – lies on the long axis (midline) of the body
    - Skull
    - Vertebrae
    - Ribs
    - Sternum

# Structure and Function

- Appendicular skeleton is made up of the bones of the front (pectoral) and hind (pelvic) limbs as well as their respective pectoral girdle (shoulder) and pelvic girdle (pelvis).
  - Pectoral girdle
    - Scapula
    - Clavicle
    - Coracoid
  - Pelvic girdle
    - Ilium
    - Ischium
    - Pubis

# The Horse Skeleton





# The Skeletal System

- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments (bone to bone)(tendon=bone to muscle)
- Divided into two divisions
  - **Axial skeleton**- skull, spinal column
  - **Appendicular skeleton** – limbs and girdle

# Functions of Bones

- Support of the body
- Protection of soft organs
- Movement due to attached skeletal muscles
- Storage of minerals and fats
- Blood cell formation

# Long Bones

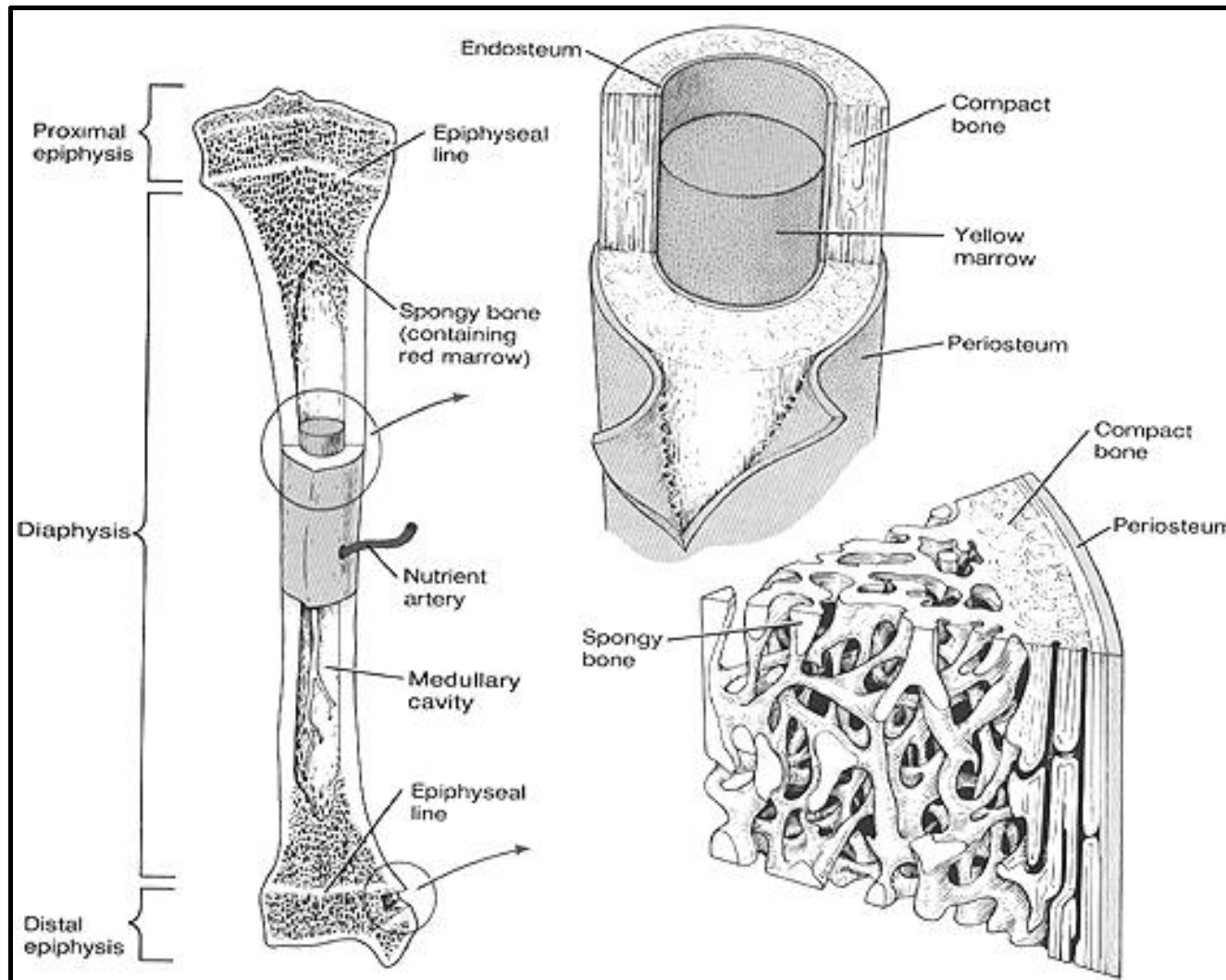
- Composed of compact bone and spongy bone.
- Compact bone appears to be solid while spongy bone has the appearance of a sponge.
- In spongy bone, there are trabecular (spicules) of mineralized tissue, and the empty spaces between the trabeculae are filled with bone marrow in living animals.

# Long Bones

- Rigidity and strength of long bones is not only due to the hardness of the compact bone, but also by the scaffolding arrangement of the trabeculae which are generally parallel to lines of stress and act as pillars for stress points.



# Long Bones



# Long Bones

- Epiphysis of a long bone is at either end of a long bone.
  - consists chiefly of spongy bone with a thin outer layer of compact bone
  - Epiphyseal plate (physis) is composed of hyaline cartilage and represents the point of growth in a longitudinal direction.
    - Hyaline cartilage is normal type. Matrix is glassy-bluish white and somewhat translucent.
    - In mature animals, the cartilage has been replaced by bone and epiphyseal lines remain where the plate last existed.

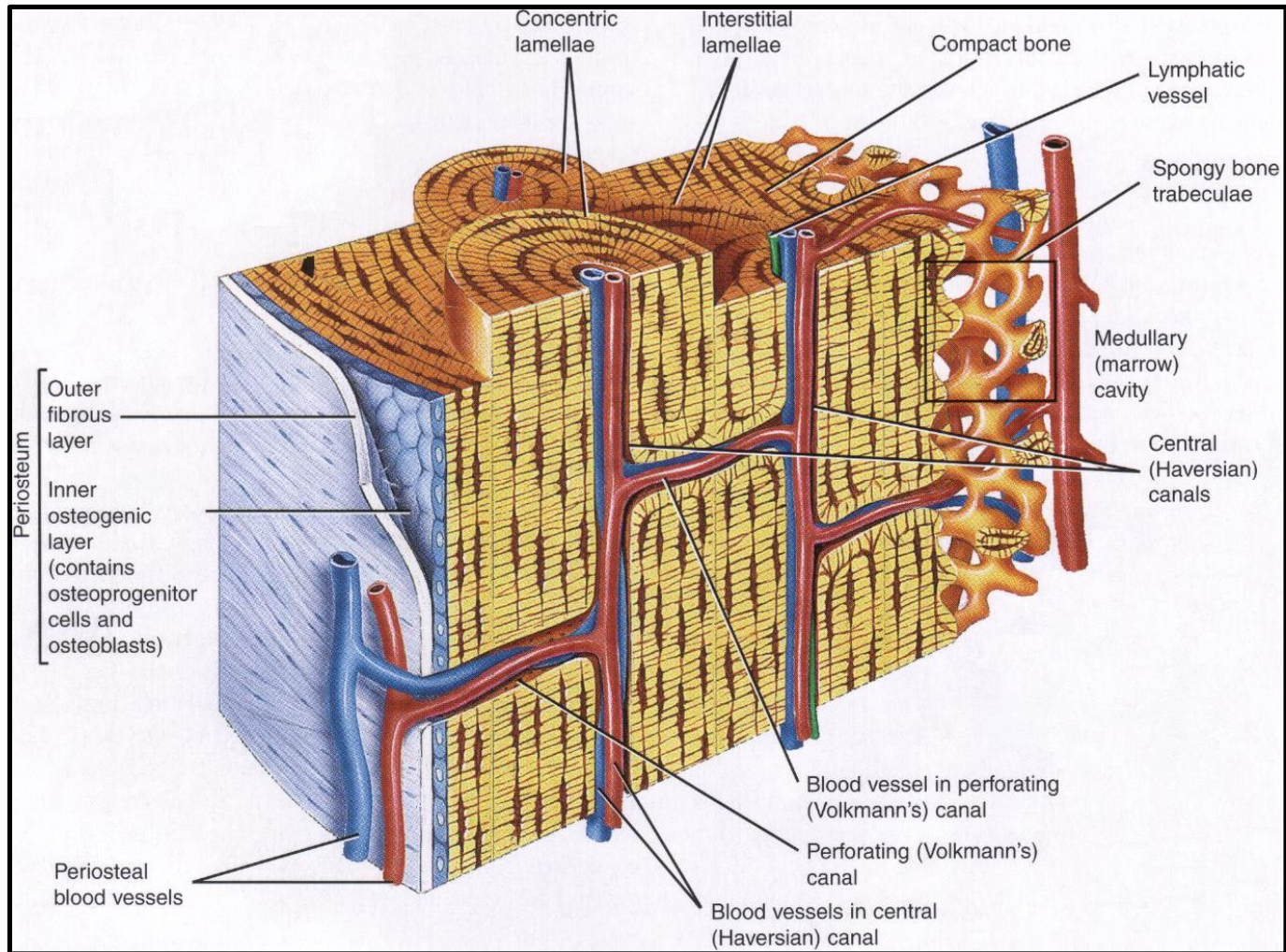
# Long Bones

- Diaphysis is the cylindrical shaft of a long bone between either epiphysis.
  - contains marrow (medullary) cavity surrounded by a thick wall of compact bone
    - Site of red blood cell production
- Metaphysis is the expanded or flared part of the bone at the ends of the diaphysis.

# Long Bones

- The contact area of the bone that articulates with its neighboring bone at a moveable joint is covered with articular cartilage.
- With exception of the joint surfaces, all other outer surfaces of the bone are covered with periosteum.

# Long Bones



# Long Bones

- Periosteum is composed of an outer fibrous layer and an inner cell-rich layer containing osteoblasts.
  - osteoblasts synthesize and secrete the organic substance of bone
  - osteoblasts participate in the mineralization of the organic matrix
- Periosteum is responsible for the increase in diameter of bones and also functions in the healing of fractures.

# Long Bones

- Endosteum is the lining tissue of all surfaces of the bone that face the medullary cavity and also the trabeculae of the bone.
  - only 1 cell layer thick and the cells can become osteoblasts when stimulated



# Long Bones

- Channels that run parallel to the long axis of the bone are the Haversian canals, which contain blood vessels that communicate with blood vessels serving the external surfaces and marrow cavity.
  - Volkmanns canals are perpendicular to the long axis of the bone and contain the blood vessels which communicate with vessels in the haversian canals.



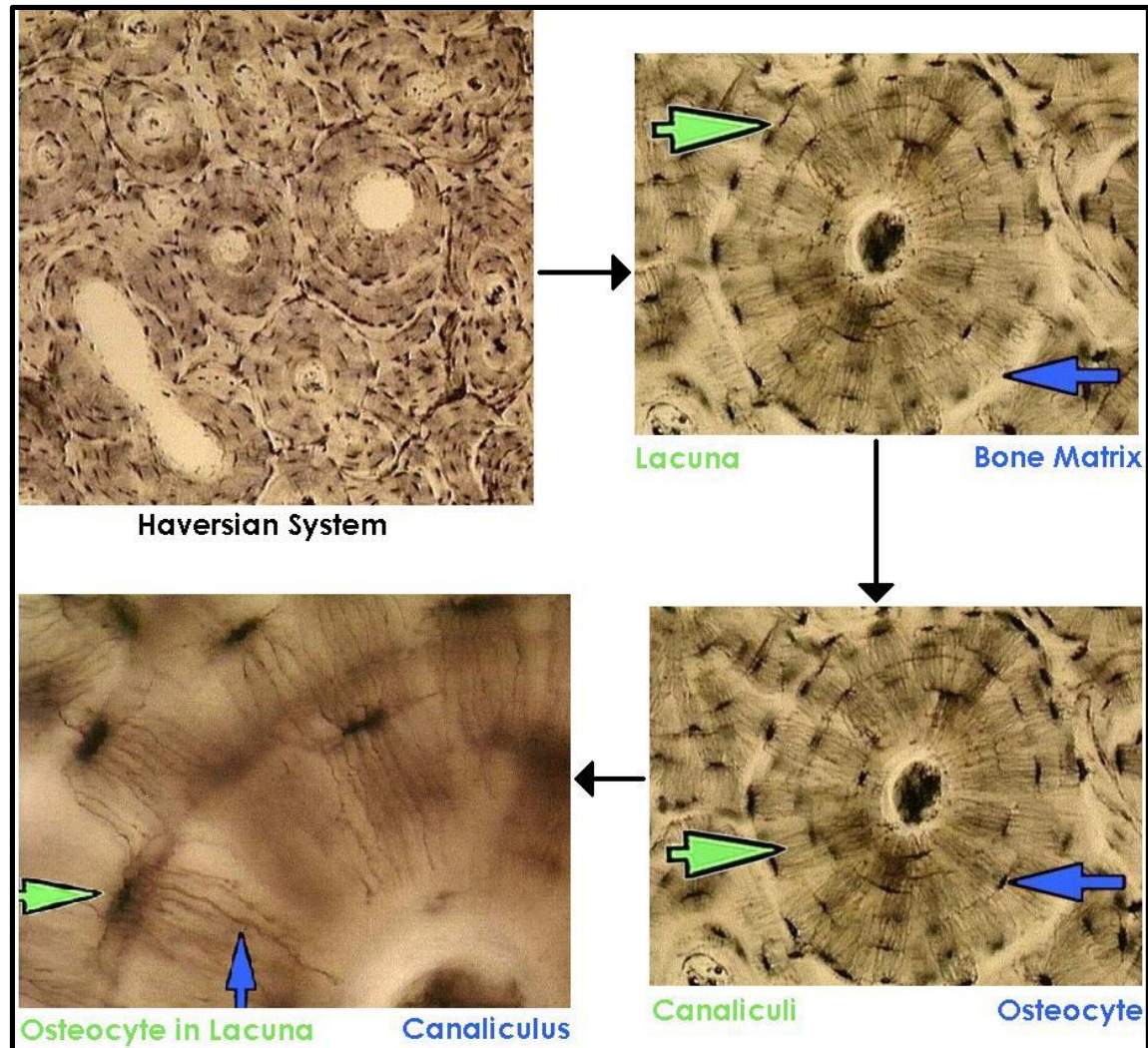
# Haversian System

- The unit of structure of compact bone
  - composed of central haversian canal surrounded by concentric layers of bone, the lamellae
- Bone cells (osteocytes) are contained within small cavities known as lacunae (little lakes).
- Osteocytes communicate with each other and with the haversian canal through a branching network of canals known as canaliculi.

# Haversian System

- Interstitial fluid for the osteocytes is contained within the lacunae and canaliculi. It diffuses through the canalicular network from the blood vessels in the canals for maintenance of the osteocytes.
- Haversian systems are absent in spongy bone, but concentric lamellae with enclosed lacunae and osteocytes with intercommunicating canaliculi are present.

# Haversian System



# Bone Cells

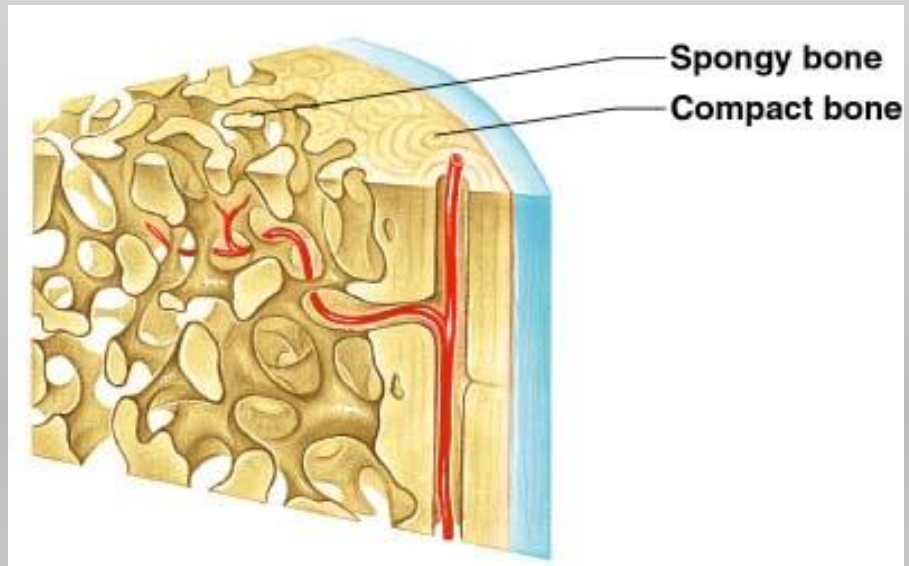
- Four different types of cells are associated with bone however they should all be considered as different functional states of the same cell type.
  - Osteoprogenitor cells
  - Osteoblasts
  - Osteocytes
  - Osteoclasts

# Types of Bone Cells

- **Osteocytes**
  - Mature bone cells
- **Osteoblasts**
  - Bone-forming cells
- **Osteoclasts**
  - Bone-destroying cells
  - Break down bone matrix for remodeling and release of calcium
- ***Bone remodeling is a process by both osteoblasts and osteoclasts***

# Bones of the Human Body

- The skeleton has **206** bones
- Two basic types of bone tissue
  - **Compact** bone
    - Homogeneous
  - **Spongy** bone
    - Small needle-like pieces of bone
    - Many open spaces

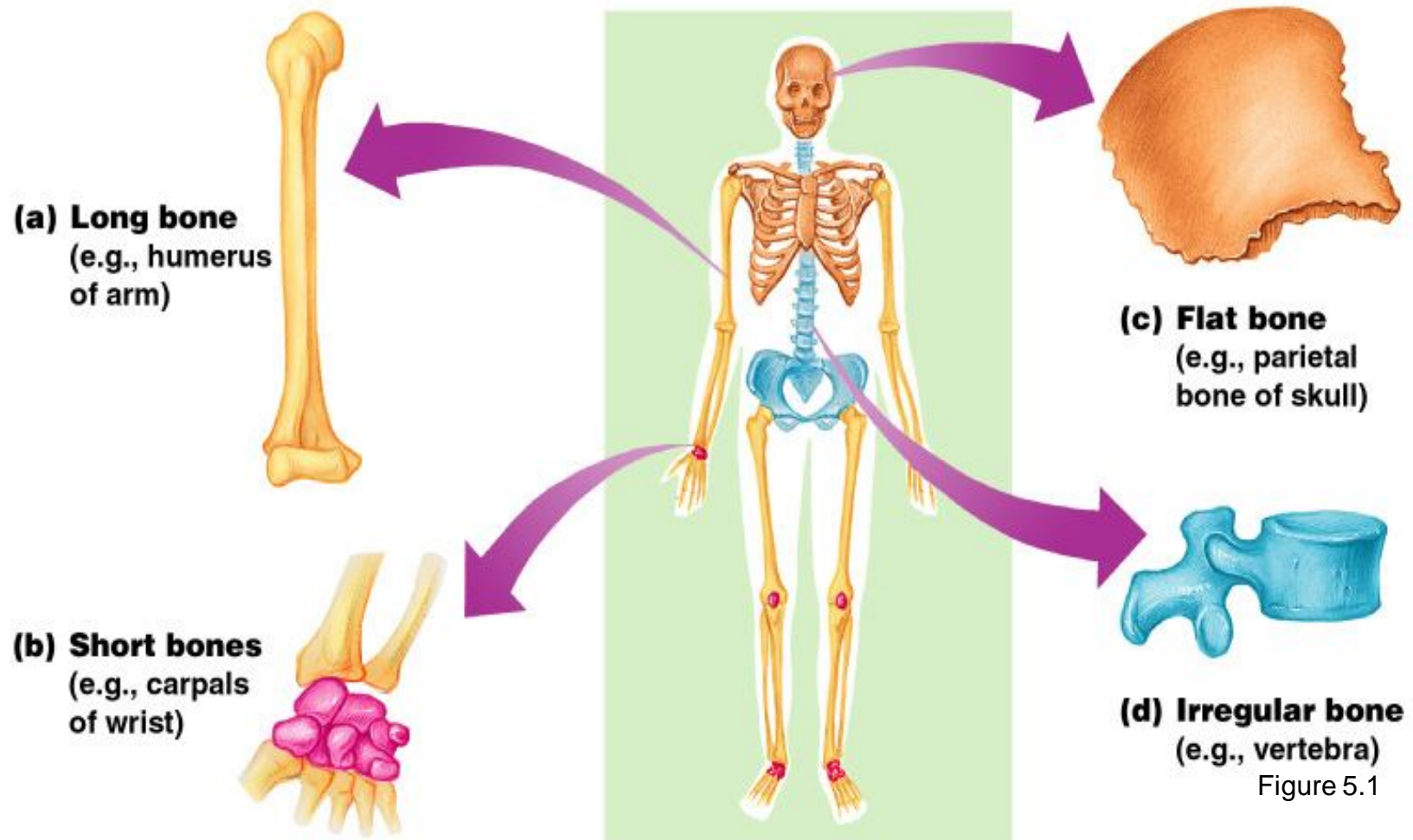


# Bones are classified by their **shape**:

- 1. Long-** bones are longer than they are wide (arms, legs)
- 2. Short-** usually square in shape, cube like (wrist, ankle)
- 3. Flat-** flat , curved (skull, Sternum)
- 4. Irregular-** odd shapes (vertebrae, pelvis)



# Classification of Bones on the Basis of Shape





# Axial skeleton supports and protects organs of head, neck and trunk

## Axial skeleton:

skull (cranium and facial bones)

hyoid bone (anchors tongue and muscles associated with swallowing)

vertebral column (vertebrae and disks)

bony thorax (ribs and sternum)

**Appendicular skeleton includes bones of limbs and bones that anchor them to the axial skeleton**

Appendicular skeleton:

- pectoral girdle (clavicle, scapula)

- upper limbs (arms)

- pelvic girdle (sacrum, coccyx)

- lower limbs (legs)

**Articulation-** where joints meet, connect, and are formed.

# Endoskeletal Tissues

## ■ Visceral Skeleton

### ■ Jaw cartilages and middle ear bones

- Weberian ossicles of fish (are referred to as ear ossicles)
- Derived from transverse processes of anterior most vertebrae

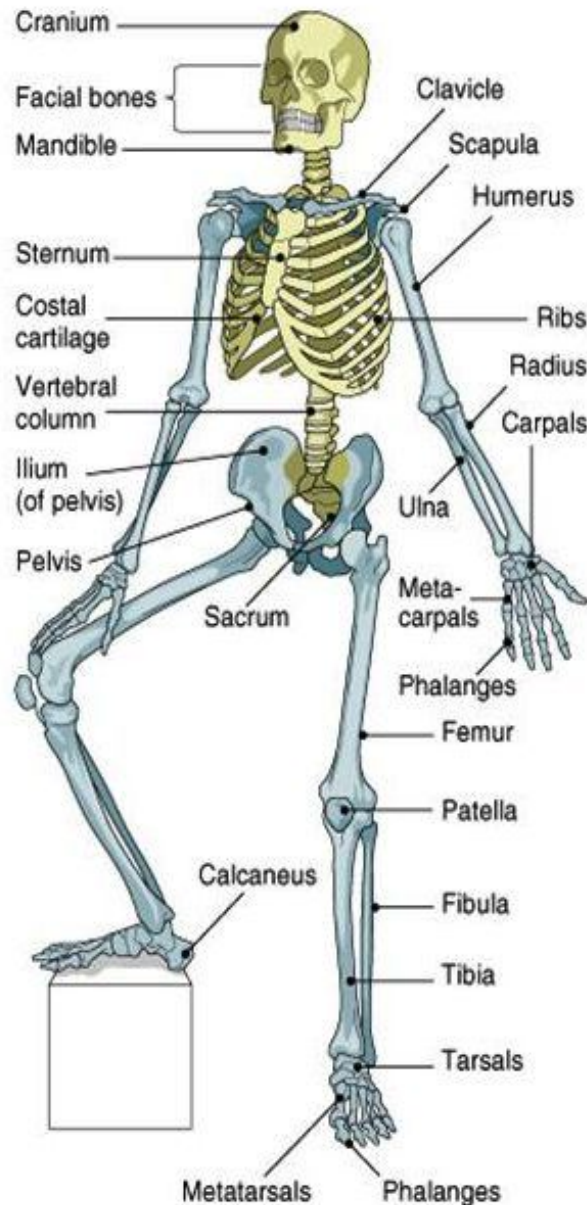
## ■ Somatic Skeleton

- Remaining internal bones developing from mesoderm proper
- Sclerotome of somite

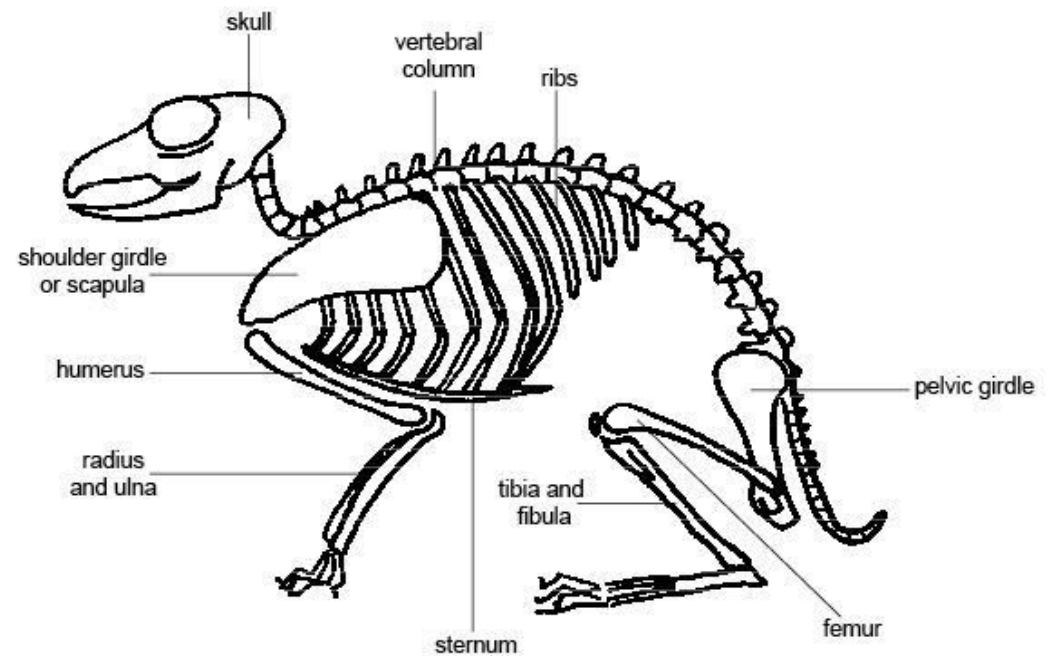
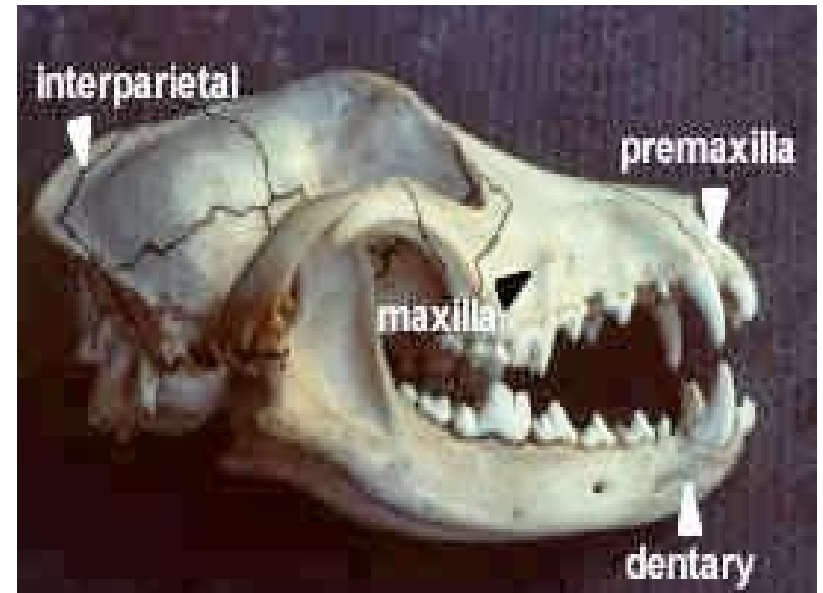
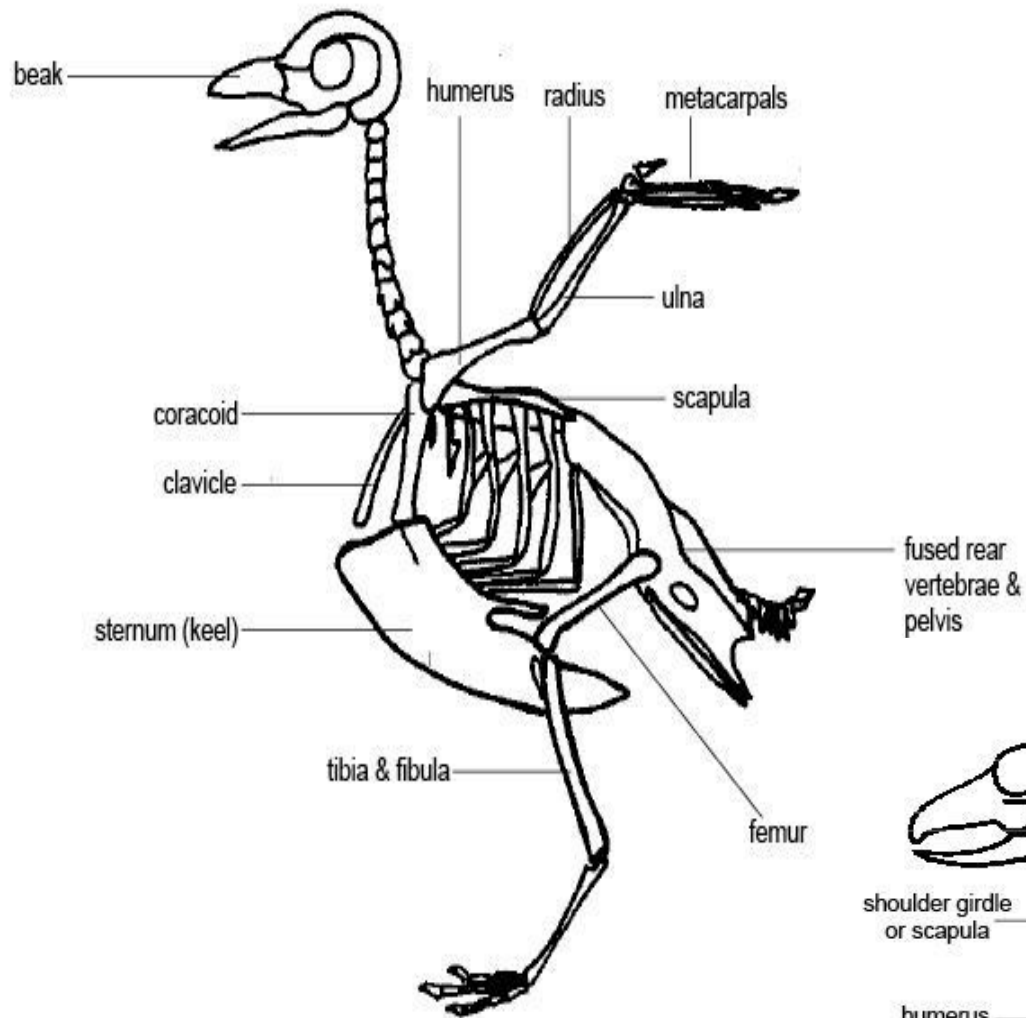
## ■ Axial Skeleton

## ■ Appendicular Skeleton

# Divisions of the Skeleton

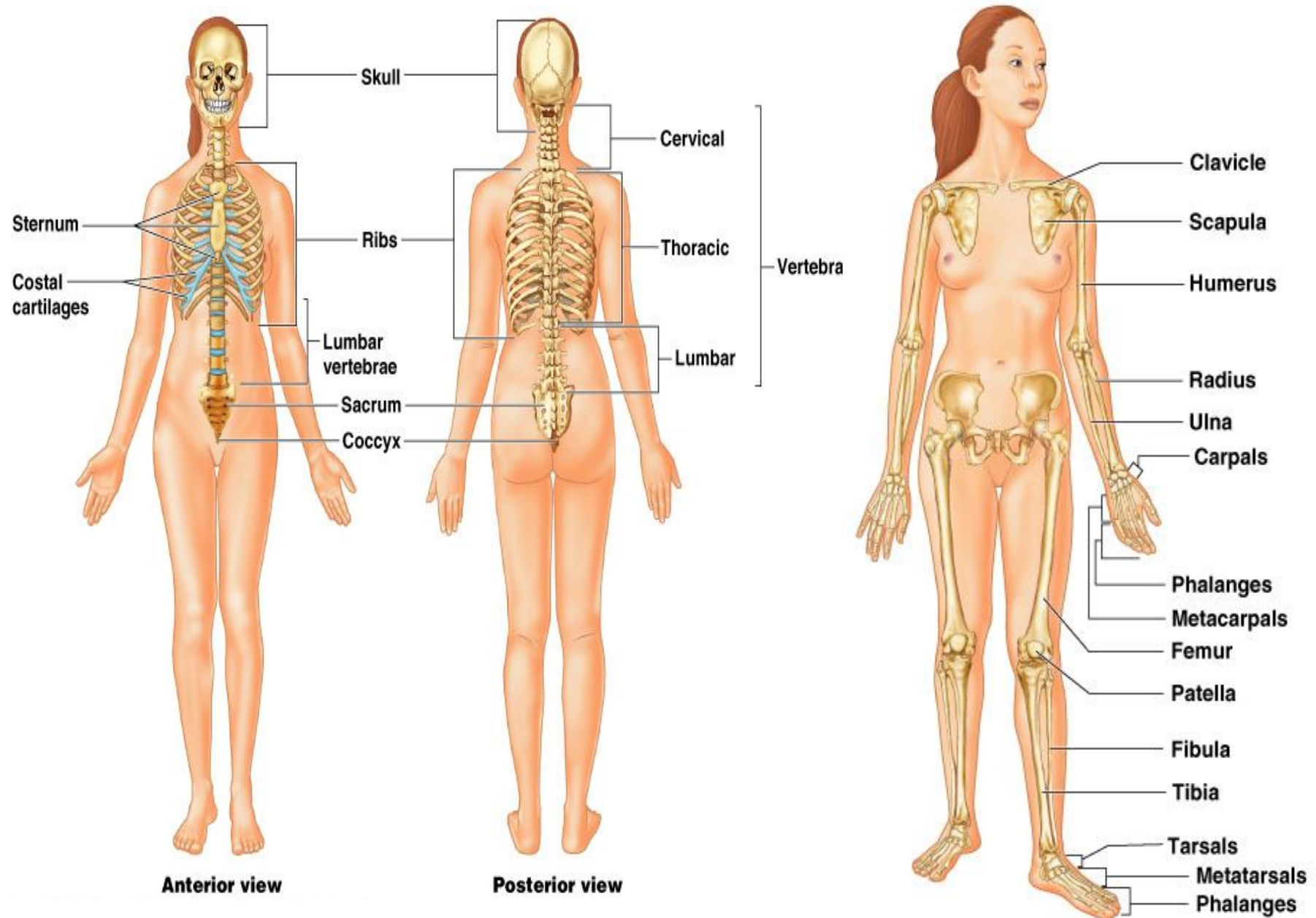


- **Axial skeleton** – skull, vertebrae, and bony thorax
- **Appendicular skeleton** – bones of the arms and legs, including their associated girdles

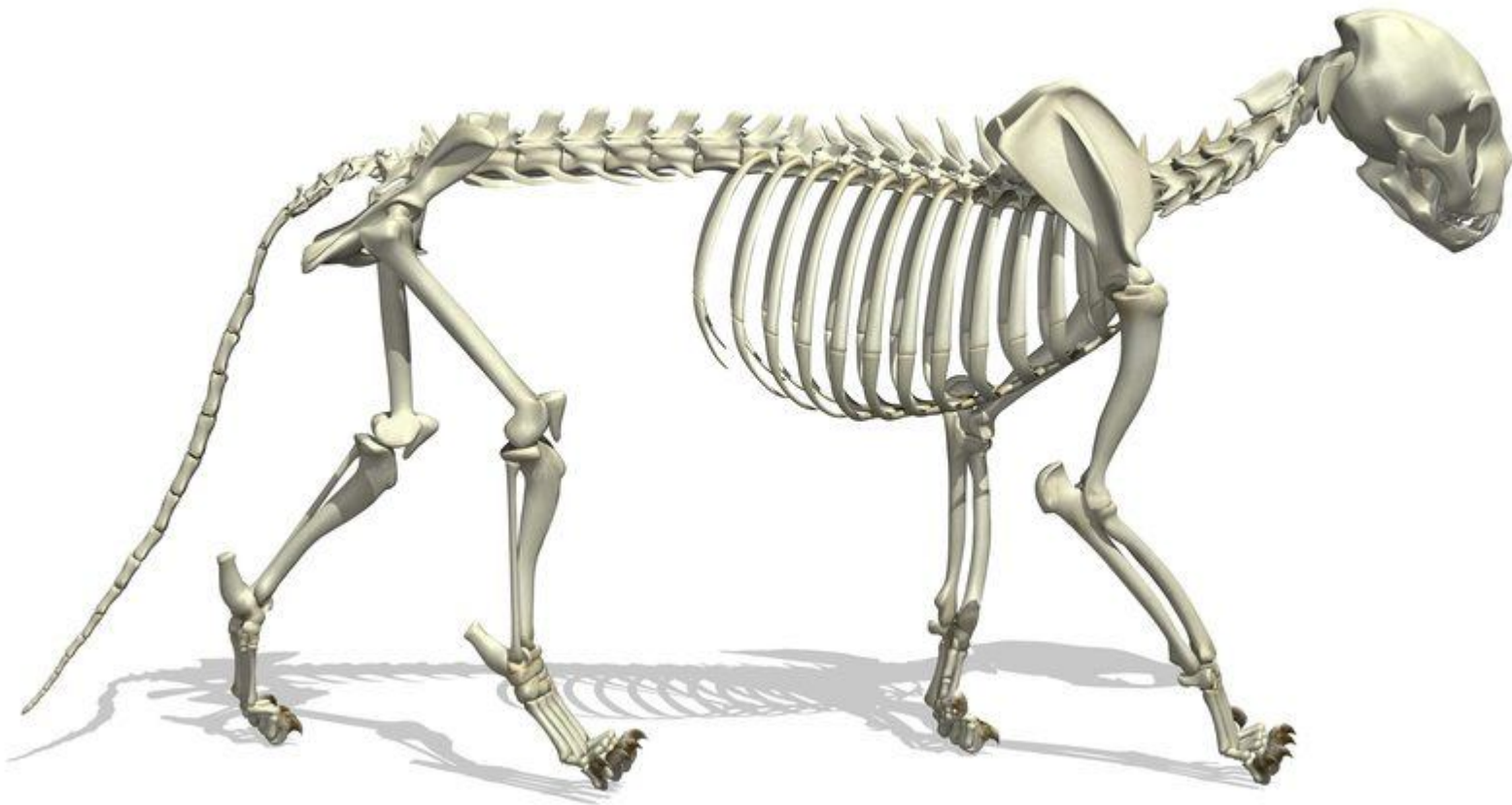




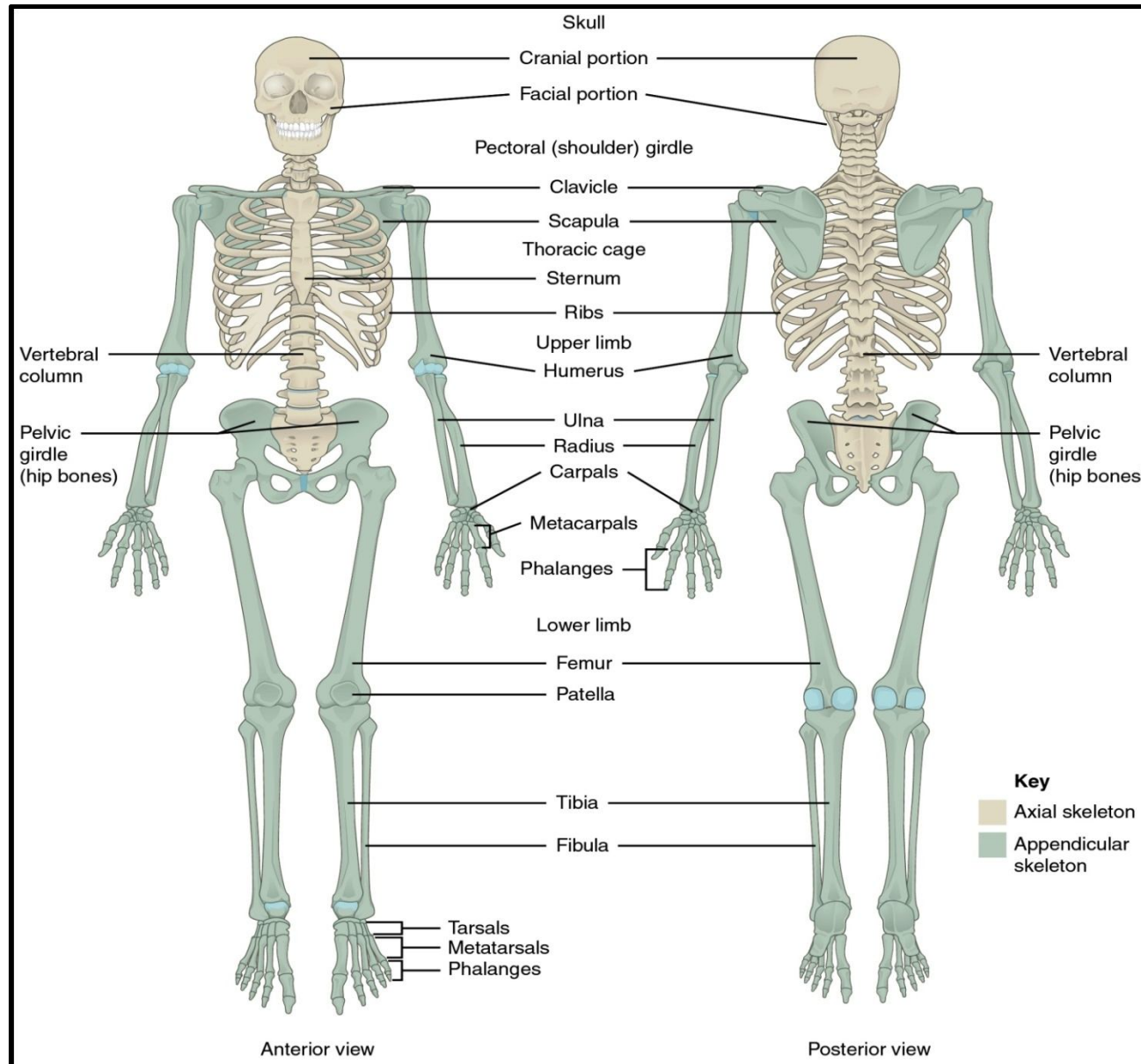
# Axial Skeleton Appendicular Skeleton



# Skeleton of Cat



# Human Skeleton: Anterior & Posterior





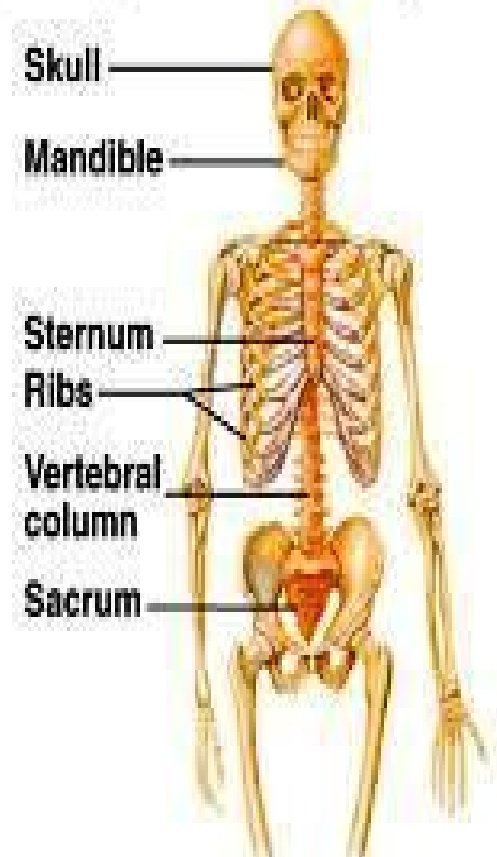
# Types of Bones

- Long Bones- metacarples, metatarsals, phelangies, humerus, ulna, radius, tibia, fibula
- Short Bones- carpals, tarsals
- Shortest/Smallest Bones- MIS
- Flat Bones- rib, scapula, skull, sternum
- Irregular Bones- vertebrae, some facial bones
- Sesamoid- patella

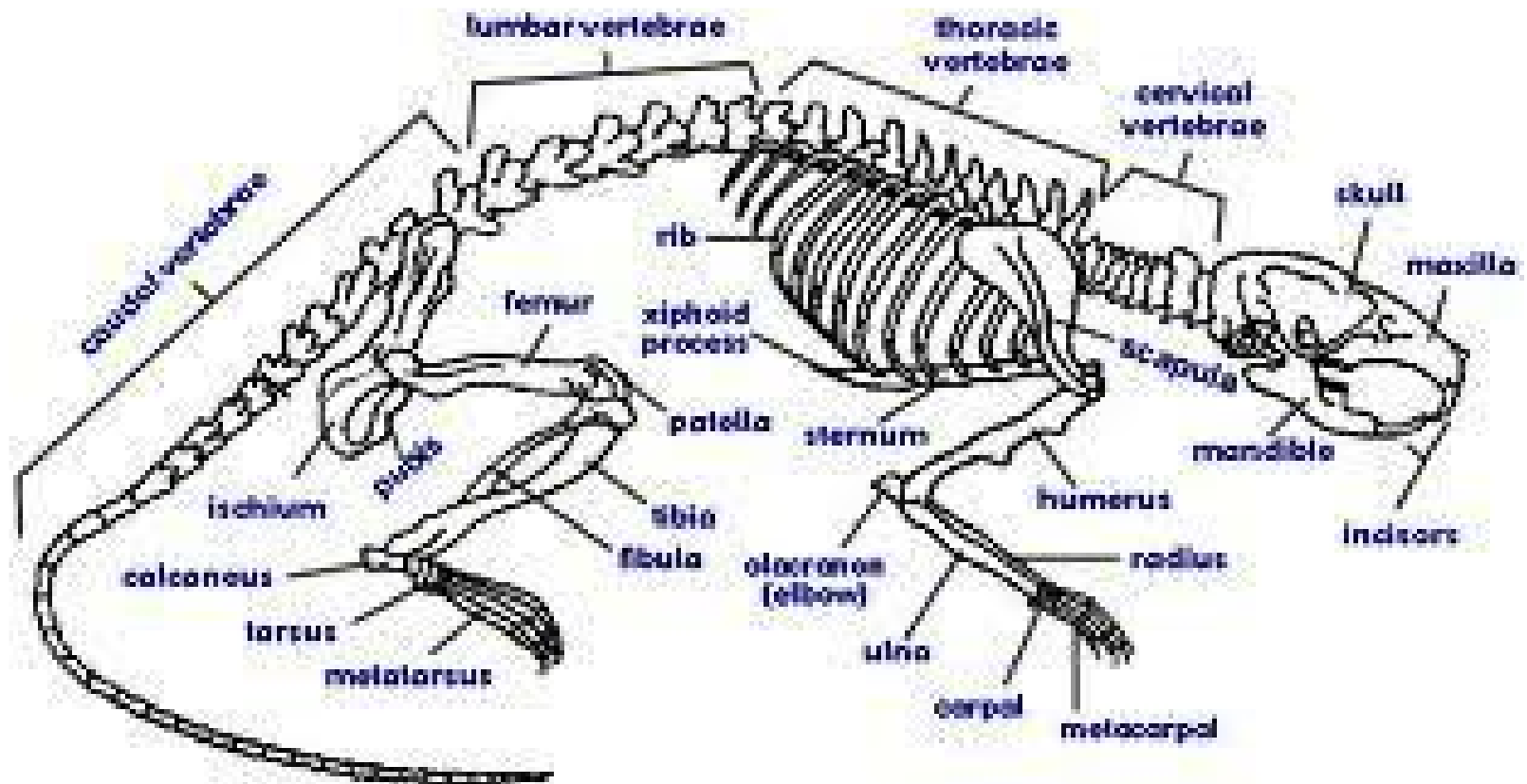
- 270 Bones **At Birth**
- 206 Bones **As Adult**
- Skeleton Divisions: **Axial** and **Appendicular**
- **Axial Skeleton** – 80 Bones, 3 Regions
  - ❖ Skull
  - ❖ Vertebrae
  - ❖ Ribs



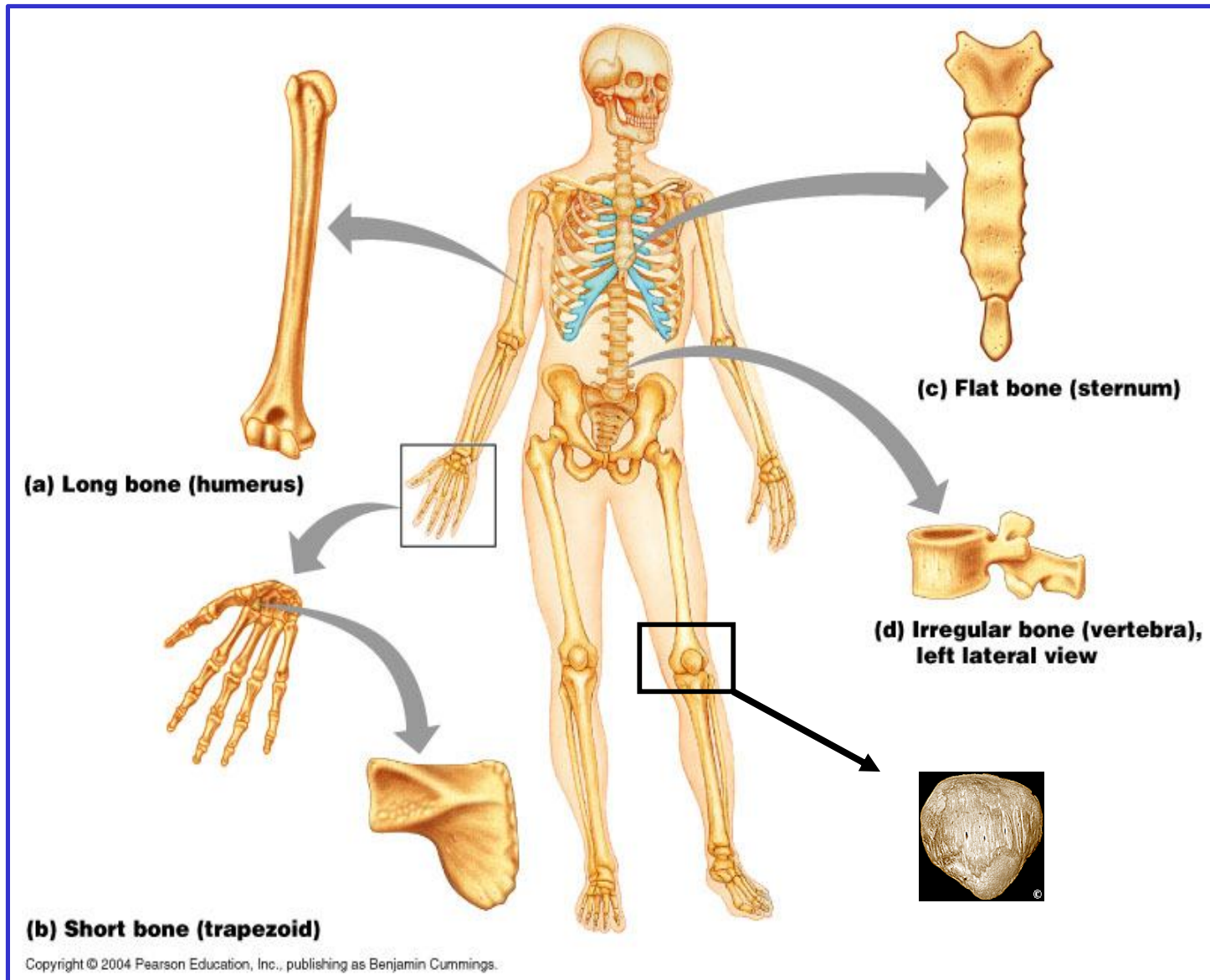
### Axial Skeleton (Anterior)



# TYPICAL TETRAPOD SKELETON



# Bone Classification



# Bone Markings

## **Depression & Openings:**

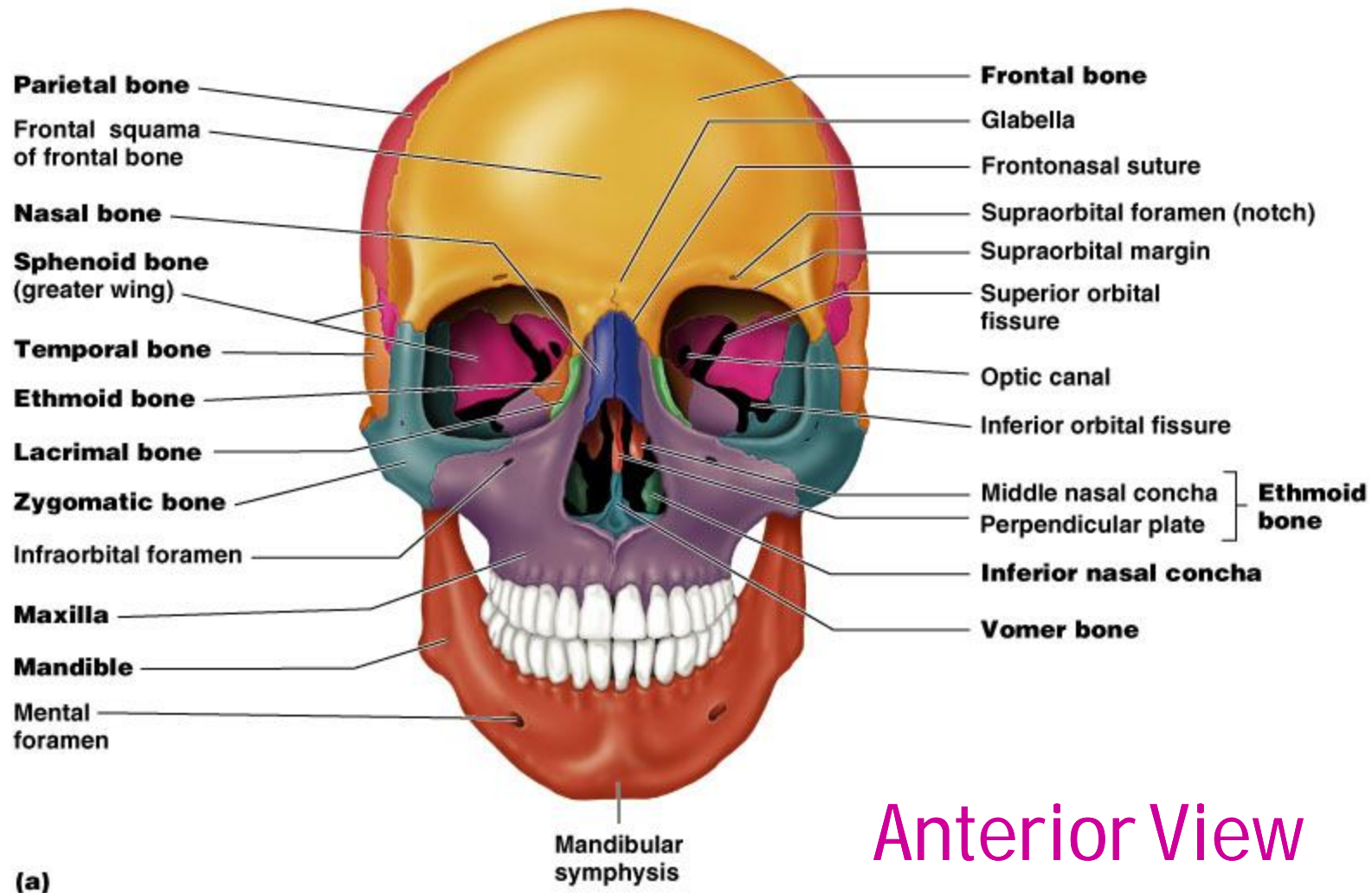
- Fissure
- Foramen
- Fossa
- Sulcus
- Meatus

## **Processes:**

- Condyle
- Facet
- Head
- Crest
- Epicondyle
- Line
- Spinous process
- Trochanter
- Tubercle
- Tuberosity

# Axial Skeleton

## Cranium Facial Bones

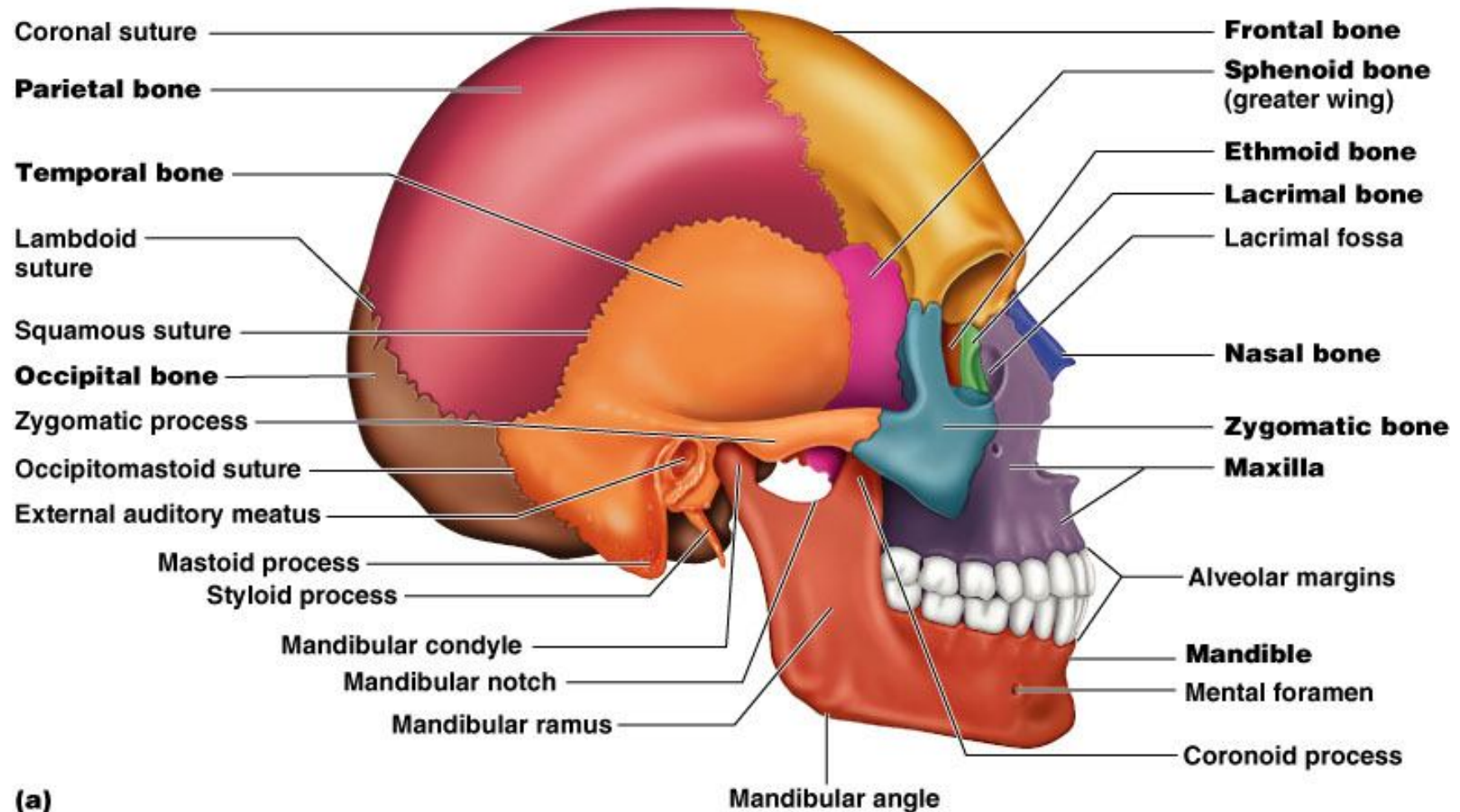


Anterior View



# Axial Skeleton

## Cranium Facial Bones

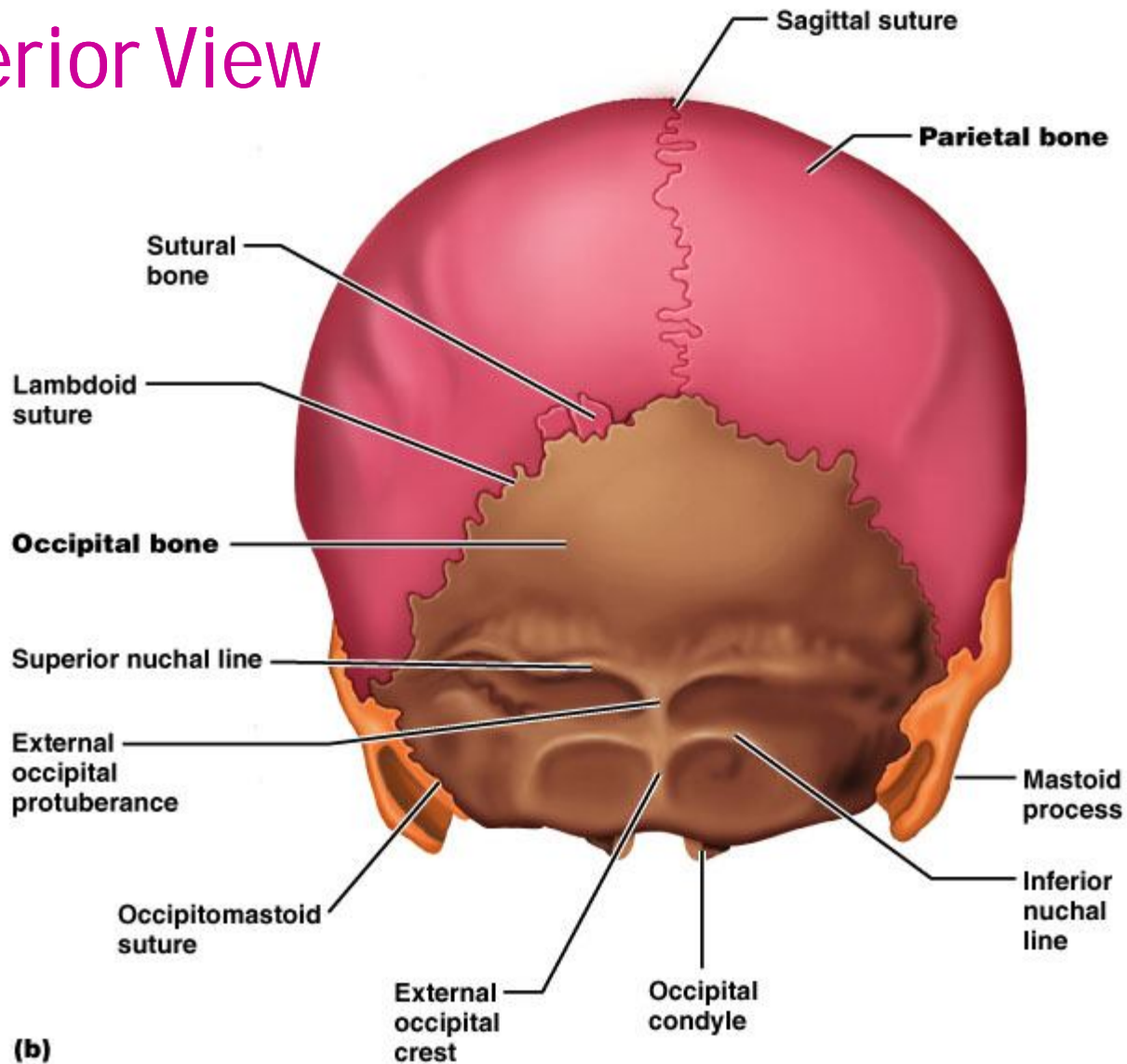


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Lateral View

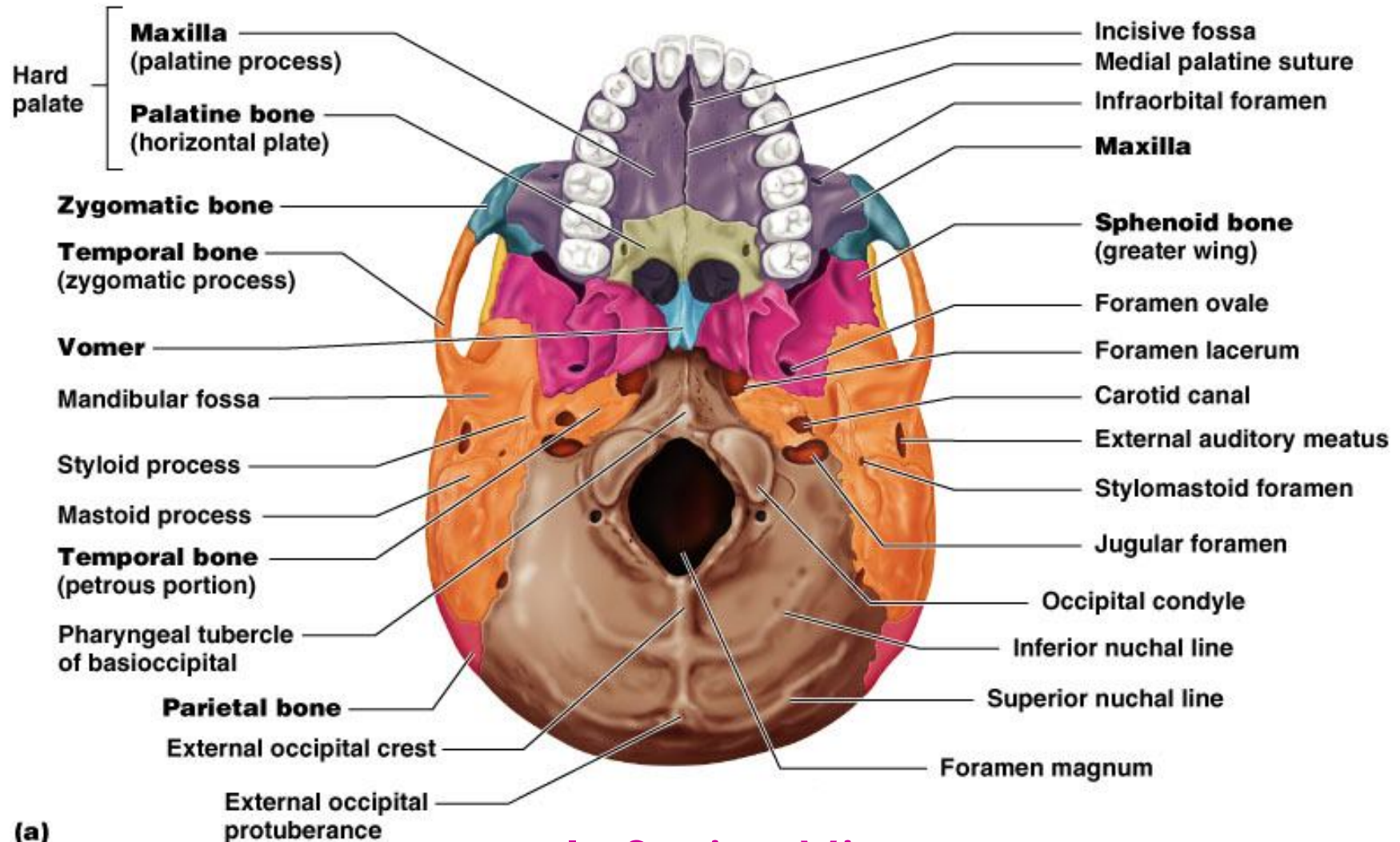
# Axial Skeleton

## Posterior View





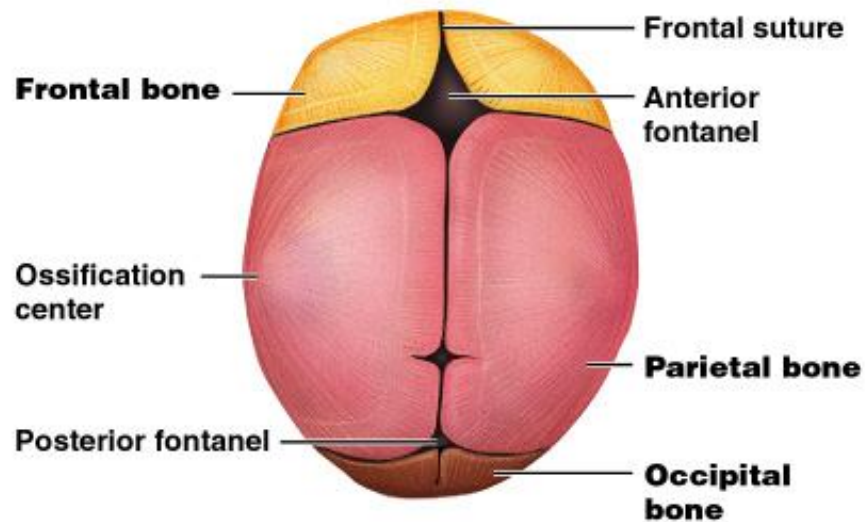
# Axial Skeleton



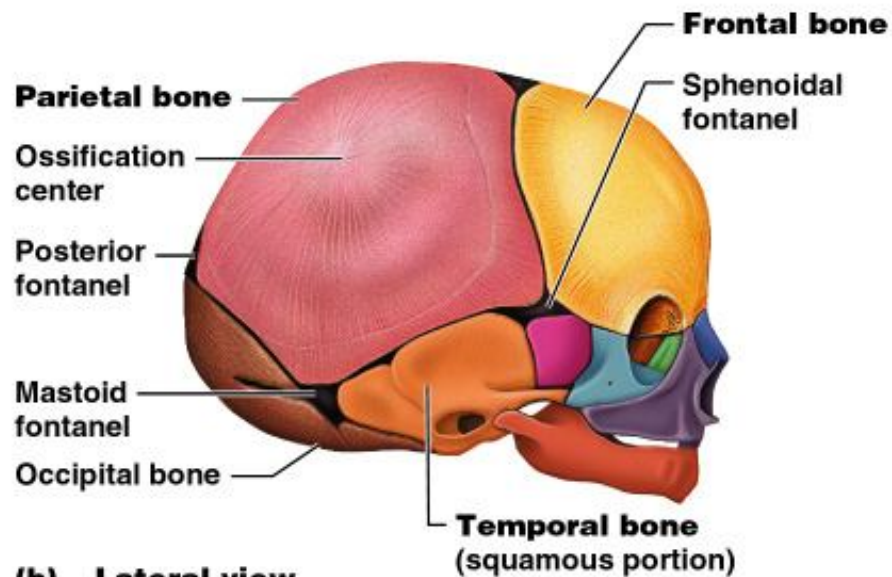
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## Inferior View

# Fetal Skull

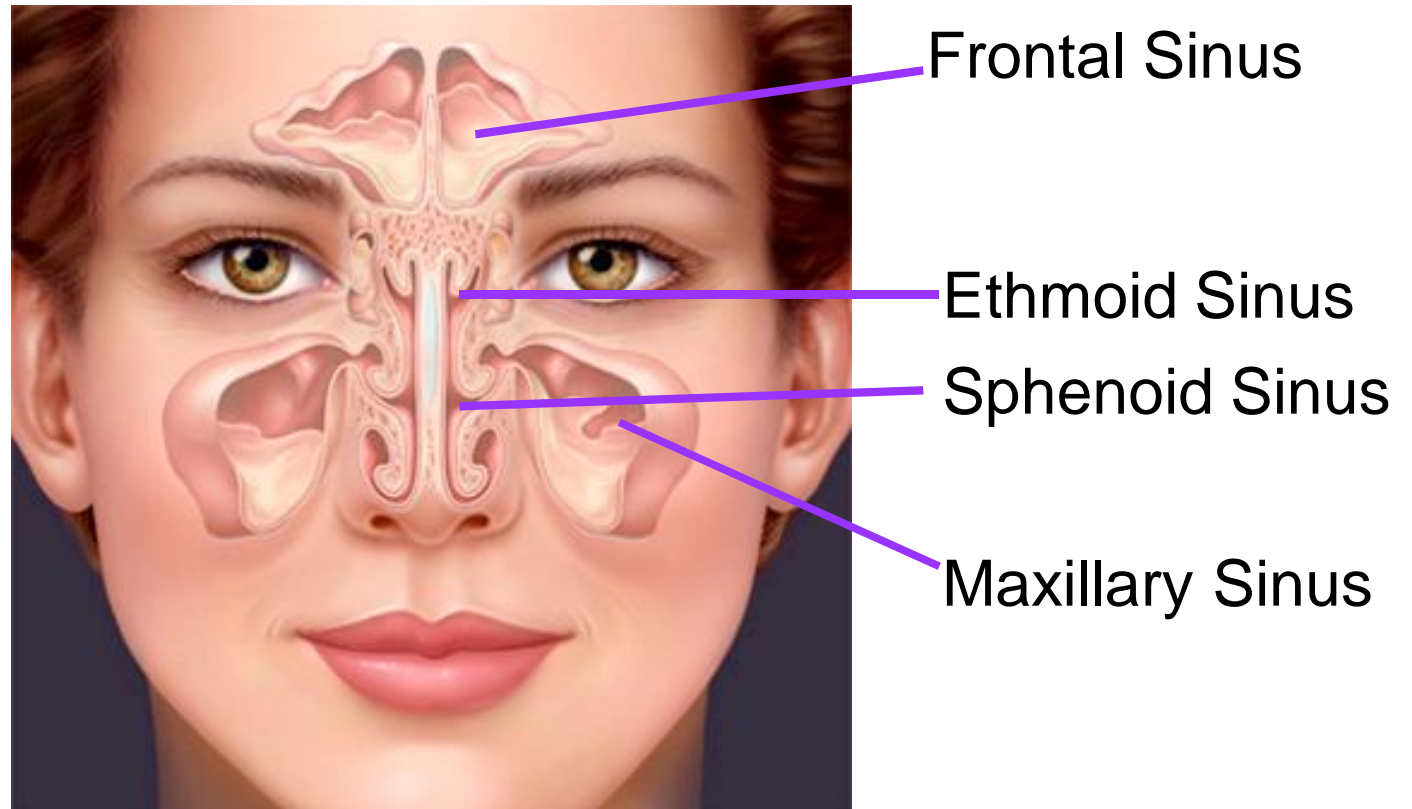


(a) Superior view



(b) Lateral view

# Sinal Cavities



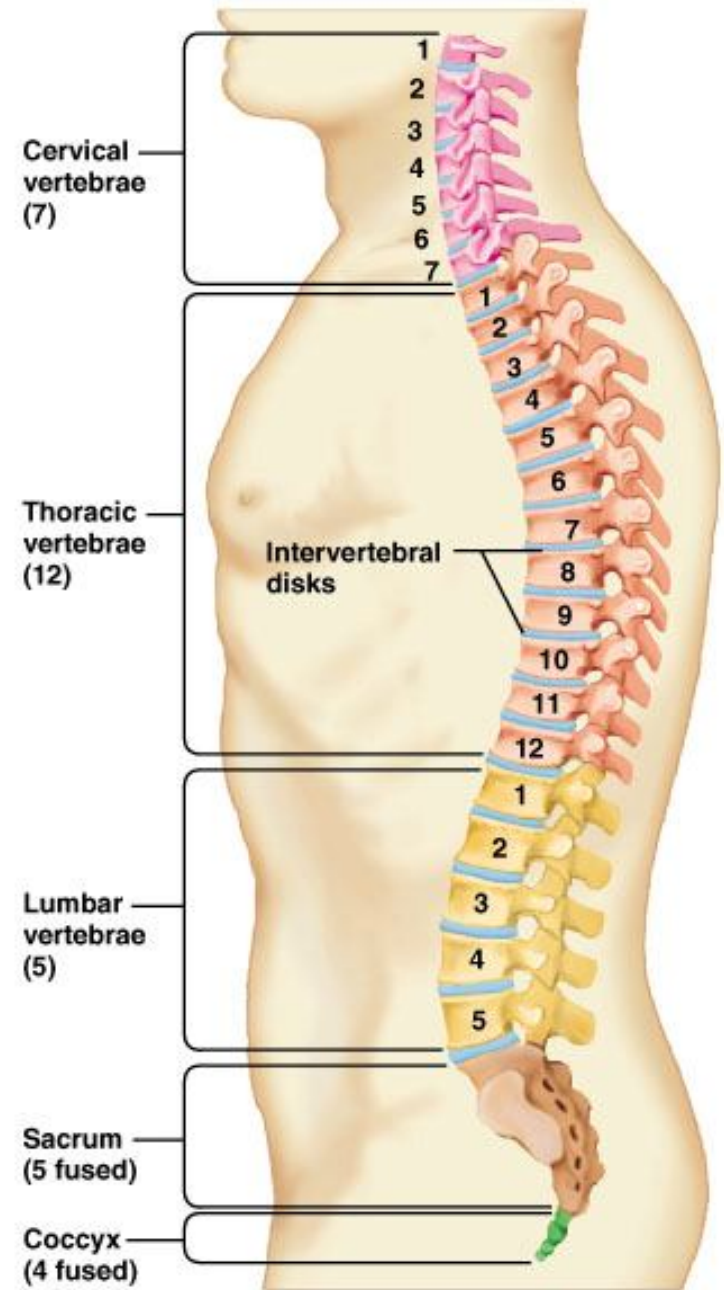
- Warm and moisten air
- Lighten the skull
- Enhance voice resonance

# Axial Skeleton

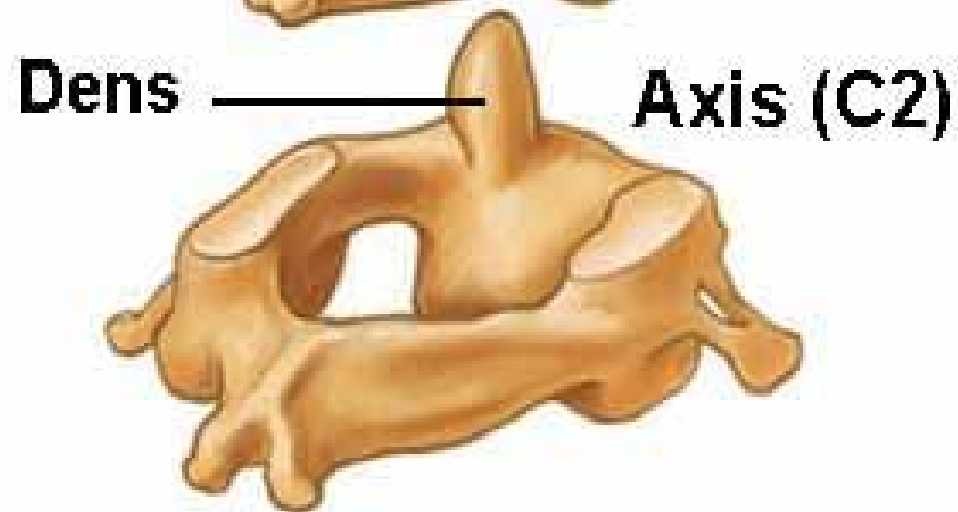
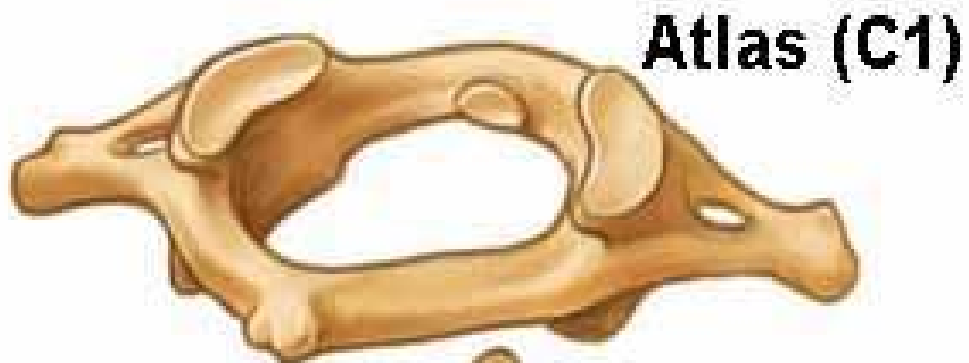
## The Vertebral Column

Cervical Vertebrae (7)  
Thoracic Vertebrae (12)  
Lumbar Vertebrae (5)  
Sacrum (5 fused)  
Coccyx (4 fused)

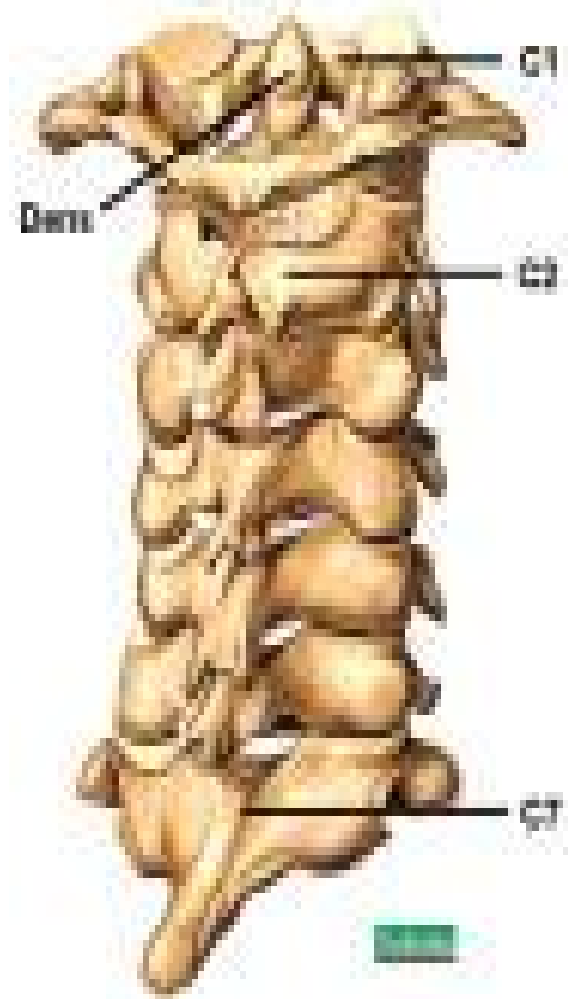
Total= 33 segments



# Cervical Vertebrae



Cervical Vertebral Column



# Thoracic Vertebrae

**Axial (Overhead) View**



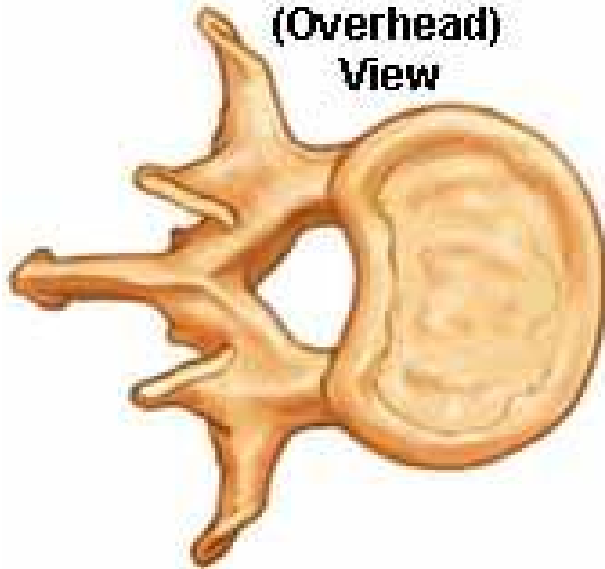
**Lateral (Side) View**



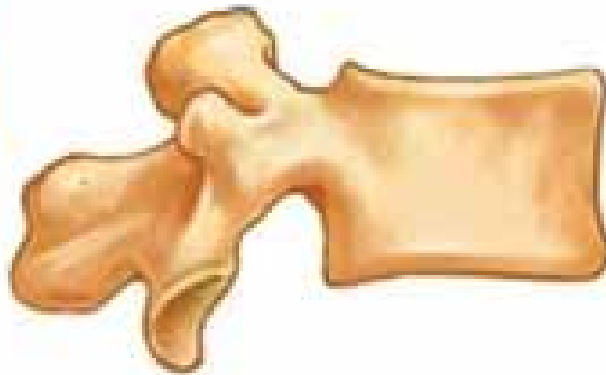


# Lumbar Vertebrae

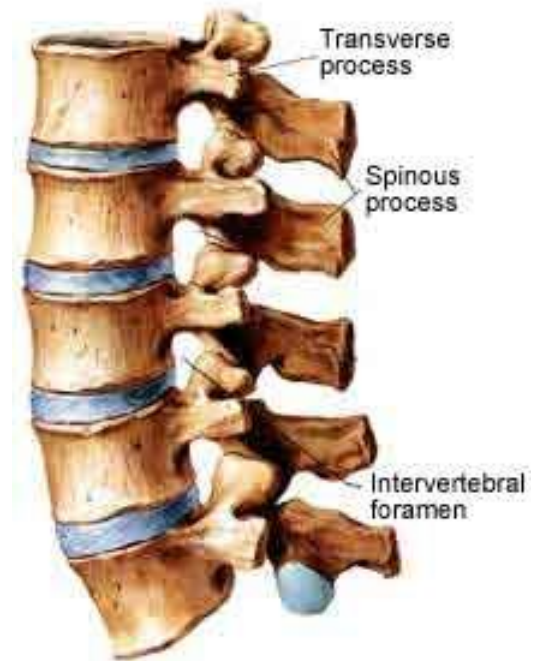
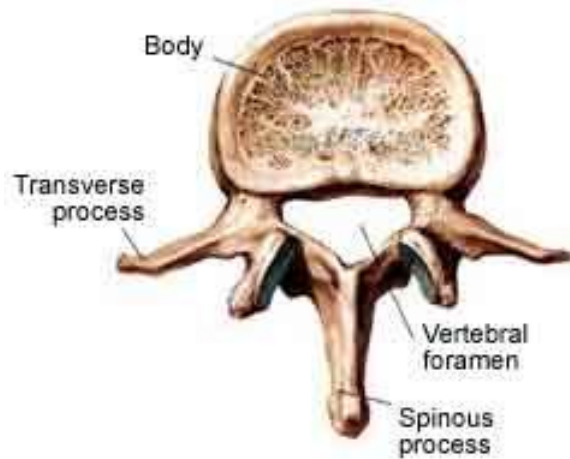
**Axial  
(Overhead)  
View**



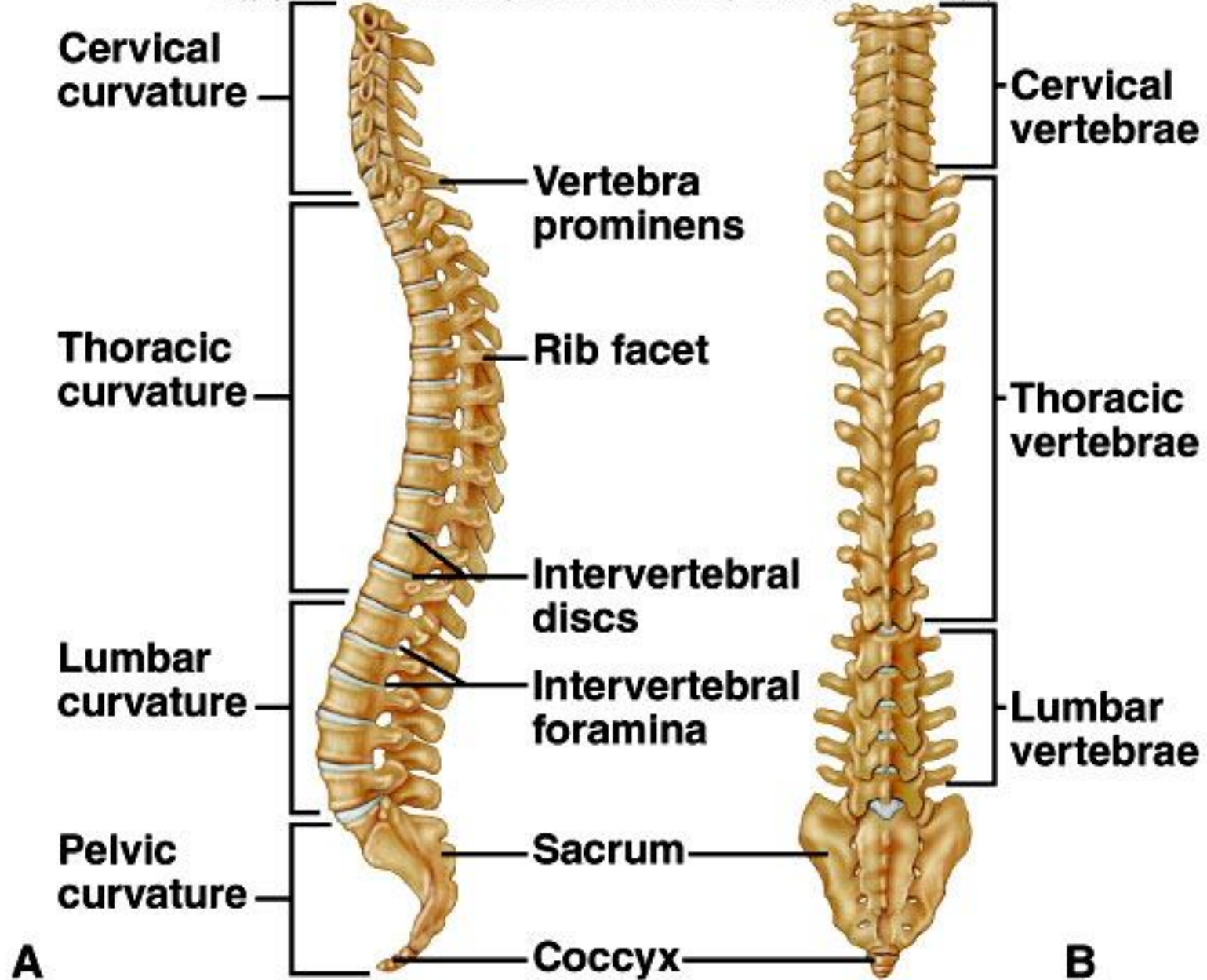
**Lateral  
(Side)  
View**



**Annulus  
fibrosus**      **Nucleus  
pulposus**







## Thoracic cage

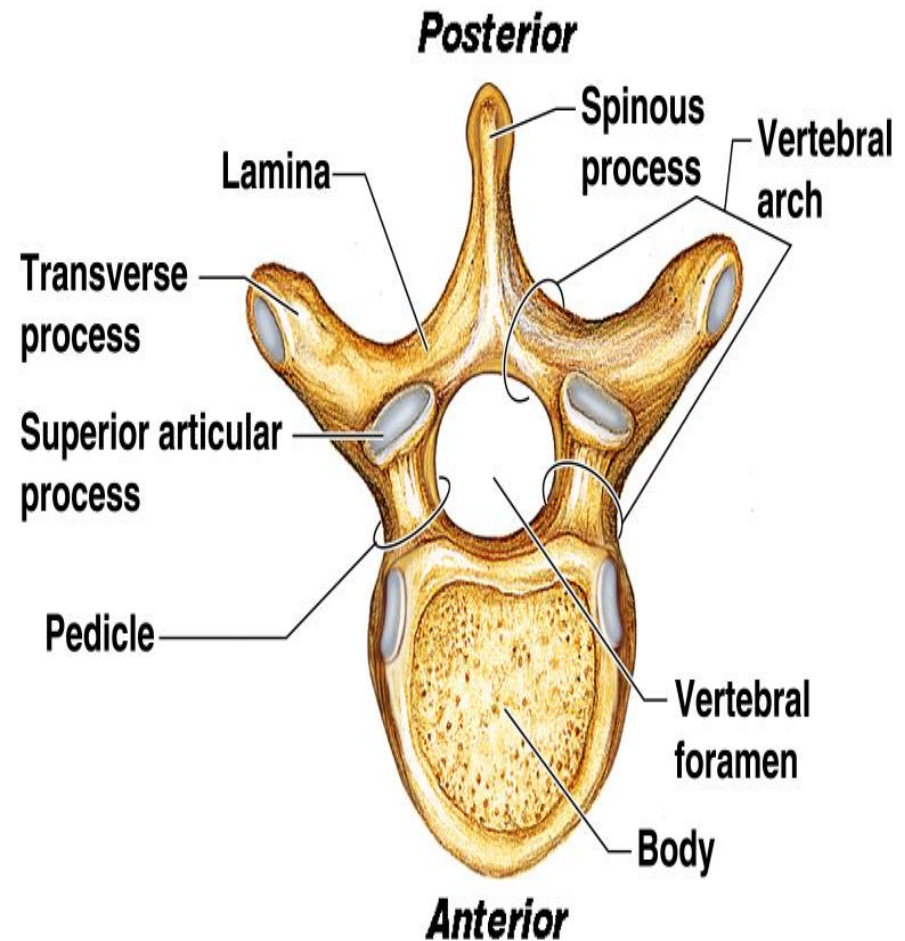
ribs

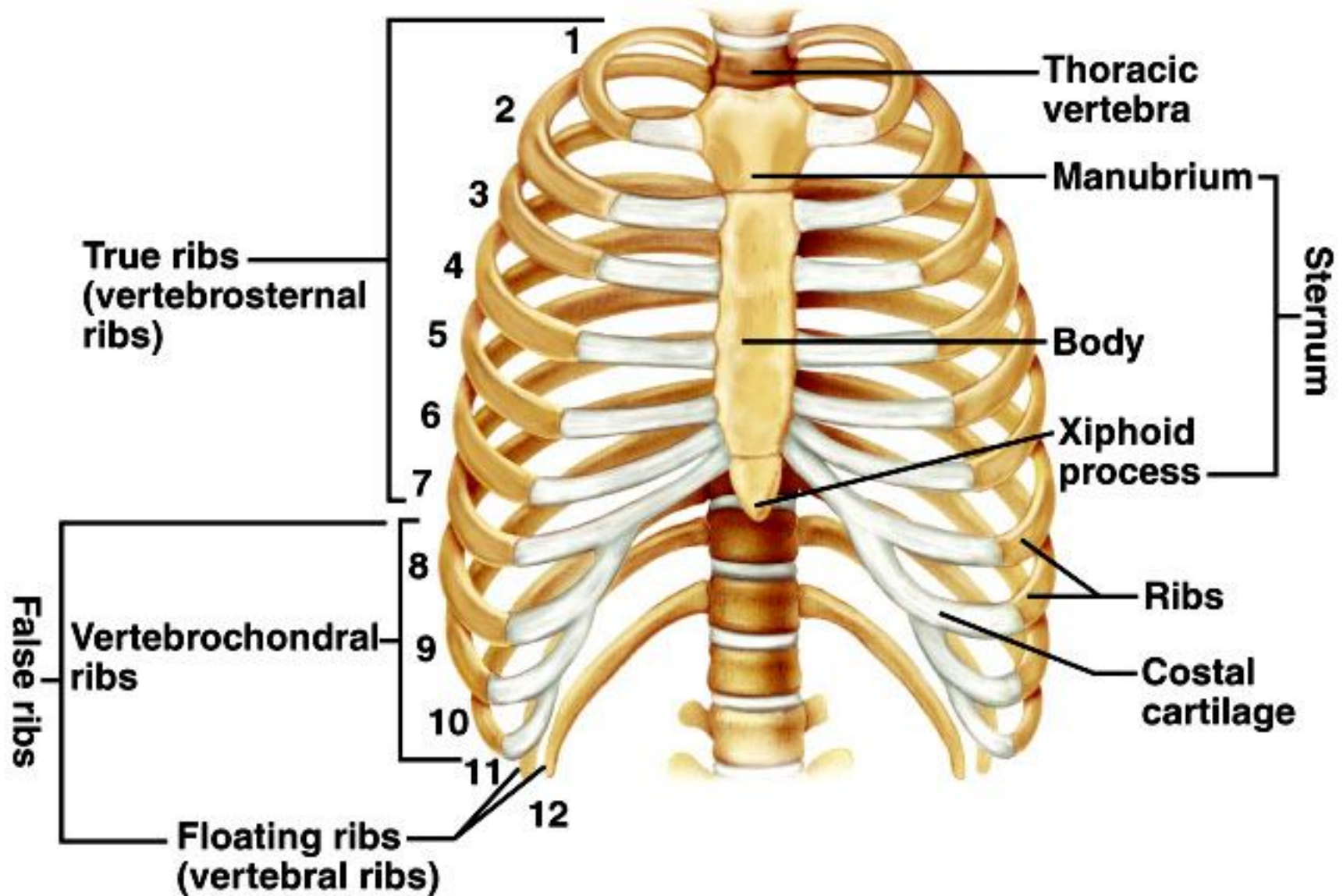
thoracic **Vertebrae**

sternum

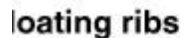
costal cartilages

- True ribs are directly attached to the sternum (first seven pairs)
- Three false ribs are joined to the 7<sup>th</sup> rib
- Two pairs of floating ribs





A diagram of a human skeleton. The rib cage is highlighted in yellow and blue. A large grey arrow points from the rib cage area to a detailed view of a rib cage structure, which is shown in a yellowish-brown color.

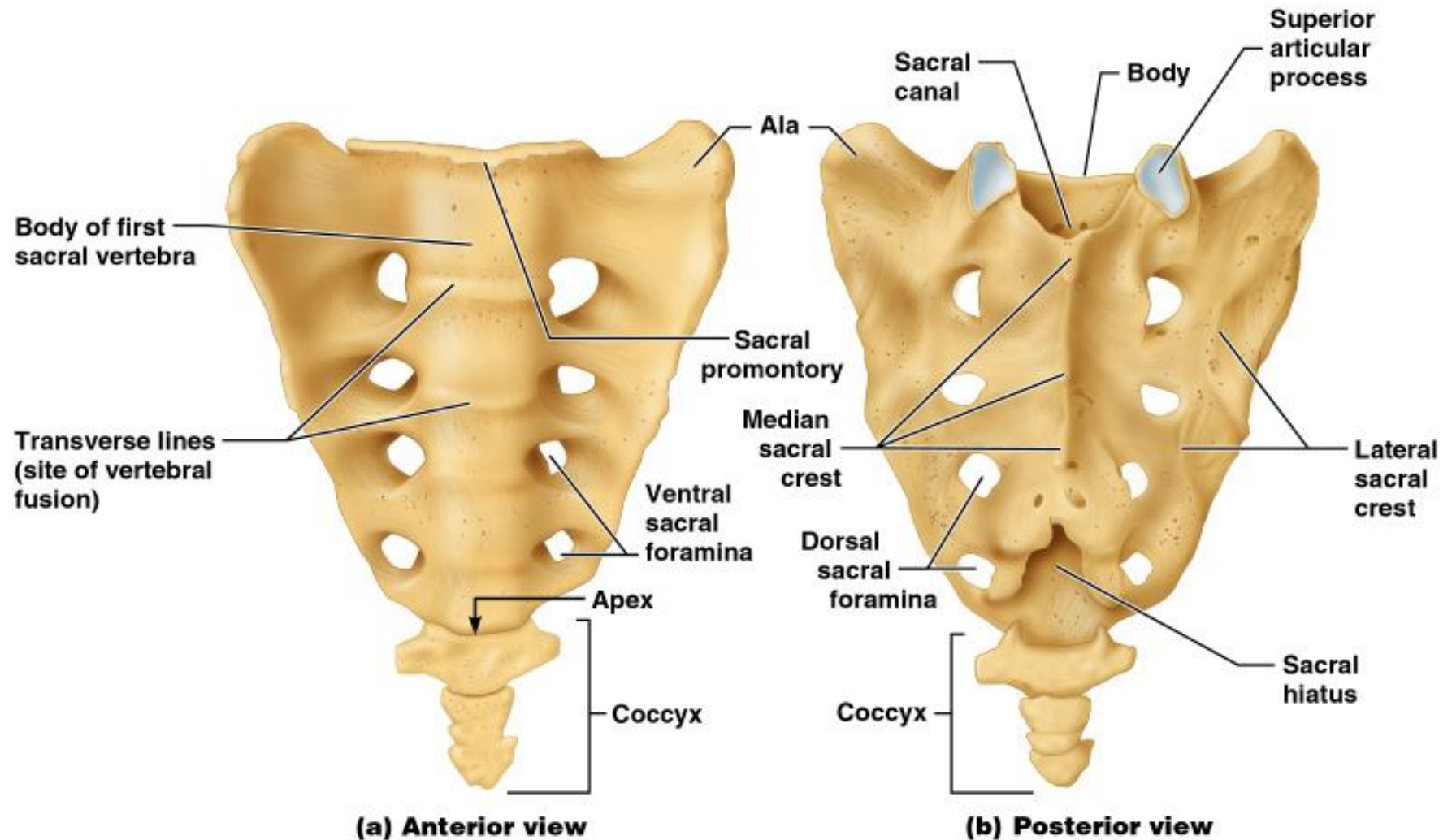


## Floating Ribs (2)



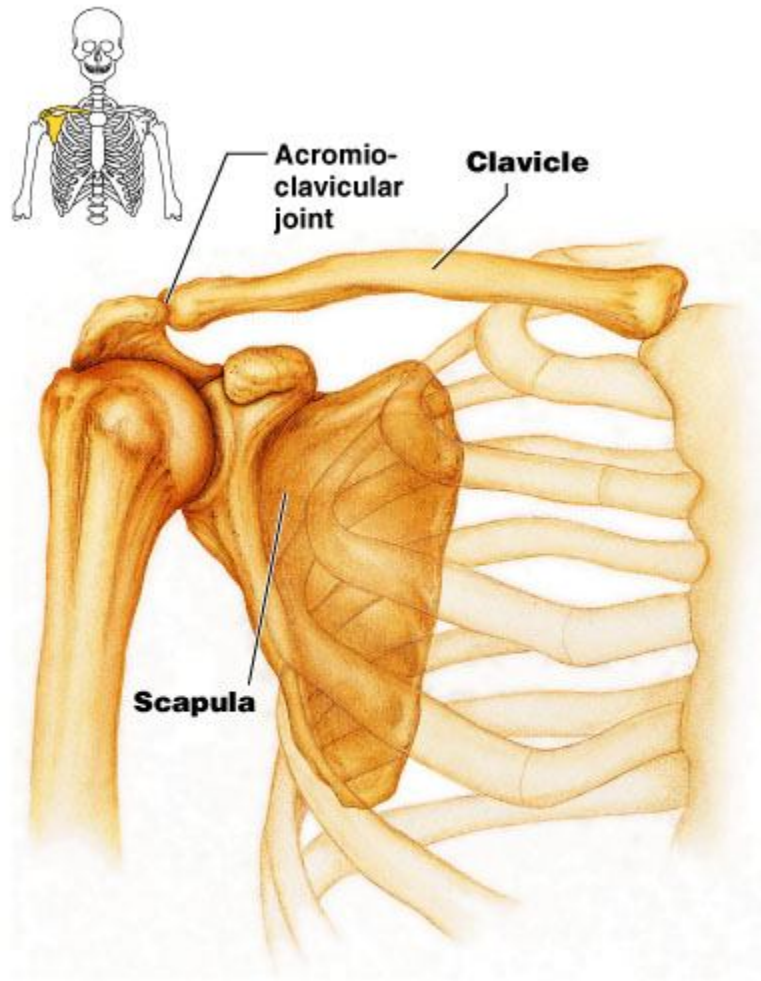
# Axial Skeleton

## Sacrum & Coccyx

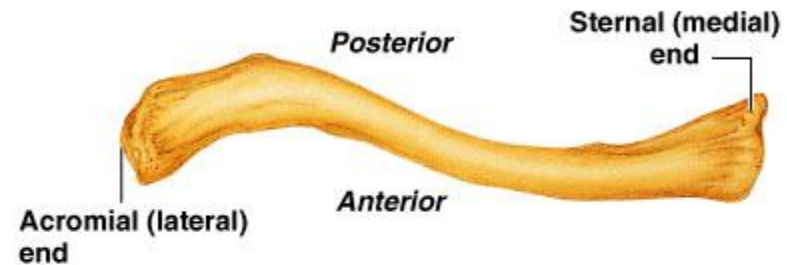


# Appendicular Skeleton

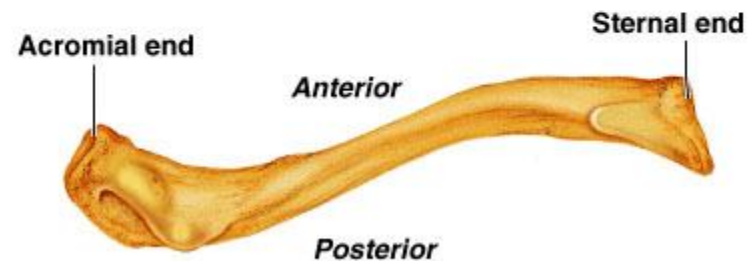
## Bones of the Pectoral Girdle



**(a) Articulated pectoral girdle**



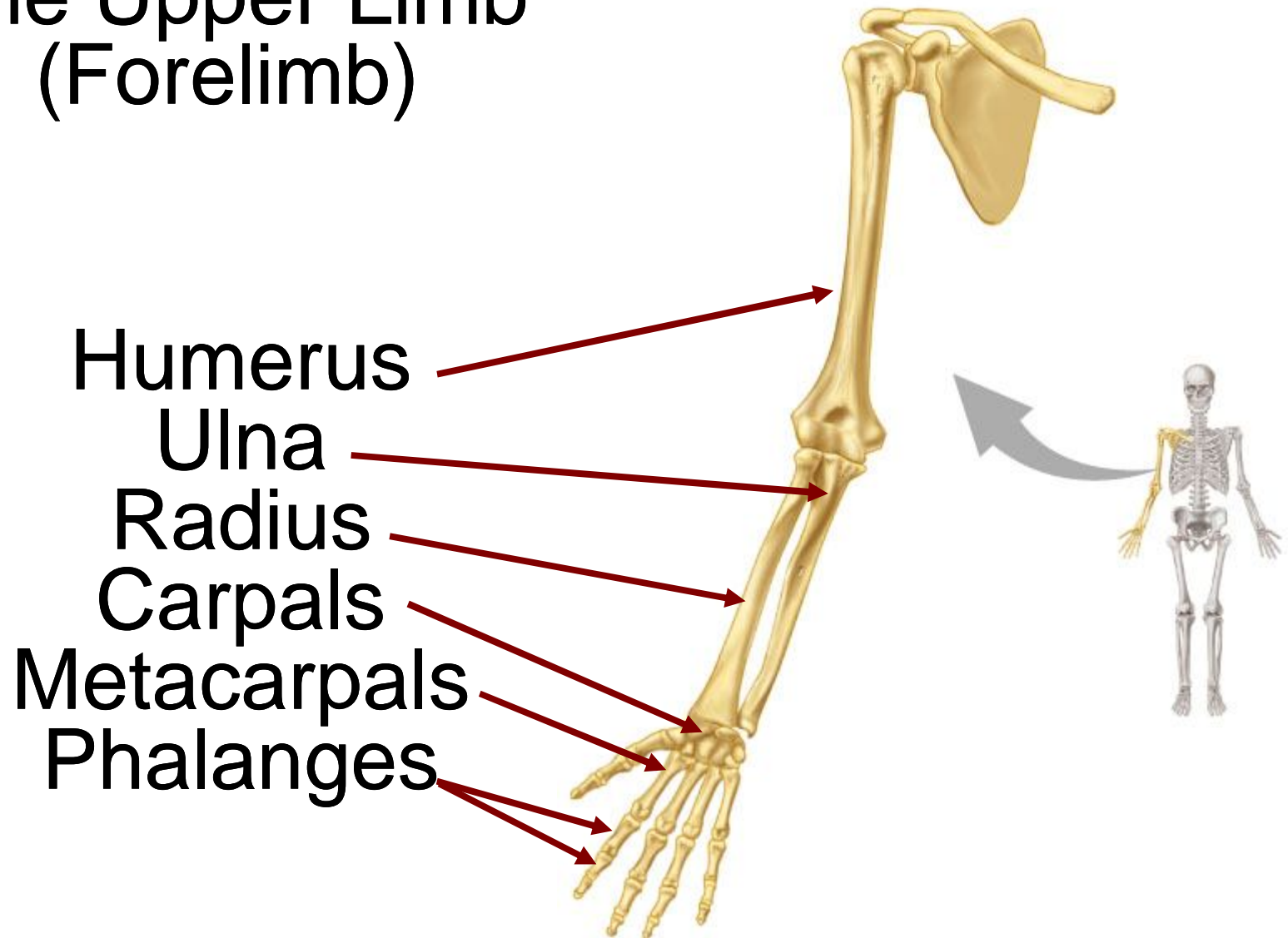
**(b) Right clavicle, superior view**



**(c) Right clavicle, inferior view**

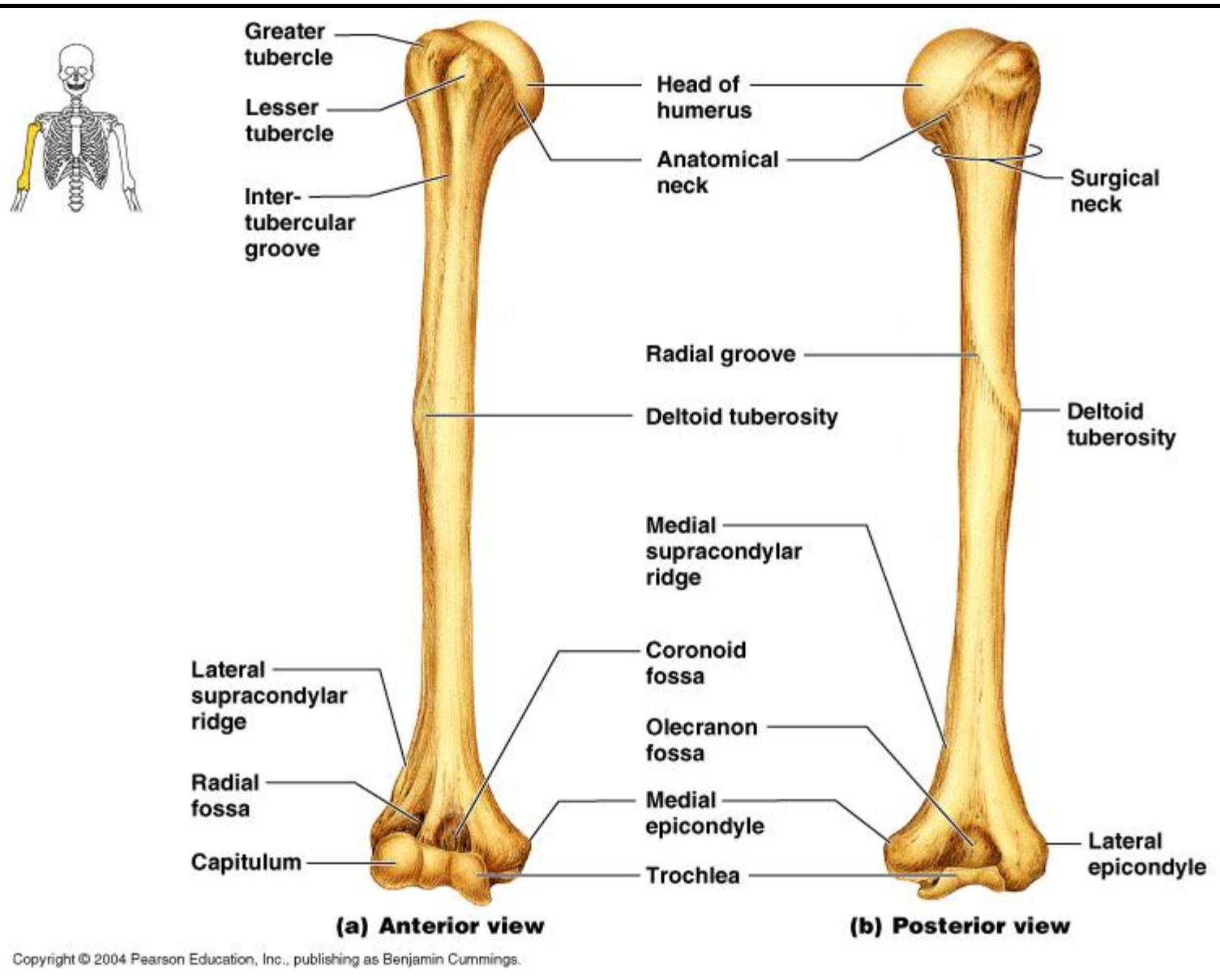
# Appendicular Skeleton

## The Upper Limb (Forelimb)

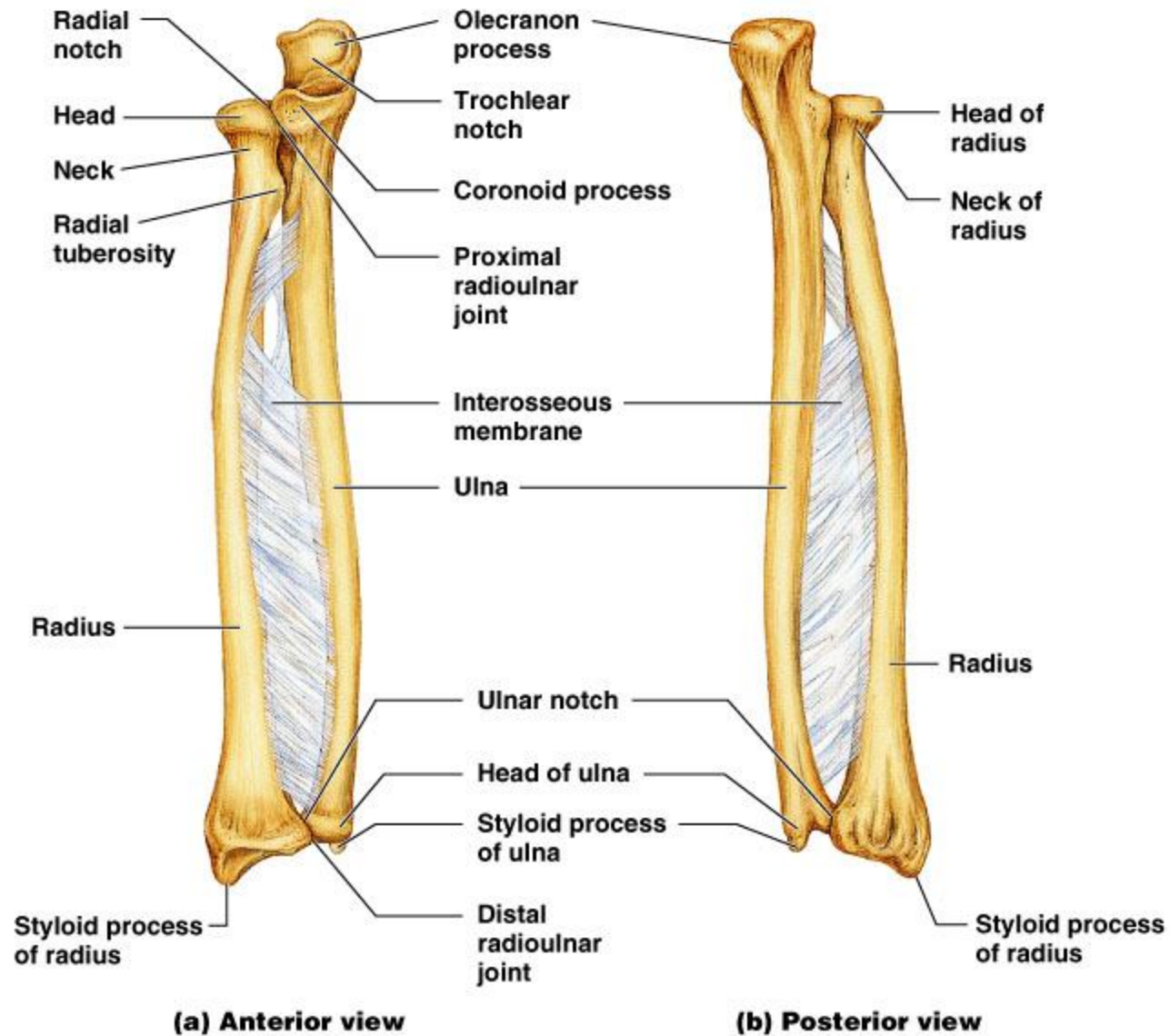
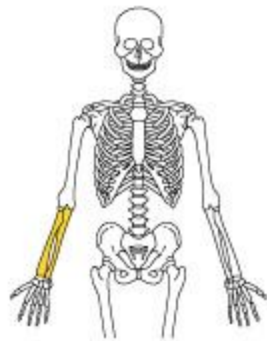




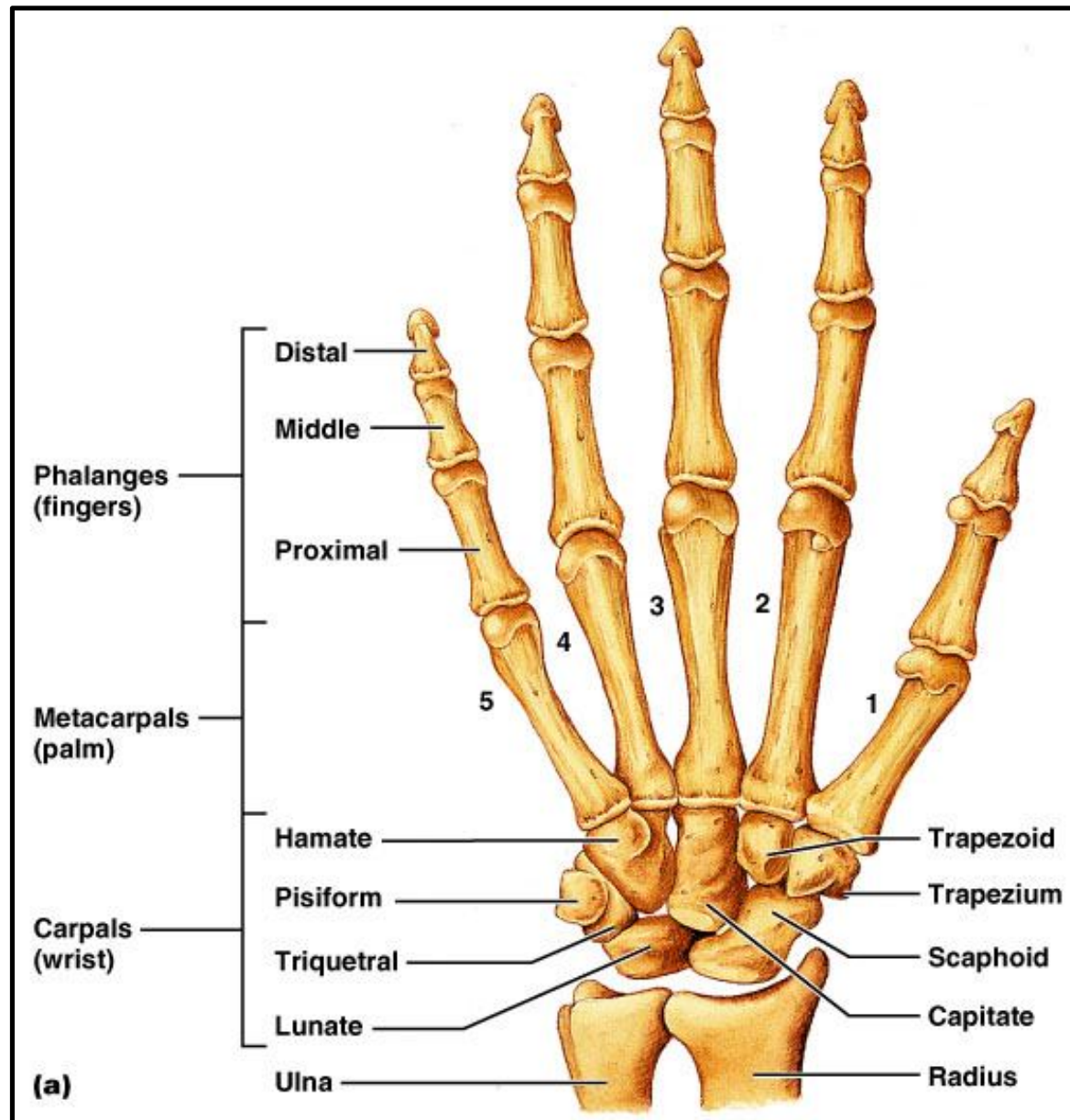
# Humerus



# Radius & Ulna



# Hand Bones

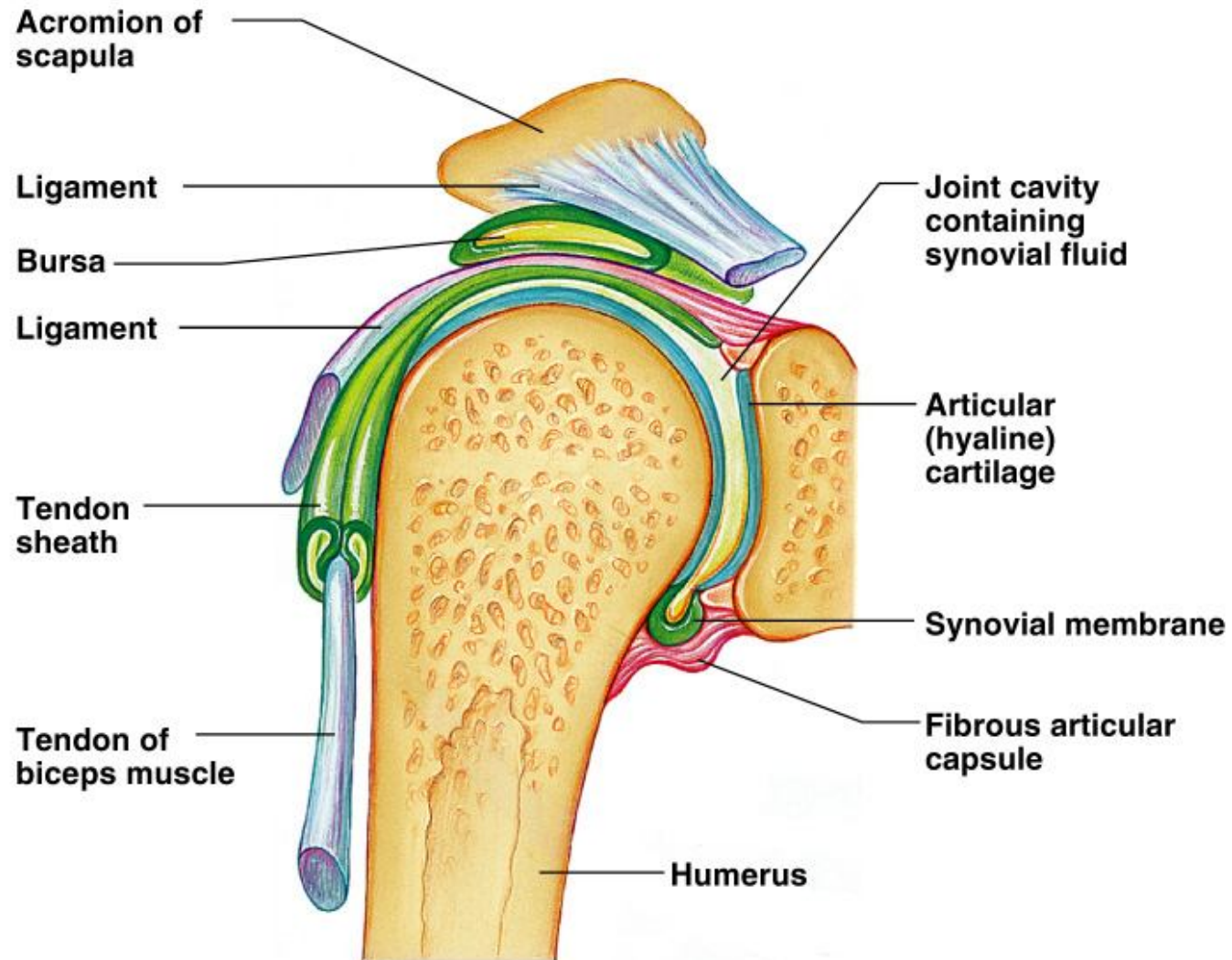


# Joints

A joint, or articulation, is the place where two bones come together.

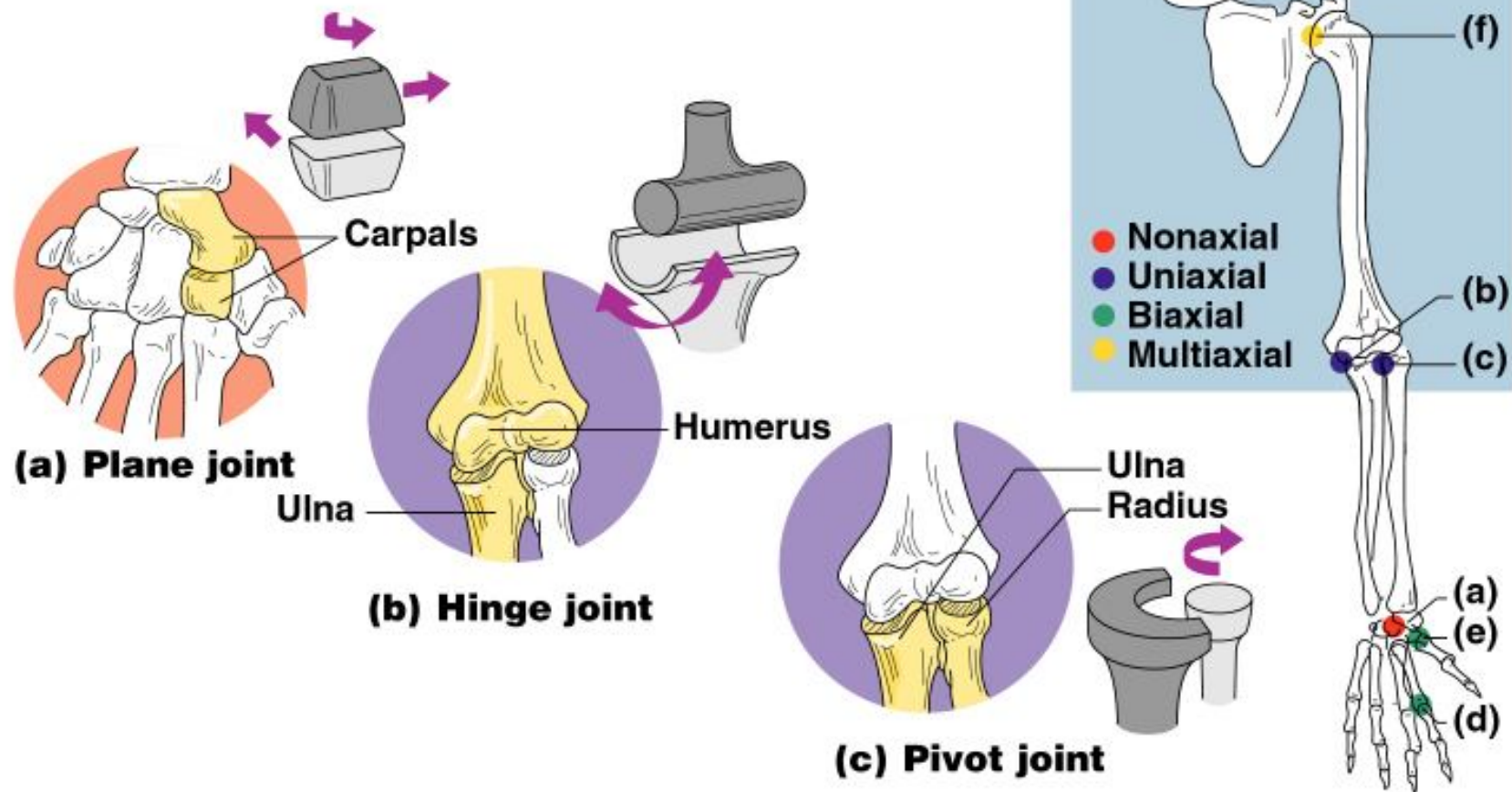
- **Fibrous-** **Immovable**: connect bones, no movement. (skull and pelvis).
- **Cartilaginous-** **slightly movable**, bones are attached by cartilage, a little movement (spine or ribs).
- **Synovial-** **freely movable**, much more movement than cartilaginous joints. Cavities between bones are filled with synovial fluid. This fluid helps lubricate and protect the bones.

# The Synovial Joint

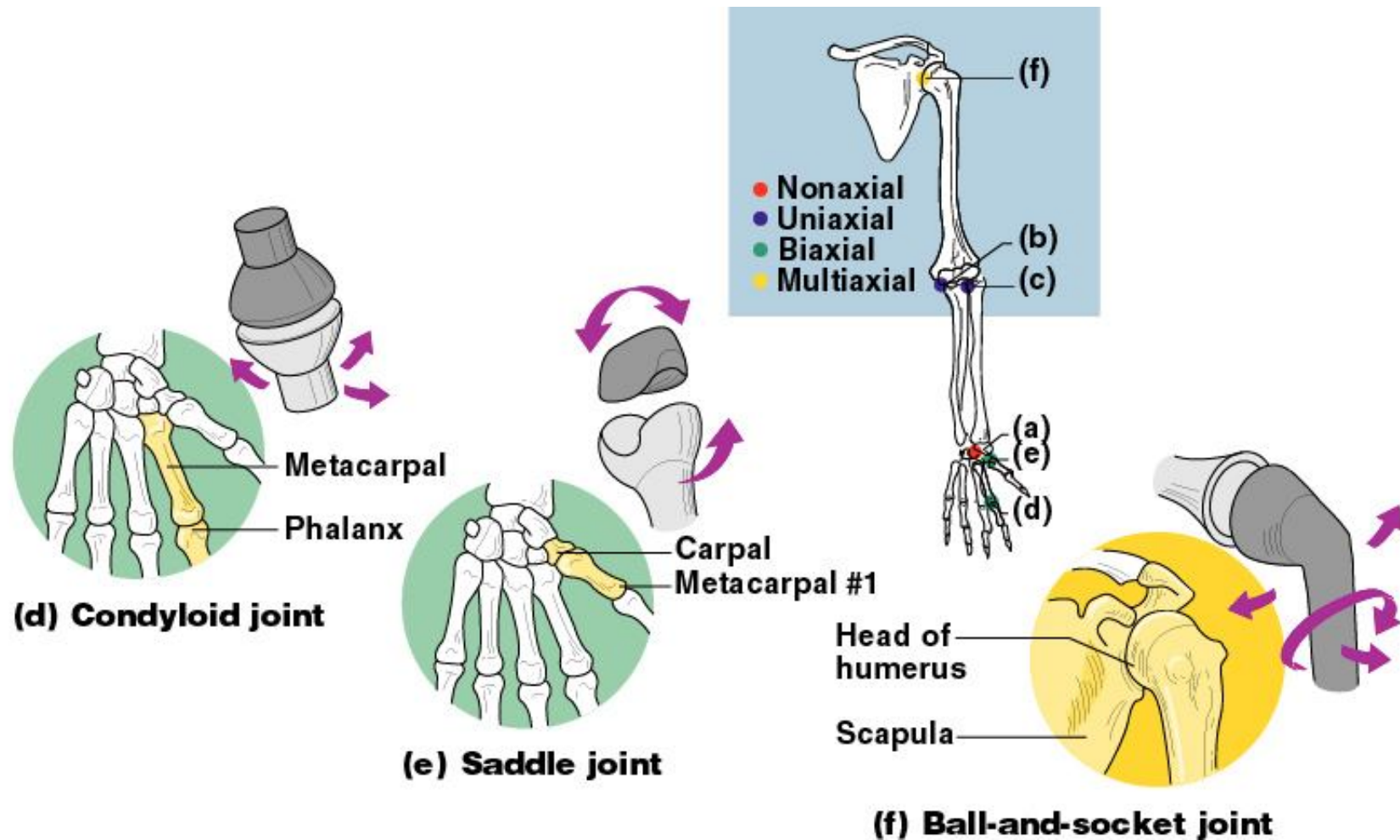




# Types of Synovial Joints Based on Shape



# Types of Synovial Joints Based on Shape



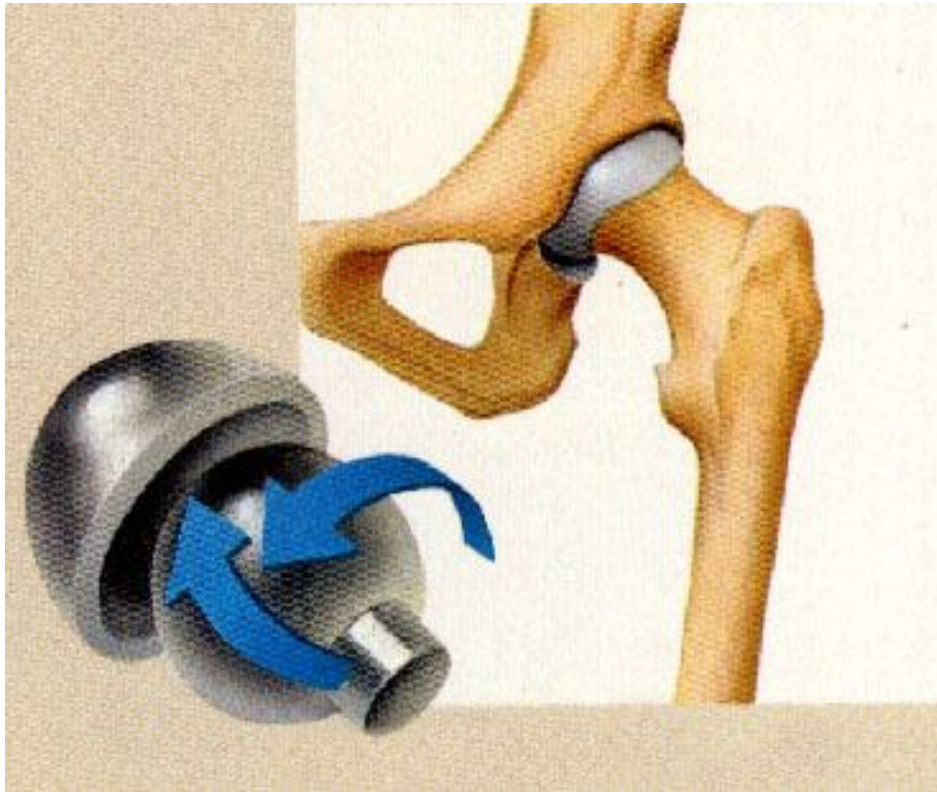


# Types of Joints

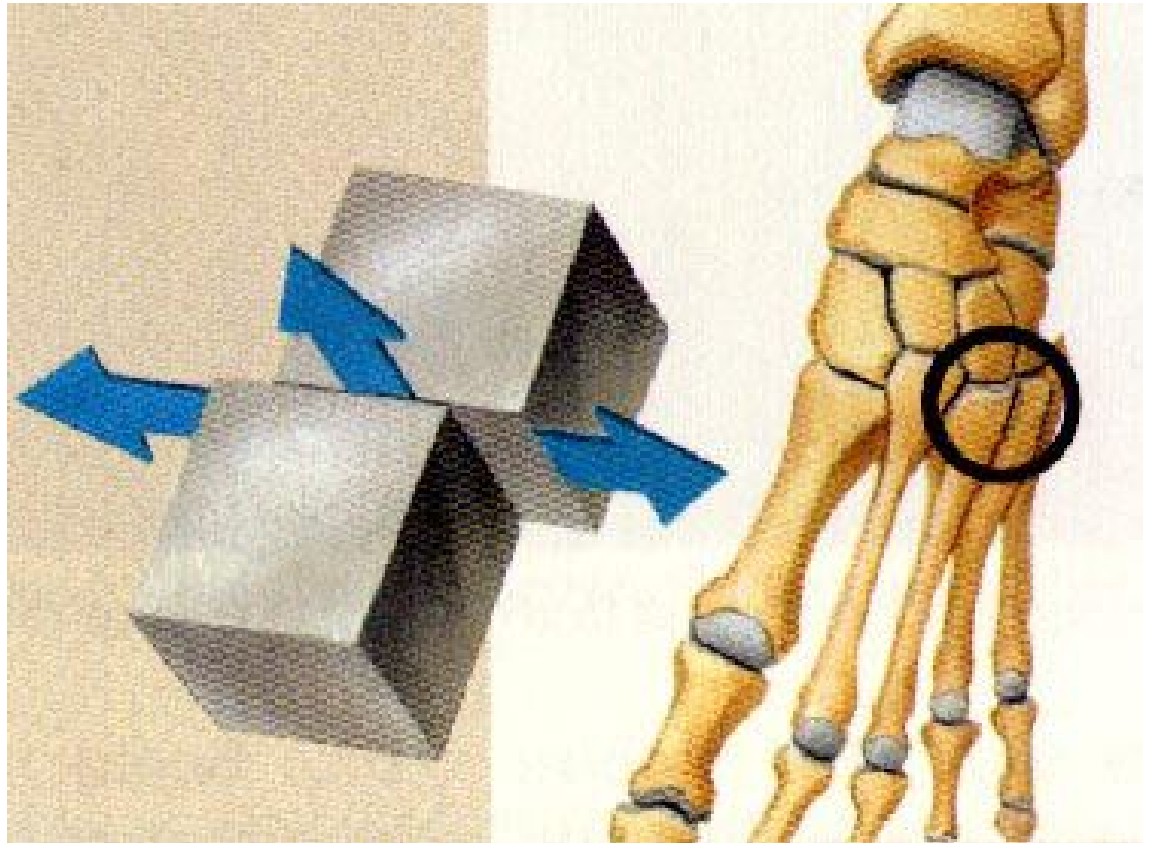
**Hinge-** A hinge joint allows extension and retraction of an appendage. (Elbow, Knee)



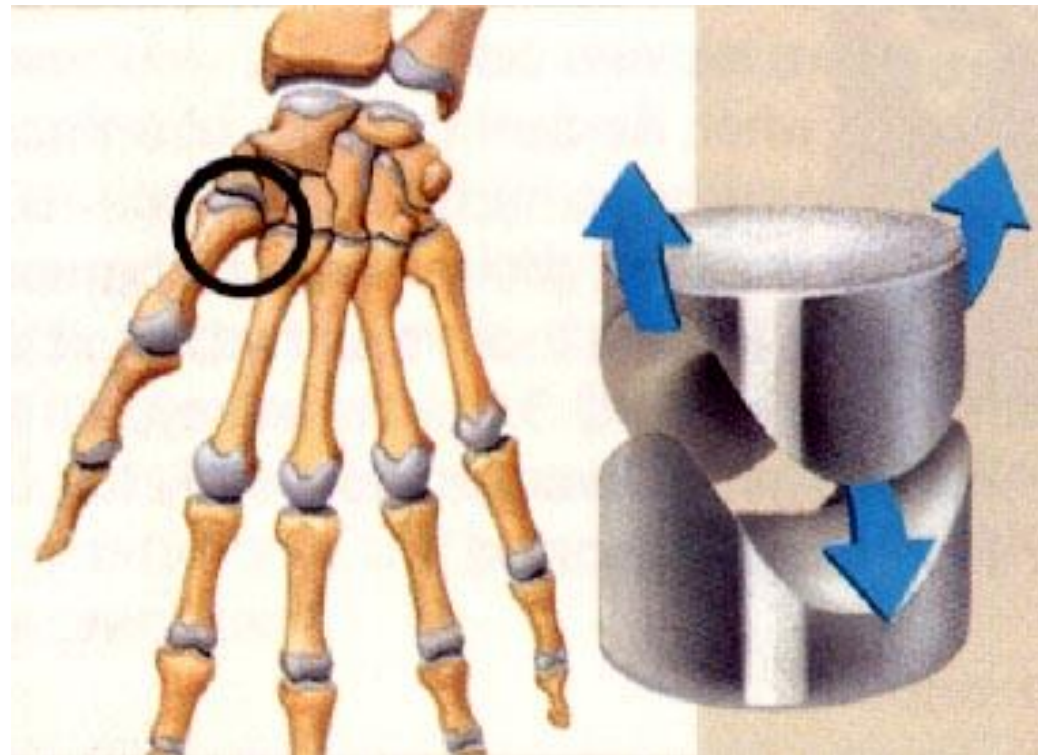
**Ball and Socket-** A ball and socket joint allows for radial movement in almost any direction. They are found in the hips and shoulders. (Hip, Shoulder)



**Gliding-** In a gliding or plane joint bones slide past each other. Mid-carpal and mid-tarsal joints are gliding joints. (Hands, Feet)

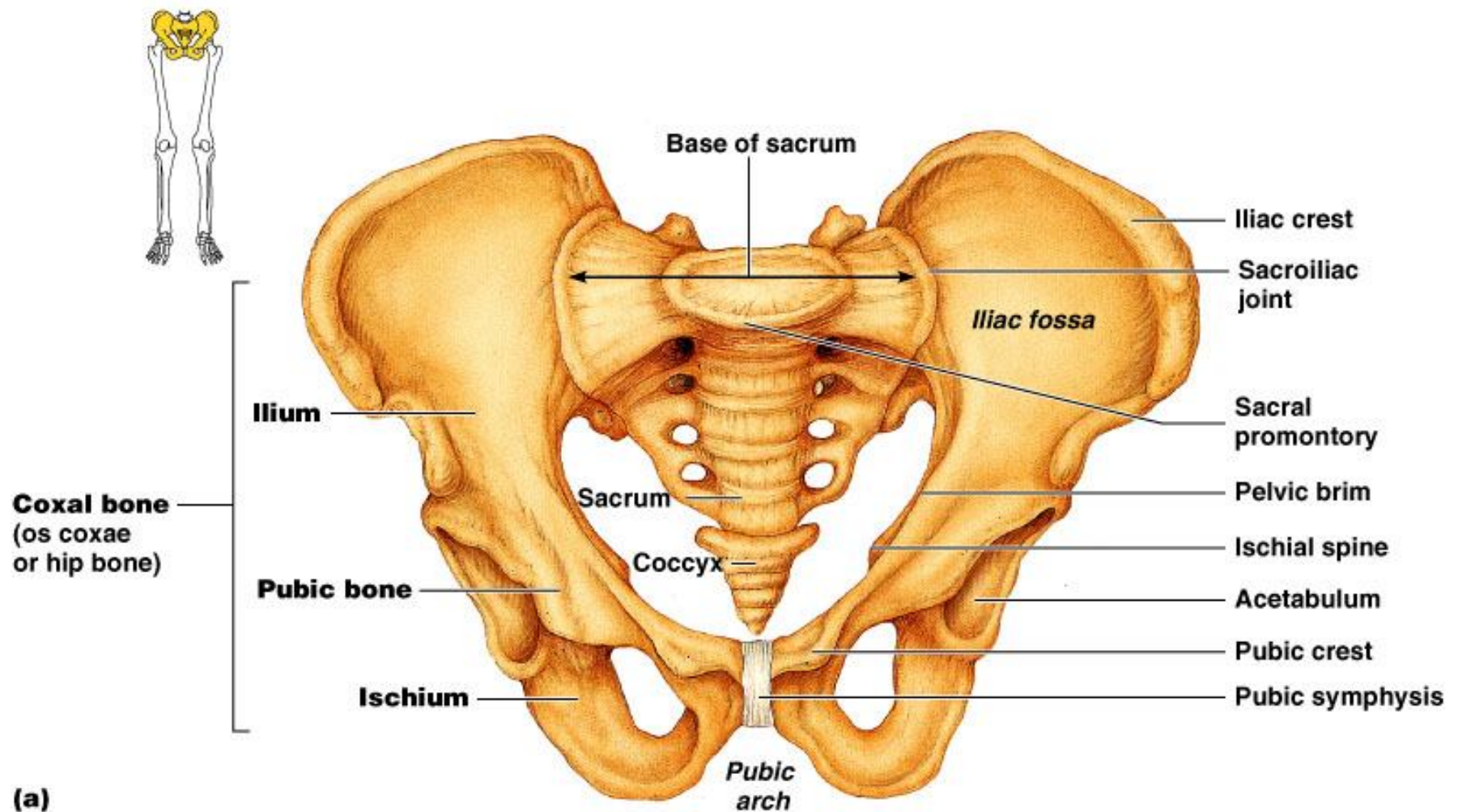


**Saddle-** This type of joint occurs when the touching surfaces of two bones have both concave and convex regions with the shapes of the two bones complementing one other and allowing a wide range of movement. (Thumb)



# Appendicular Skeleton

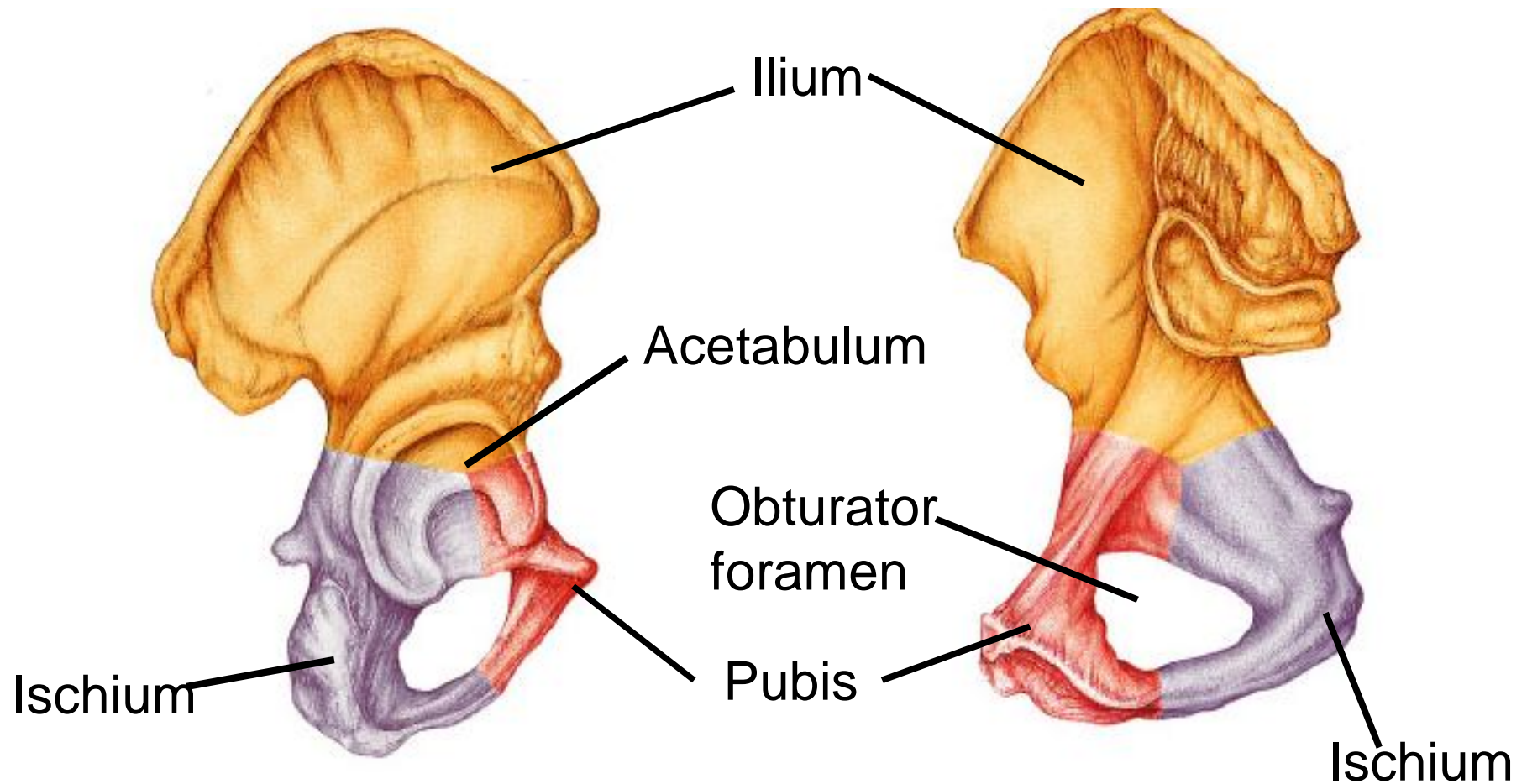
## Pelvis



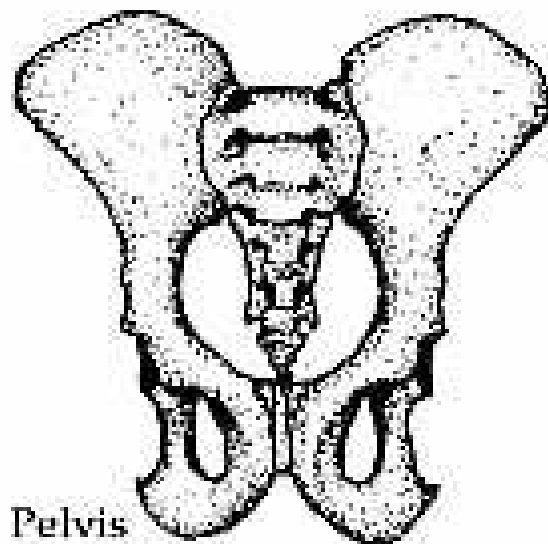


# Appendicular Skeleton

## Pelvis (lateral view)

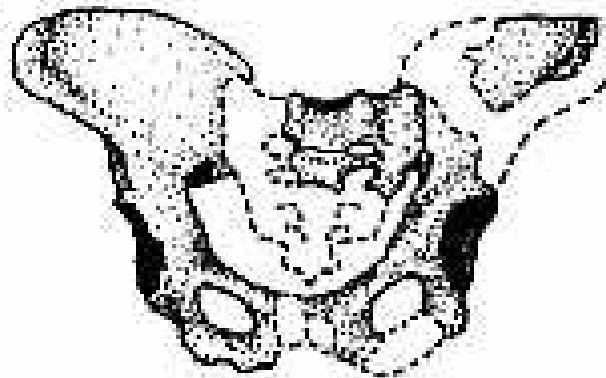


CHIMPANZEE

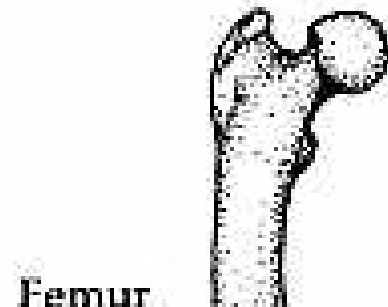
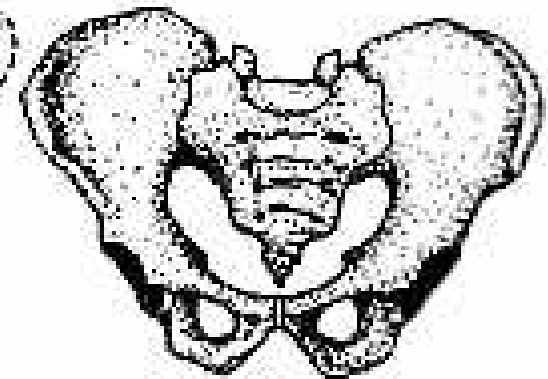


Pelvis

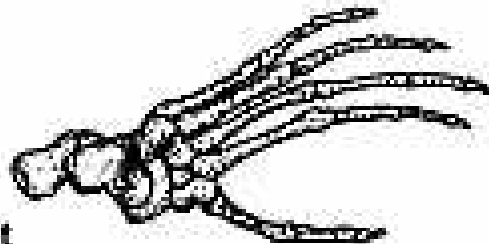
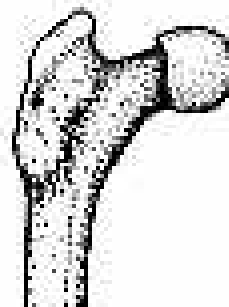
*AUSTRALOPITHECUS*  
*AFRICANUS*



HUMAN



Femur

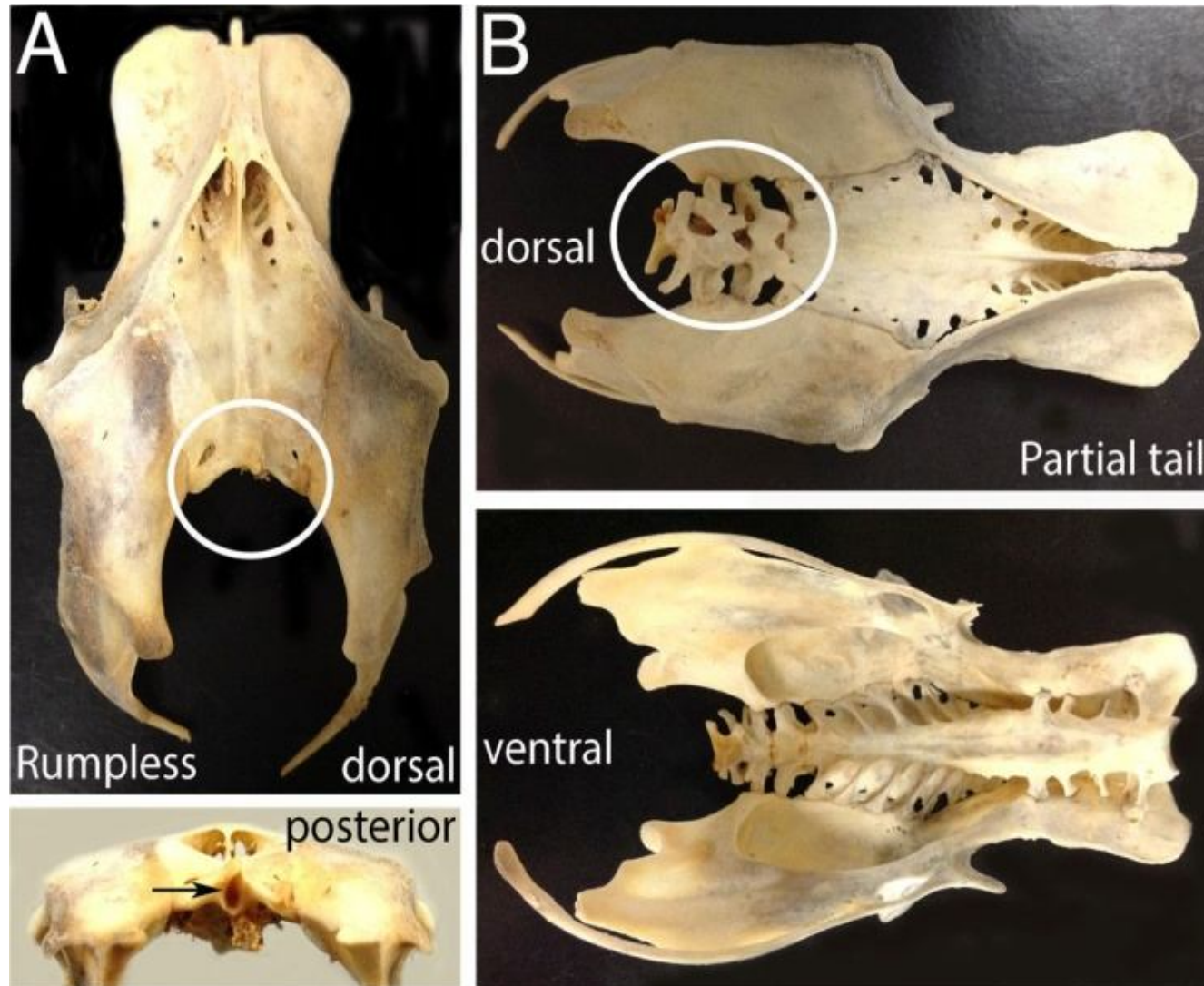


Foot



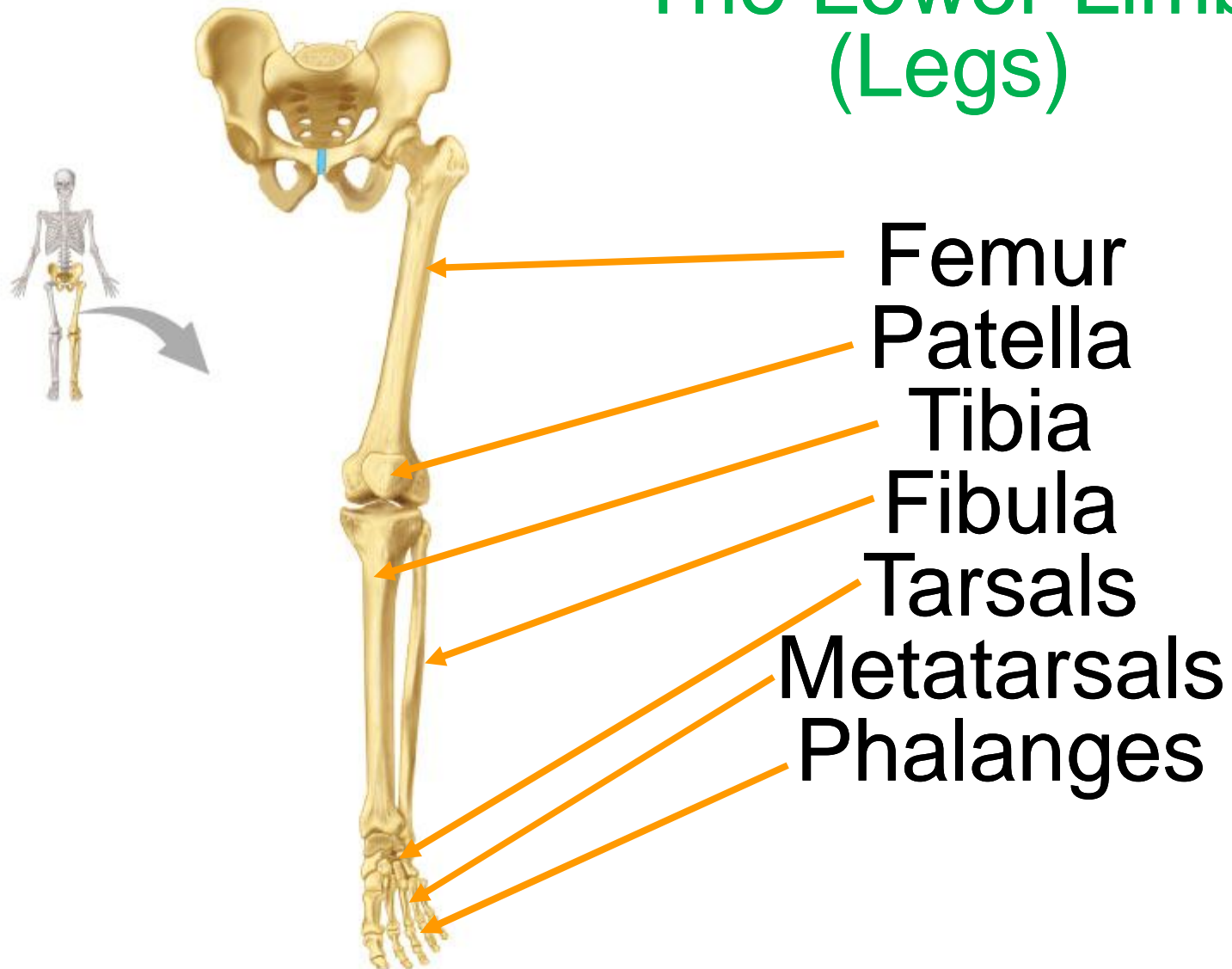


# Modification in Pelvic Girdle of Birds

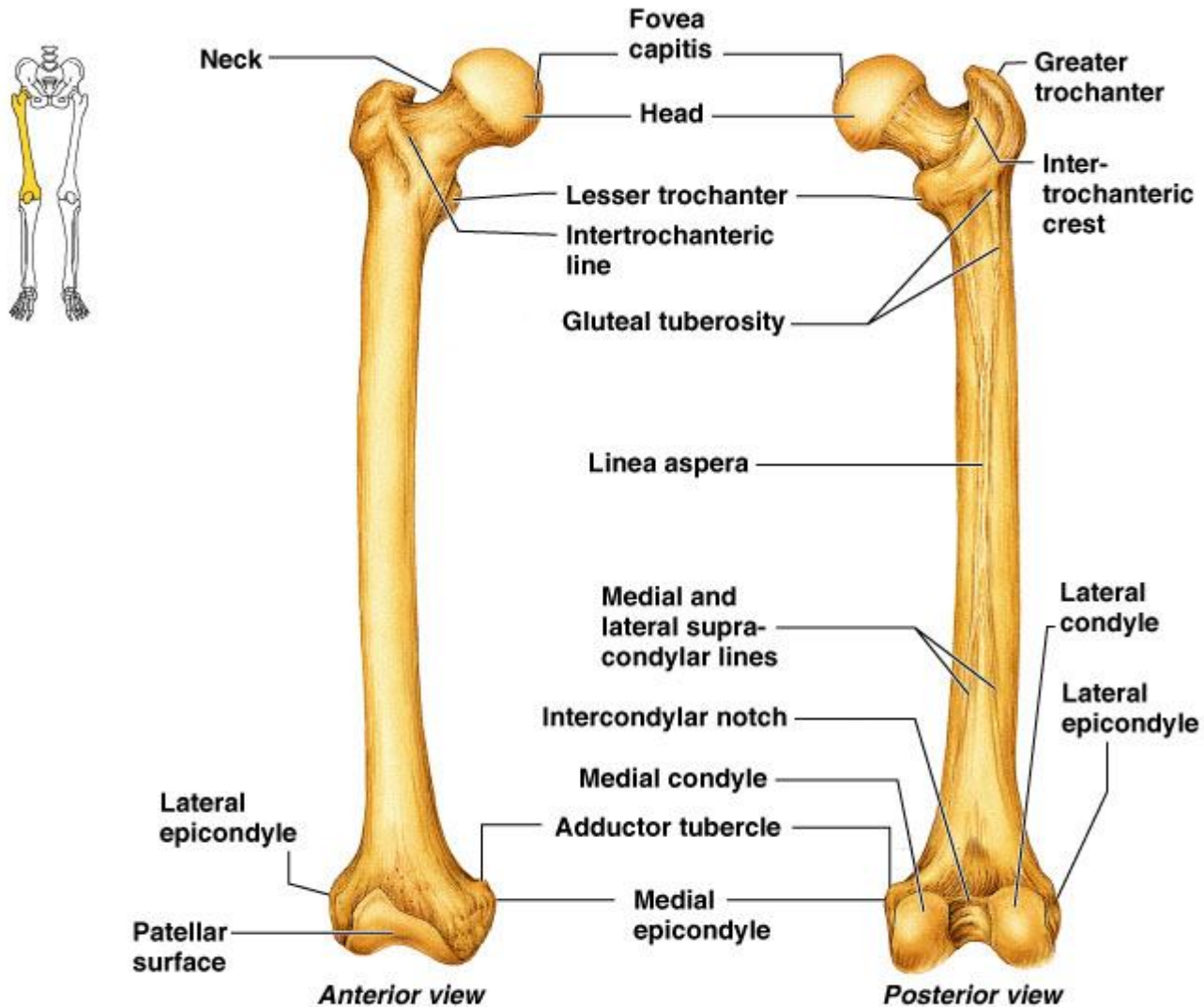


# Appendicular Skeleton

## The Lower Limb (Legs)

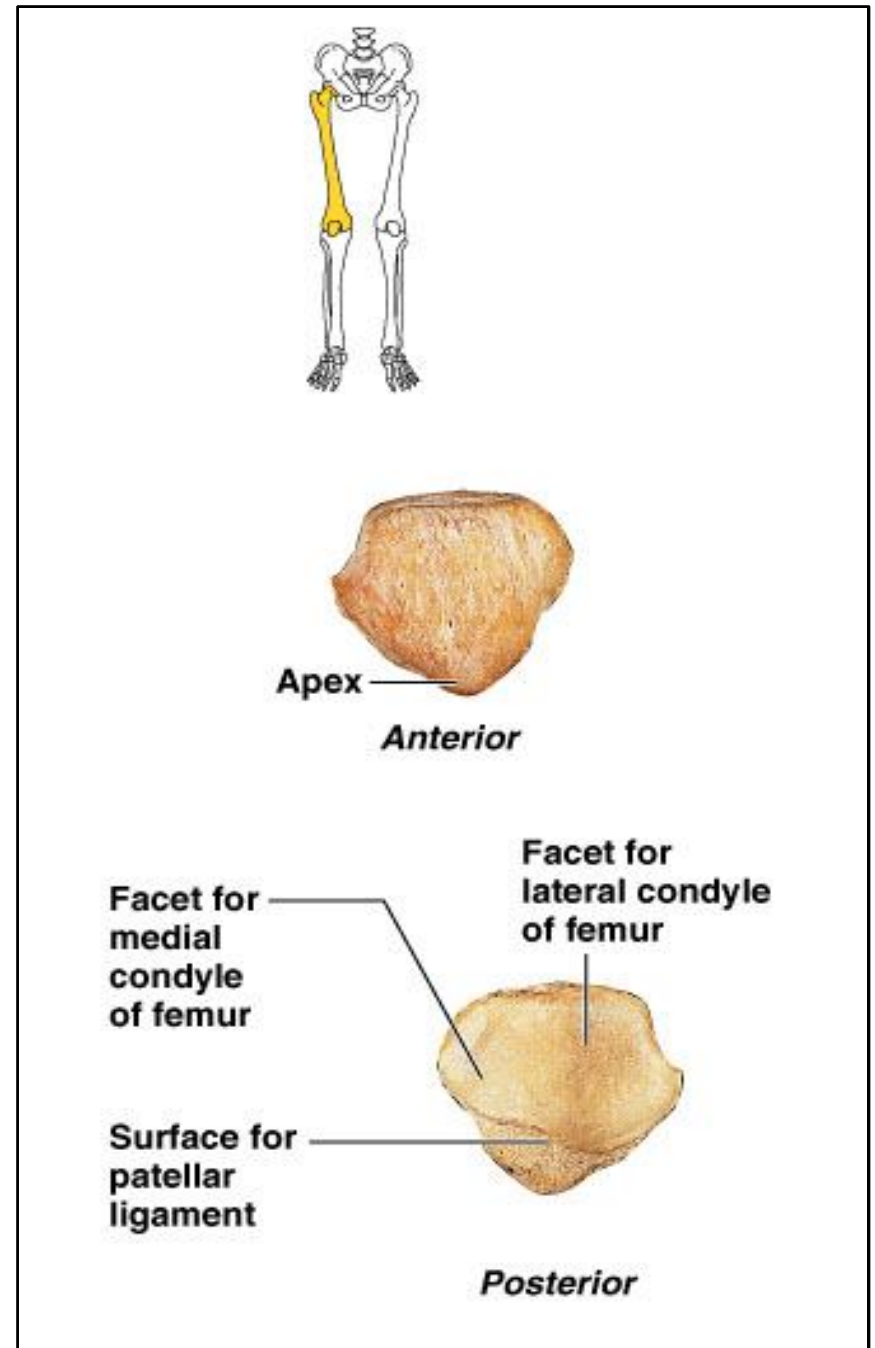


# Femur

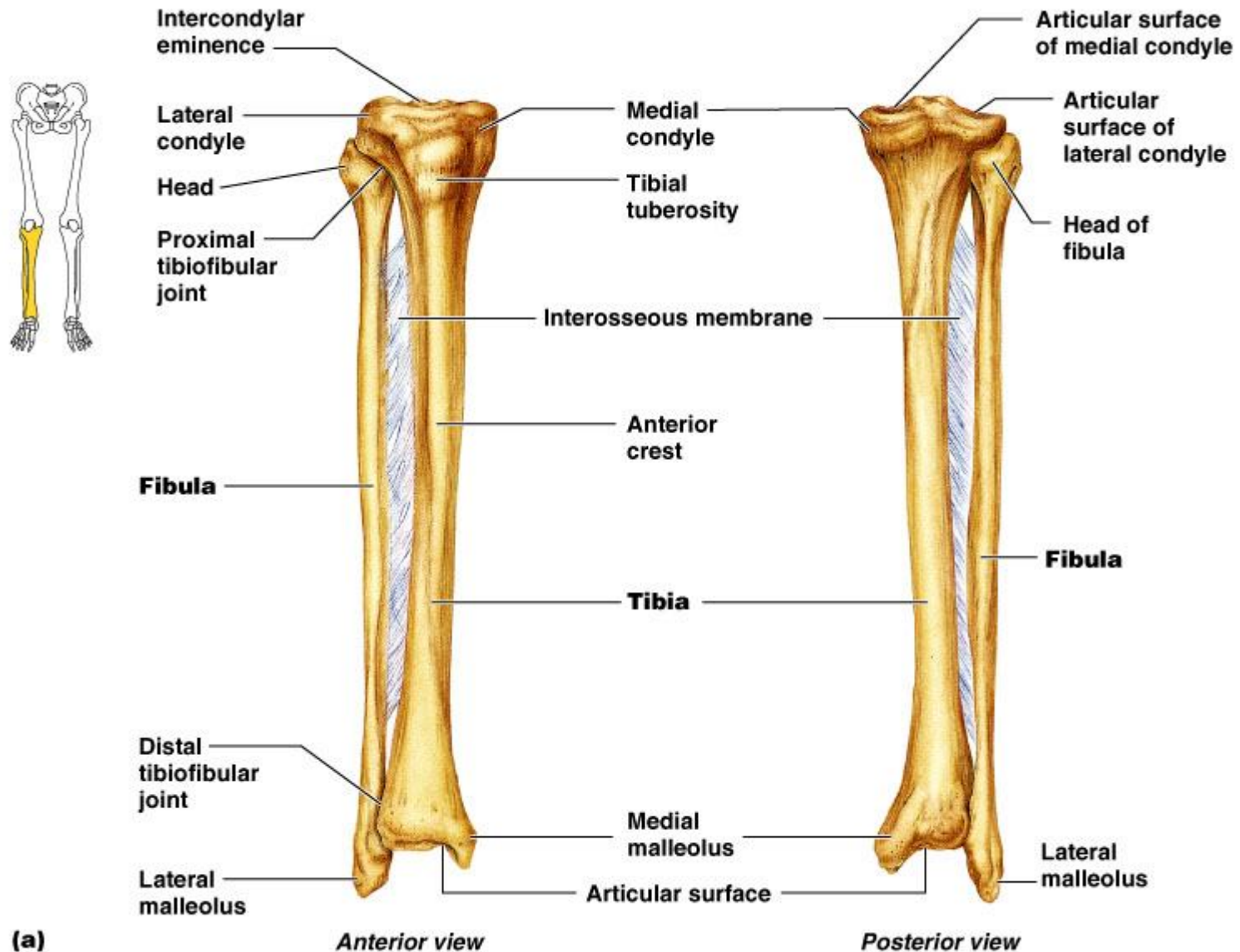


**(b) Femur**

# Patella(DISC)

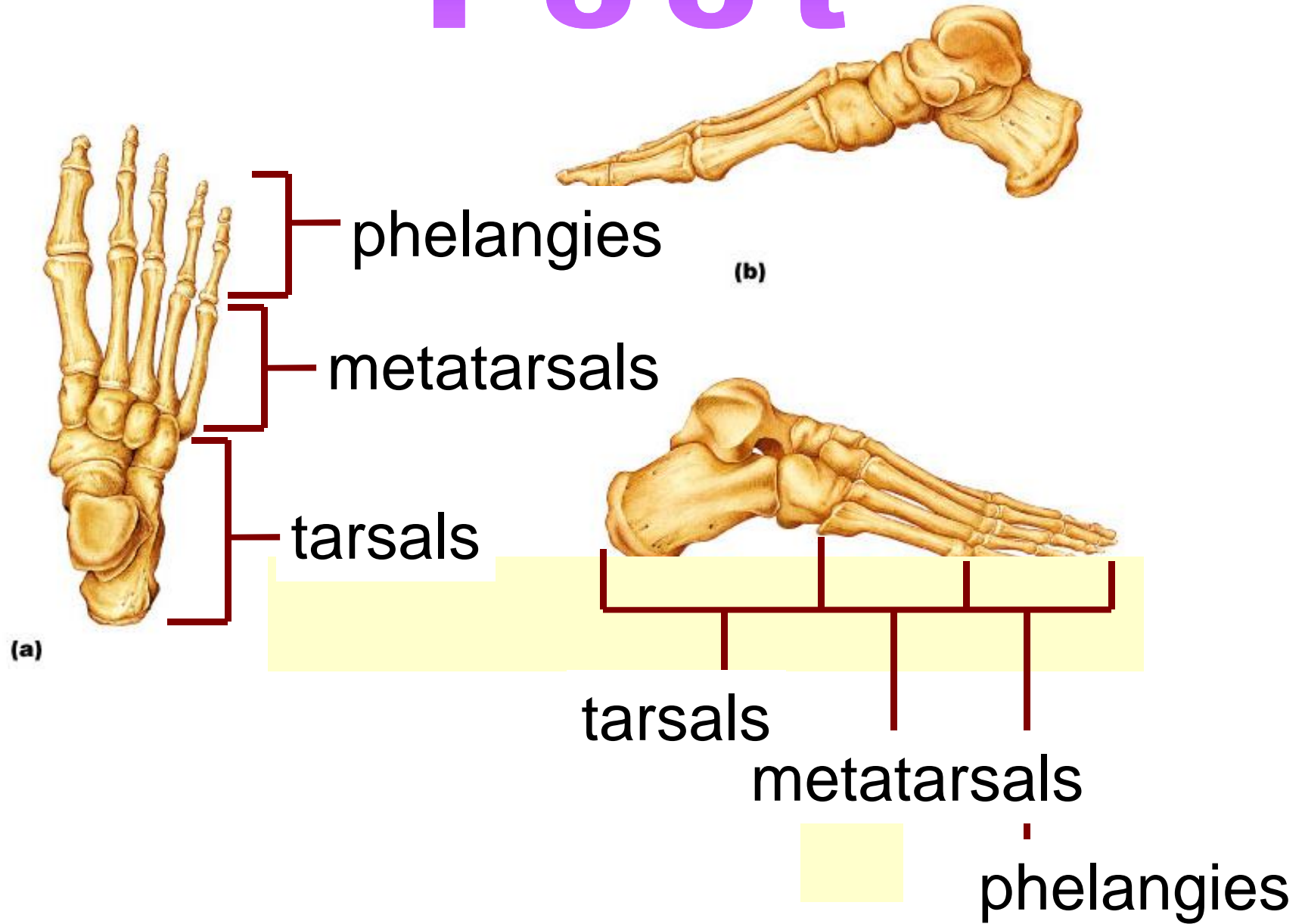


# Tibia & Fibula

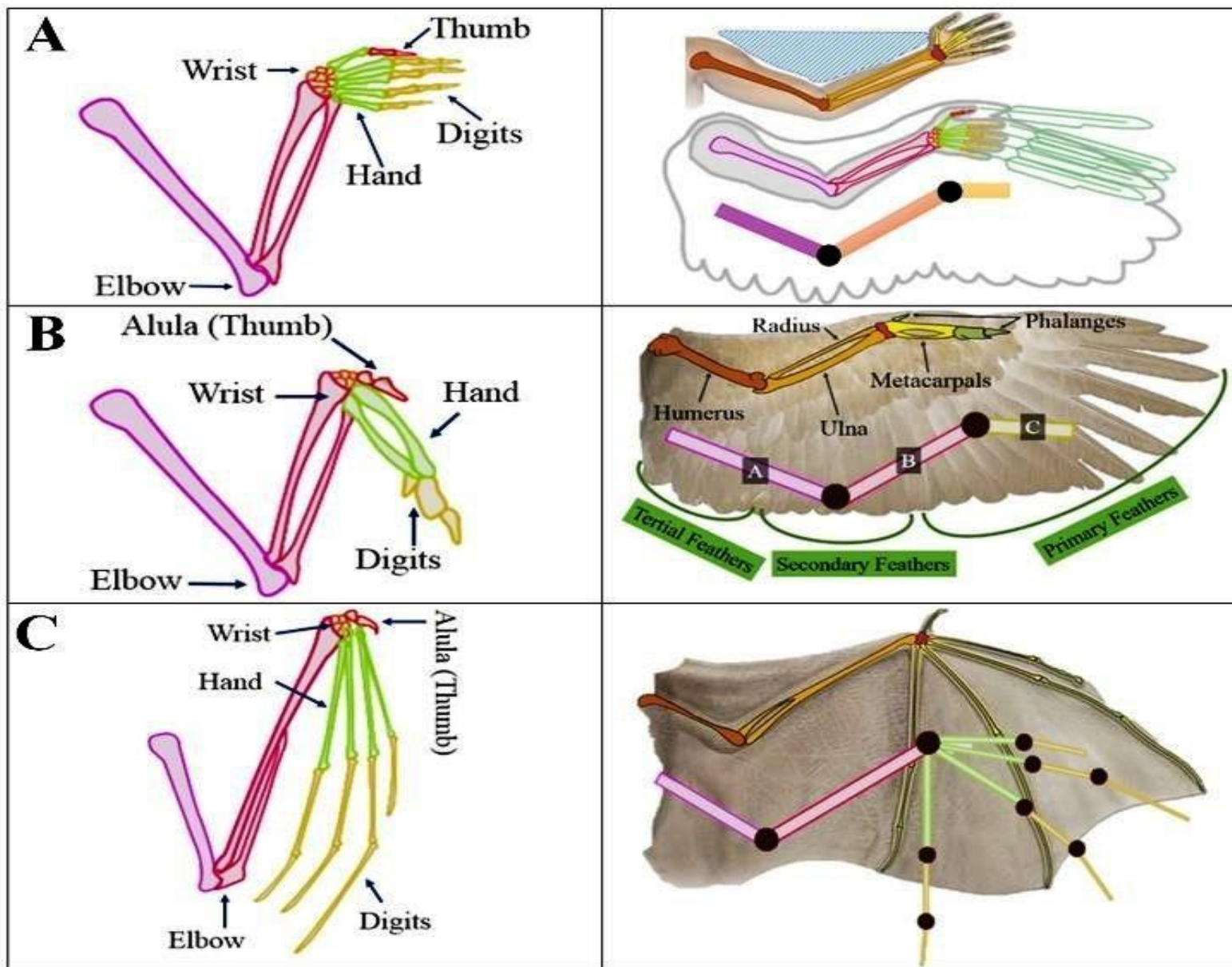




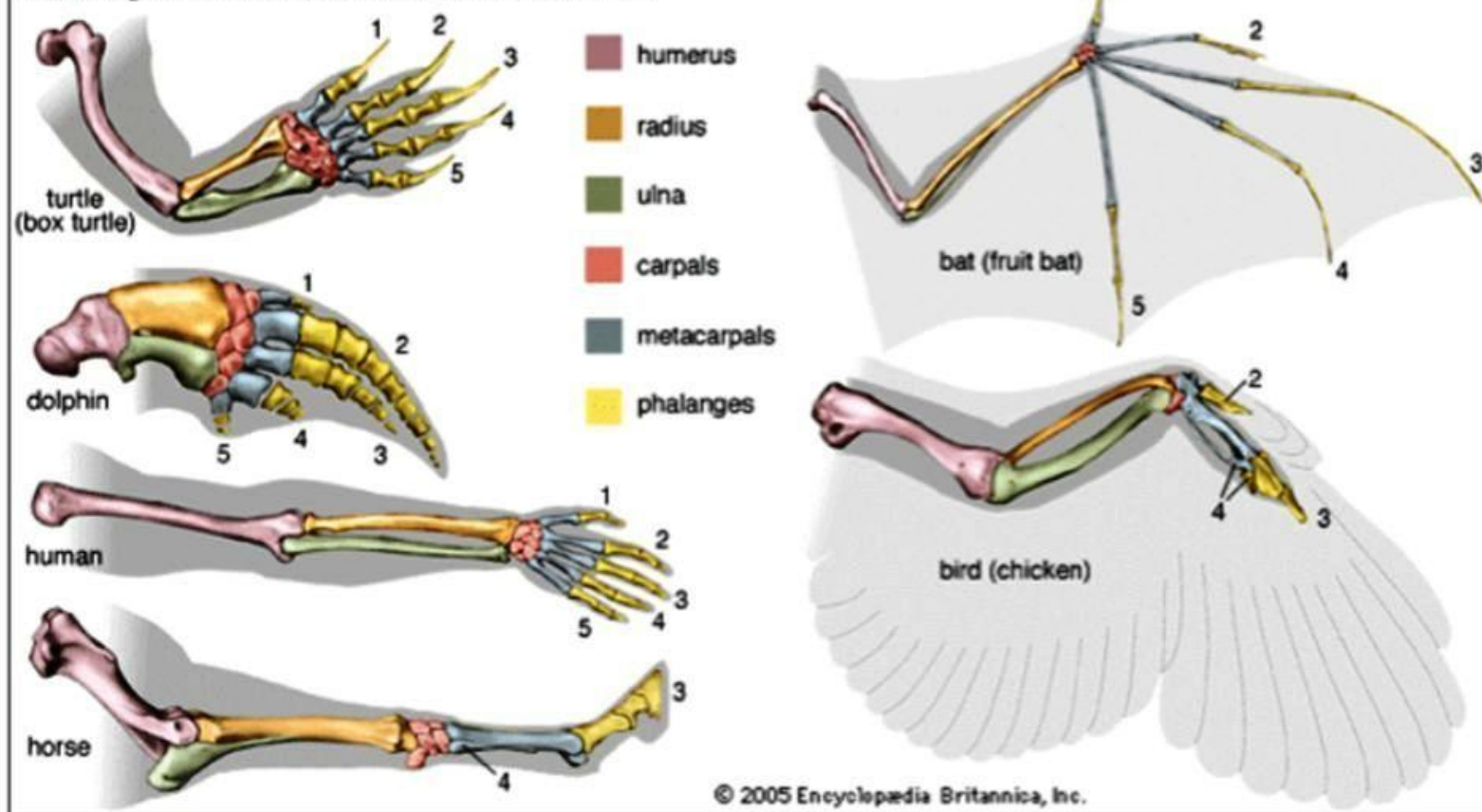
# Foot







### Homologies of the forelimb in six vertebrates



Look at a the bones of the human arm. Identify the humerus, ulna and radius. Compare the similar features between the chicken wing and the human arm. #4 on your worksheet.

## Chapter Review

The skeletal system includes all of the bones, cartilages, and ligaments of the body. It serves to support the body, protect the brain and other internal organs, and provides a rigid structure upon which muscles can pull to generate body movements. It also stores fat and the tissue responsible for the production of blood cells. The skeleton is subdivided into two parts. The axial skeleton forms a vertical axis that includes the head, neck, back, and chest. It has 80 bones and consists of the skull, vertebral column, and thoracic cage. The adult vertebral column consists of 24 vertebrae plus the sacrum and coccyx. The thoracic cage is formed by 12 pairs of ribs and the sternum. The appendicular skeleton consists of 126 bones in the adult and includes all of the bones of the upper and lower limbs plus the bones that anchor each limb to the axial skeleton.

# Review Questions

1. Which of the following is part of the axial skeleton?

- shoulder bones
- thigh bone
- foot bones
- vertebral column

2. Which of the following is a function of the axial skeleton?

- allows for movement of the wrist and hand
- protects nerves and blood vessels at the elbow
- supports trunk of body
- allows for movements of the ankle and foot

3. The axial skeleton \_\_\_\_\_.

- consists of 126 bones
- forms the vertical axis of the body
- includes all bones of the body trunk and limbs
- includes only the bones of the lower limbs

**Answers  
for Review  
Questions**

- D
- C
- B

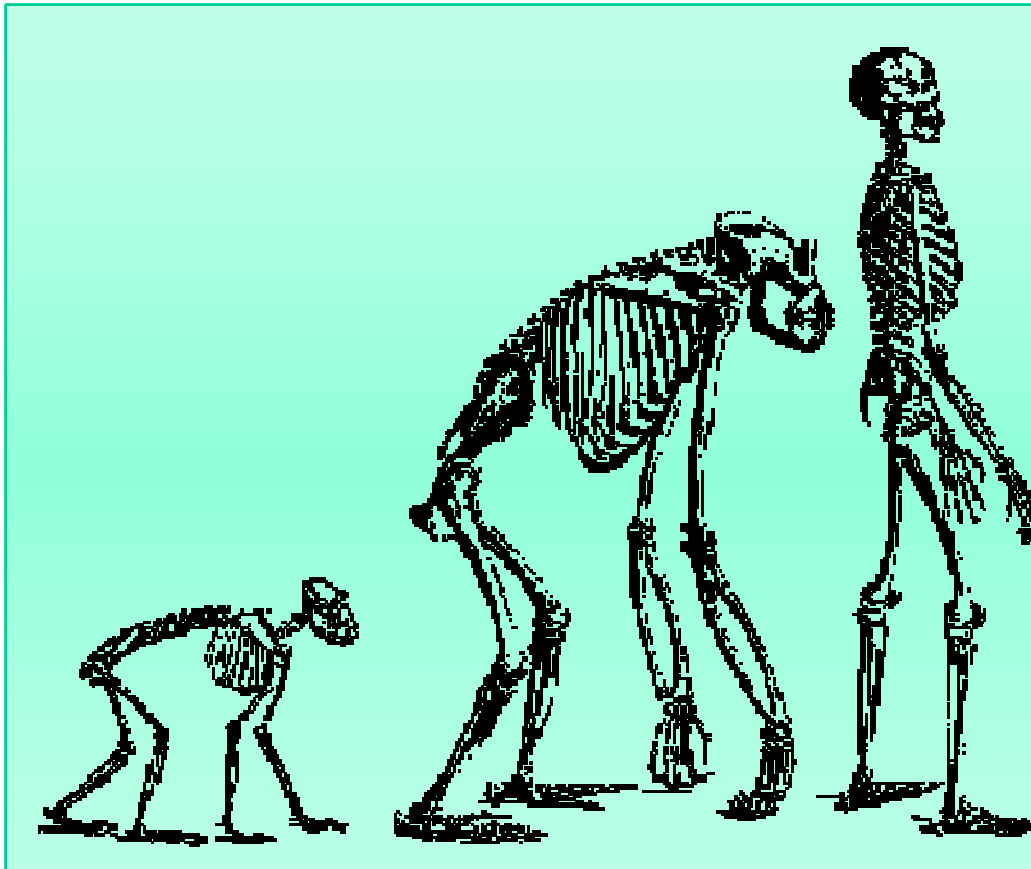
# Critical Thinking Questions

1. Define the two divisions of the skeleton.
2. Discuss the functions of the axial skeleton.
3. Discuss the Modifications of appendicular skeleton in vertebrates

## **Answers for Critical Thinking Questions**

- The axial skeleton forms the vertical axis of the body and includes the bones of the head, neck, back, and chest of the body. It consists of 80 bones that include the skull, vertebral column, and thoracic cage. The appendicular skeleton consists of 126 bones and includes all bones of the upper and lower limbs.
- The axial skeleton supports the head, neck, back, and chest of the body and allows for movements of these body regions. It also gives bony protections for the brain, spinal cord, heart, and lungs; stores fat and minerals; and houses the blood-cell producing tissue.
- Answer remains for YOU....

# Skeleton & Limb Posture in Human Evolution



**THANKS  
for  
Your Patience**

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07/02/2019