SKELETAL SYSTEM

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The Skeletal System

- Parts of the skeletal system include:
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments
- Divided into two divisions:
  1. Axial skeleton – 80 bones
  2. Appendicular skeleton – 126 bones

Functions of Bones

- Framework
  - Supports muscle, fat and skin
- Protection
  - Surrounds vital organs like skull, ribs, pelvis
- Movement
  - Muscles attach to bones to provide movement
- Mineral homeostasis
  - Stores and maintain minerals (Calcium & phosphorus)
- Production of blood cells
  - Red bone marrow – produes Red and white blood cells and platelets
- Storage
  - Calcium
  - Yellow bone marrow – has adipocytes – stores fat.

Classification of Bones

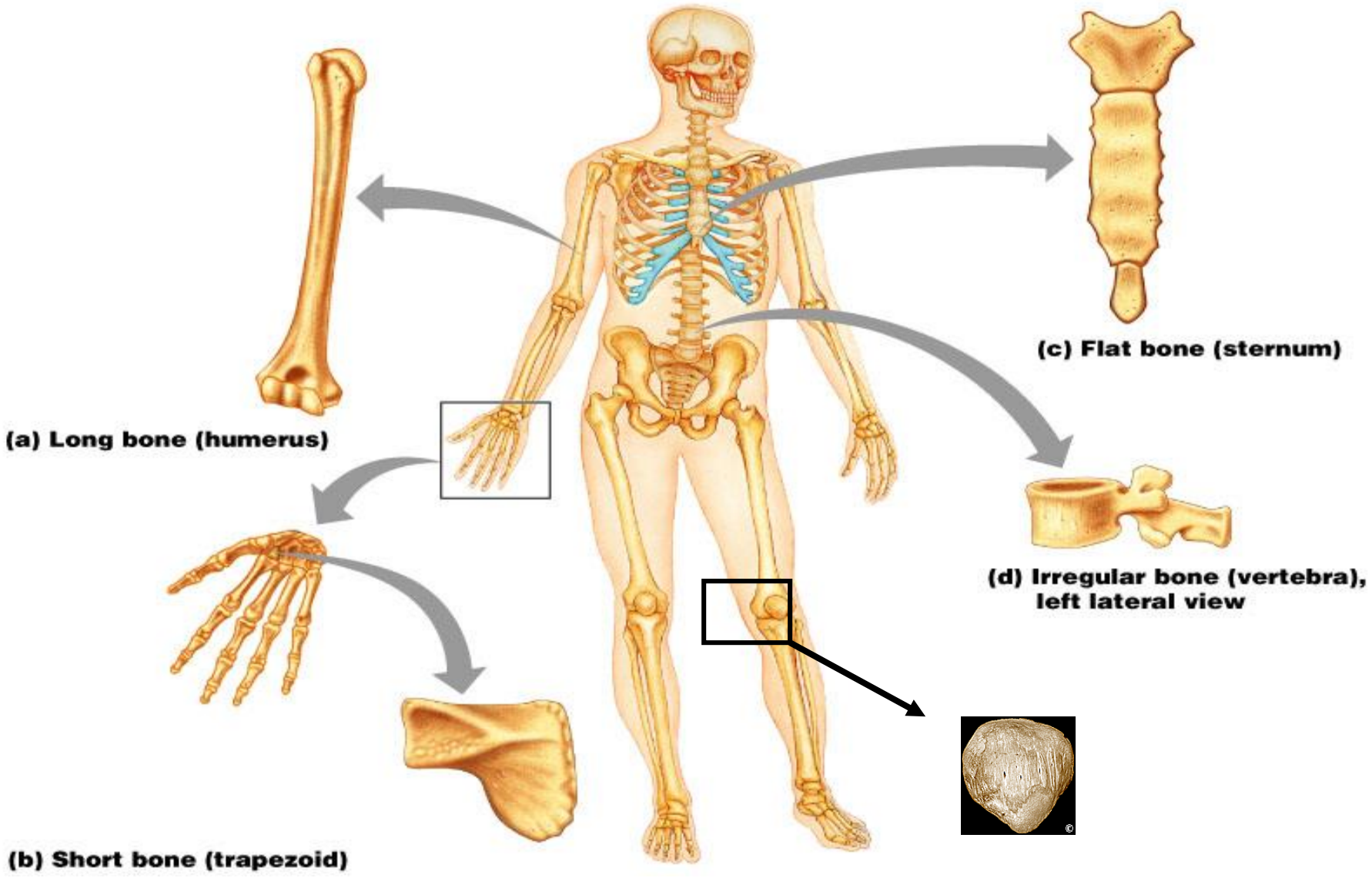
- Long bones
  - Typically longer than wide
  - Have a shaft with heads at both ends
  - Contain mostly compact bone
    - Examples: Femur, humerus

- Short bones
  - Generally cube-shape
  - Contain mostly spongy bone
    - Examples: Carpals, tarsals

Classification of Bones

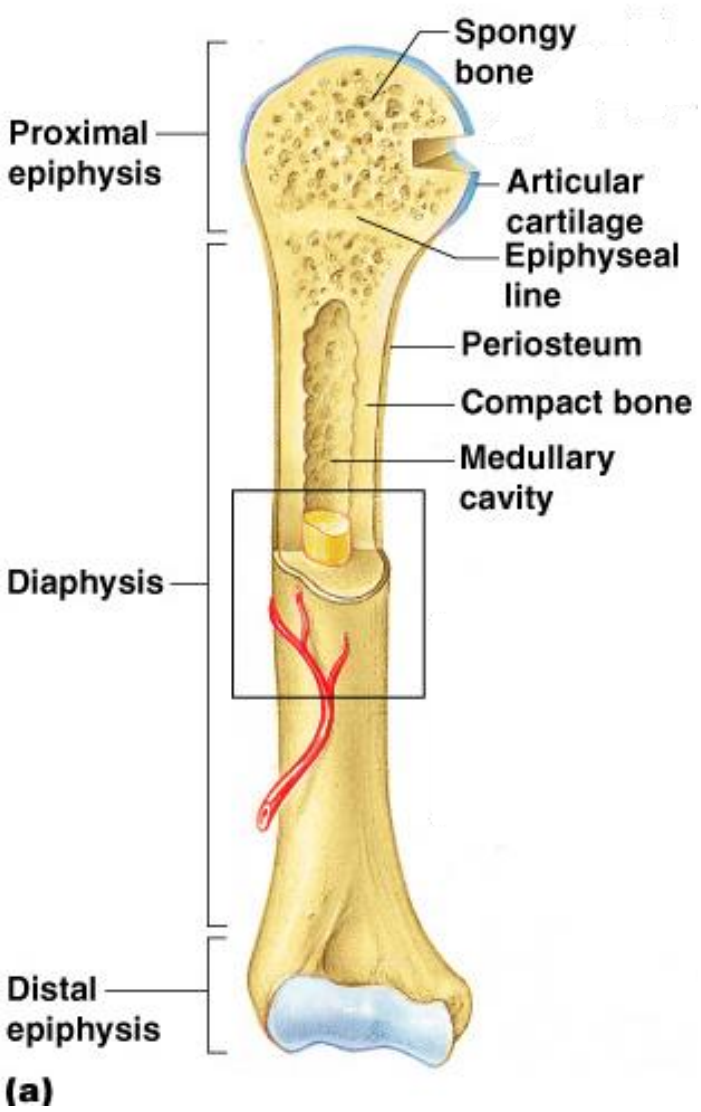
- Flat bones
  - Thin and flattened, usually curved
  - Thin layers of compact bone around a layer of spongy bone
    - Examples: Skull, ribs, sternum
- Irregular bones
  - Irregular in shape
  - Do not fit into other bone classification categories
    - Example: Vertebrae and hip

Bone Classification – Based on Shape



Gross Anatomy of a Long Bone

- Diaphysis
  - Shaft
  - Composed of compact bone
- Epiphysis
  - Ends of the bone
  - Composed mostly of spongy bone



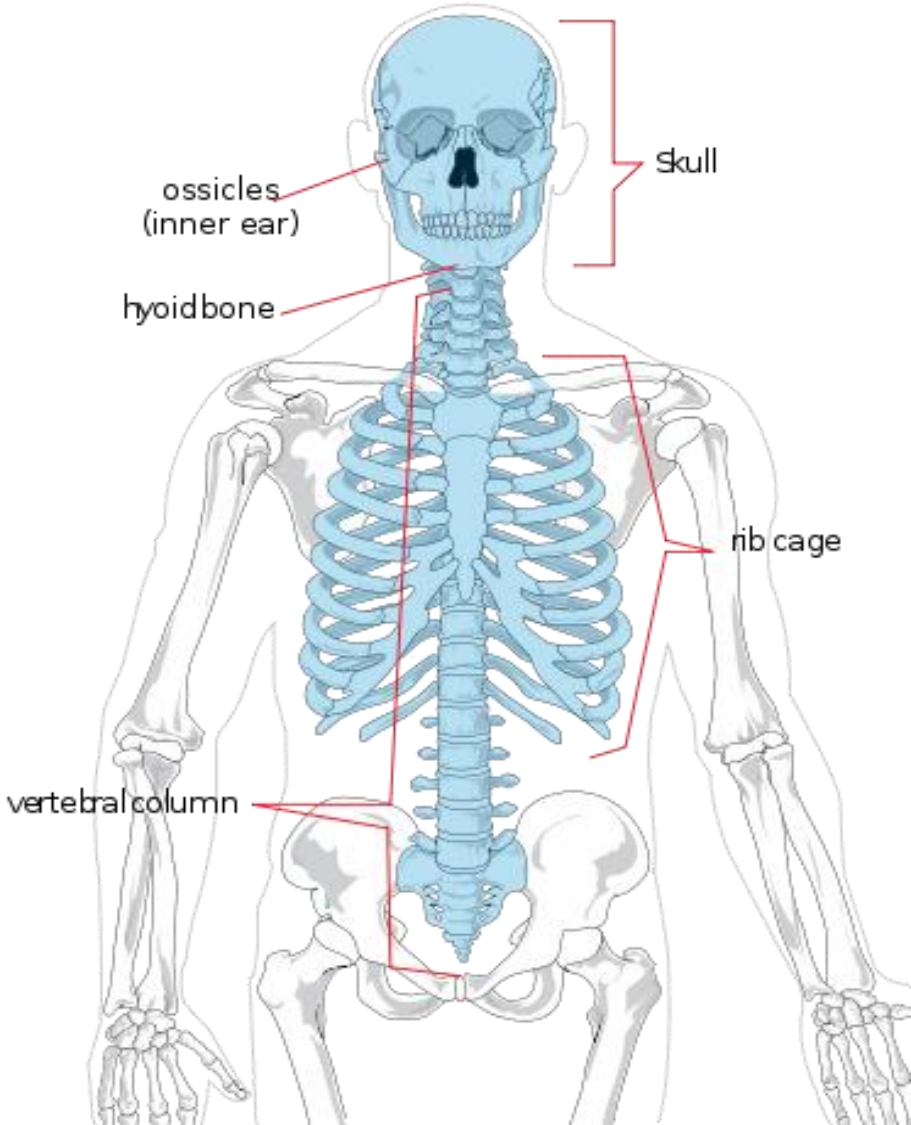
Divisions of the Skeletal System

DIVISION OF THE SKELETON	STRUCTURE	NUMBER OF BONES
Axial Skeleton		
		
	Skull	
	Cranium	8
	Face	14
	Hyoid	1
	Auditory ossicles	6
	Vertebral column	26
	Thorax	
	Sternum	1
	Ribs	24
		Subtotal = 80

DIVISION OF THE SKELETON	STRUCTURE	NUMBER OF BONES
Appendicular Skeleton		
		
	Pectoral (shoulder) girdles	
	Clavicle	2
	Scapula	2
	Upper limbs	
	Humerus	2
	Ulna	2
	Radius	2
	Carpals	16
	Metacarpals	10
	Phalanges	28
	Pelvic (hip) girdle	
	Hip, pelvic, or coxal bone	2
	Lower limbs	
	Femur	2
	Patella	2
	Fibula	2
	Tibia	2
	Tarsals	14
	Metatarsals	10
	Phalanges	28
		Subtotal = 126
		Total in an adult skeleton = 206

The Axial Skeleton

- Forms the longitudinal part of the body
- Divided into three parts
  - Skull
  - Vertebral column
  - Bony thorax



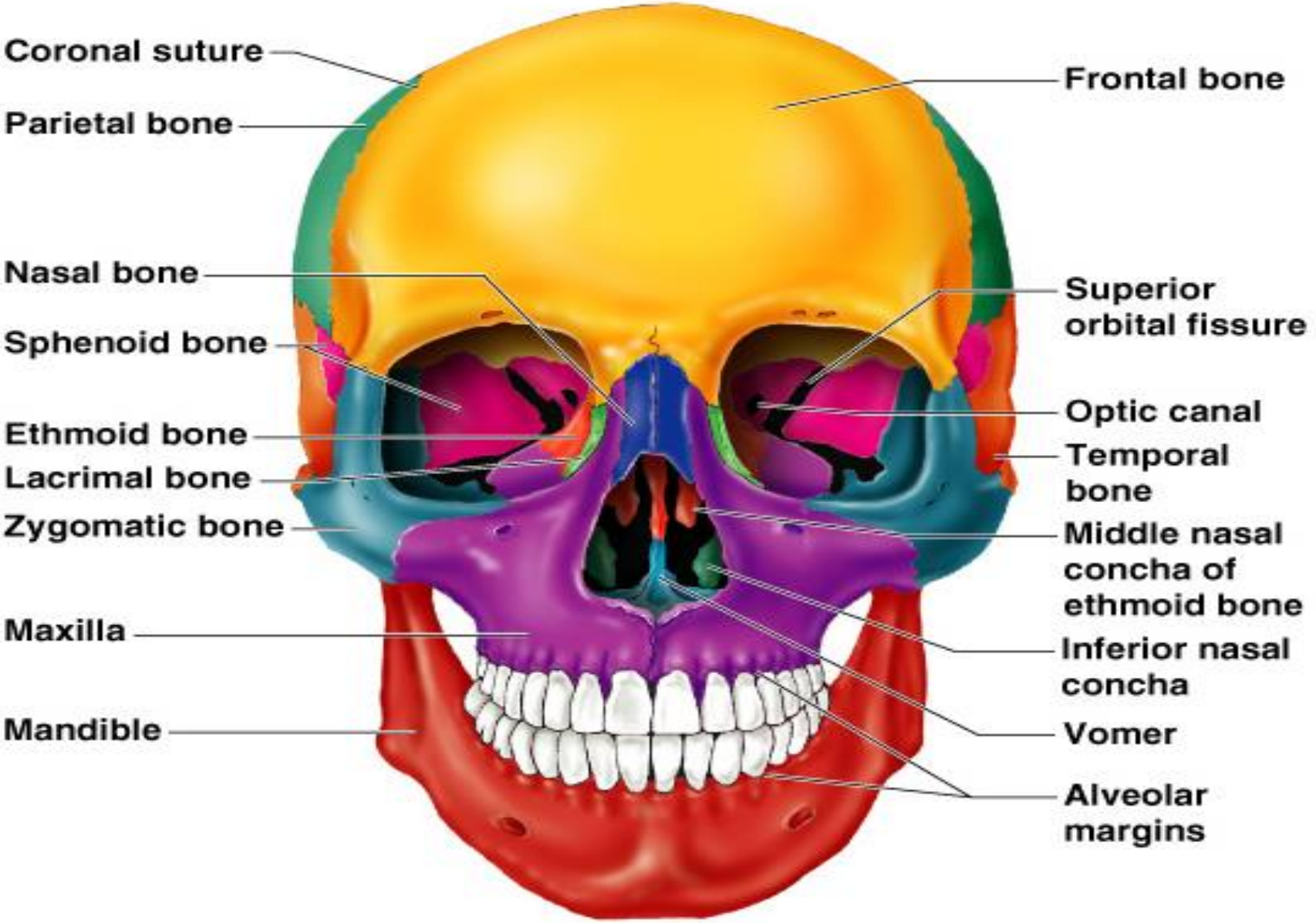
Skull (Cranium)

- Consists of 22 bones
- Bones of the skull are grouped into two categories:
  - Cranial bones - Eight cranial bones form the cranial cavity
    - Frontal bone,
    - two parietal bones,
    - two temporal bones,
    - the occipital bone,
    - the sphenoid bone,
    - ethmoid bone
  - Facial bones - Fourteen facial bones form the face
    - Two nasal bones,
    - two maxillae,
    - two zygomatic bones,
    - the mandible,
    - two lacrimal bones,
    - two palatine bones,
    - two inferior nasal conchae and vomer

Skull

- The cranial and facial bones protect and support special sense organs and the brain.
- Besides forming the large cranial cavity, the skull also forms several smaller cavities
  - Nasal cavity
  - Orbits (eye sockets)
  - Paranasal sinuses
  - Small cavities which house organs involved in hearing and equilibrium

Bones of the Skull



Skull

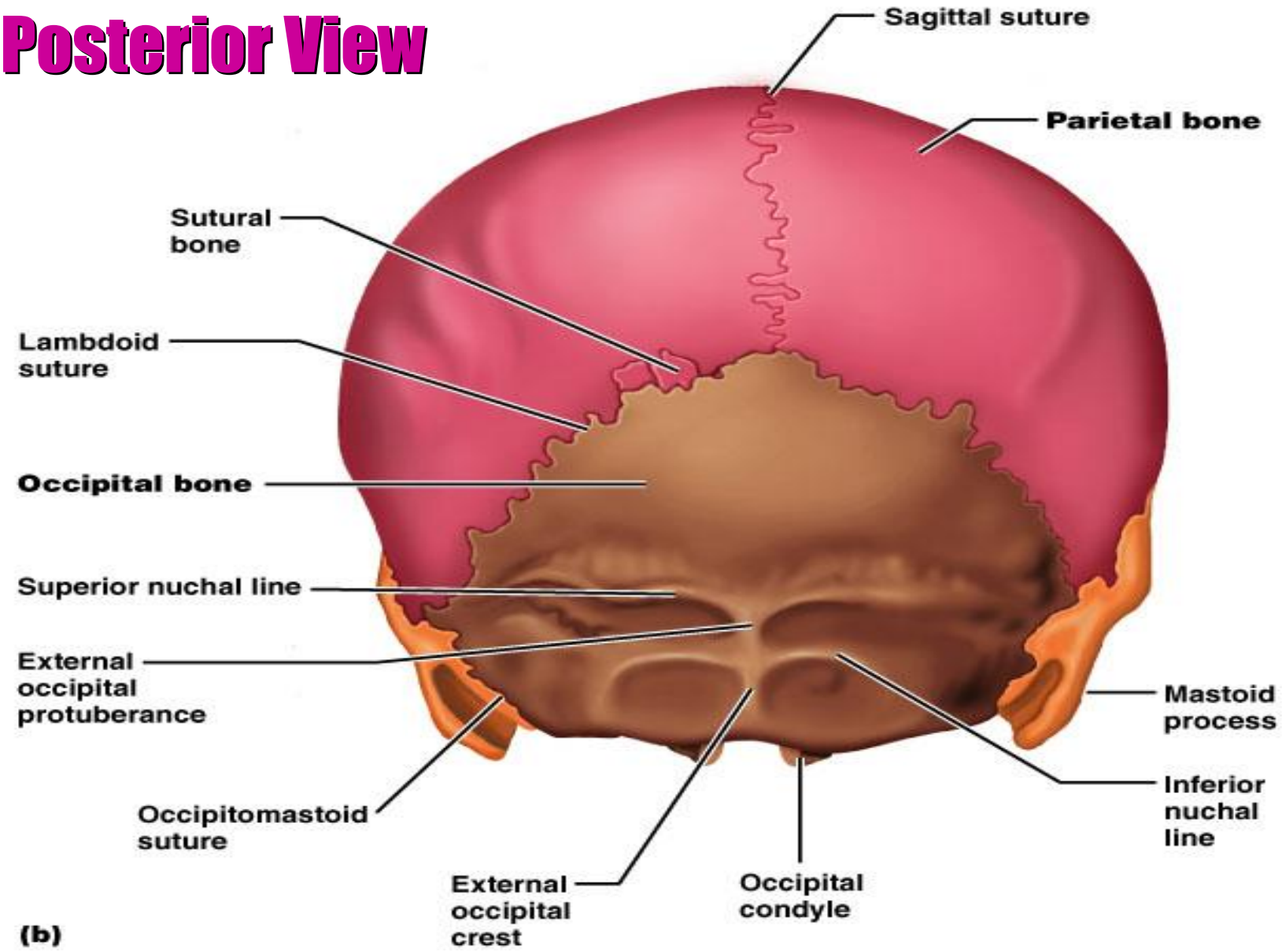
- Immovable joints called sutures fuse most of the skull bones together.
- The skull provides large areas of attachment for muscles that move various parts of the head.
- Skull and facial bones provide attachment for muscles that produce facial expressions.
- The facial bones form the framework of the face and provide support for the entrances to the digestive and respiratory systems.

Skull (Cranial Bones)

- **Frontal Bone**
  - Forms the forehead
- **Parietal Bones**
  - Form the sides and roof of the cranial cavity
- **Temporal Bones**
  - Form the lateral aspects and floor of the cranium
- **Occipital Bone**
  - Forms the posterior part and most of the base of the cranium
- **Sphenoid Bone**
  - Lies at the middle part of the base of the skull
- **Ethmoid Bone**
  - Located on the midline in the anterior part of the cranial floor medial to the orbits
  - A major superior supporting structure of the nasal cavity
  - Contain thin projections called conchae which are lined by mucous membranes
  - Increased surface area in the nasal cavity helps to humidify inhaled air trapping inhaled particles

Axial Skeleton

Posterior View



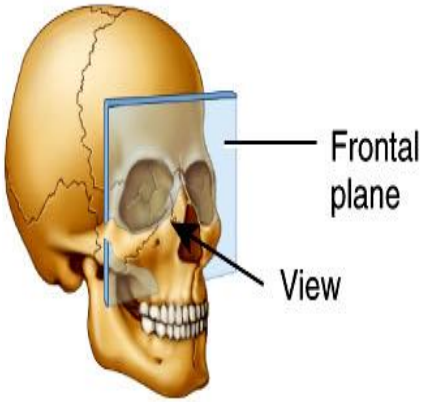
Skull (Facial Bones)

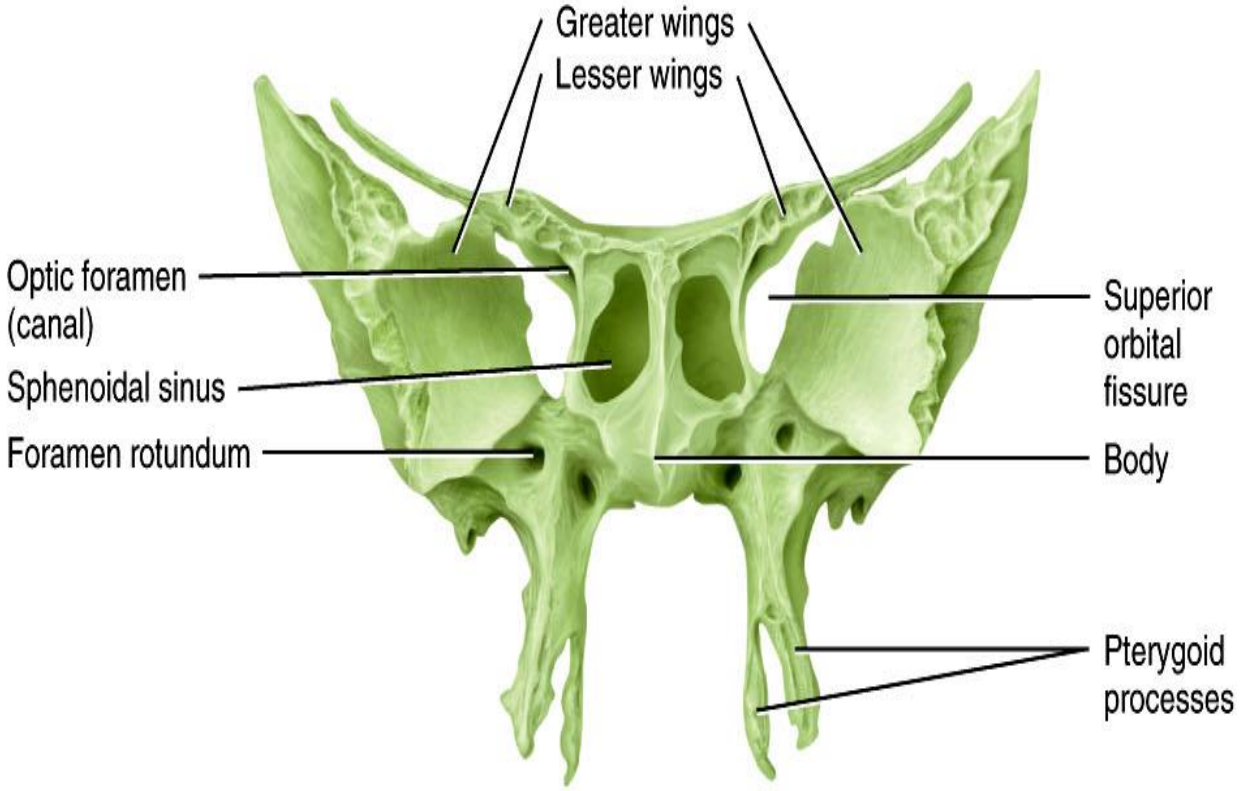
- **Nasal Bones**
  - Form the bridge of the nose
- **Maxillae**
  - Form the upper jawbone and most of the hard palate
  - Separates the nasal cavity from the oral cavity
- **Zygomatic Bones (Cheek bones)**
  - form the prominences of the cheeks
- **Lacrimal Bones**
  - Form a part of the medial wall of each orbit
- **Palatine Bones**
  - Form the posterior portion of the hard palate
- **Inferior Nasal Conchae**
  - Form a part of the inferior lateral wall of the nasal cavity

Skull (Facial Bones)

- **Vomer**
  - Forms the inferior portion of the nasal septum
- **Mandible**
  - Lower jawbone and the only movable skull bone
  - The largest, strongest facial bone
- **Nasal Septum**
  - Divides the interior of the nasal cavity into right and left sides
- **Orbits**
  - Eye socket
- **Foramina**
  - Openings for blood vessels, nerves or ligaments of the skull

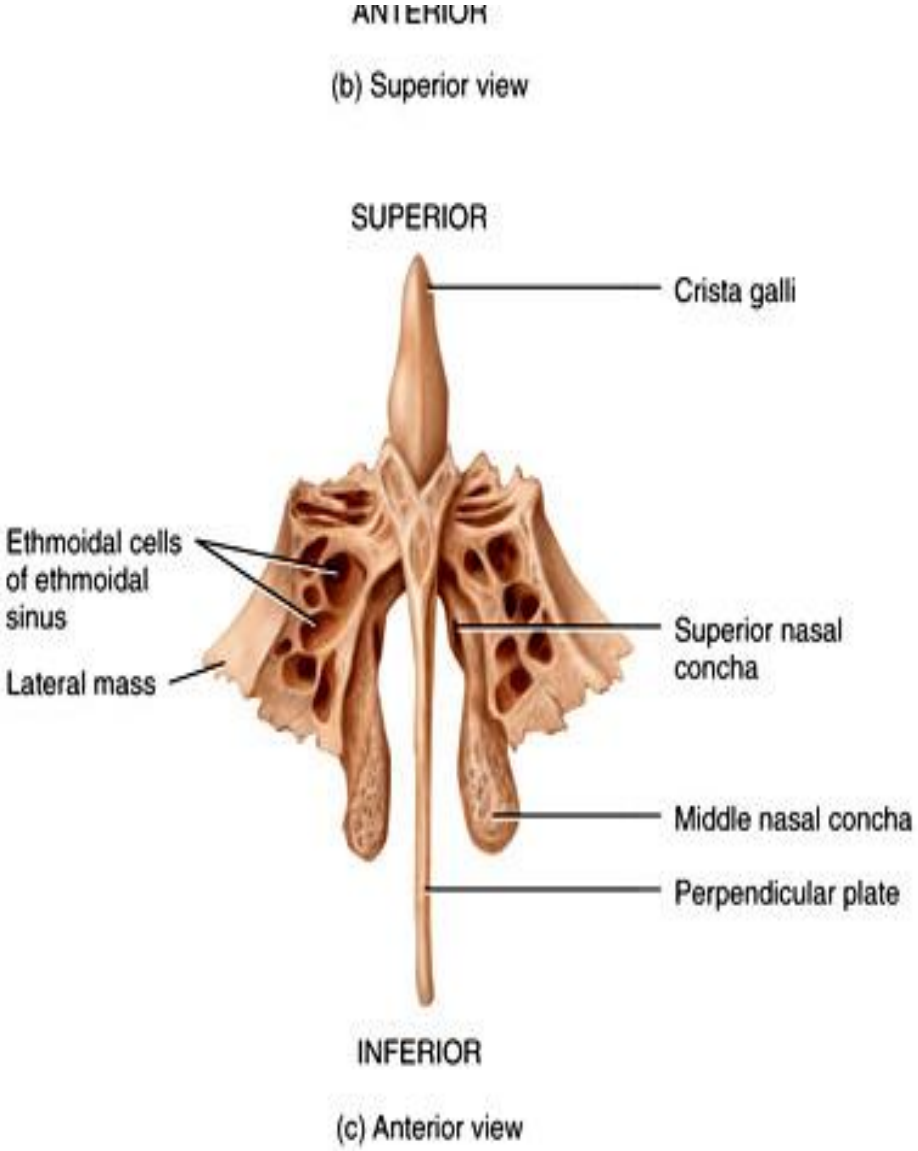
Sphenoid Bone

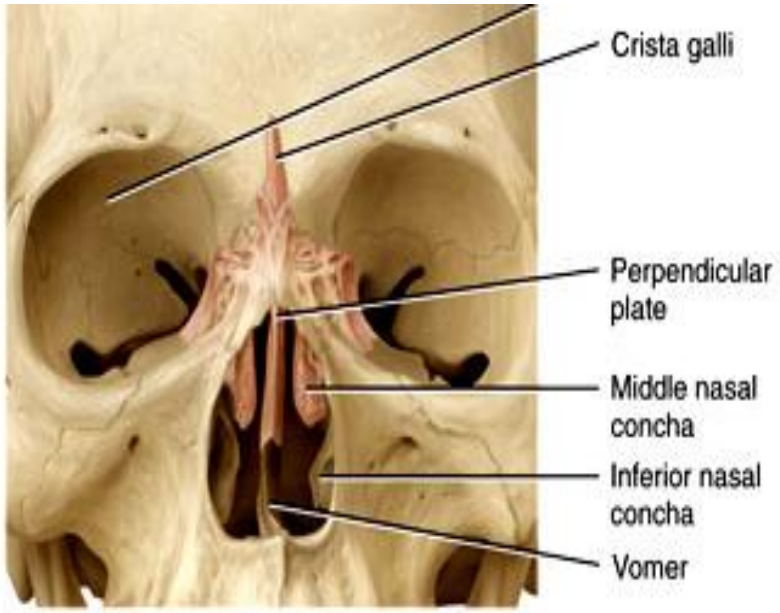




(b) Anterior view of sphenoid bone

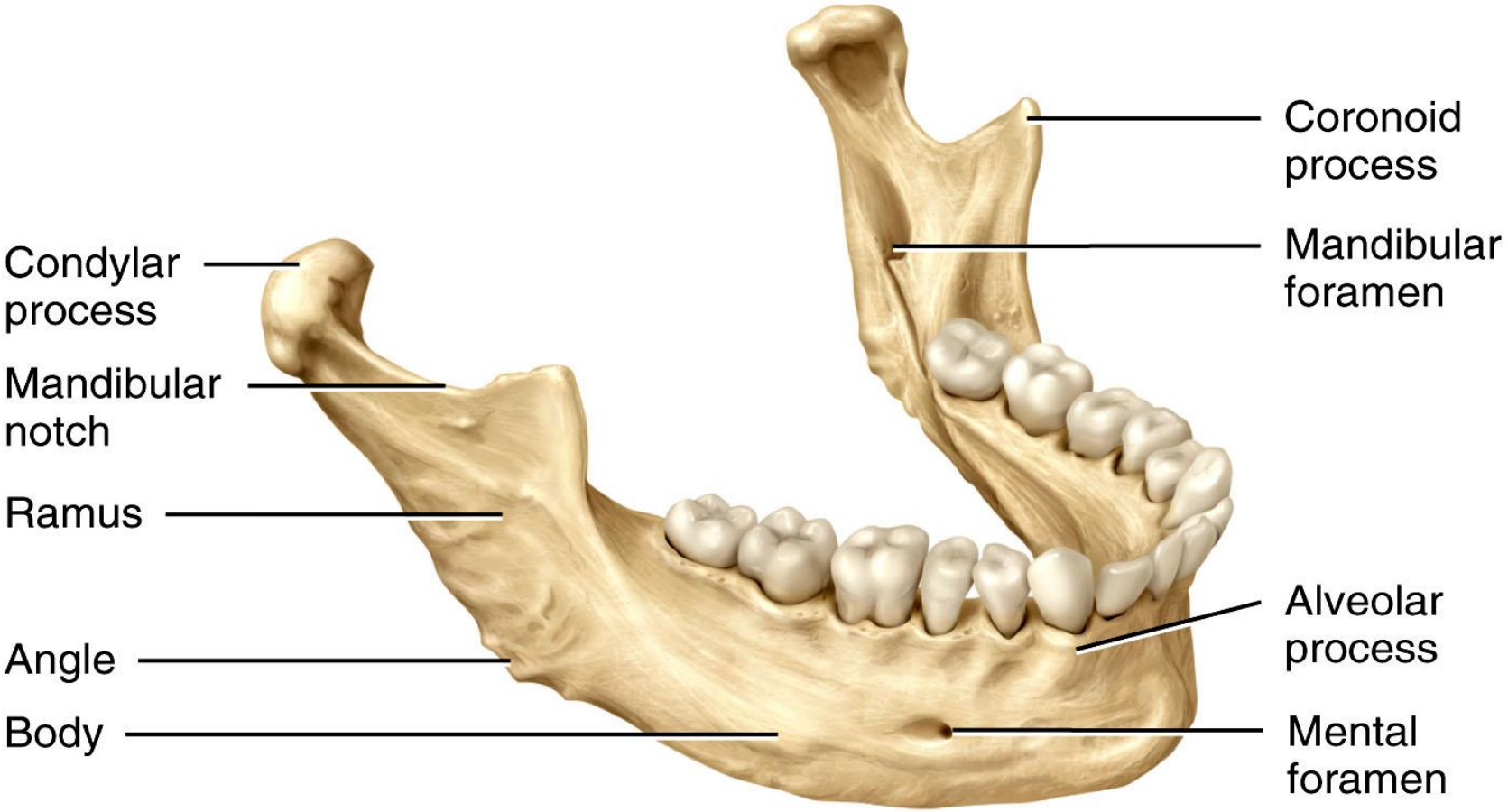
Ethmoid Bone & Vomer





(d) Anterior view of position of ethmoid bone in skull

Mandible

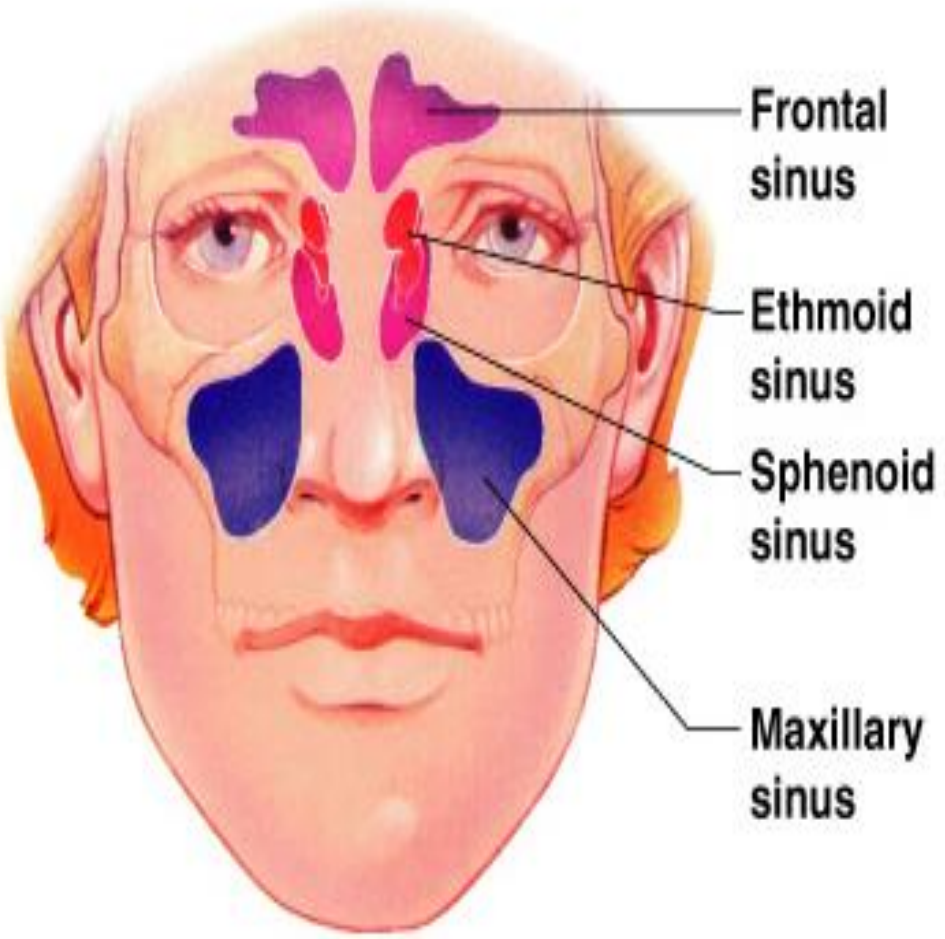


Right lateral view

Paranasal Sinuses

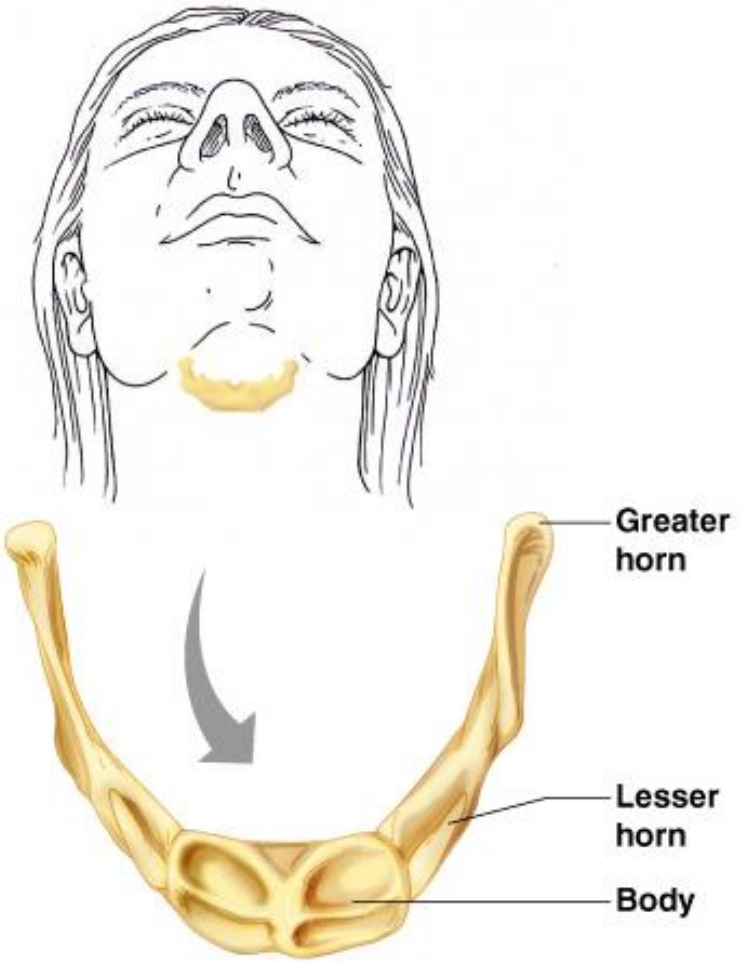
- Hollow portions of bones surrounding the nasal cavity

- Functions:
  - Lighten the skull
  - Give resonance and amplification to voice
  - Warm and moisten air



The Hyoid Bone

- The only bone that does not articulate with another bone
- Serves as a moveable base for the tongue
- The hyoid bone also helps to keep the larynx (voice box) open at all times



Vertebral Column

- Also called the spine, backbone, or spinal column
- Functions:
  - Protect the spinal cord
  - Support the head
  - Serve as a point of attachment for the ribs, pelvic girdle, and muscles
- The vertebral column is curved to varying degrees in different locations
  - Curves increase the column strength
  - Help maintain balance in the upright position
  - Absorb shocks during walking, and help protect the vertebrae from fracture

Vertebral Column

- Composed of a series of bones called **vertebrae (**Adult=26)
  - 7 **cervical** are in the neck region
  - 12 **thoracic** are posterior to the thoracic cavity
  - 5 **lumbar** support the lower back
  - 1 **sacrum** consists of five fused sacral vertebrae
  - 1 **coccyx** consists of four fused coccygeal vertebrae

Vertebral Column

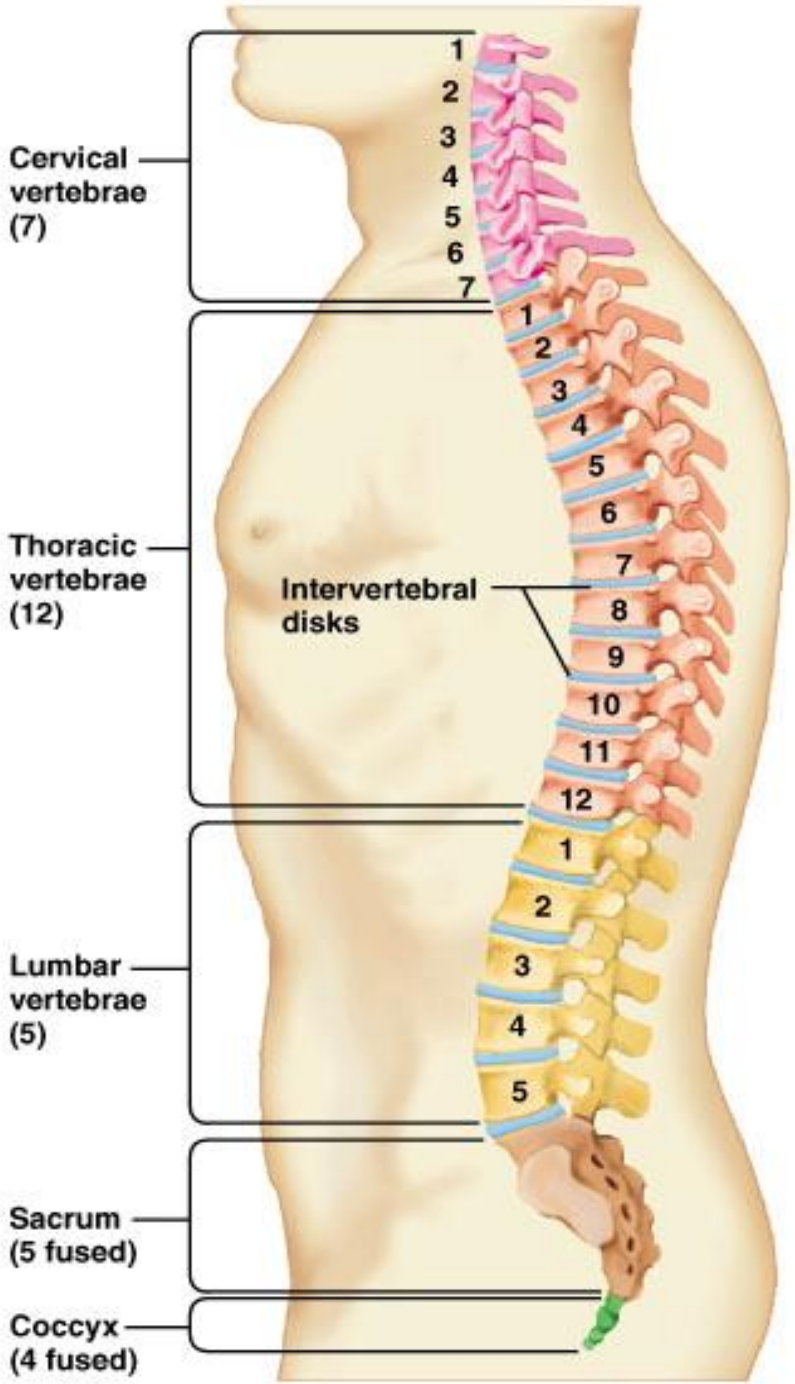
Cervical Vertebrae(7)

Thoracic Vertebrae (12)

Lumbar Vertebrae (5)

Sacrum

Coccyx



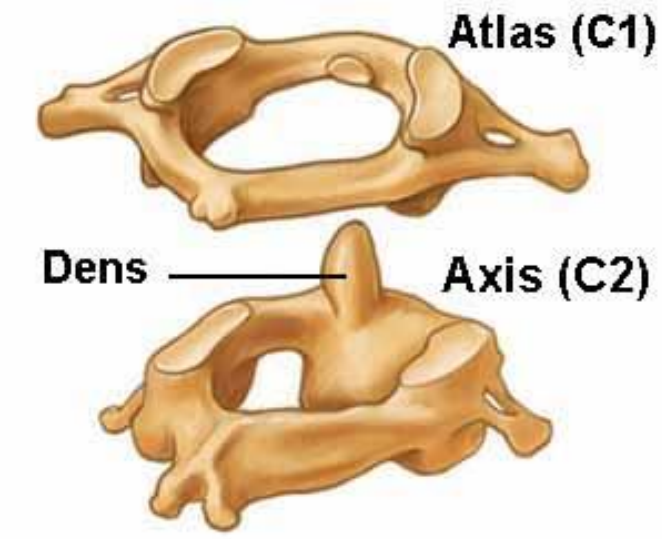
Intervertebral Discs

- Found between the bodies of adjacent vertebrae
- Functions to:
  - Form strong joints
  - Permit various movements of the vertebral column
  - Absorb vertical shock
- Vertebrae typically consist of:
  - A Body (weight bearing)
  - A vertebral arch (surrounds the spinal cord)
  - Several processes (points of attachment for muscles)

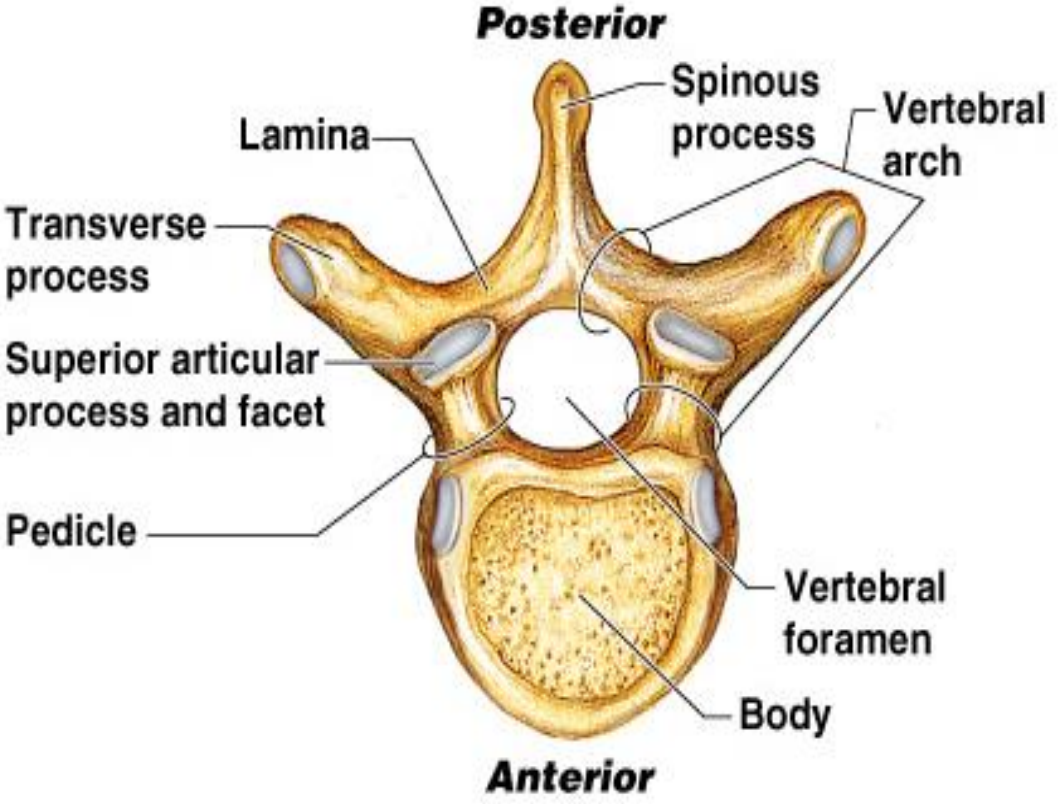
Vertebral Column (Regions)

- **Cervical Region**
  - Cervical vertebrae (C1–C7)
  - The atlas (C1) is the first cervical vertebra
  - The axis (C2) is the second cervical vertebra
- **Thoracic Region**
  - Thoracic vertebrae (T1–T12)
  - Articulate with the ribs
- **Lumbar Region**
  - Lumbar vertebrae (L1–L5)
  - Provide for the attachment of the large back muscles
- **Sacrum**
  - The sacrum is a triangular bone formed by the union of five sacral vertebrae (S1–S5)
  - Serves as a strong foundation for the pelvic girdle
- **Coccyx**
  - The coccyx, like the sacrum, is triangular in shape
  - It is formed by the fusion of usually four coccygeal vertebrae

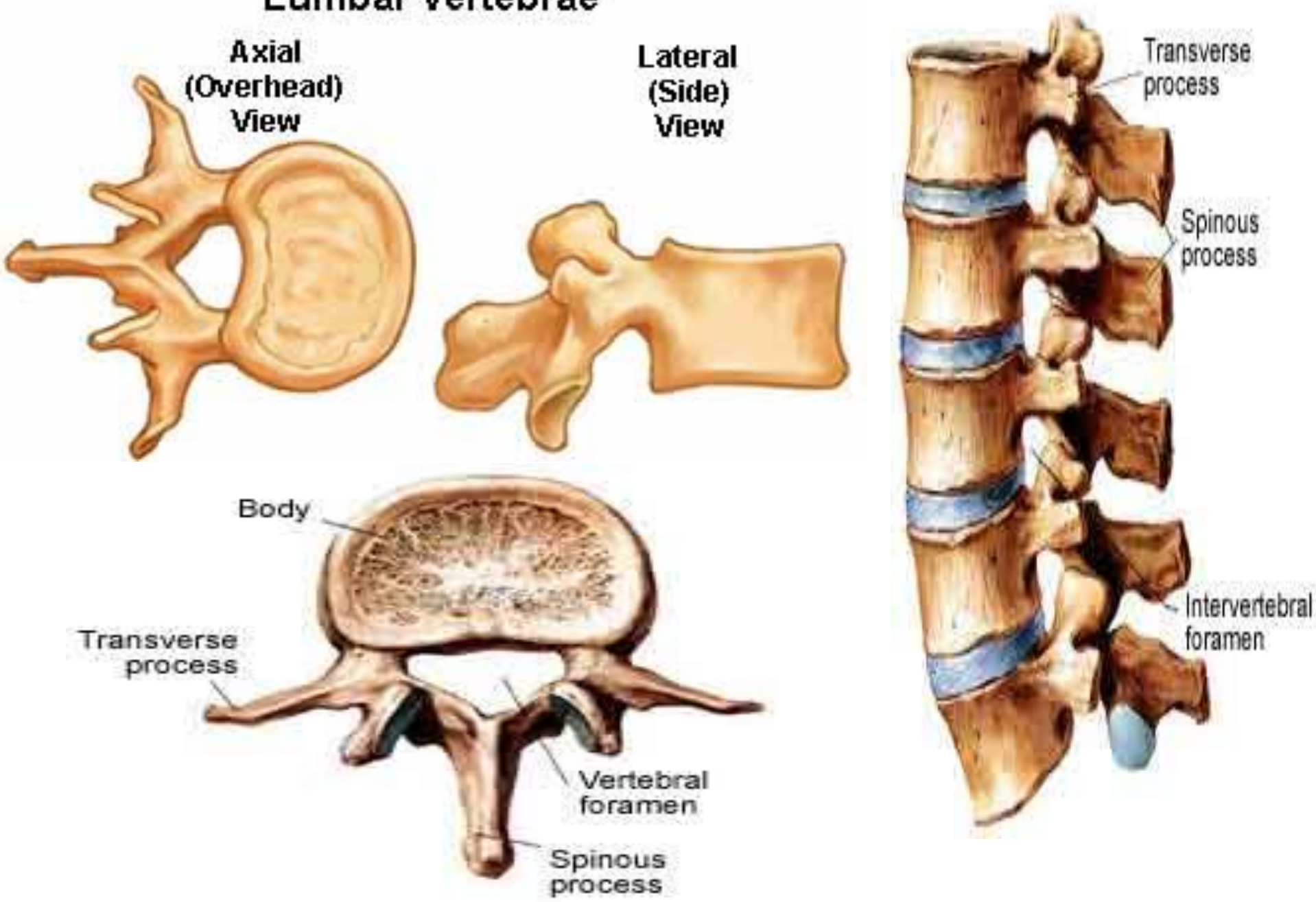
Cervical Vertebrae



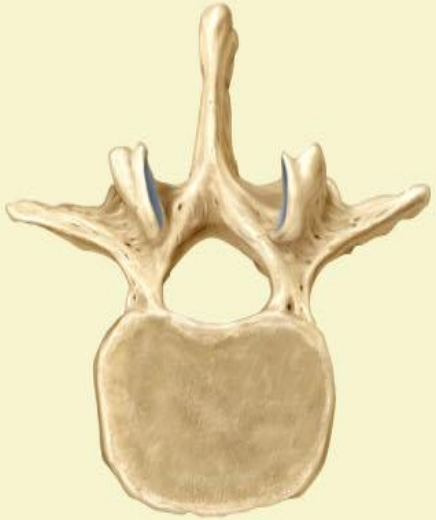
Thoracic Vertebrae



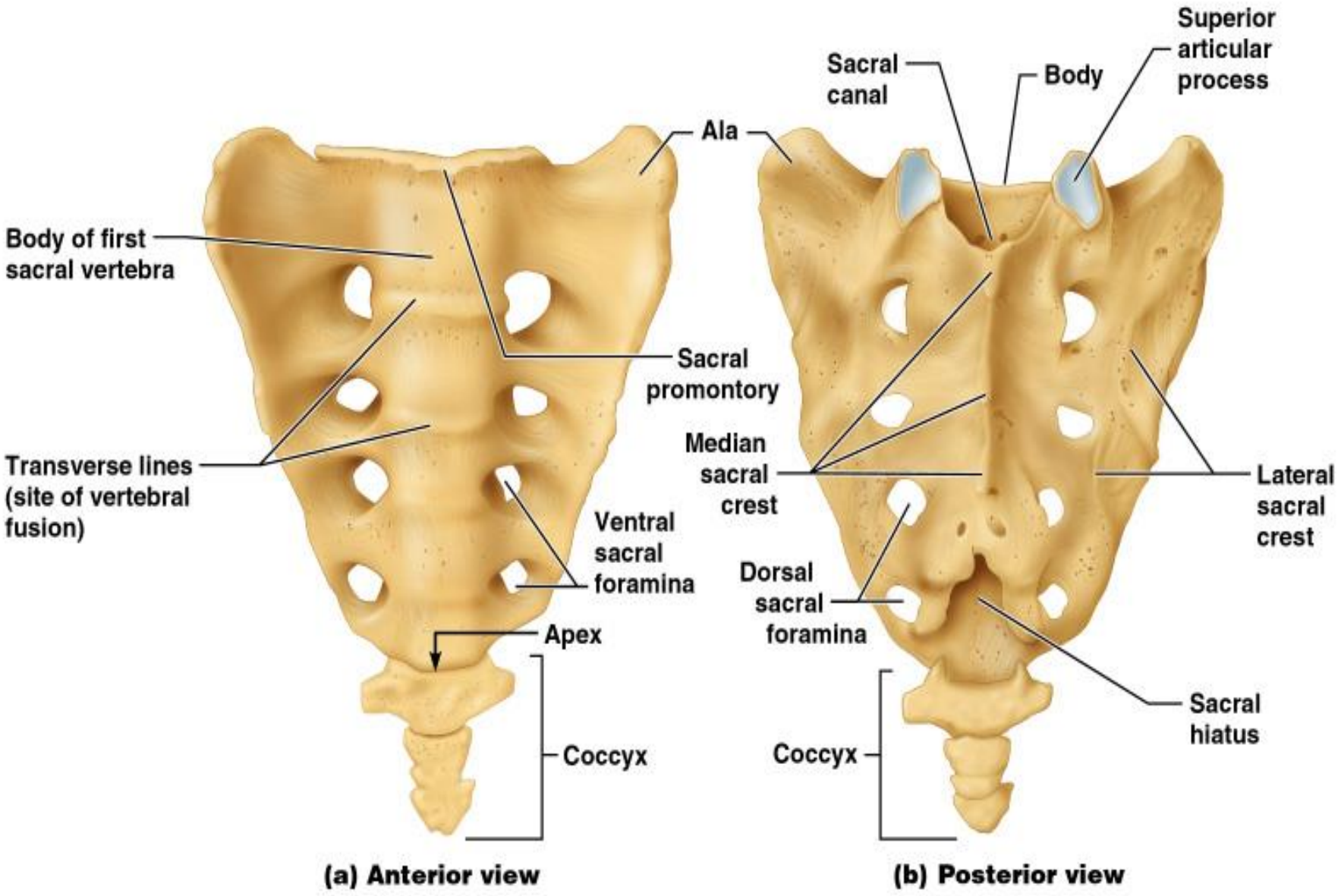
Lumbar Vertebrae



Comparison of Vertebrae

CHARACTERISTIC	CERVICAL	THORACIC	LUMBAR
Overall structure			
Body	Small.	Larger.	Largest.
Foramina	One vertebral and two transverse.	One vertebral.	One vertebral.
Spinous processes	Slender and often bifid (C2–C6).	Long and fairly thick (most project inferiorly).	Short and blunt (project posteriorly rather than inferiorly).
Transverse processes	Small.	Fairly large.	Large and blunt.
Articular facets for ribs	Absent.	Present.	Absent.
Direction of articular facets			
Superior	Posterosuperior.	Posterolateral.	Medial.
Inferior	Anteroinferior.	Anteromedial.	Lateral.
Size of intervertebral discs	Thick relative to size of vertebral bodies.	Thin relative to size of vertebral bodies.	Massive.

Sacrum & Coccyx



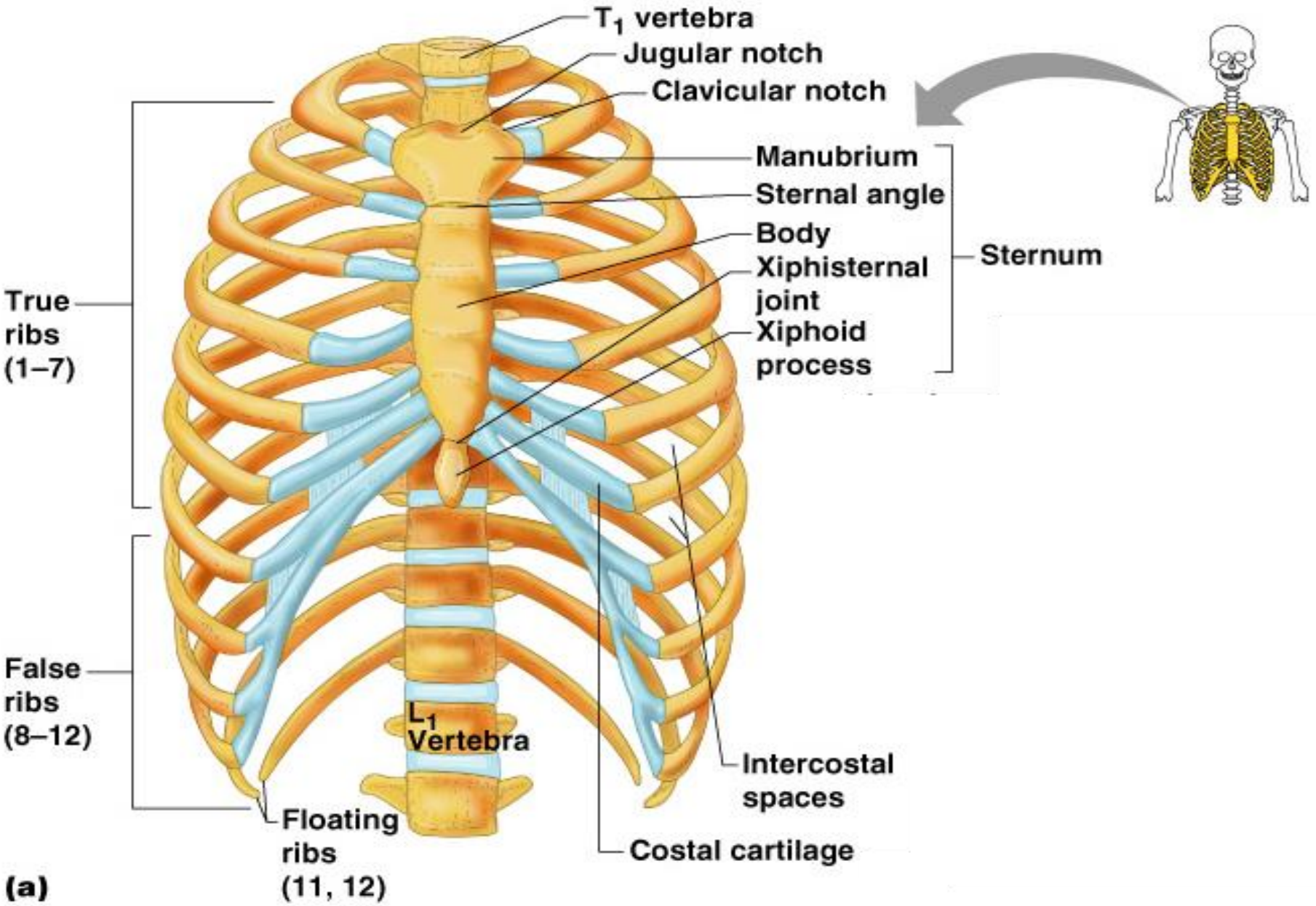
Thorax

- Thoracic cage is formed by the:
  - Sternum
  - Ribs
  - Costal cartilages
  - Thoracic vertebrae
- Functions to:
  - Enclose and protect the organs in the thoracic and abdominal cavities
  - Provide support for the bones of the upper limbs
  - Play a role in breathing

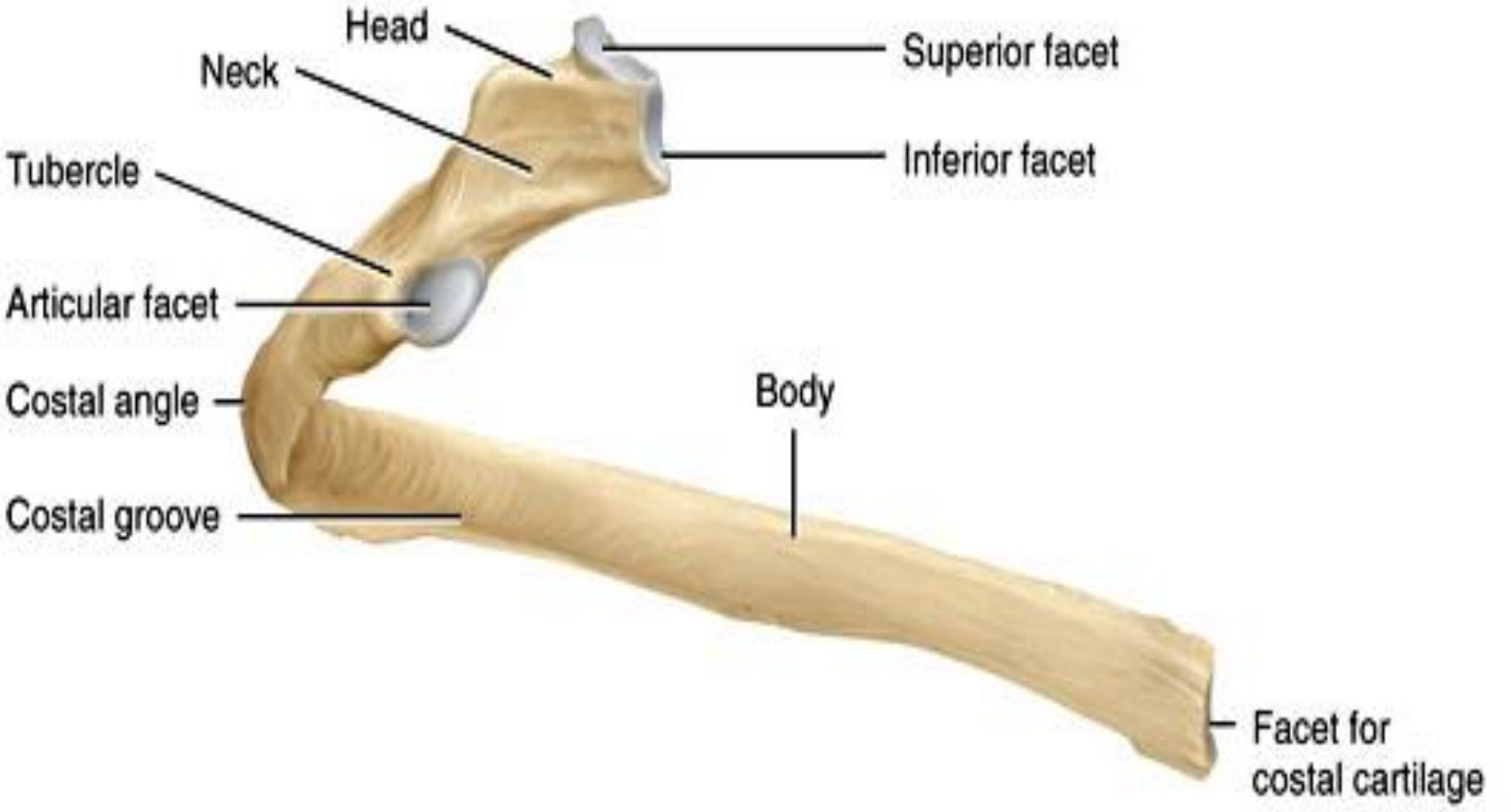
Thorax

- **Sternum**
  - “Breastbone” located in the center of the thoracic wall
  - Consists of the manubrium, body, xiphoid process
- **Ribs**
  - Twelve pairs of ribs give structural support to the sides of the thoracic cavity
  - True ribs (7 pairs), False ribs (3 Pairs) and floating ribs(2 pairs).
- **Costal cartilages**
  - Costal cartilages contribute to the elasticity of the thoracic cage

THORAX

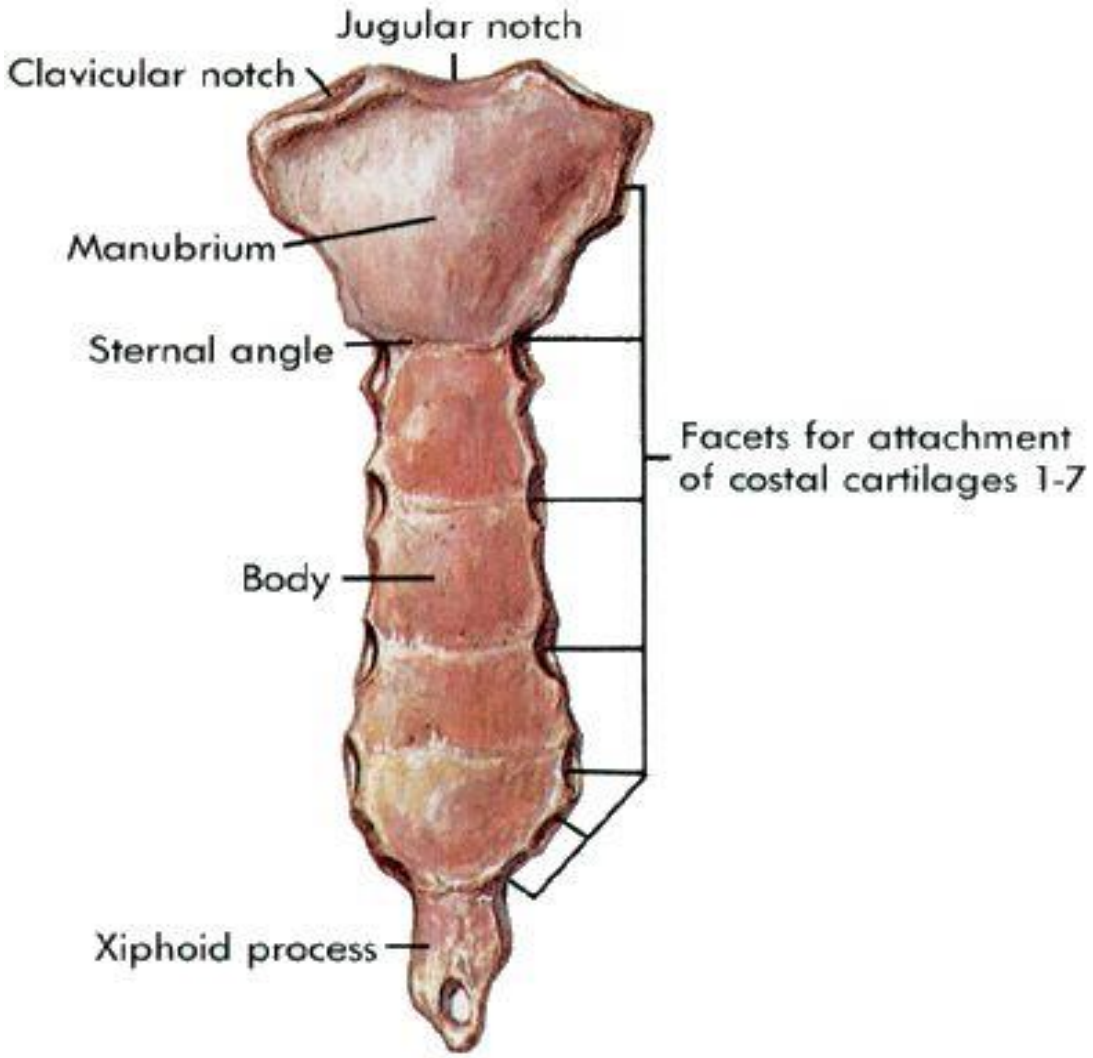

T_1 vertebra
Jugular notch
Clavicular notch
Manubrium
Sternal angle
Body
Xiphisternal joint
Xiphoid process
Sternum
True ribs (1–7)
False ribs (8–12)
L_1 Vertebra
Floating ribs (11, 12)
Intercostal spaces
Costal cartilage
(a)

Rib



(a) Posterior view of left rib

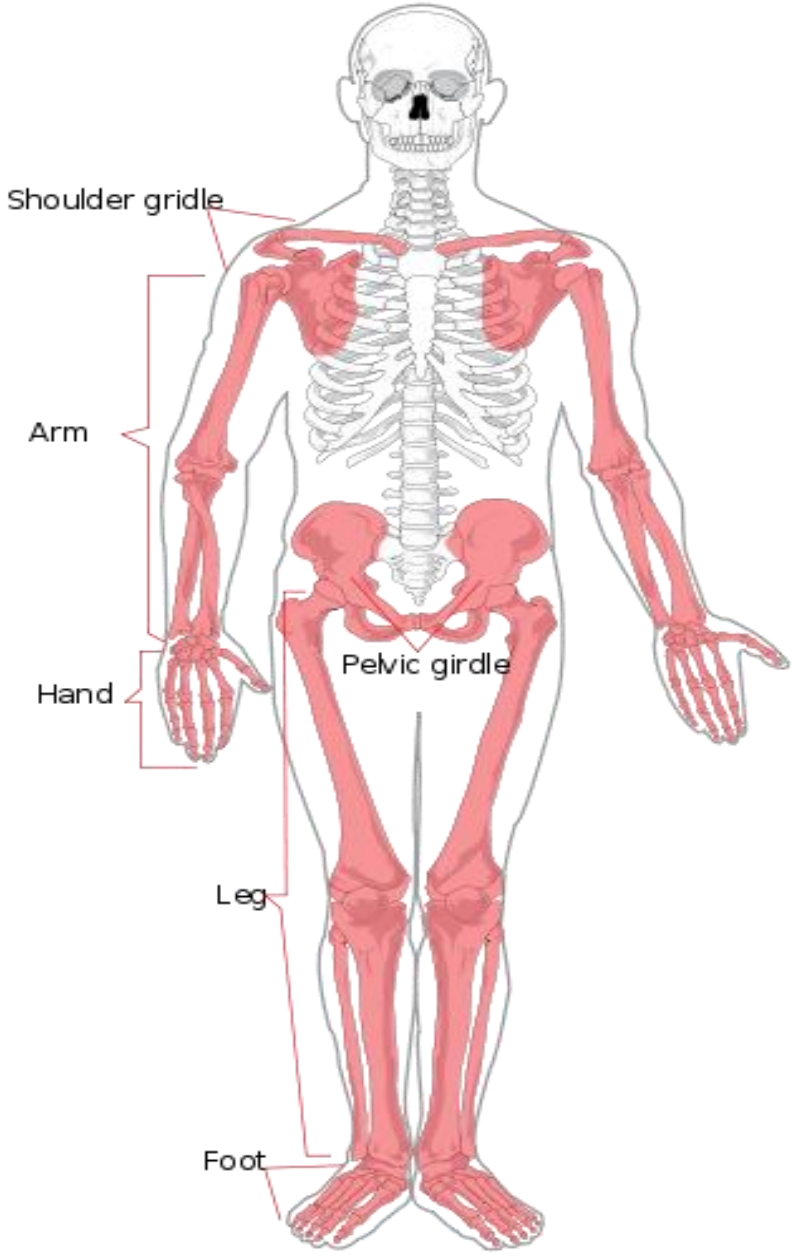
Sternum



- Three parts
  - Manubrium
  - Body
  - Xiphoid process

The Appendicular Skeleton

- Limbs (appendages)
- Pectoral girdle
- Pelvic girdle



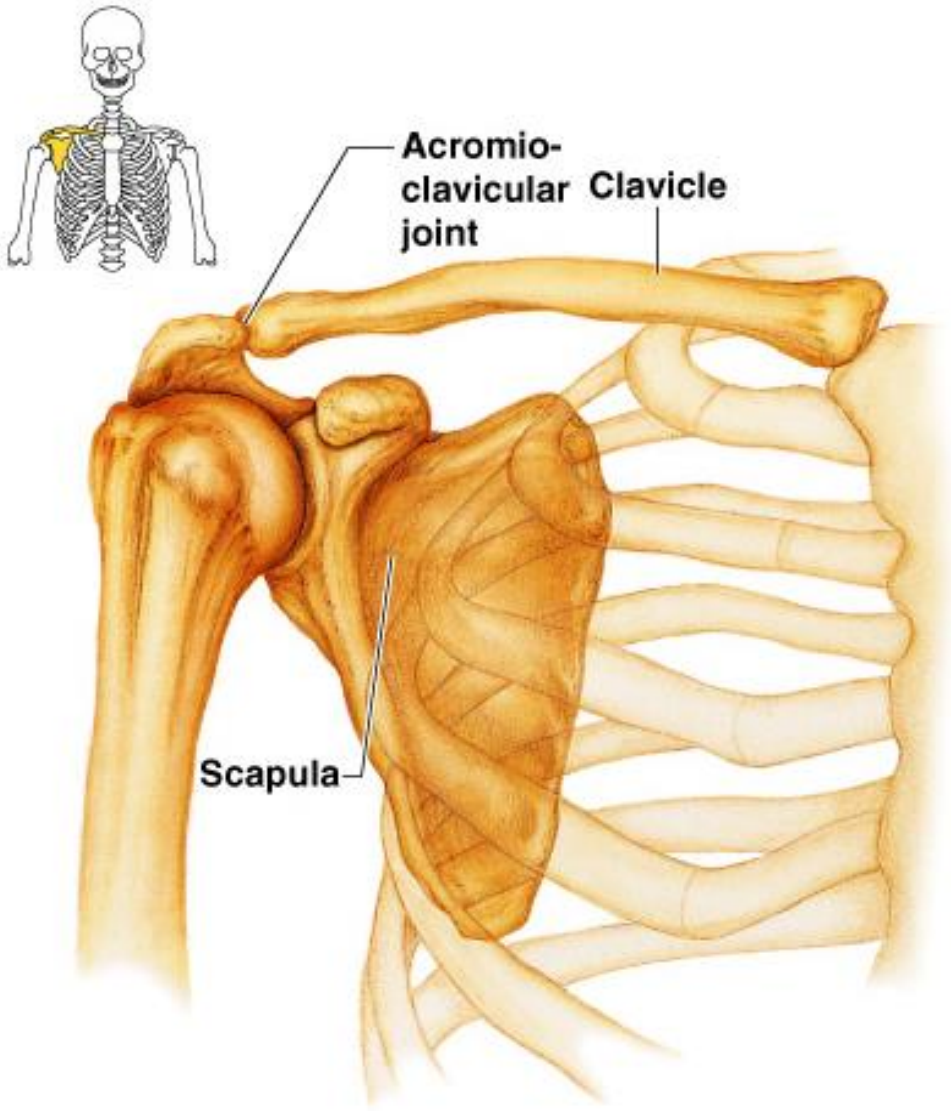
Upper Limb

- The *pectoral girdle* consists of two bones, the scapula and the clavicle
- The *free part* has 30 bones
- 1 humerus (arm)
- 1 ulna (forearm)
- 1 radius (forearm)
- 8 carpals (wrist)
- 19 metacarpal and phalanges (hand)

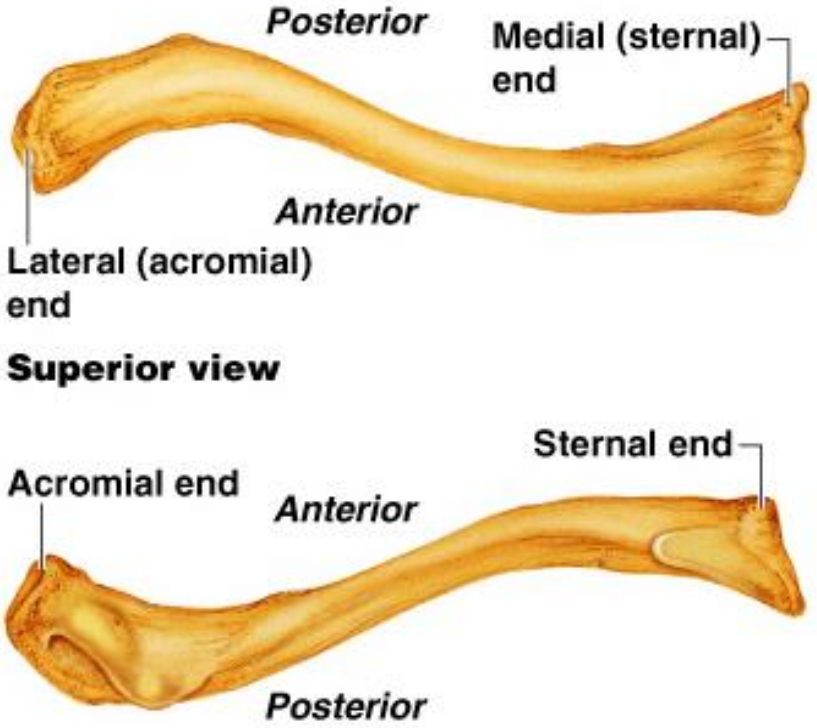
The Pectoral (Shoulder) Girdle

- Composed of two bones
  - Clavicle – collarbone
  - Scapula – shoulder blade
- These bones allow the upper limb to have exceptionally free movement.
- The clavicle is convex in shape anteriorly near the sternal junction
- The clavicle is concave anteriorly on its lateral edge near the acromion

Bones of the Shoulder Girdle



(a) Articulated shoulder (pectoral) girdle

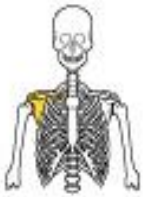


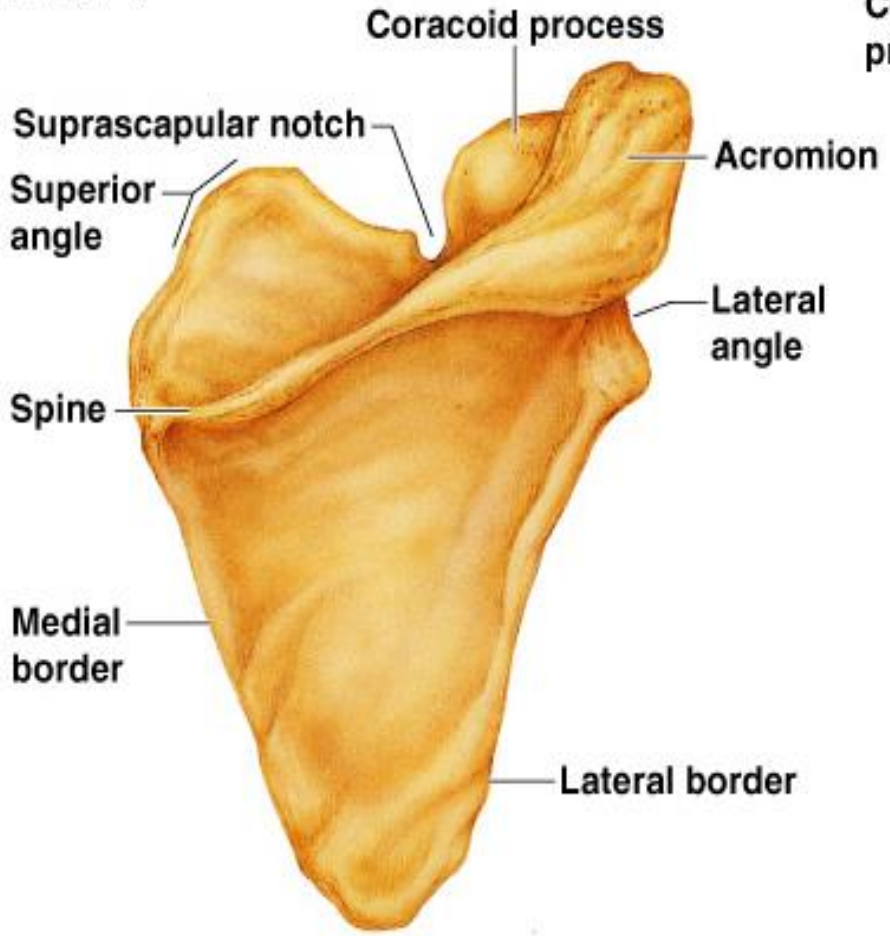
(b) Right clavicle

Pectoral Girdle - Scapula

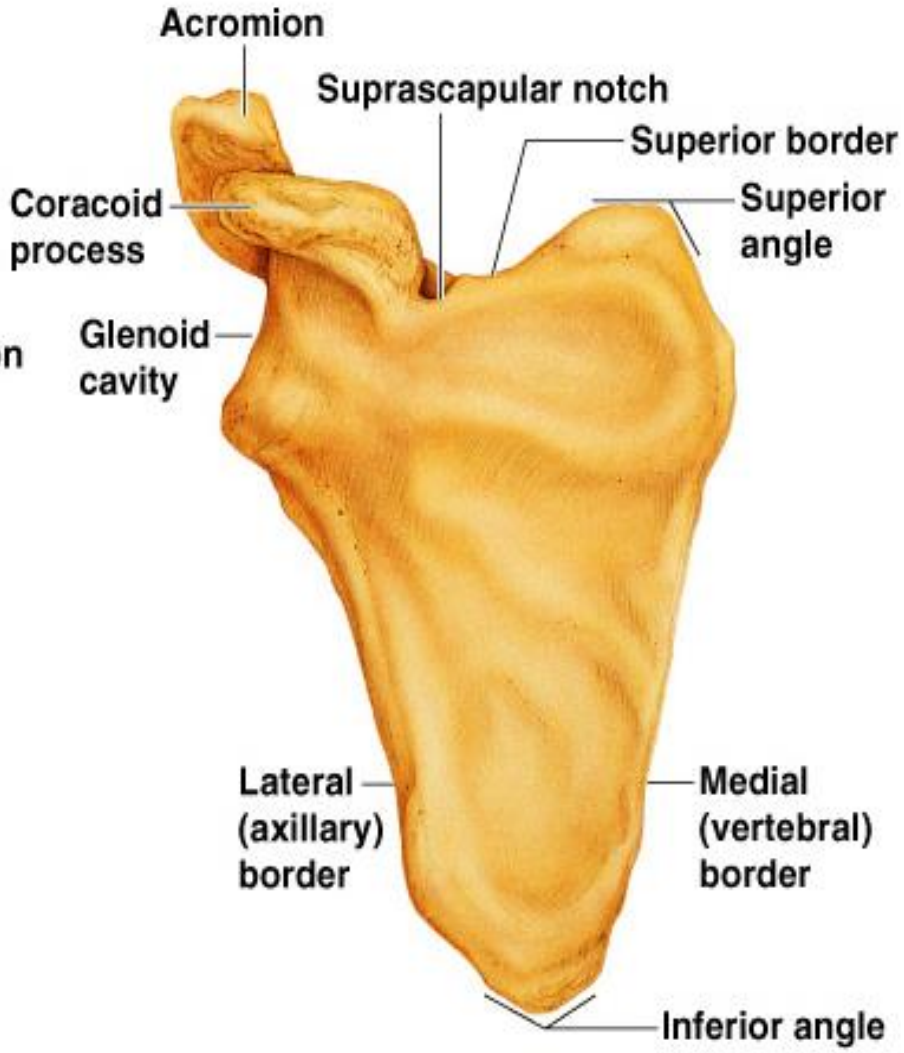
- Also called the shoulder blade
- Triangular in shape
- Most notable features include the spine, acromion, coracoid process and the glenoid cavity

Bones of the Shoulder Girdle





(c) Right scapula, posterior aspect



(d) Right scapula, anterior aspect

Features on the Scapula

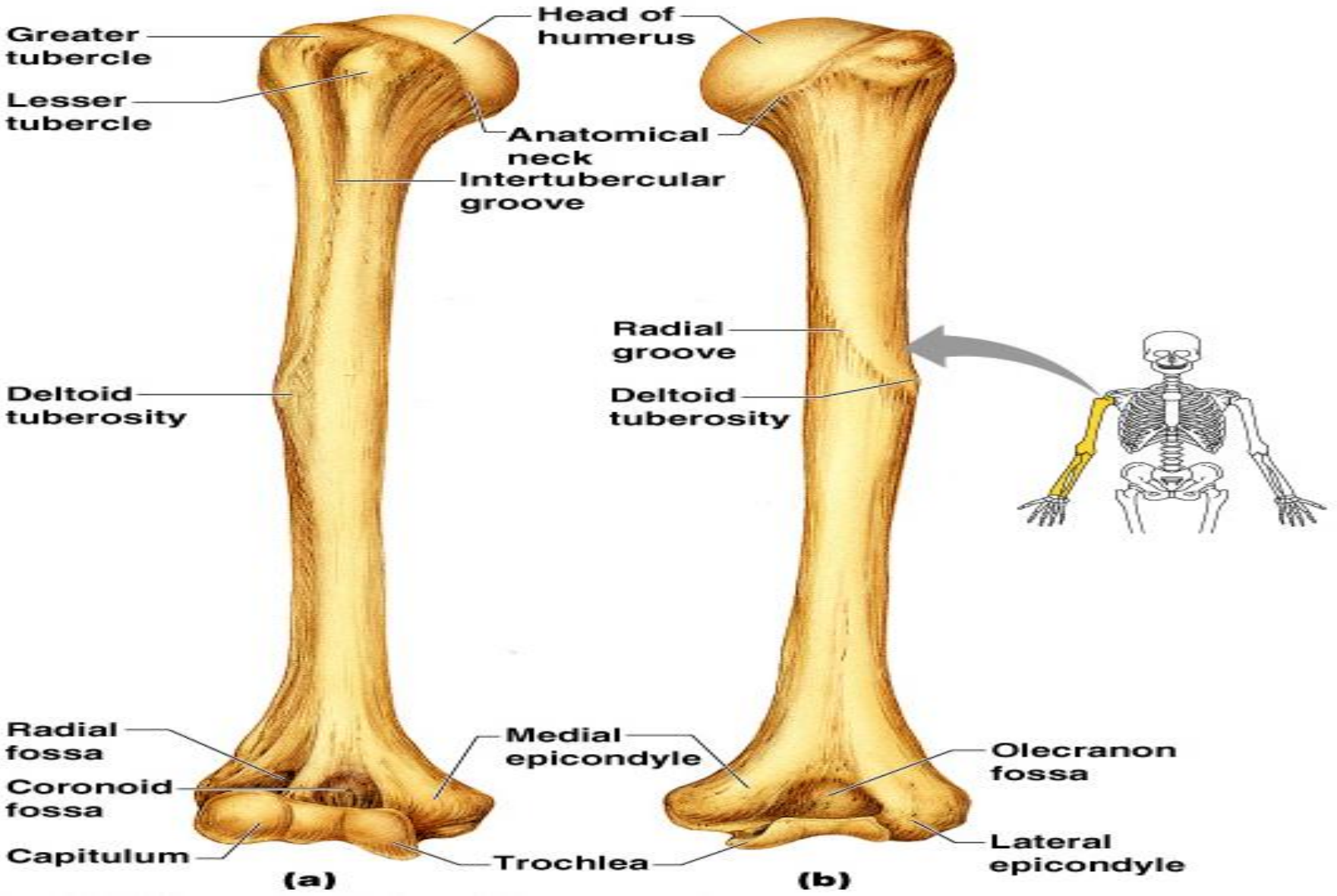
- Spine - a large process on the posterior of the scapula that ends laterally as the acromion
- Acromion - the flattened lateral portion of the spine of the scapula
- Coracoid process - a protruding projection on the anterior surface just inferior to the lateral aspect of the clavicle
- Glenoid cavity - shallow concavity that articulates with the head of the humerus

Skeleton of the Arm - Humerus

- Longest and largest bone of the free part of the upper limb
- The proximal ball-shaped end articulates with the glenoid cavity of the scapula
- The distal end articulates at the elbow with the radius and ulna

Bones of the Upper Limb

- The arm is formed by a single bone- Humerus



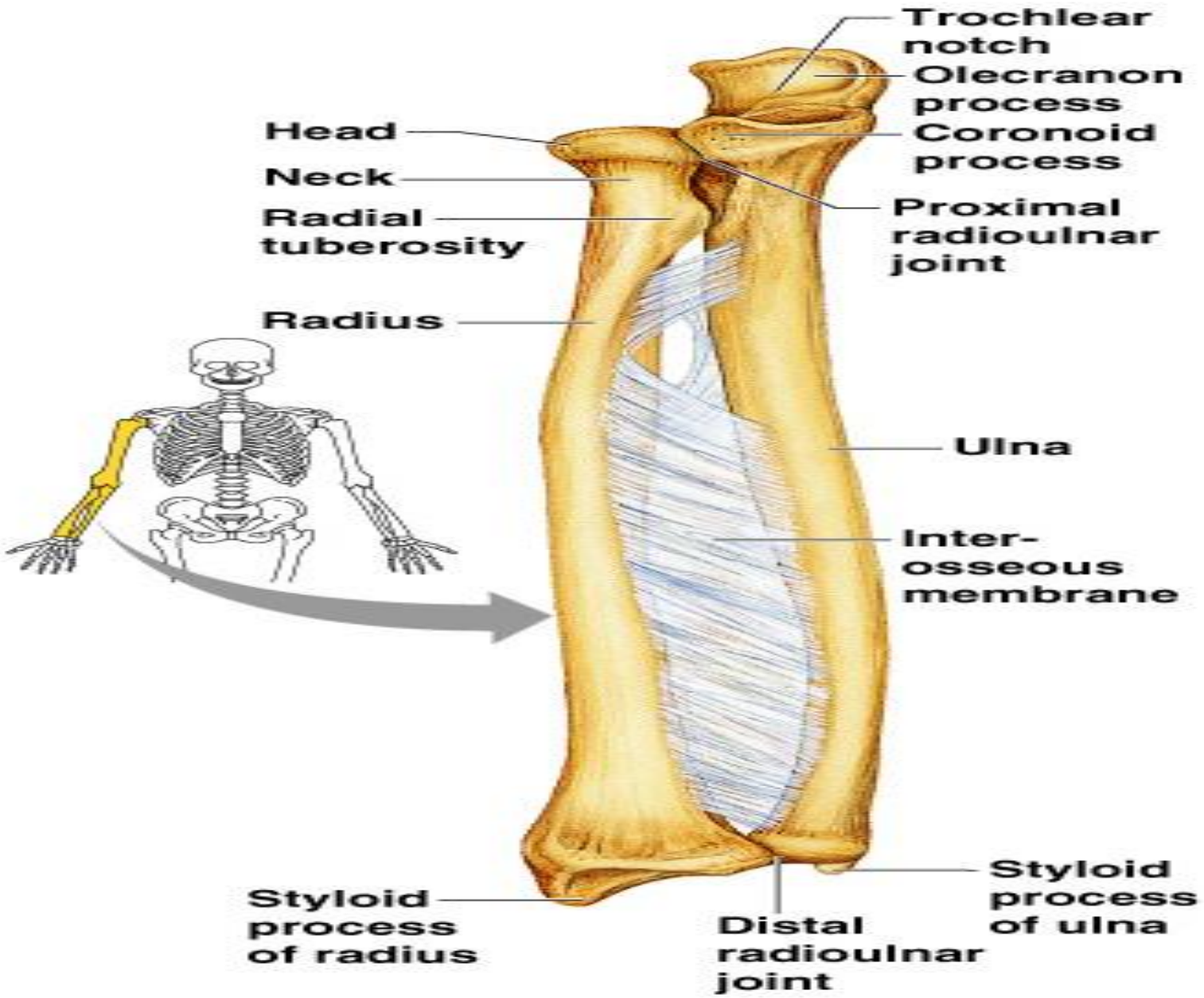
Skeleton of the Forearm - Ulna

- The longer of the two forearm bones
- Located medial to the radius
- O*lecranon* - the large, prominent proximal end, the “tip of your elbow”
- *Coronoid process* - the anterior “lip” of the proximal ulna
- *Trochlear notch* - the deep fossa that receives the trochlea of the humerus during elbow flexion
- *Styloid process* - the thin cylindrical projection on the posterior side of the ulna’s head

Radius

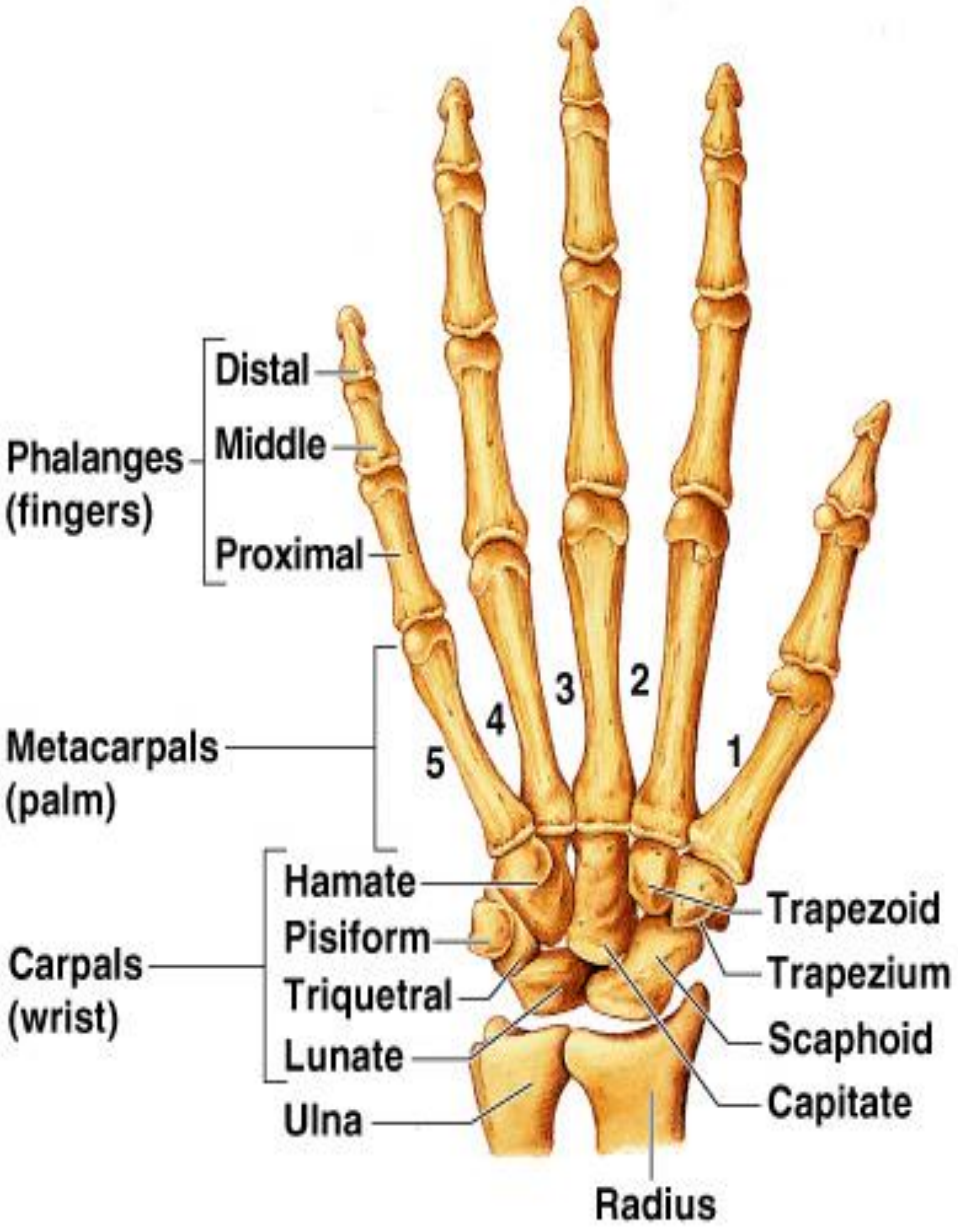
- Lies lateral to the ulna (thumb side of the forearm)
- The head (disc-shaped) and neck are at the proximal end
- The head articulates with the capitulum of the humerus and the radial notch of the ulna
- Radial tuberosity - medial and inferior to neck, attachment site for biceps brachii muscle
- Styloid process - large distal projection on lateral side of radius

Radius & Ulna


Trochlear notch
Olecranon process
Coronoid process
Head
Neck
Radial tuberosity
Proximal radioulnar joint
Radius
Ulna
Inter-osseous membrane
Styloid process of radius
Distal radioulnar joint
Styloid process of ulna

Bones of the Upper Limb

- The hand
  - Carpals – wrist
  - Metacarpals – palm
  - Phalanges – fingers



Skeleton of the Hand

- The carpus (wrist) consists of 8 small bones (carpals)
- Two rows of carpal bones
- Proximal row - scaphoid, lunate, triquetrum, pisiform
- Distal row - trapezium, trapezoid, capitate, hamate
- Scaphoid - most commonly fractured
- Carpal tunnel - space between carpal bones and flexor retinaculum

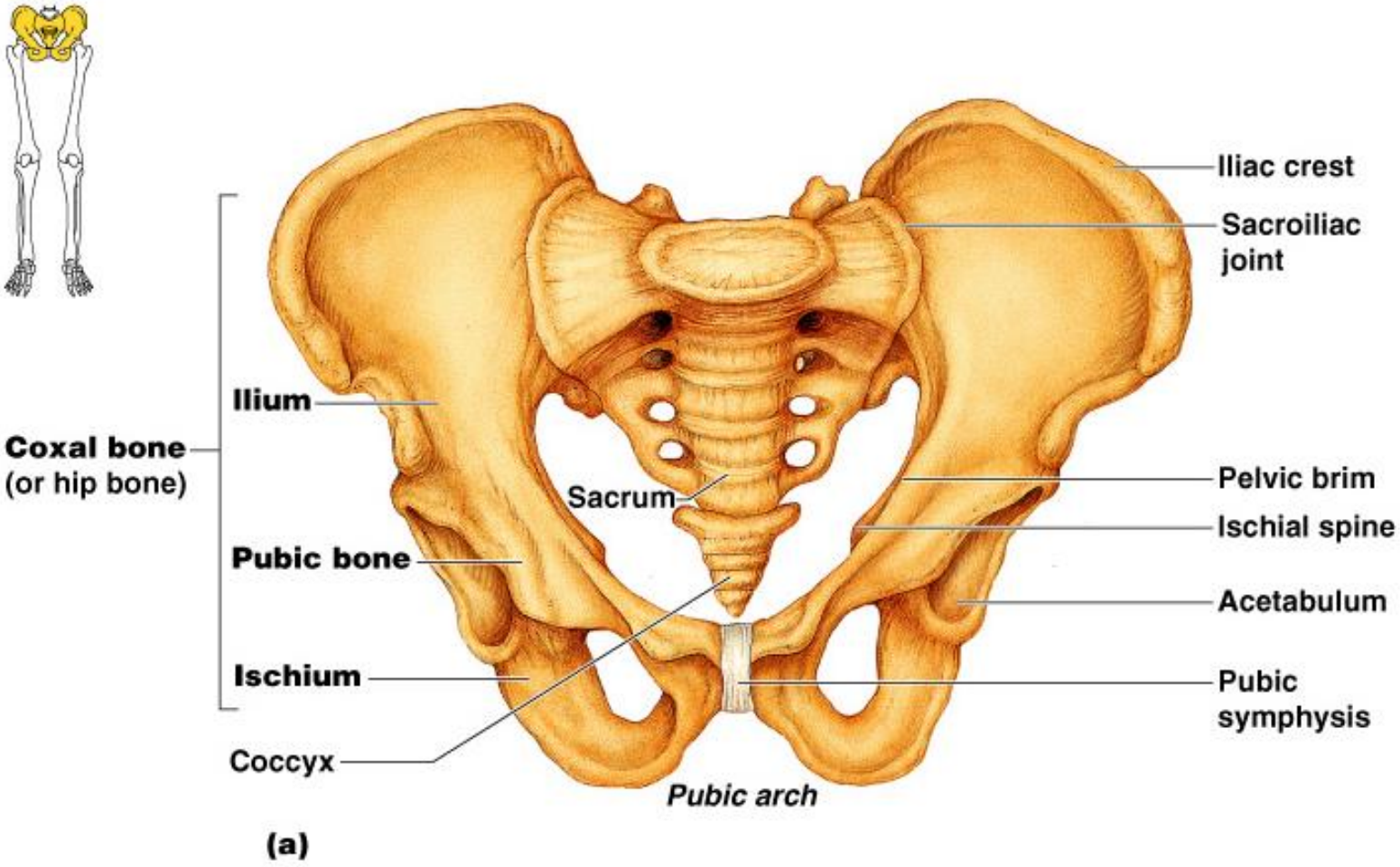
Metacarpals and Phalanges

- Five metacarpals - numbered I-V, lateral to medial
- 14 phalanges - two in the thumb (pollex) and three in each of the other fingers
- Each phalanx has a base, shaft, and head
- Joints - carpometacarpal, metacarpophalangeal, interphalangeal

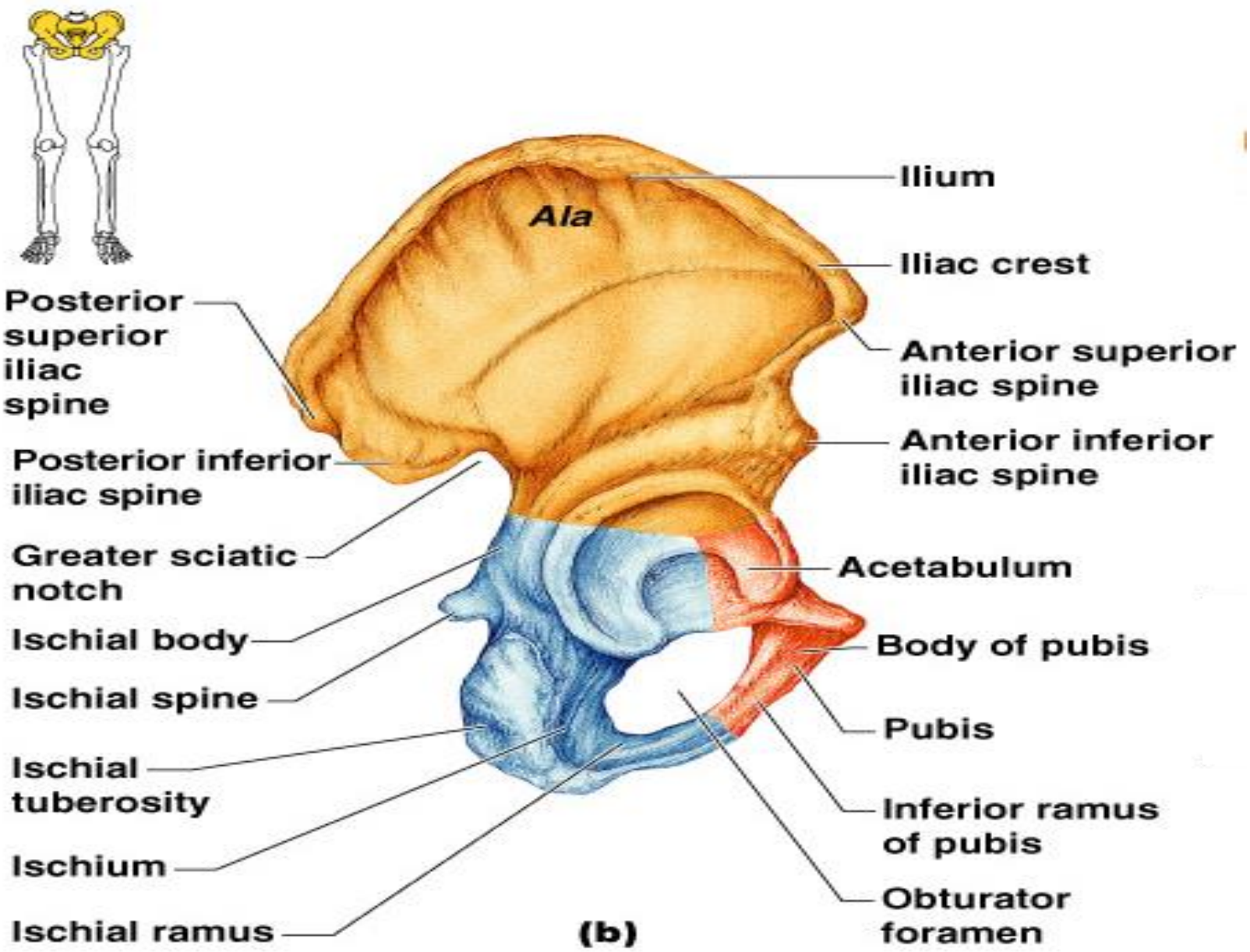
Bones of the Pelvic Girdle

- Hip bones
- Composed of three pair of fused bones
  - Ilium
  - Ischium
  - Pubic bone
- The total weight of the upper body rests on the pelvis
- Protects several organs
  - Reproductive organs
  - Urinary bladder
  - Part of the large intestine

The Pelvis


Coxal bone
(or hip bone)
Ilium
Pubic bone
Ischium
Coccyx
Sacrum
Pubic arch
Iliac crest
Sacroiliac joint
Pelvic brim
Ischial spine
Acetabulum
Pubic symphysis
(a)

The Pelvis: Right Coxal Bone



The Ilium

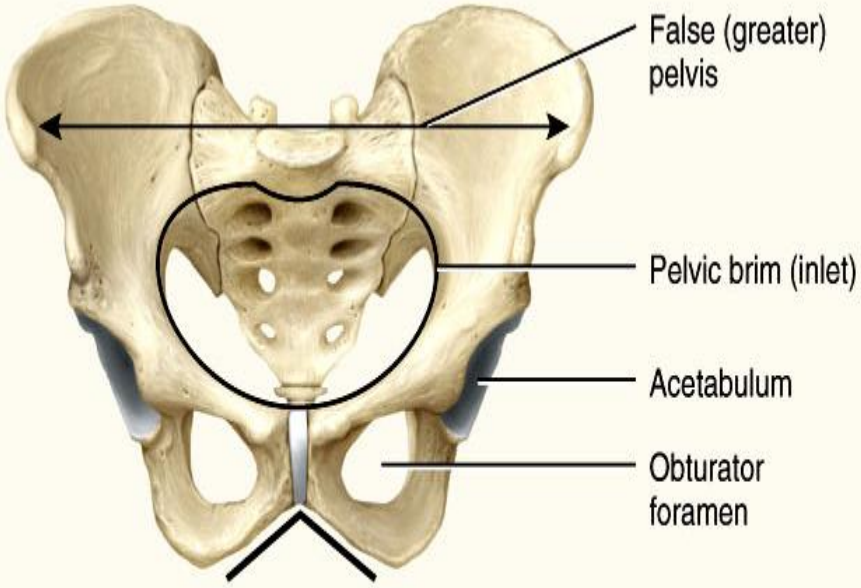
- Largest of the three hip bones
- Ilium is the superior part of the hip bone
- Consists of a superior *ala* and inferior *body* which forms the acetabulum (socket for head of the femur)
- Superior border - iliac crest
- *Hip pointer* - occurs at anterior superior iliac spine
- Greater sciatic notch - allows passage of sciatic nerve

Ischium and Pubis

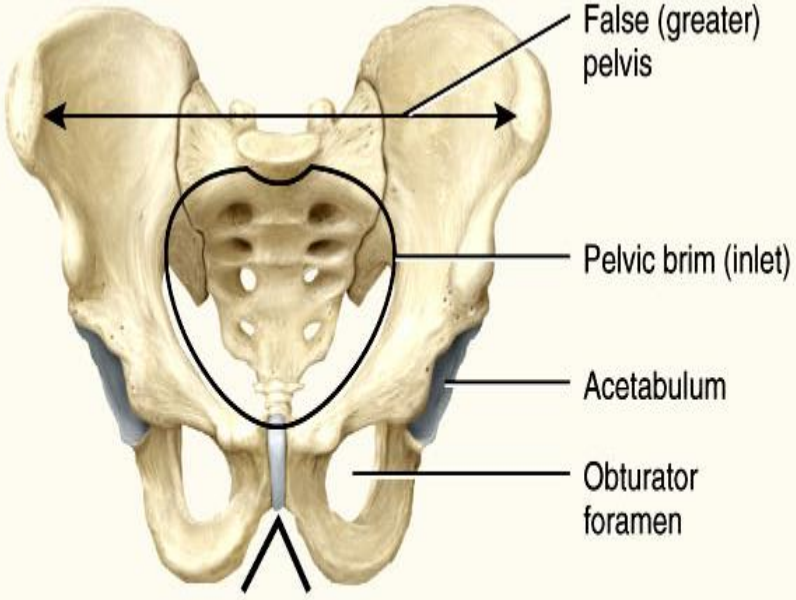
- Ischium - inferior and posterior part of the hip bone
- Most prominent feature is the ischial tuberosity, it is the part that meets the chair when you are sitting
- Pubis - inferior and anterior part of the hip bone
- Superior and inferior rami and body

Comparing Male and Female Pelves

POINT OF COMPARISON	FEMALE	MALE
General structure	Light and thin.	Heavy and thick.
False (greater) pelvis	Shallow.	Deep.
Pelvic brim (inlet)	Larger and more oval.	Smaller and heart-shaped.
Acetabulum	Small and faces anteriorly.	Large and faces laterally.
Obturator foramen	Oval.	Round.
Pubic arch	Greater than 90° angle.	Less than 90° angle.

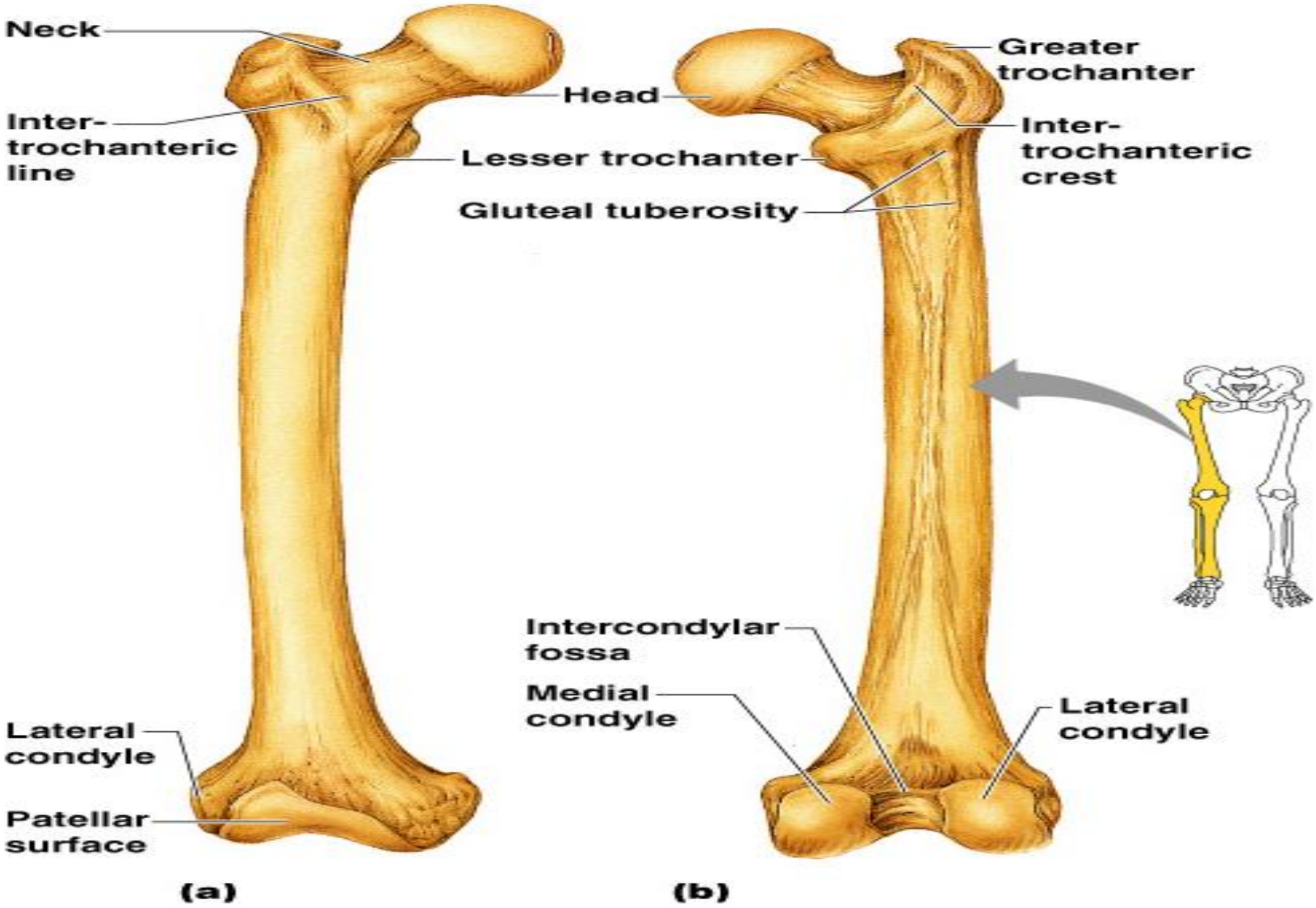


Pubic arch (greater than 90°)



Pubic arch (less than 90°)

FEMUR

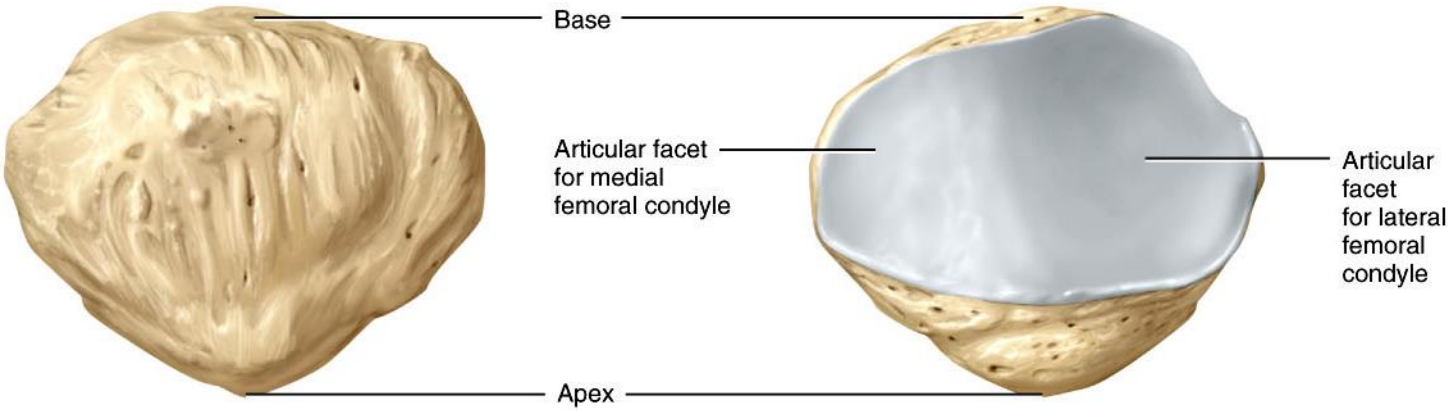

Neck
Inter-trochanteric line
Lesser trochanter
Lateral condyle
Patellar surface
(a)
Head
Greater trochanter
Inter-trochanteric crest
Gluteal tuberosity
Intercondylar fossa
Medial condyle
Lateral condyle
(b)

Skeleton of the Thigh - Femur and Patella

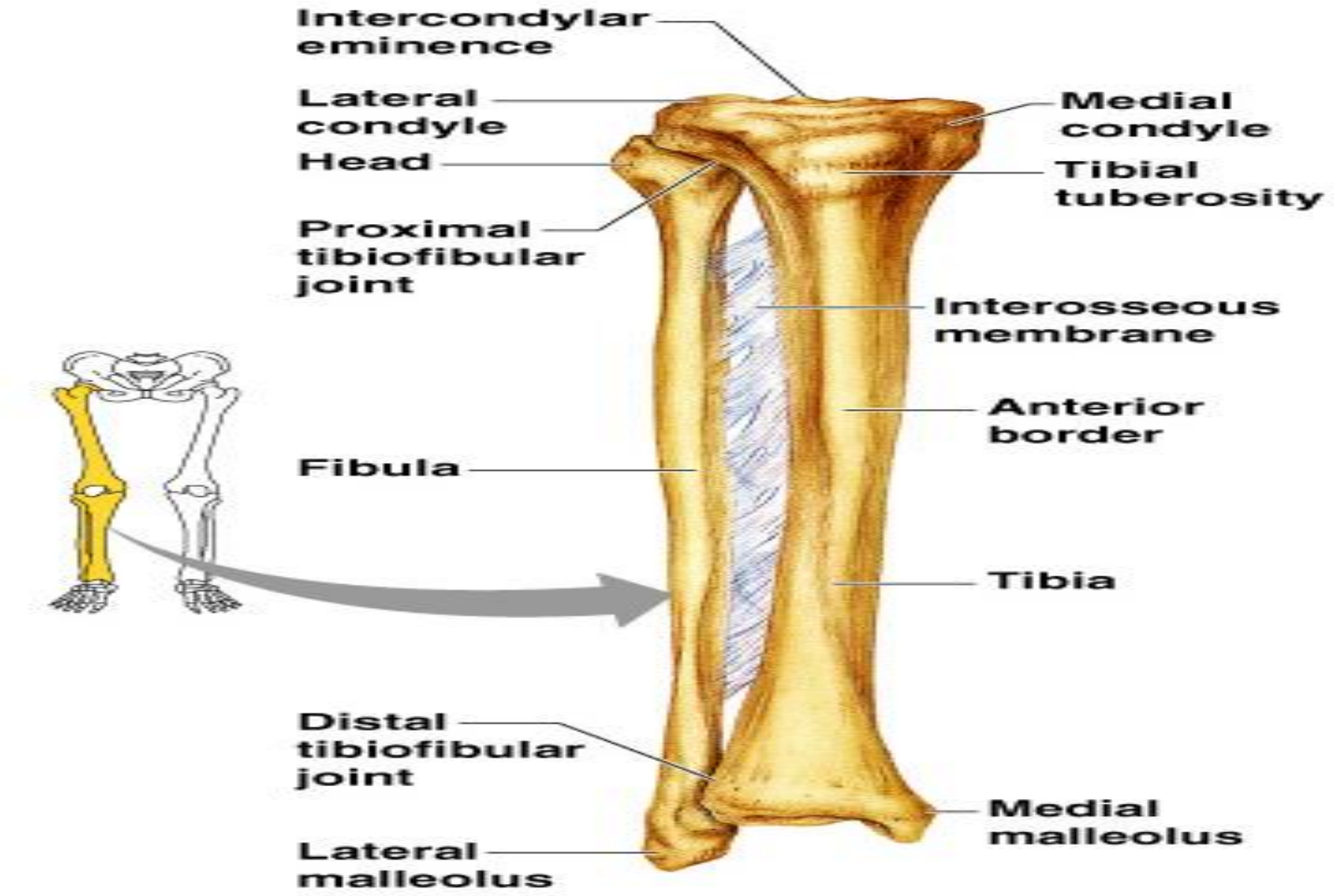
- Femur - longest, heaviest, and strongest bone in the body
- Proximally, the head articulates with the acetabulum of the hip bone forming the hip (coxal) joint
- Neck - distal to head, common site of fracture
- Distally, the medial and lateral condyles articulate with the condyles of the tibia forming the knee joint
- Also articulates with patella

Patella

- Largest sesamoid bone in the body
- Forms the patellofemoral joint
- Superior surface is the base
- Inferior, narrower surface is the apex
- Thick articular cartilage lines the posterior surface
- Increases the leverage of the quadriceps femoris muscle



TIBIA & FIBULA



Tibia (shin bone)

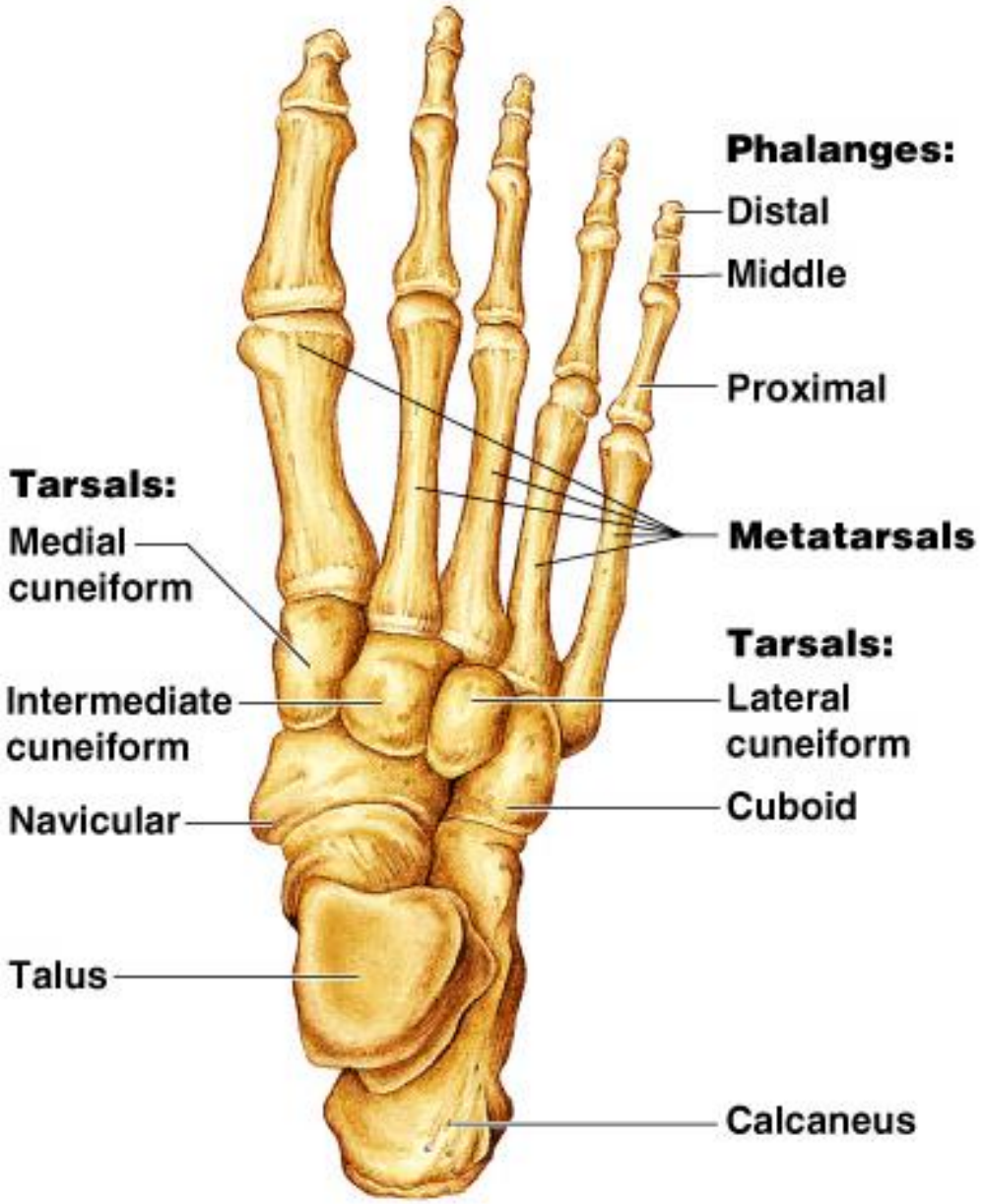
- The larger, medial weight-bearing bone of leg
- The lateral and medial condyles at the proximal end articulate with the femur
- It articulates distally with the talus and fibula
- Tibial tuberosity - attachment site for the patellar ligament
- Medial malleolus - medial surface of distal end (medial surface of ankle joint)

Fibula

- The smaller, laterally placed bone of leg
- Non-weight bearing
- The head forms the proximal tibiofibular joint
- Lateral malleolus - distal end, articulates with the tibia and the talus at the ankle

Bones of Lower Limbs

- The foot
  - Tarsus – ankle
  - Metatarsals – sole
  - Phalanges – toes



Skeleton of the Foot - Tarsals, Metatarsals & Phalanges

- Seven tarsal bones - talus (articulates with tibia and fibula), calcaneus (the heel bone, the largest and strongest), navicular, cuboid and three cuneiforms
- Five metatarsals - (I-V) base, shaft, head
- 14 phalanges (big toe is the hallux)
- Tarsus = ankle