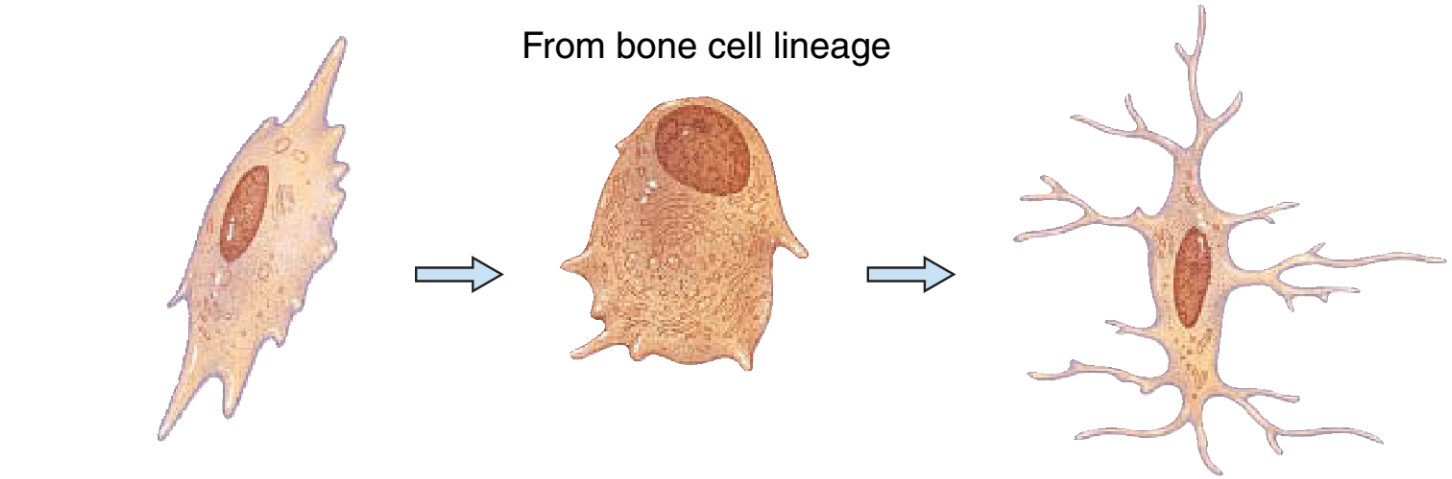
HUMAN ANATOMY

THE SKELETAL SYSTEM

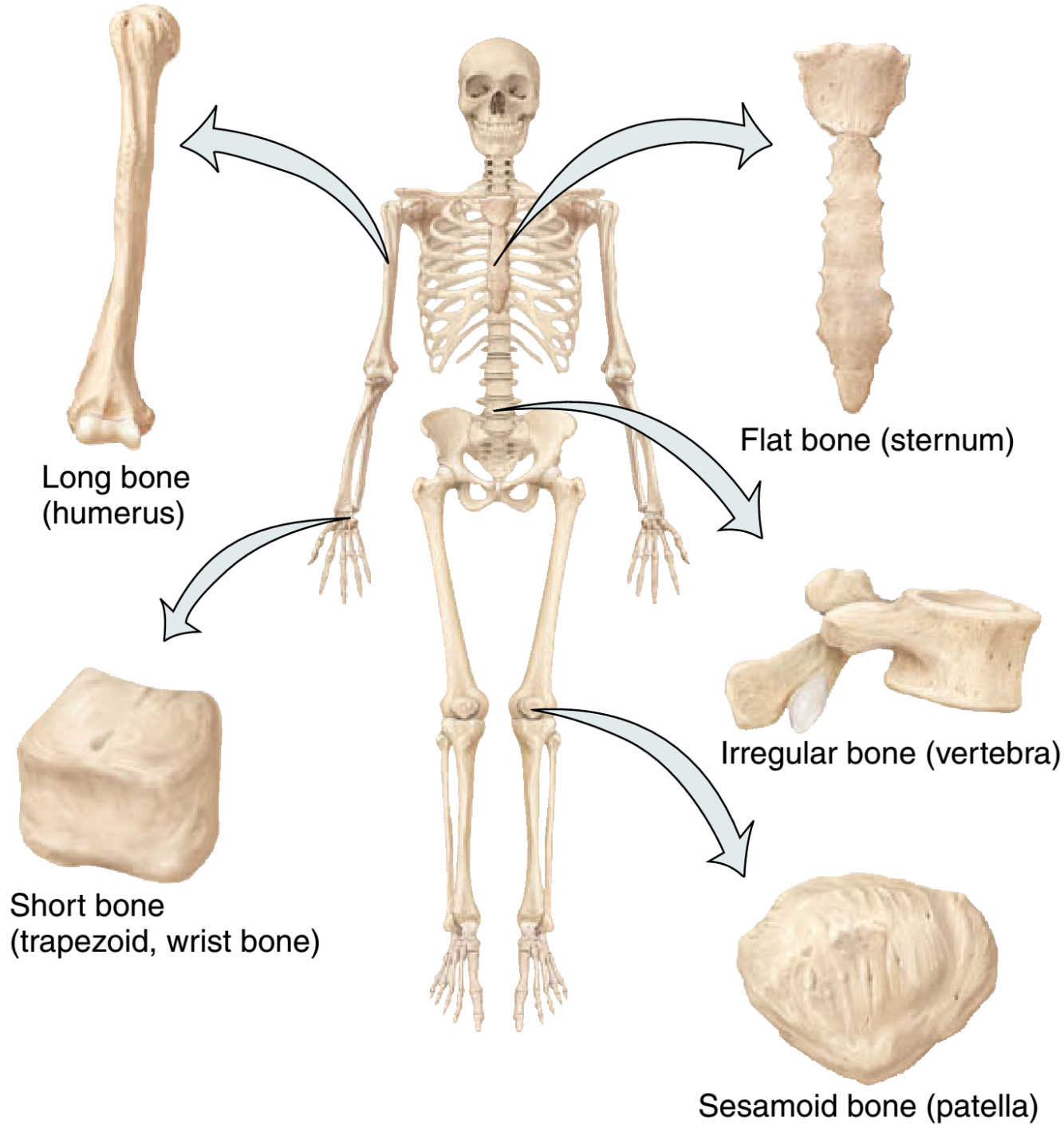
AYDIN ÇÖL

The Skeleton

- The human skeleton contains 206 individual bones.
- The bones of the skull, spine, ribs, and sternum form the **axial skeleton.**
- The other bones, including those of the arms, legs, pelvis, and shoulder, form the **appendicular skeleton.**

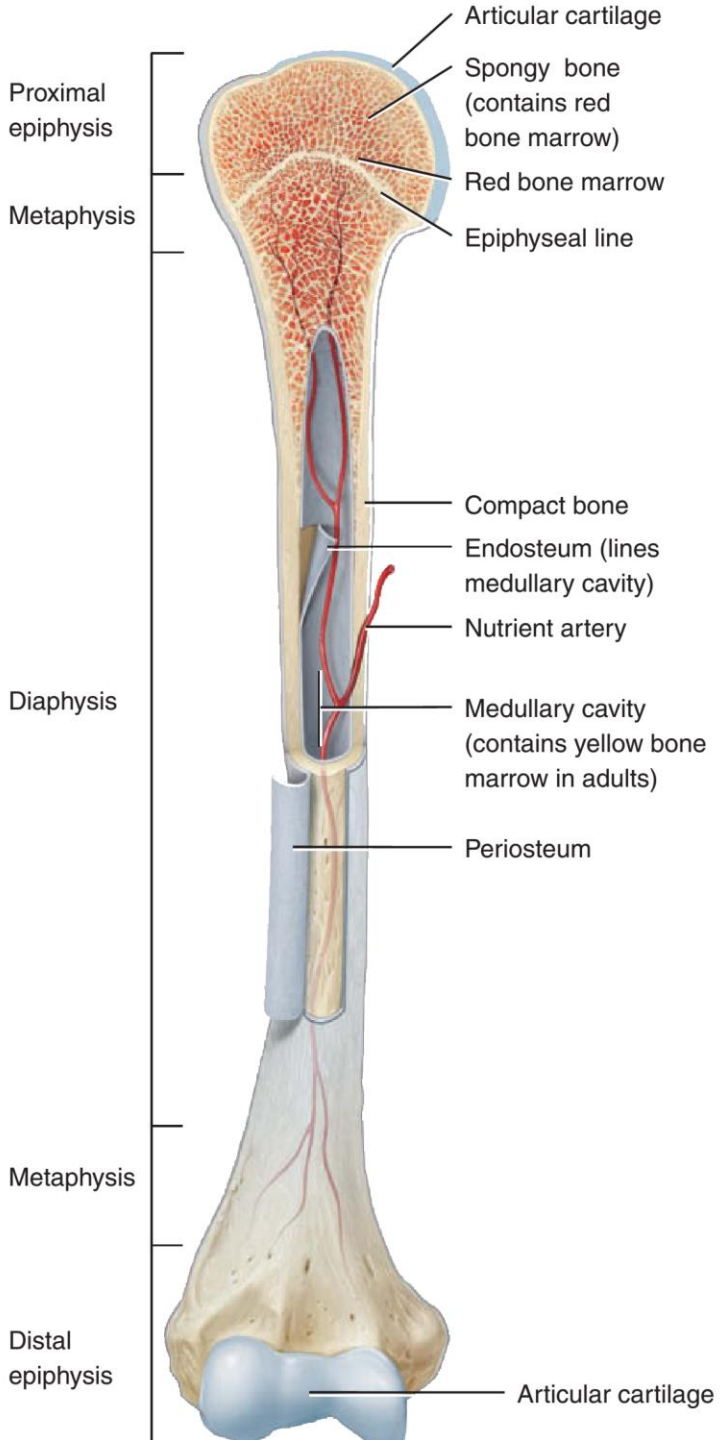


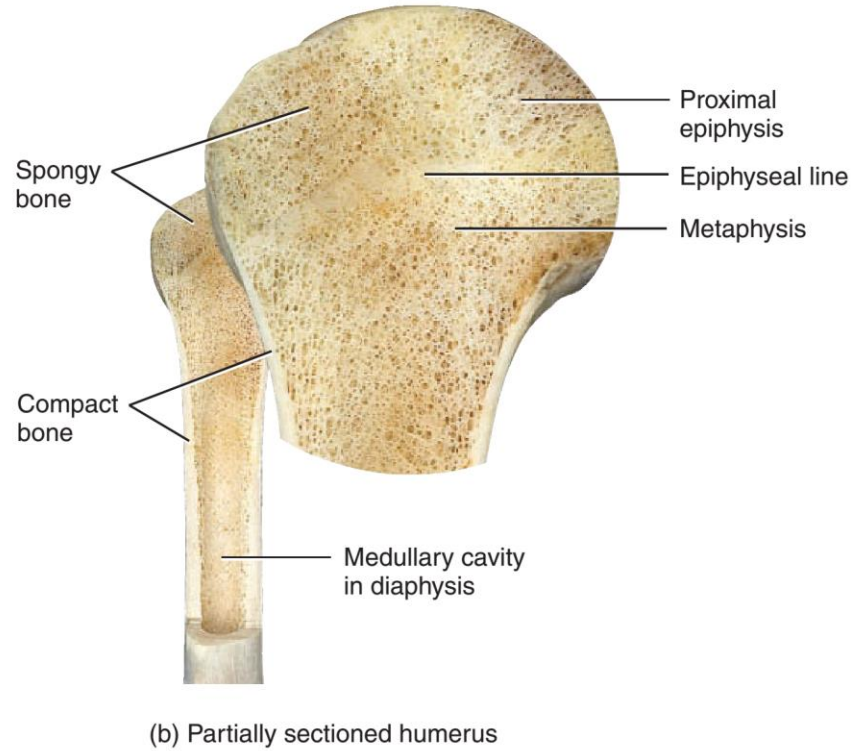
Types of bones based on shape



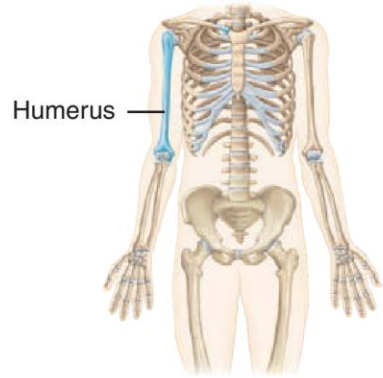
Structure of Bone

- Bones are made of a hard outer covering of **compact** bone surrounding an inner core of **spongy** bone.
- Some cavities in spongy bone are filled with a soft tissue called **bone marrow.**
- Bones are surrounded and protected by a tough exterior membrane called the **periosteum.**

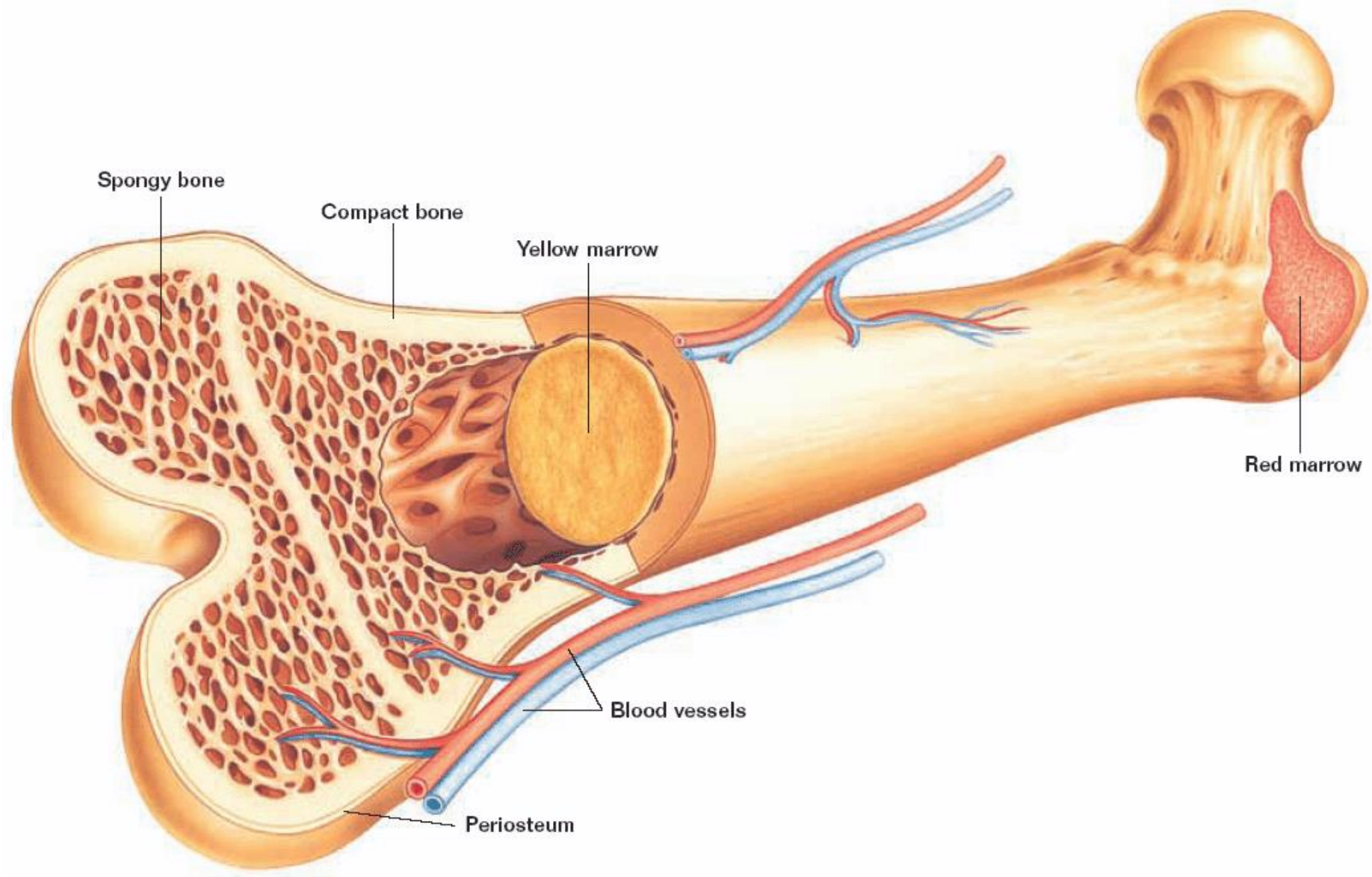




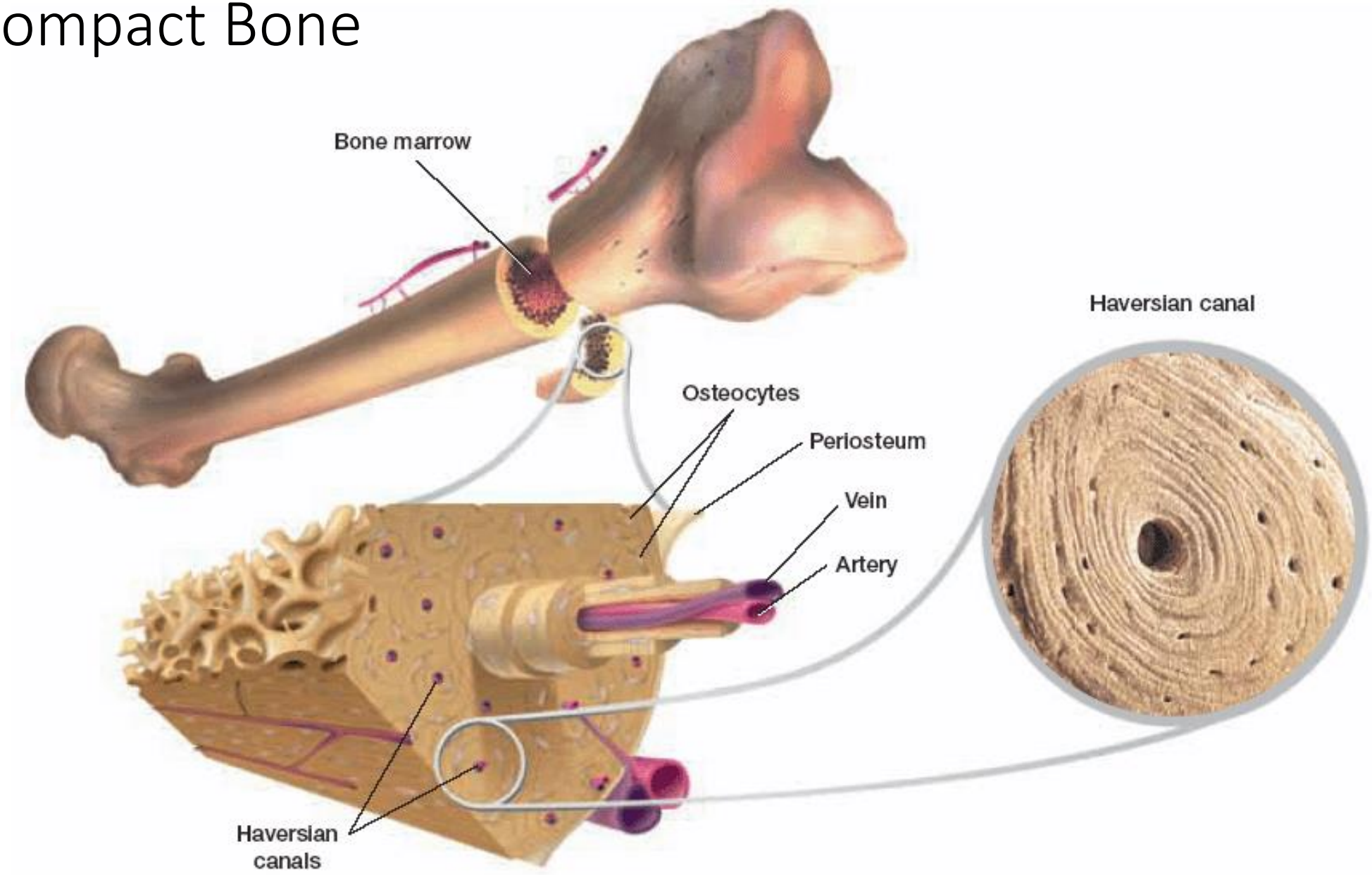
(b) Partially sectioned humerus

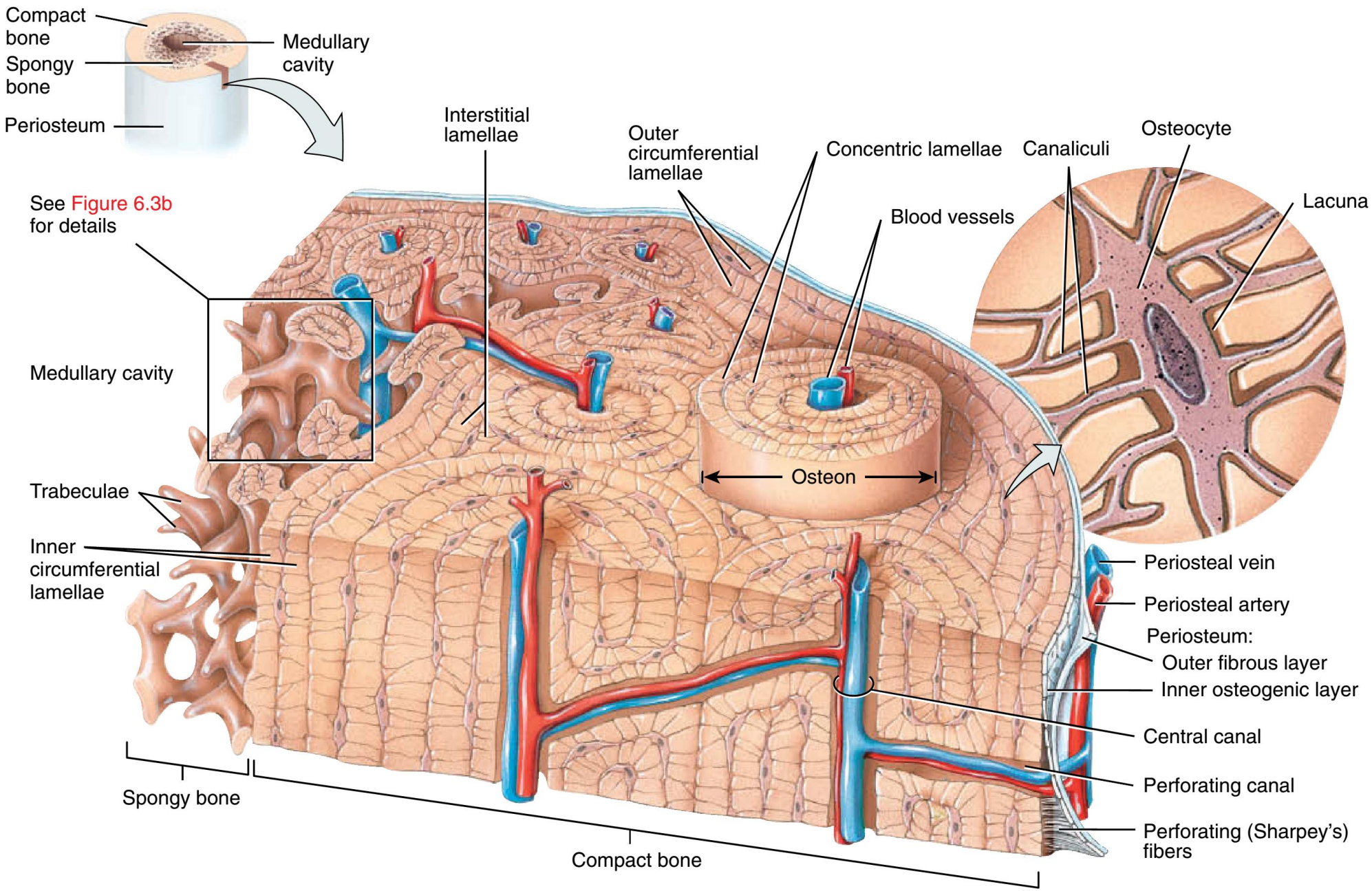


Structure of Bone



Compact Bone

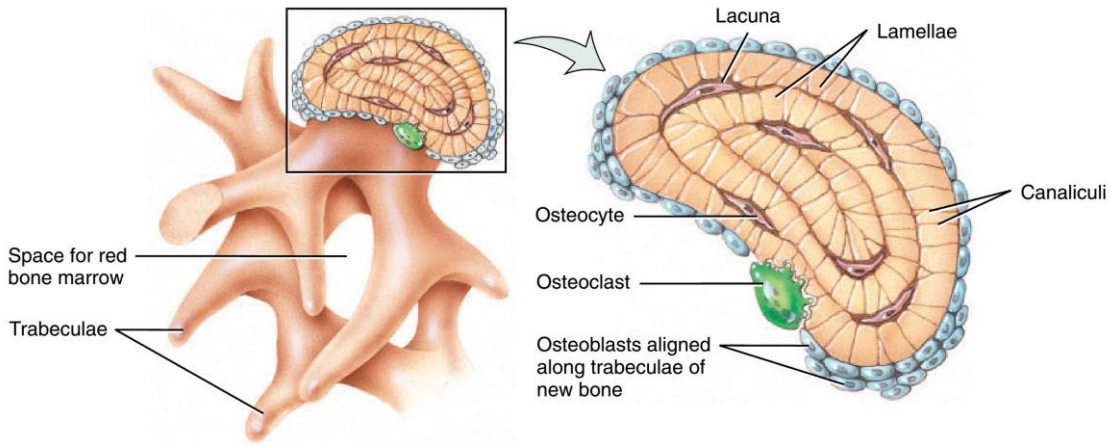




(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone

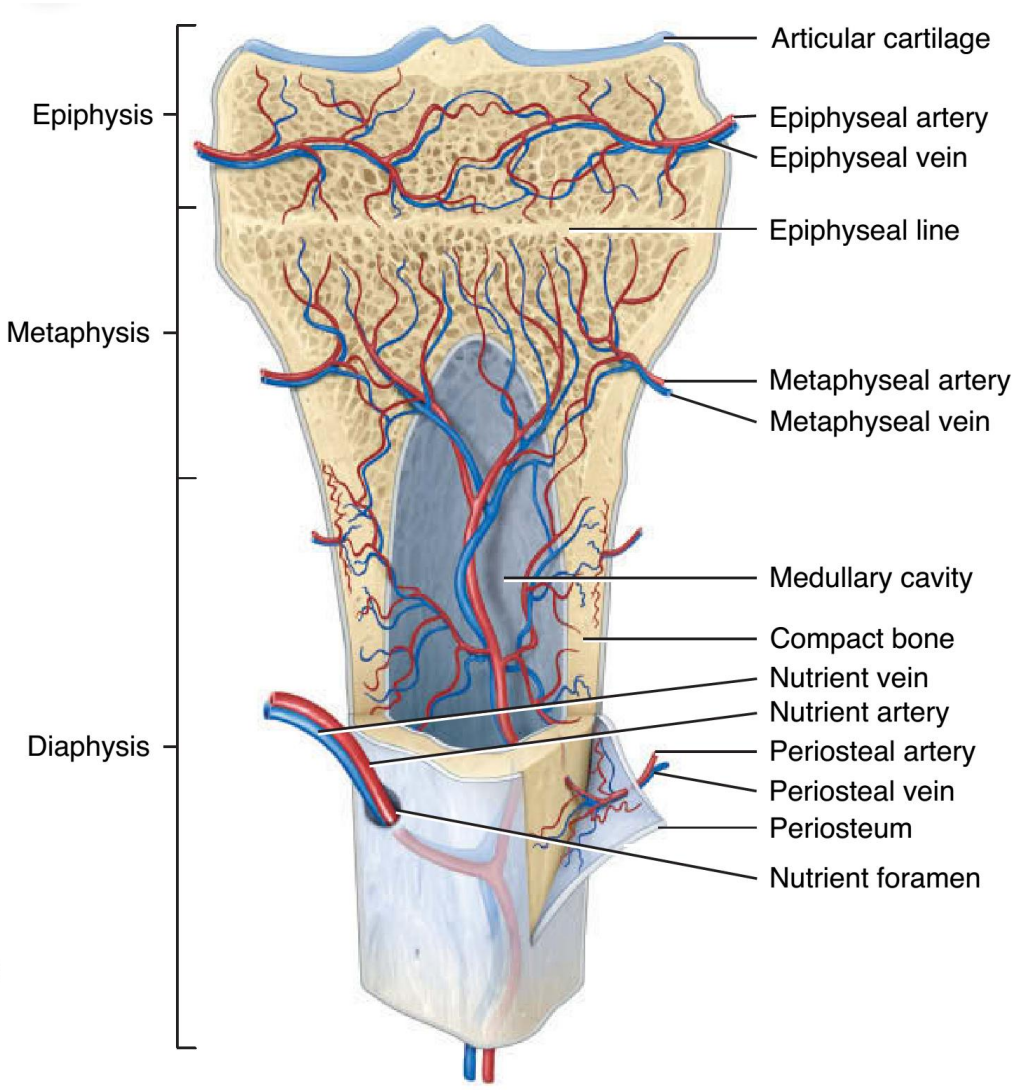
Growth of Bones

- During development, a type of connective tissue called **cartilage** is gradually replaced by bone as minerals are deposited.
- In compact bone, new bone cells are added in layers around narrow, hollow channels called **Haversian canals.**
- Bone cells called **osteocytes** maintain the mineral content of bone.



(b) Enlarged aspect of spongy bone trabeculae

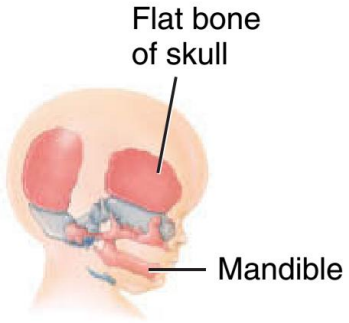
(c) Details of a section of a trabecula

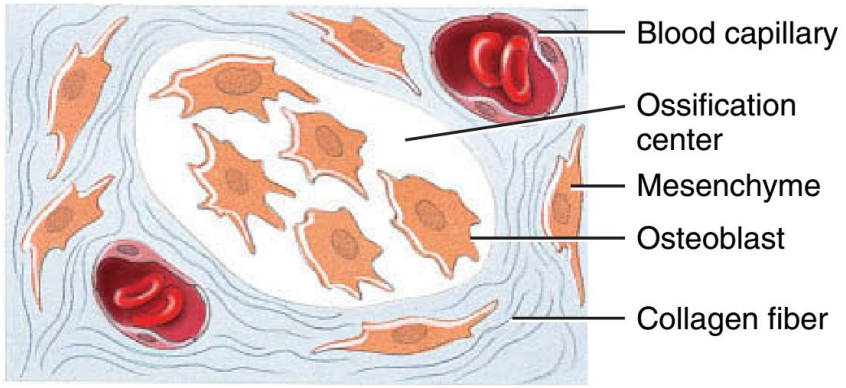


Partially sectioned tibia (shin bone)

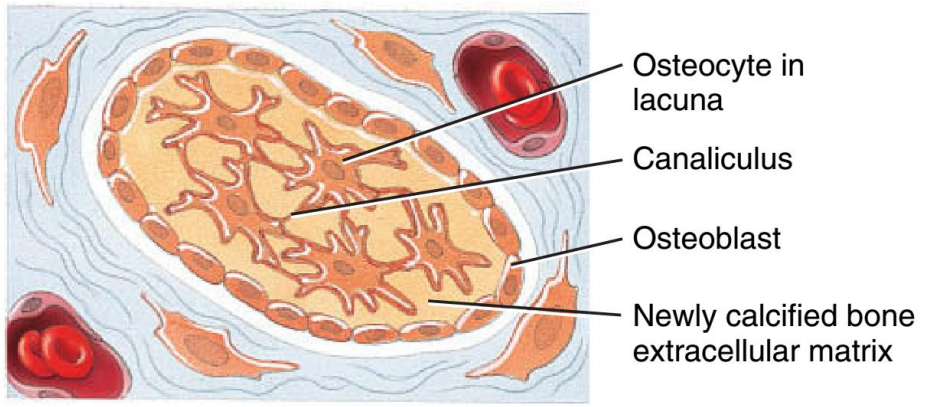
Initial Bone Formation in an Embryo and Fetus

Intramembranous ossification

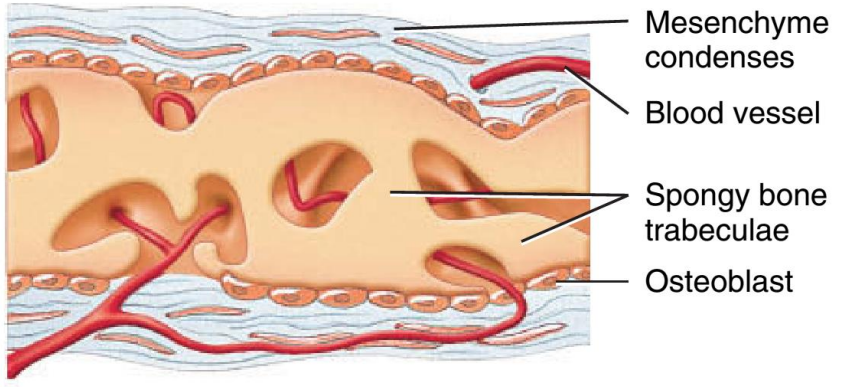




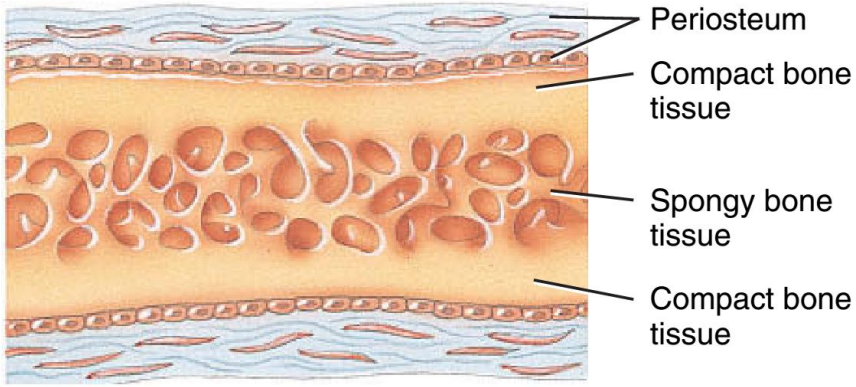
1 Development of ossification center: osteoblasts secrete organic extracellular matrix.



2 Calcification: calcium and other mineral salts are deposited and extracellular matrix calcifies (hardens).

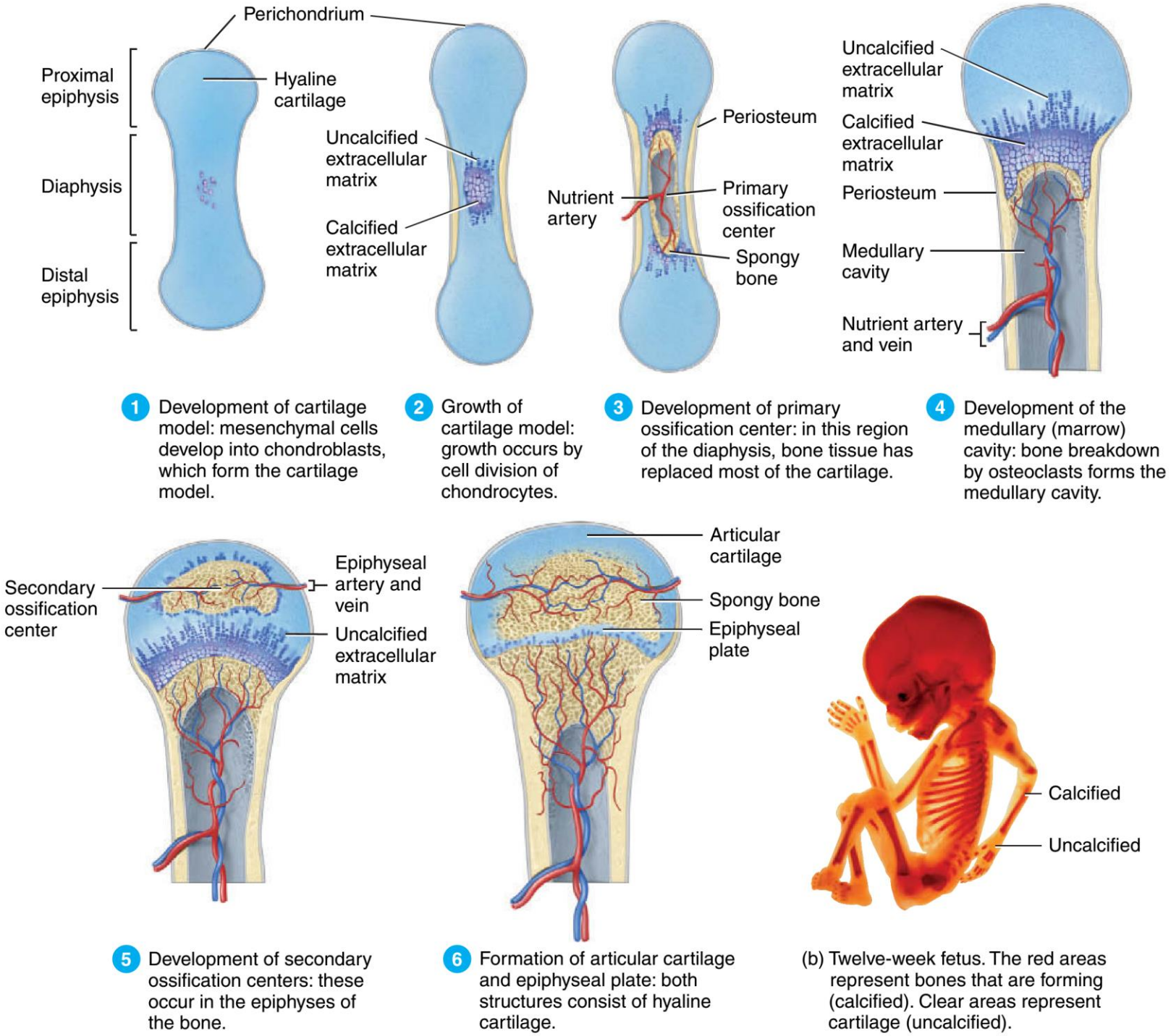


3 Formation of trabeculae: extracellular matrix develops into trabeculae that fuse to form spongy bone.

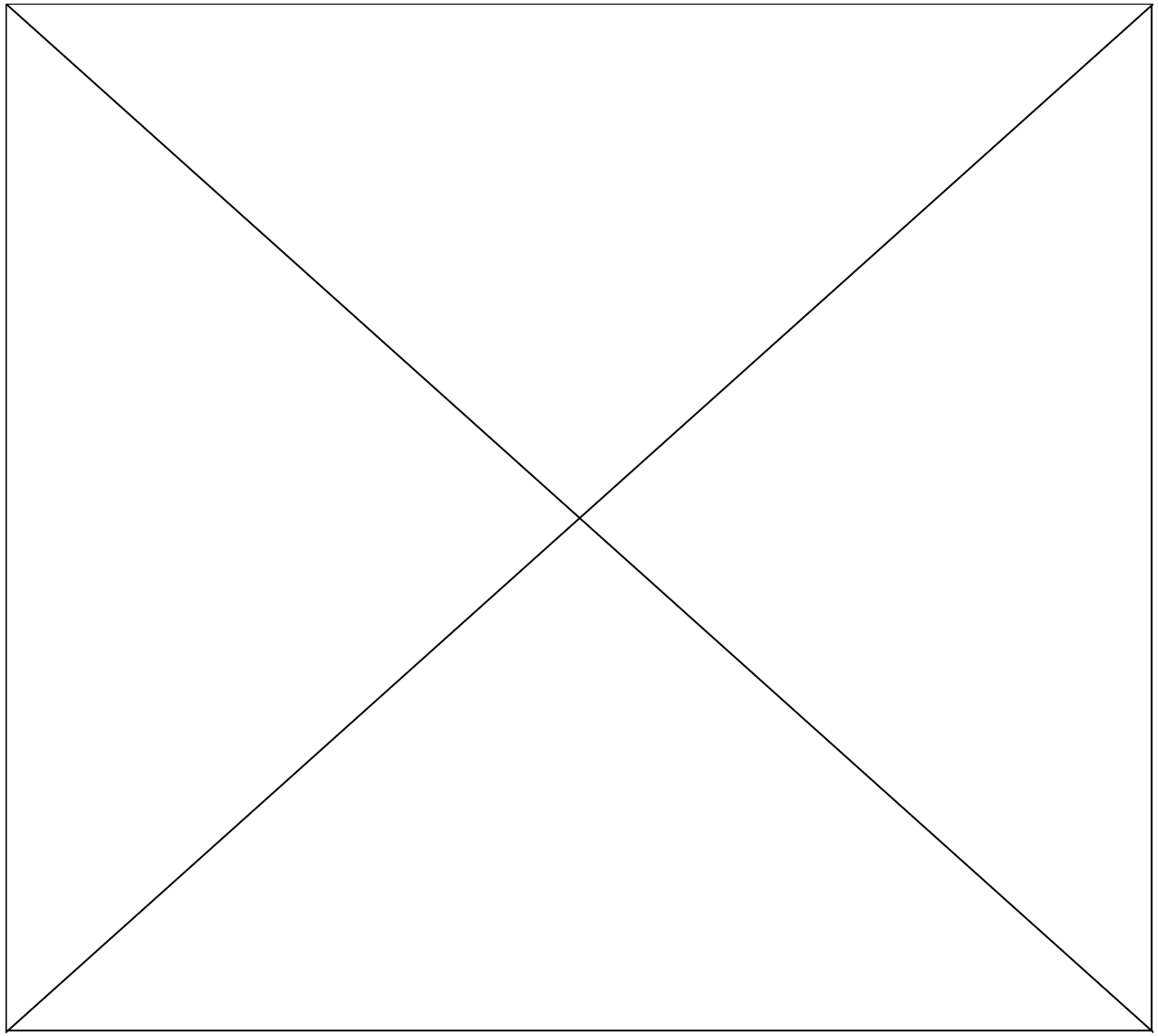


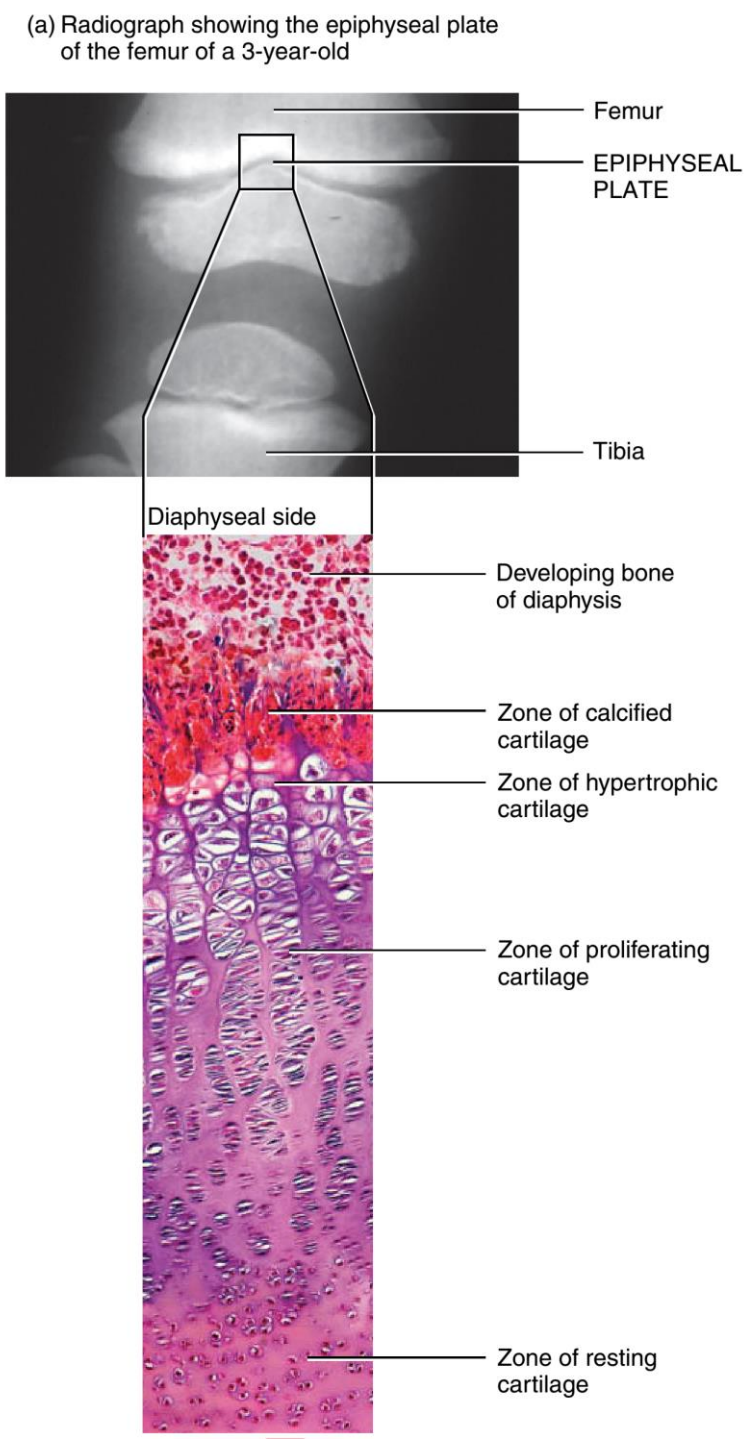
4 Development of the periosteum: mesenchyme at the periphery of the bone develops into the periosteum.

Endochondral ossification

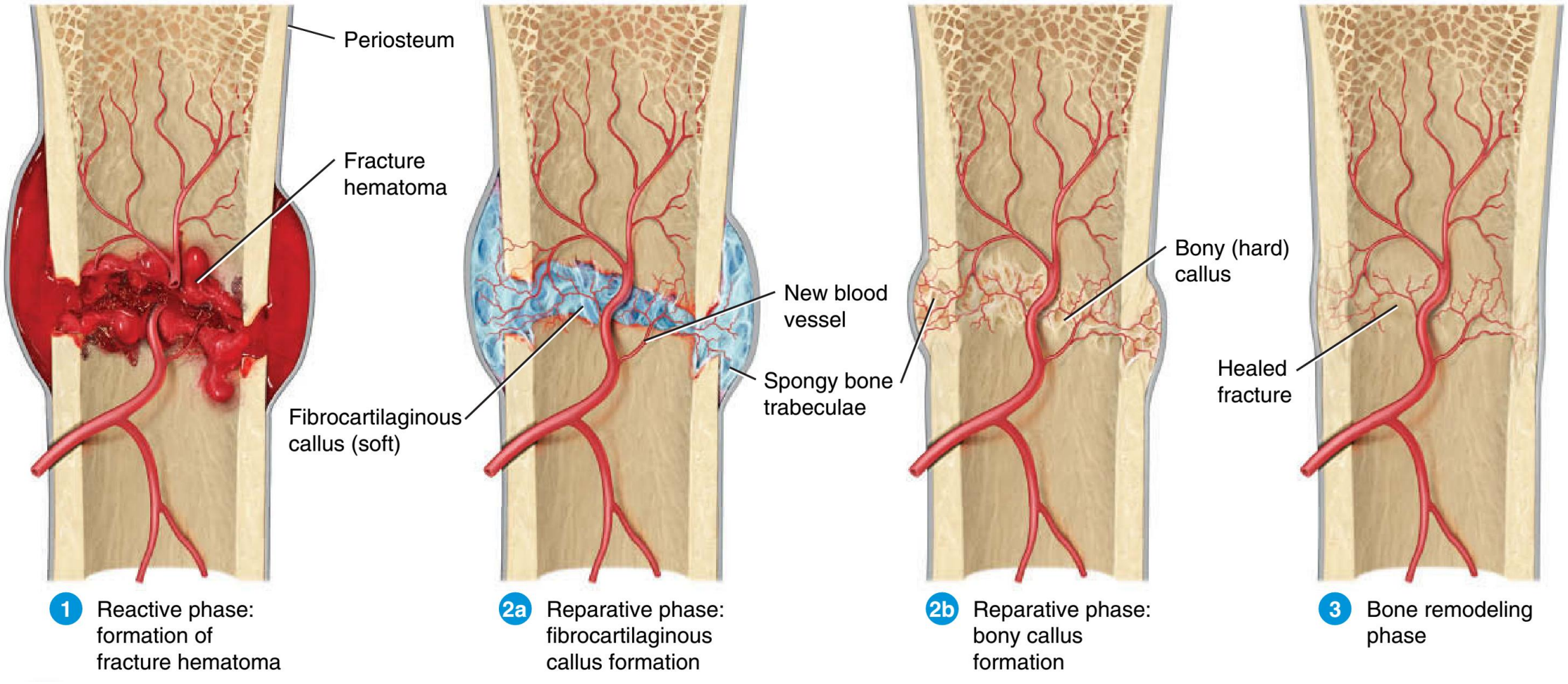


Human Bone Growth





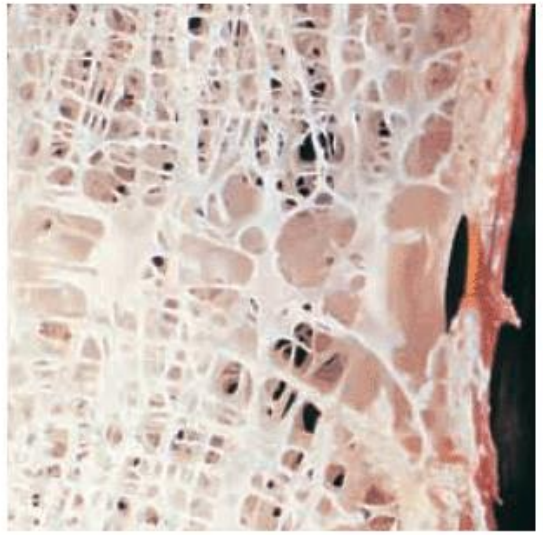
Fracture and Repair of Bone



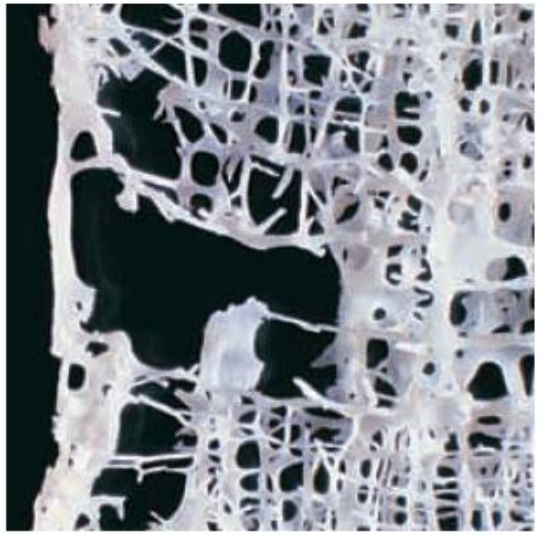
Steps in repair of a bone fracture

1. Reactive phase: This phase is an early inflammatory phase.
Blood vessels crossing the fracture line are broken.
This mass of blood, called a fracture hematoma usually forms 6 to 8 hours after the injury.
Swelling and inflammation occur in response to dead bone cells.
Phagocytes (neutrophils and macrophages) and osteoclasts begin to remove the dead or damaged tissue in and around the fracture hematoma.
This stage may last up to several weeks.
2. Reparative phase: The reparative phase is characterized by two events: the formation of a **fibrocartilaginous callus** and a **bony callus** to bridge the gap between the broken ends of the bones.
Fibroblasts from the periosteum invade the fracture site and produce collagen fibers.
In addition, cells from the periosteum develop into chondroblasts and begin to produce **fibrocartilage** in this region.
The fibrocartilage is converted to spongy bone, and the callus is then referred to as a bony (hard) callus.
The bony callus lasts about 3 to 4 months.
3. Bone remodeling phase: The final phase of fracture repair is bone remodeling of the callus.
Dead portions of the original fragments of broken bone are gradually resorbed by osteoclasts.

Osteoporosis



Normal bone

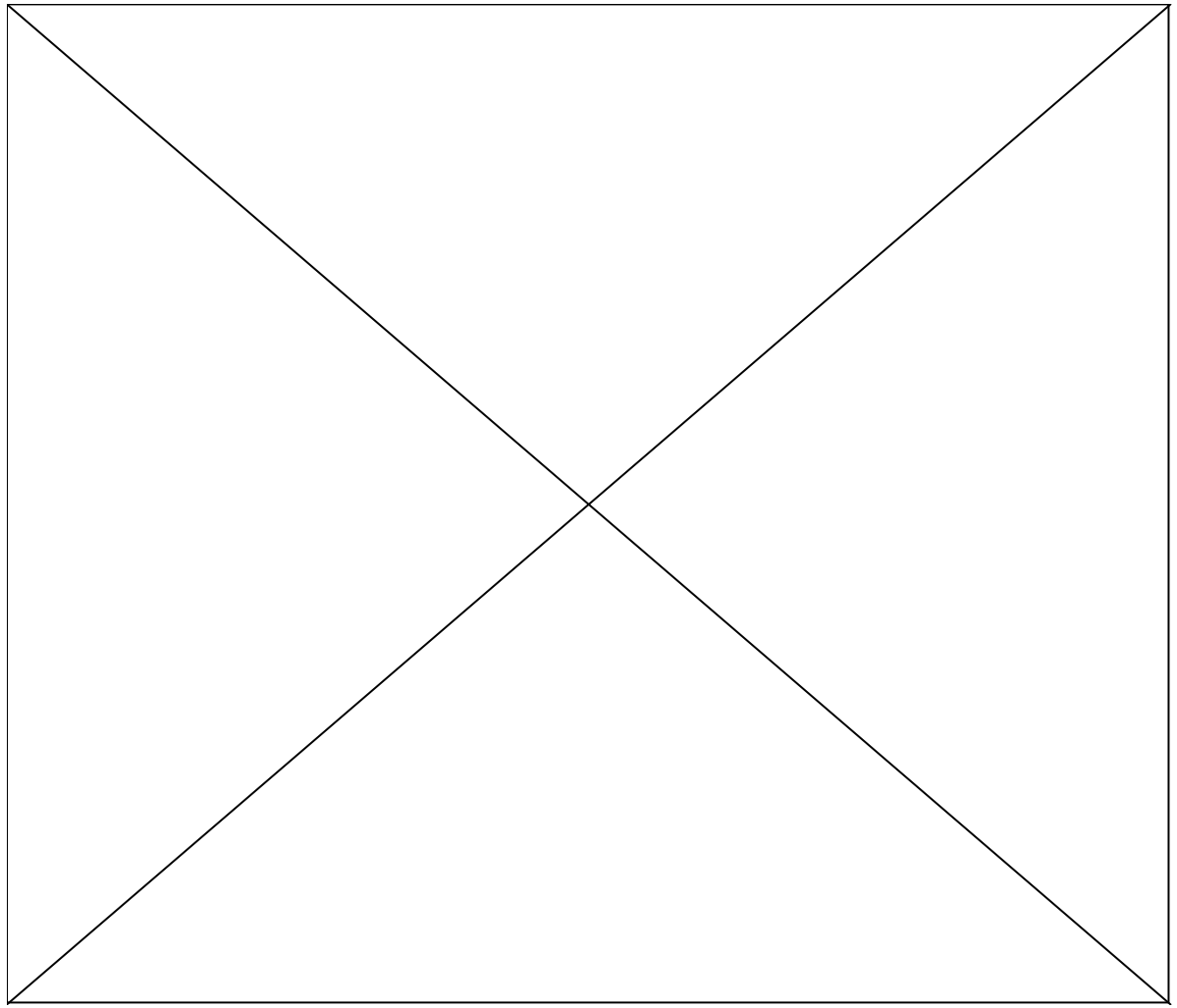


Bone in osteoporosis

Dowager's hump

- In young adults, the density of bone usually remains constant.
- Severe bone loss can lead to a condition called **osteoporosis.** In osteoporosis, bones become **brittle** and are **easily fractured**.

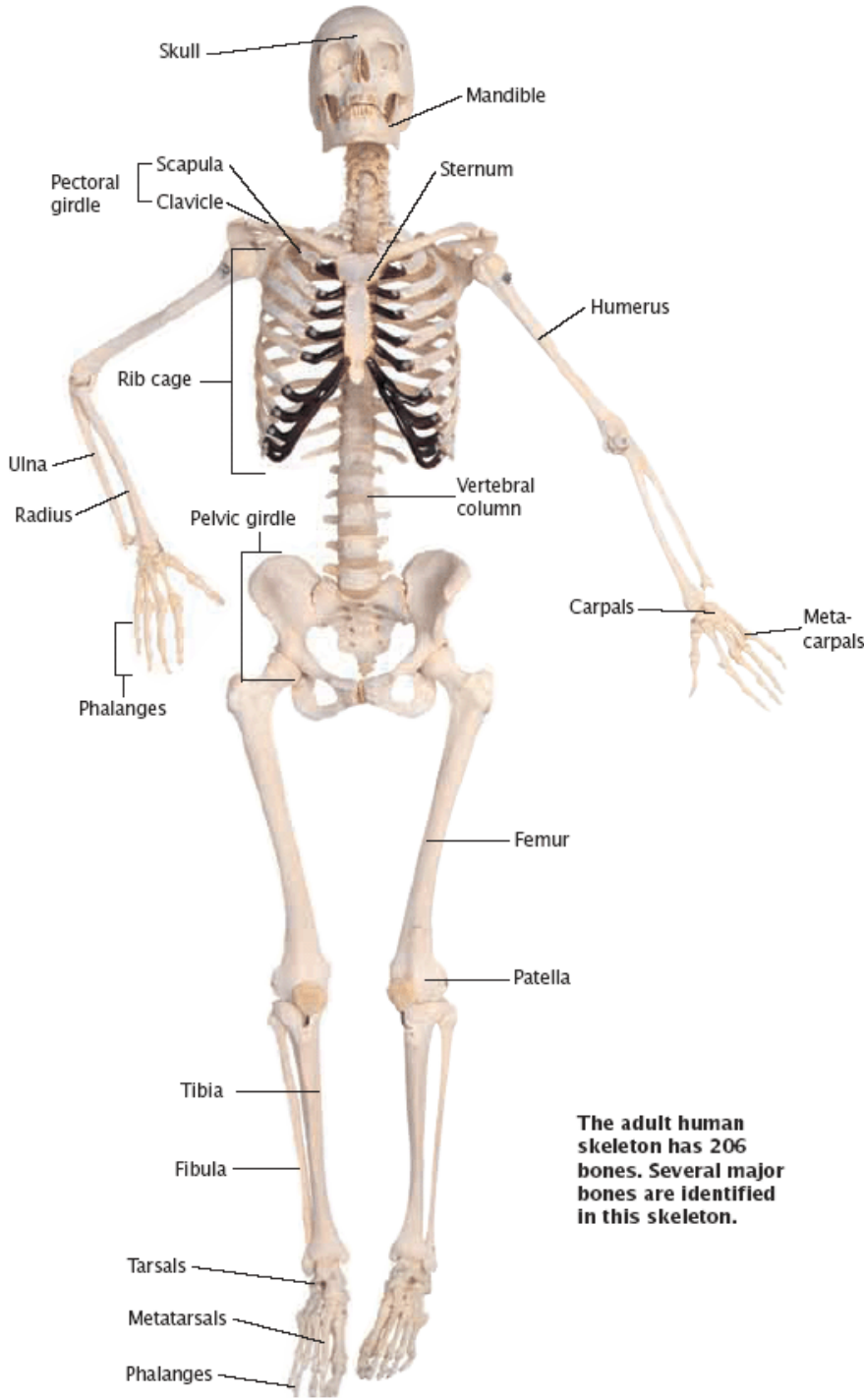
Bone Marrow and Production of Red Blood Cells



Human Skeleton

The Bones of the Adult Skeletal System

DIVISION OF THE SKELETON	STRUCTURE	NUMBER OF BONES
Axial skeleton		
	Skull	
	Cranium	8
	Face	14
	Hyoid bone	1
	Auditory ossicles (see Figure 17.18)	6
	Vertebral column	26
	Thorax	
	Sternum	1
	Ribs	24
	Number of bones = 80	
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
	Number of bones = 126	
	Total bones in an adult skeleton = 206	



The adult human skeleton has 206 bones. Several major bones are identified in this skeleton.

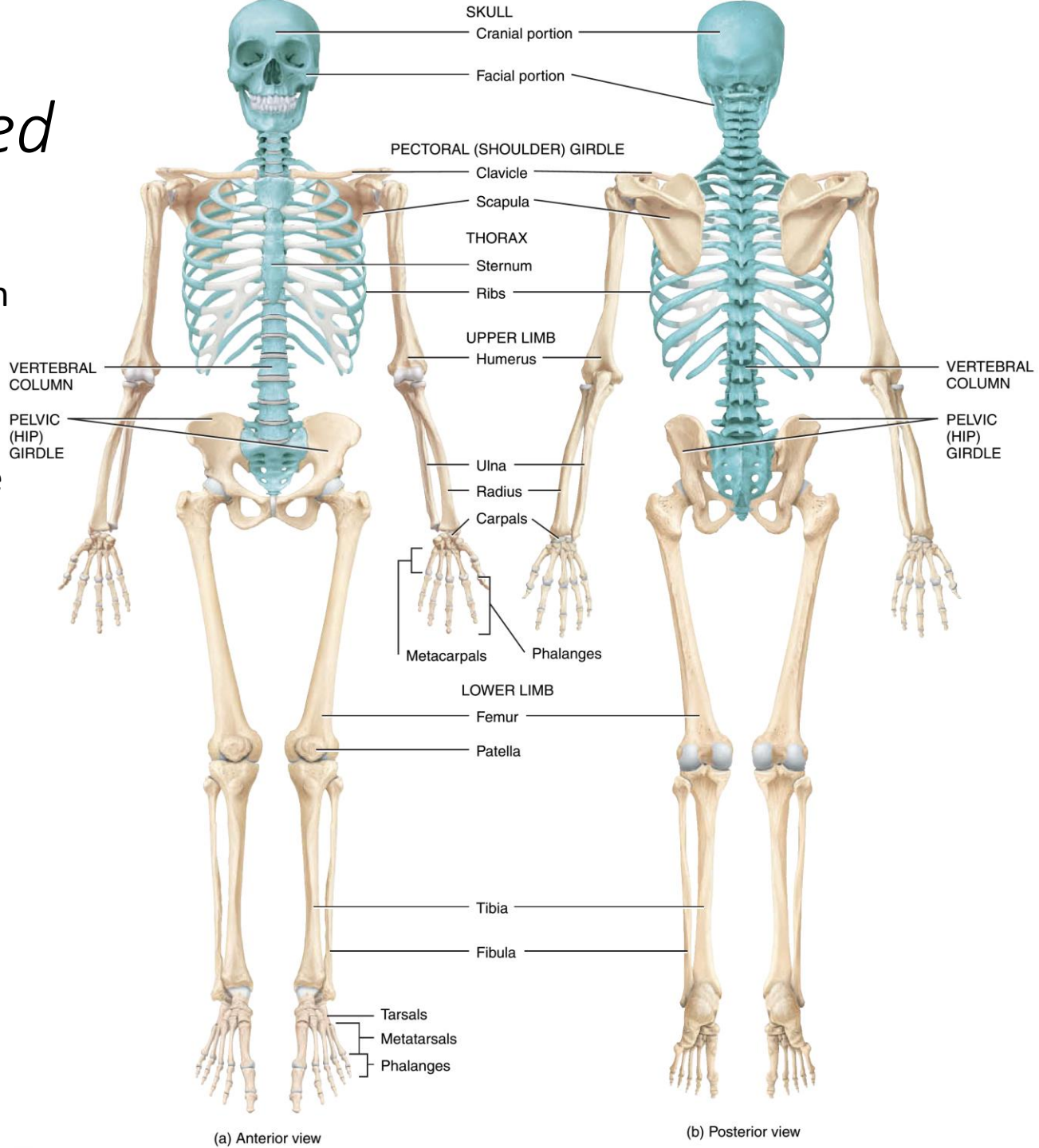
The Skeleton, *continued*

Axial Skeleton

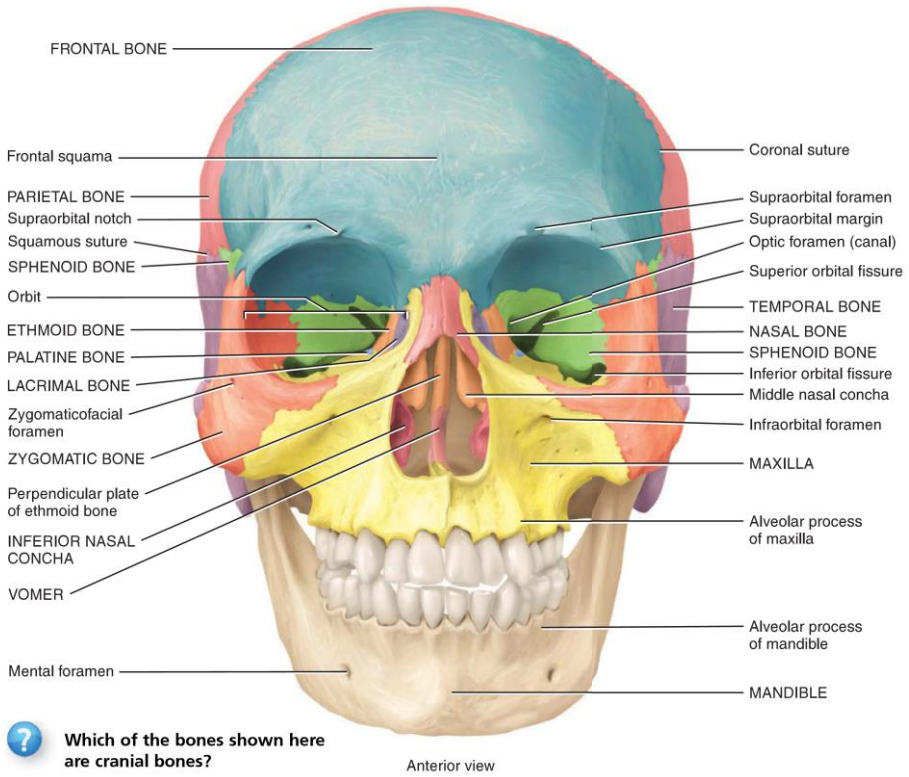
- The most complex part of the axial skeleton is the skull. The skull is attached to the top of the spine, or backbone, which is a flexible, curving column of vertebrae.
- Curving forward from the middle vertebrae are 12 pairs of ribs, which form the rib cage.

Appendicular Skeleton

- The appendicular skeleton forms the appendages, or limbs—the shoulders, arms, hips, and legs.
- The shoulder attachment is called the **pectoral girdle**. The hip attachment is called the **pelvic girdle**.

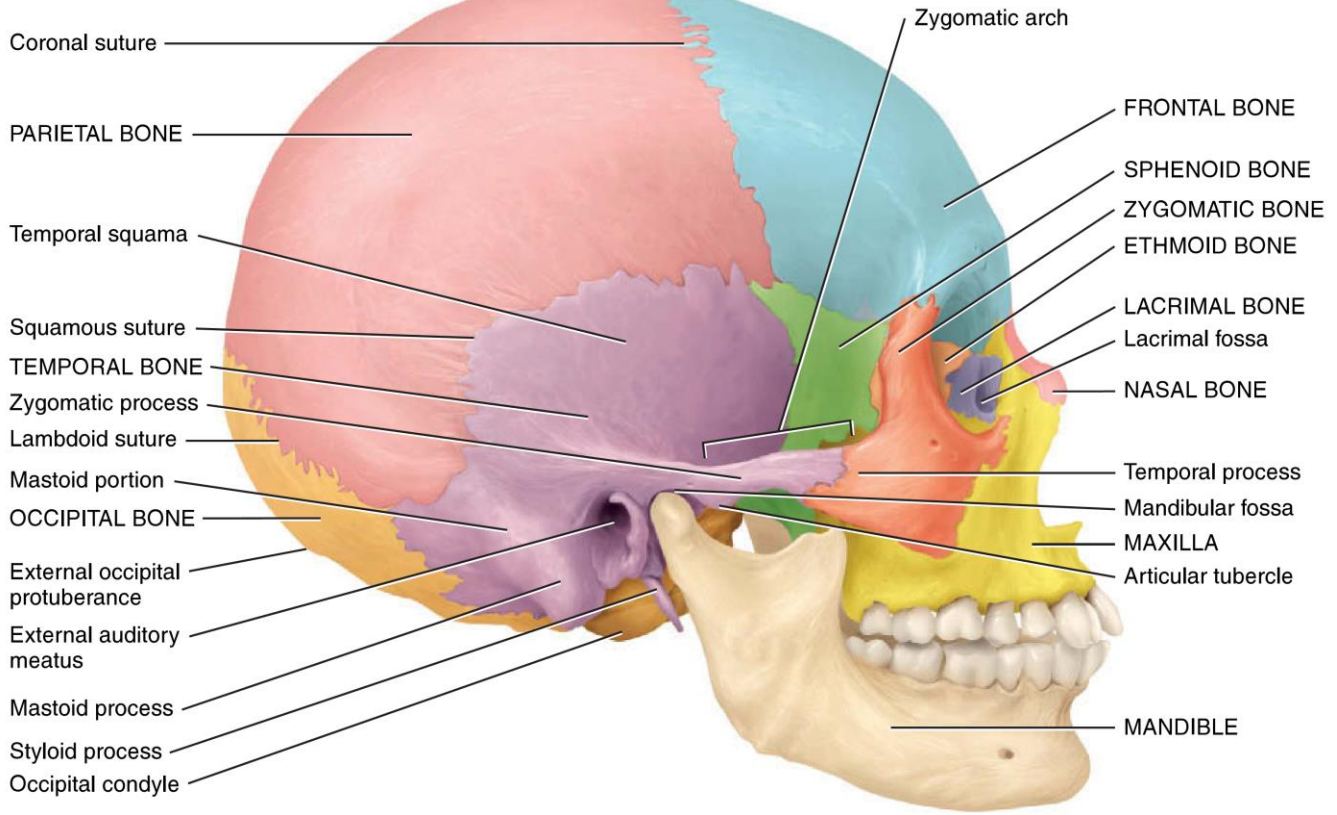


Cranial Bones—Parietal Bones

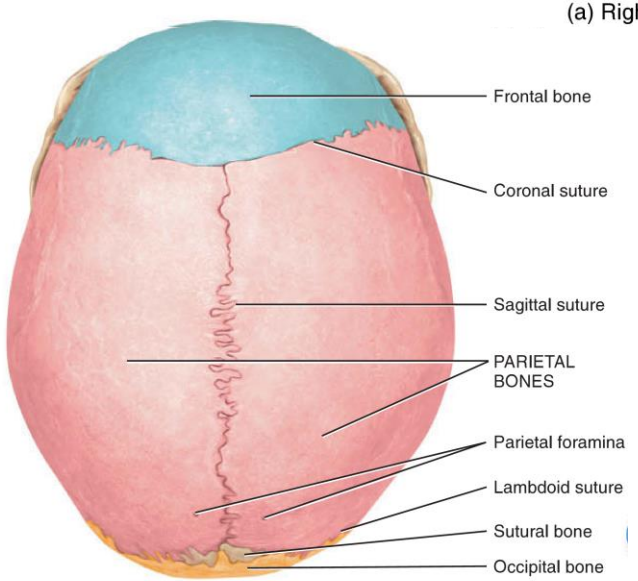


Anterior view

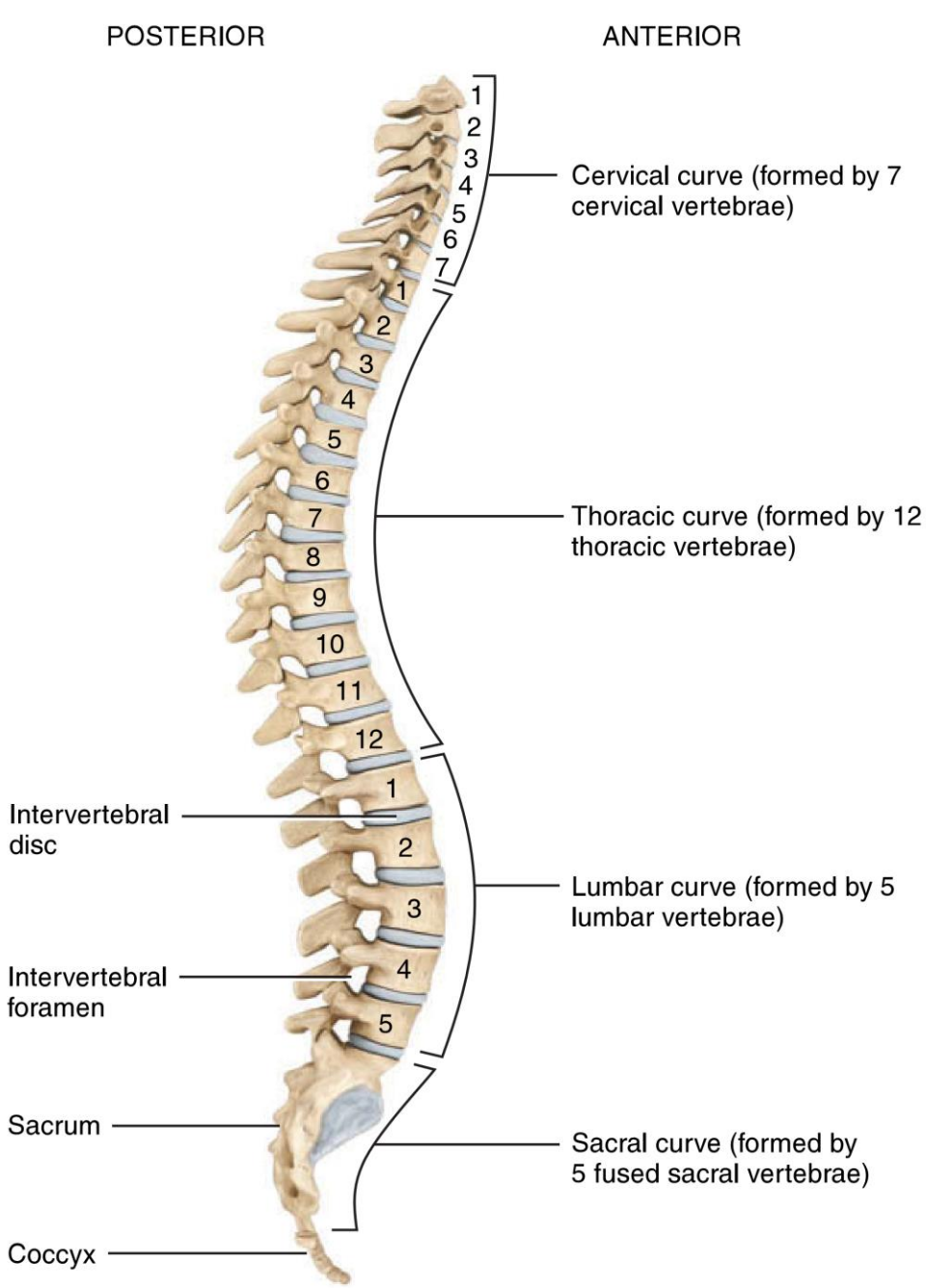
Which of the bones shown here are cranial bones?



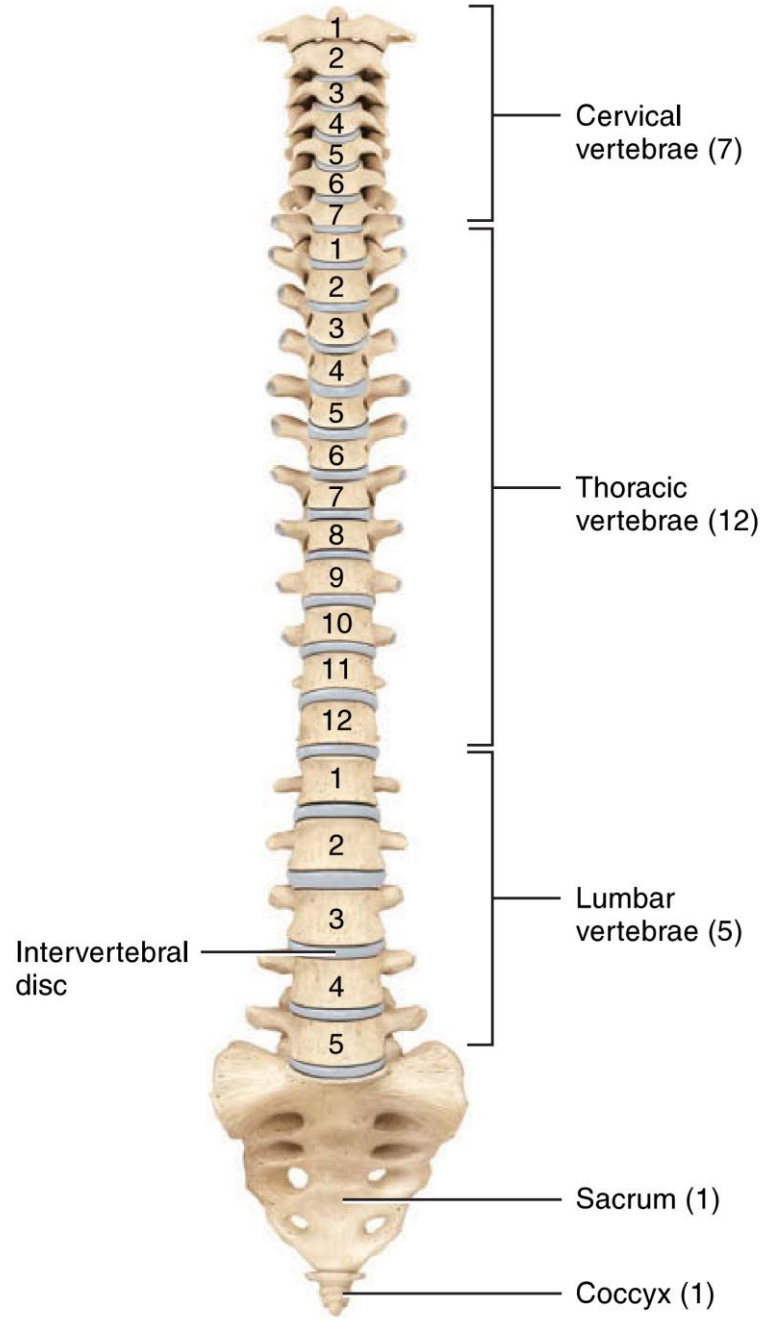
(a) Right lateral view



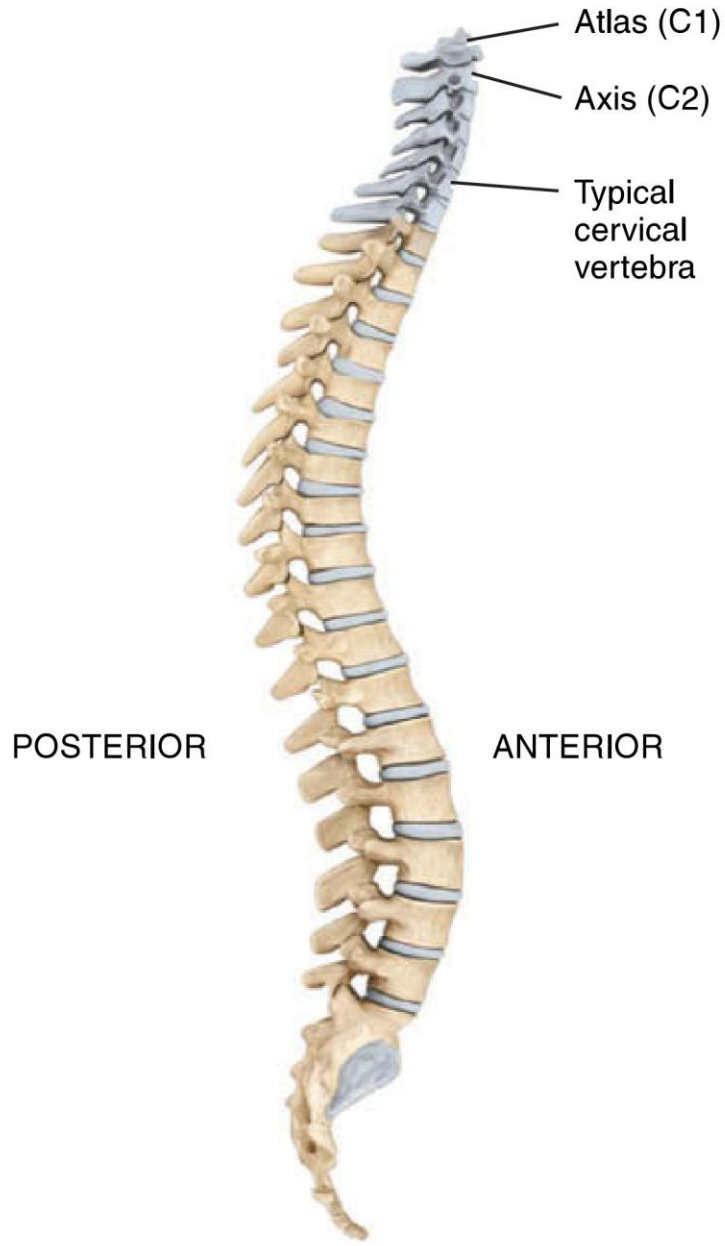
(b) Superior view

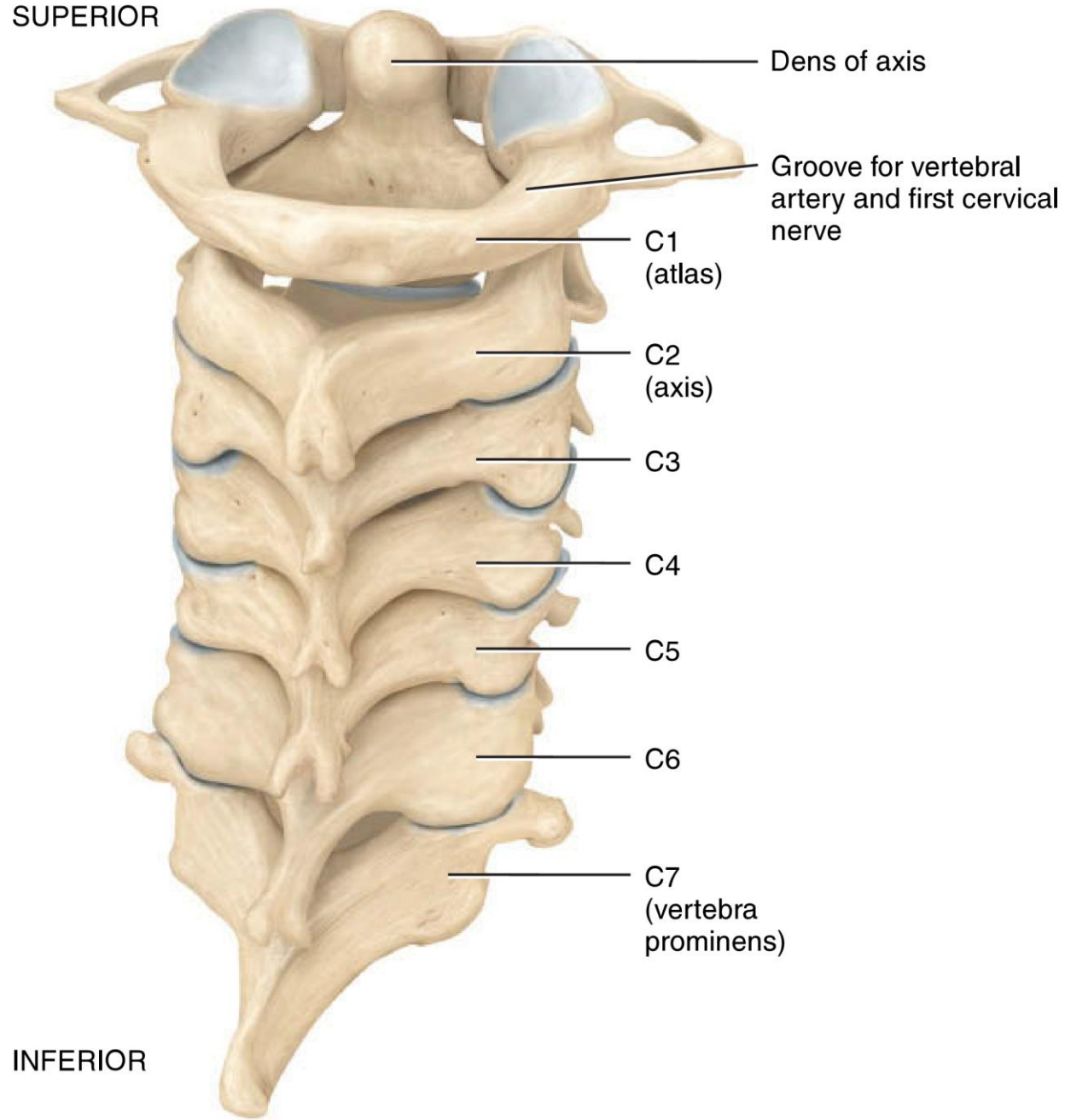


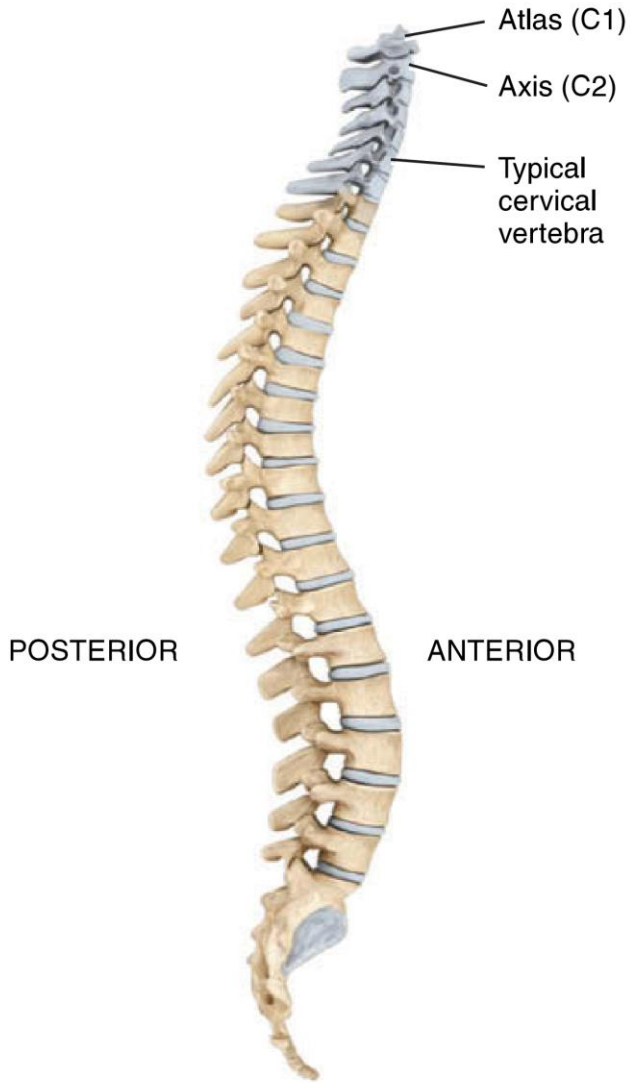
(b) Right lateral view showing four normal curves



(a) Anterior view showing regions of the vertebral column

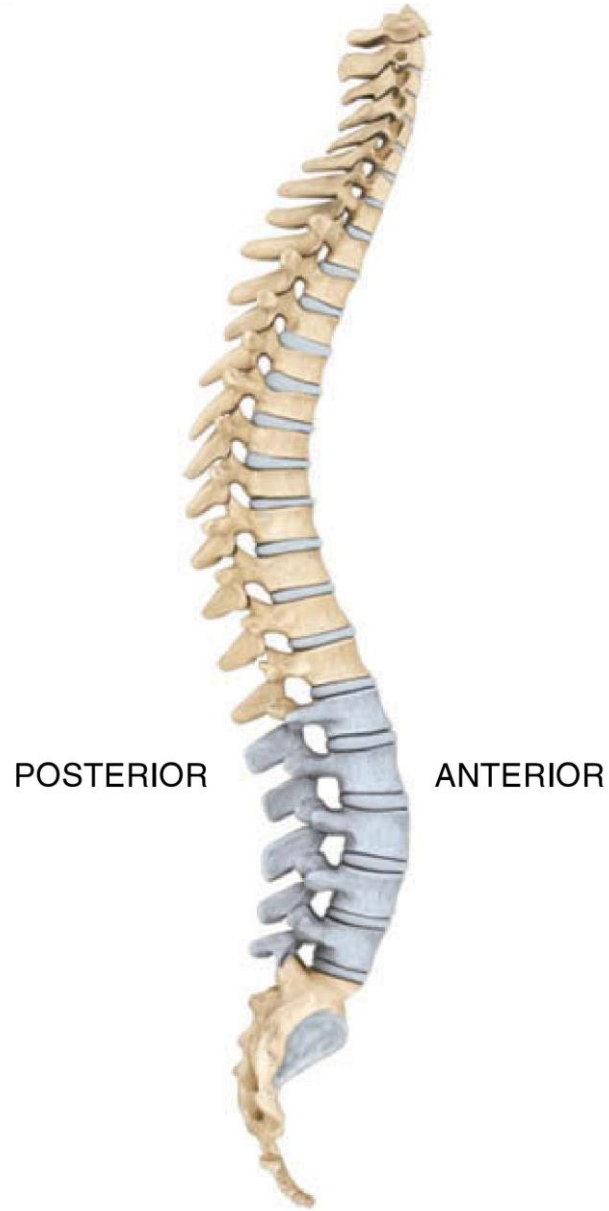

Atlas (C1)
Axis (C2)
Typical cervical vertebra
POSTERIOR
ANTERIOR


SUPERIOR
Dens of axis
Groove for vertebral artery and first cervical nerve
C1 (atlas)
C2 (axis)
C3
C4
C5
C6
C7 (vertebra prominens)
INFERIOR



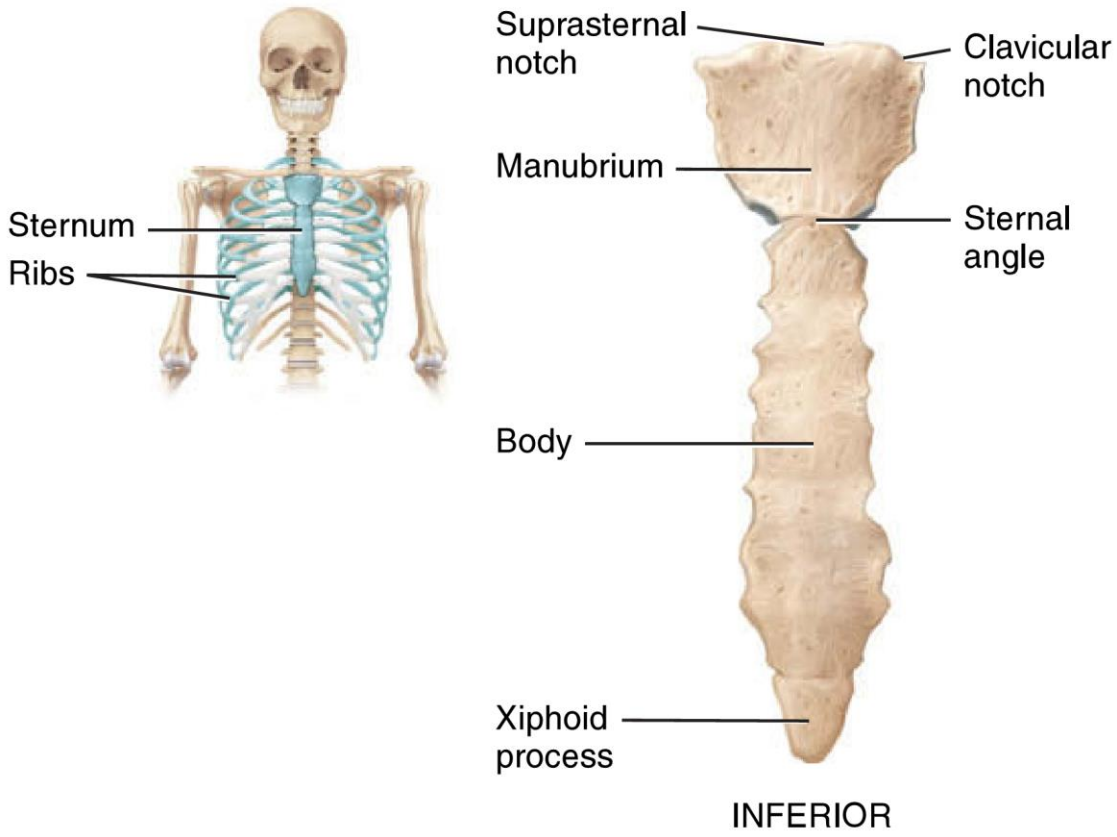
Location of cervical vertebrae

Location of thoracic vertebrae

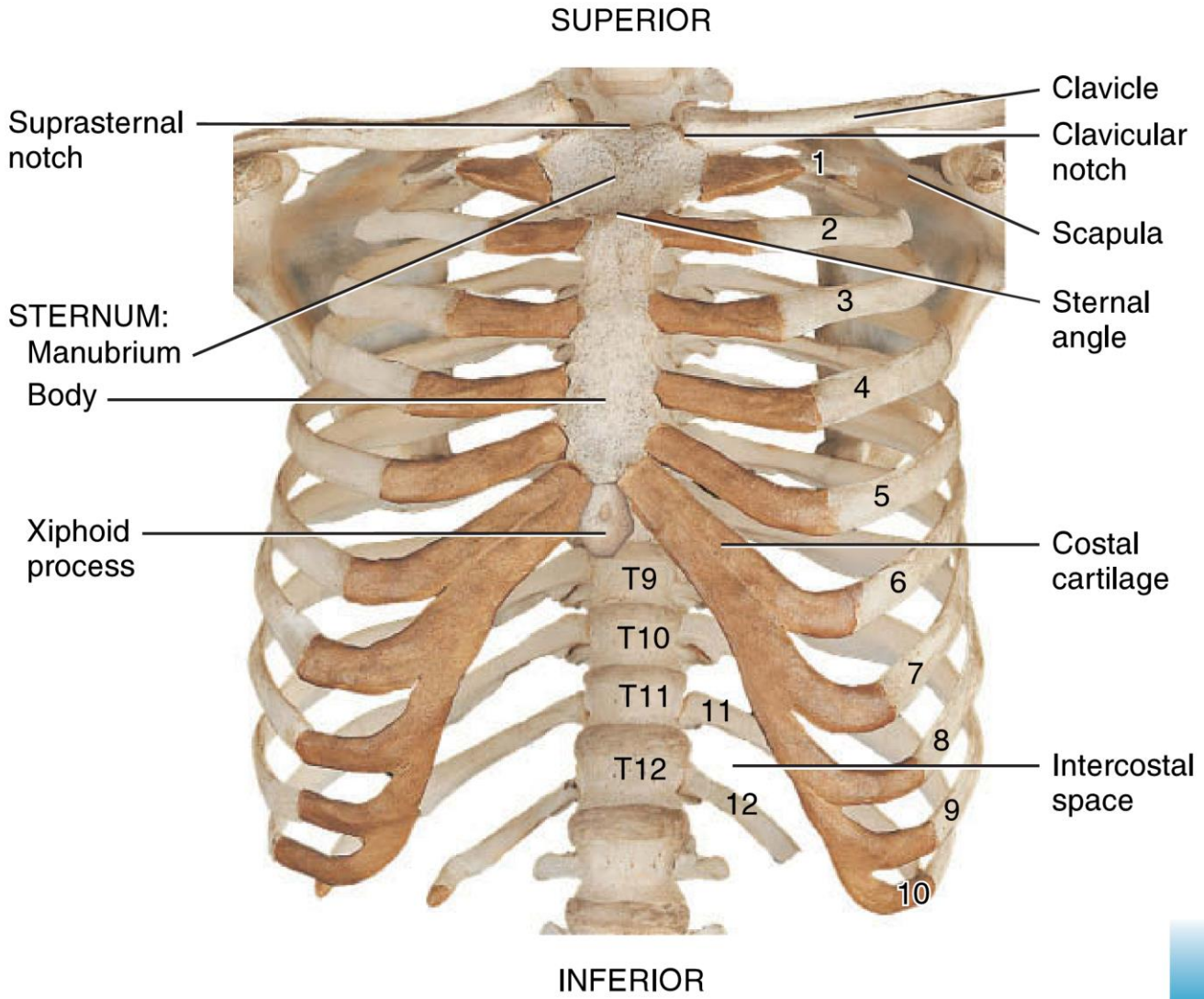


Location of lumbar vertebrae

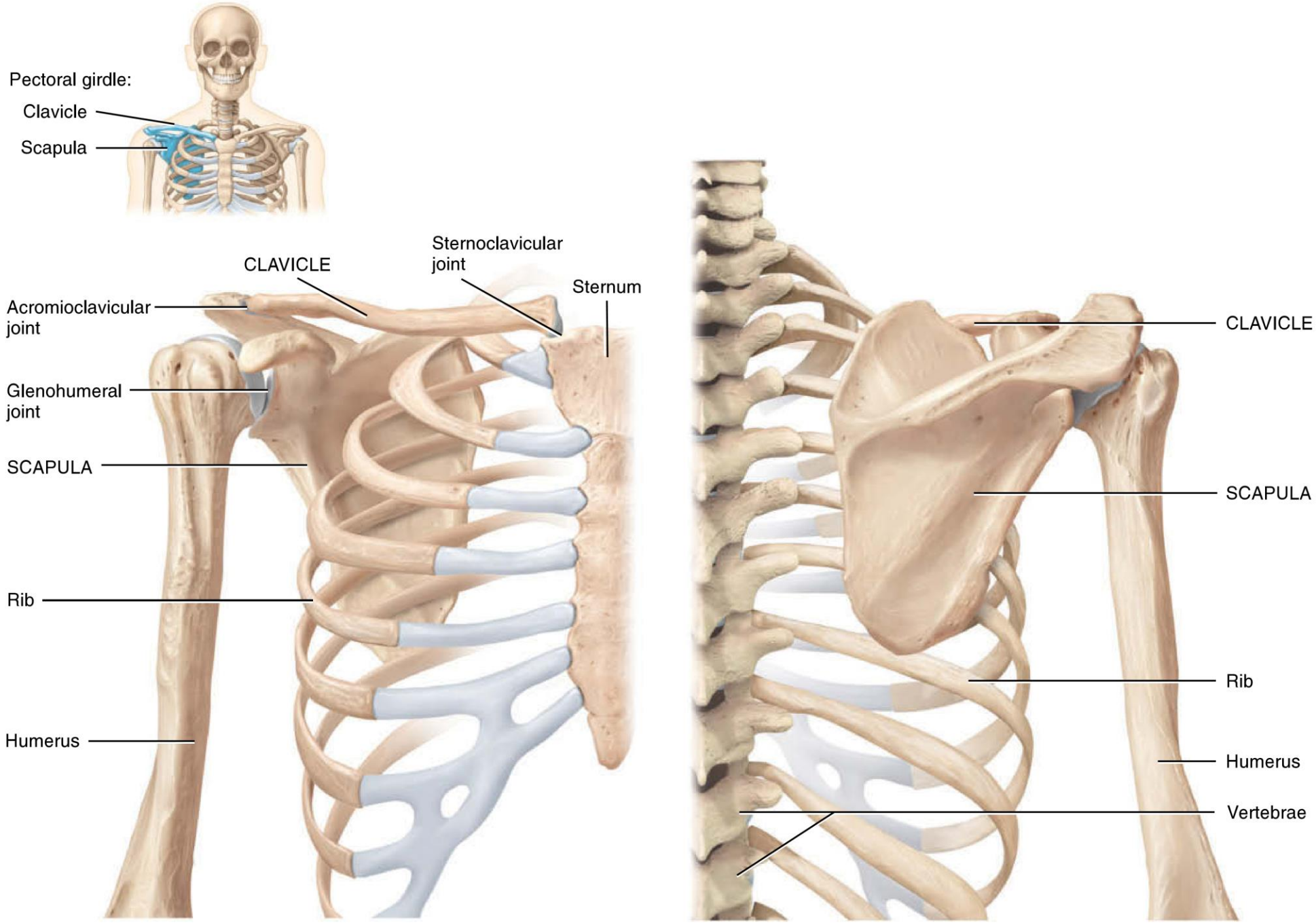
Location of sacrum and coccyx



(a) Anterior view of sternum

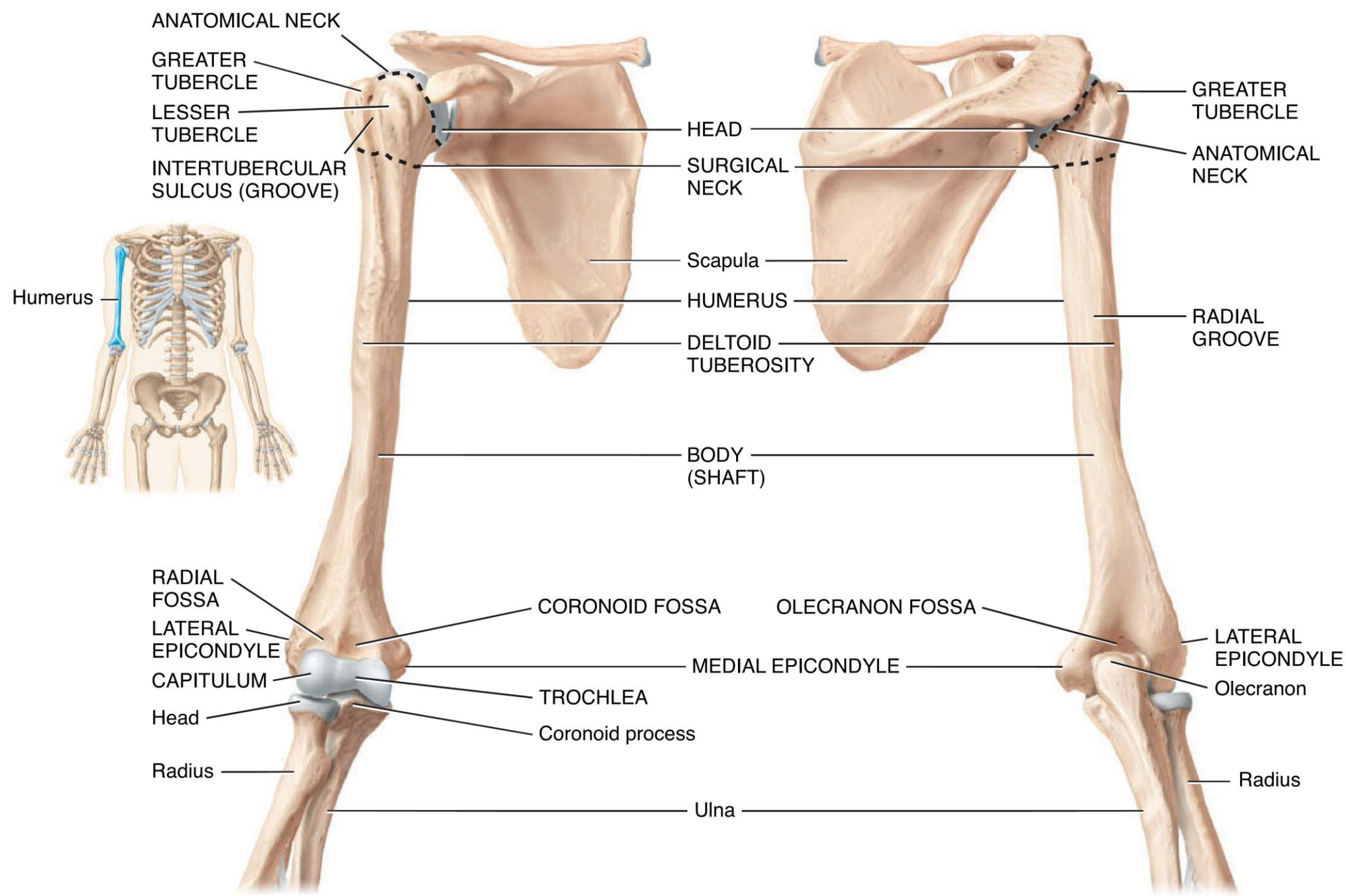


(b) Anterior view of skeleton of thorax



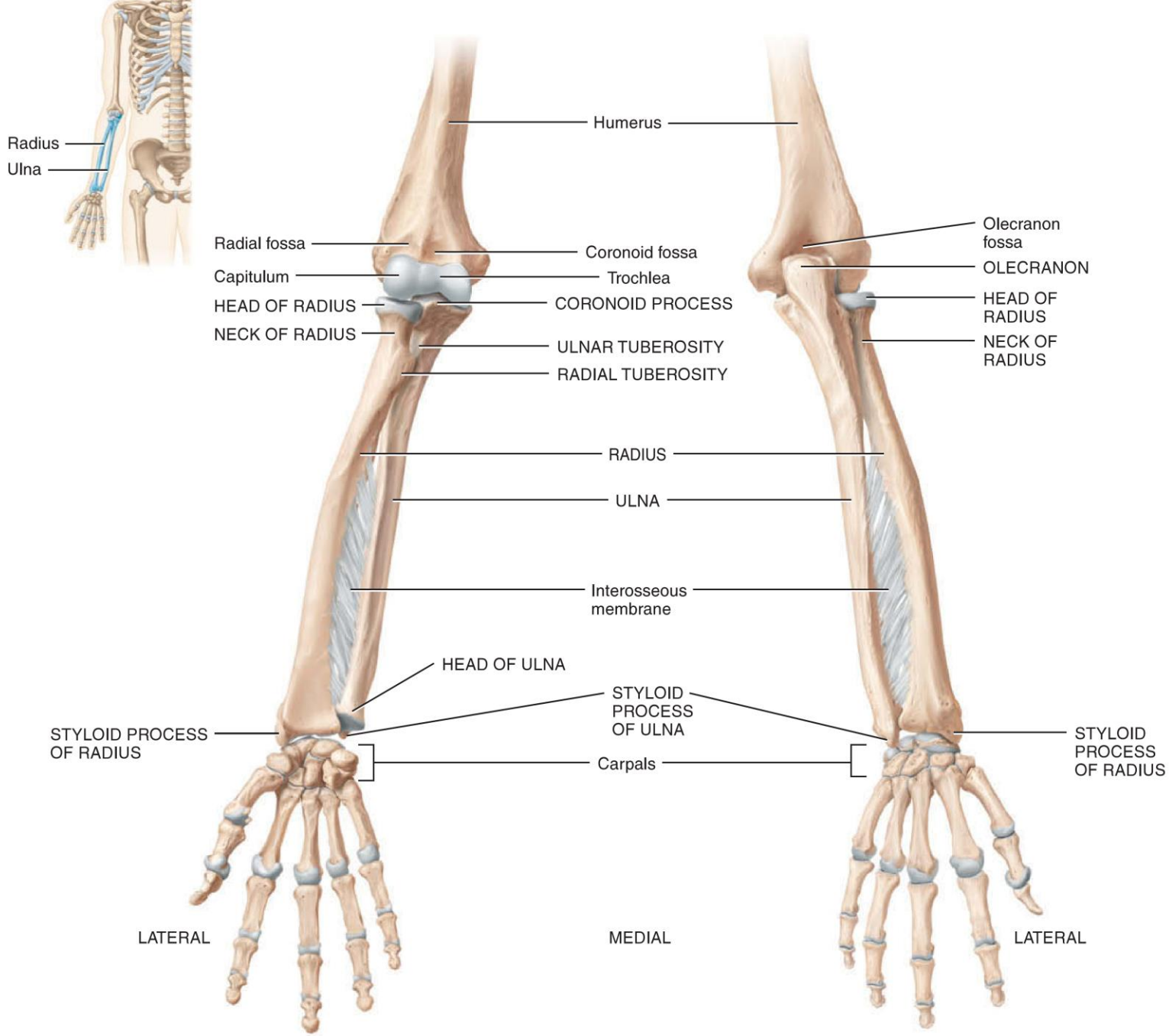
(a) Anterior view of pectoral girdle

(b) Posterior view of pectoral girdle



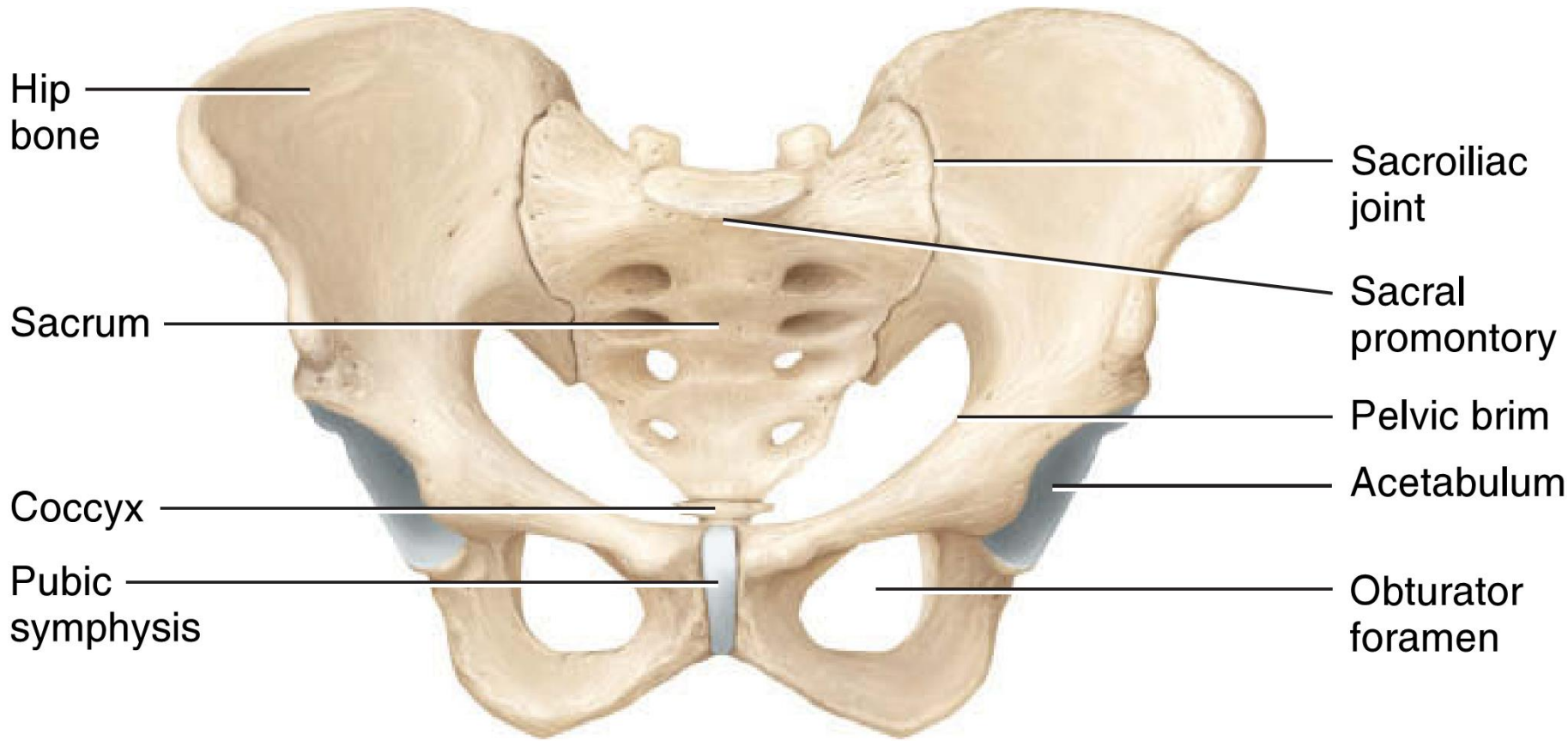
(a) Anterior view

(b) Posterior view

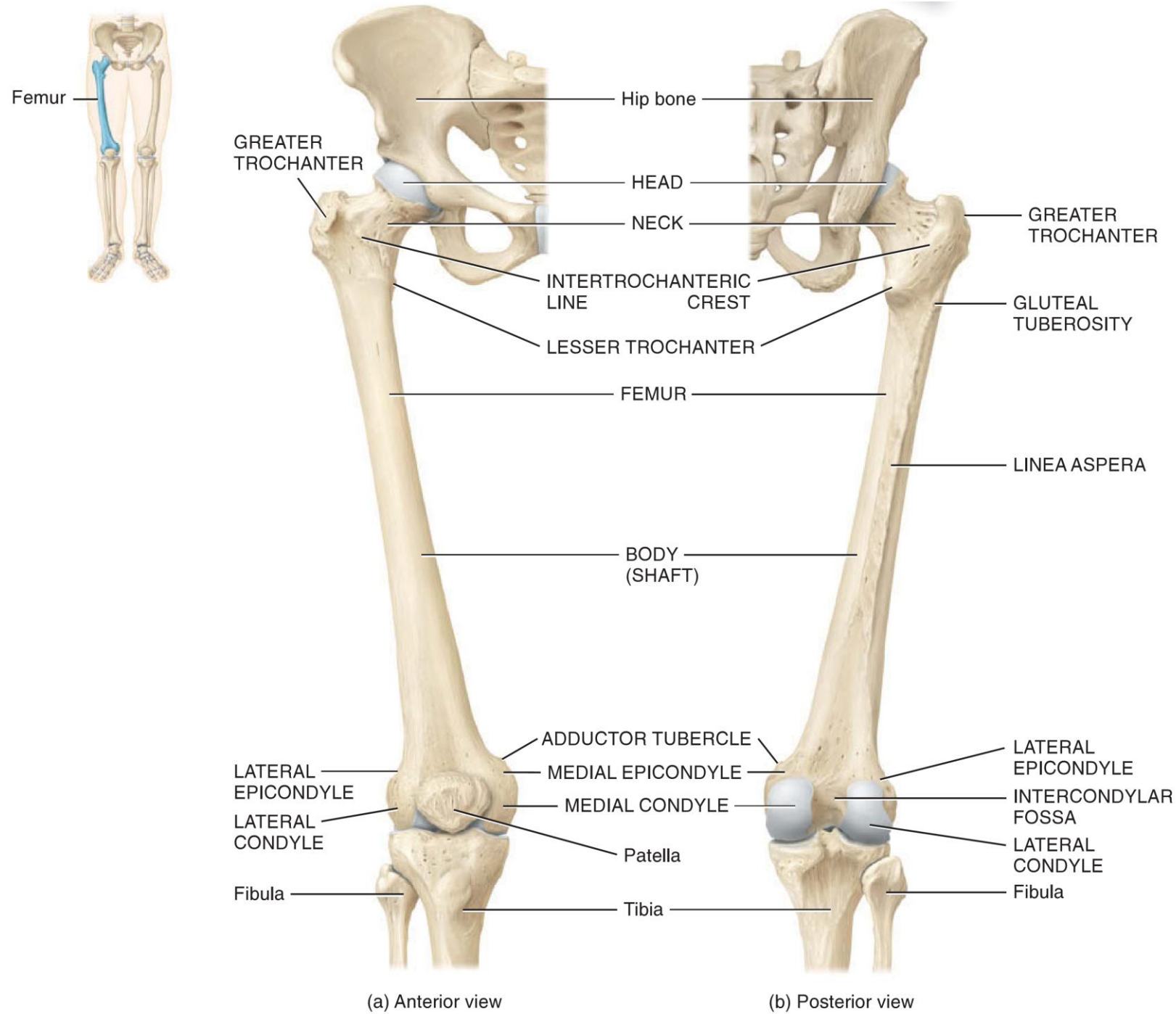


(a) Anterior view

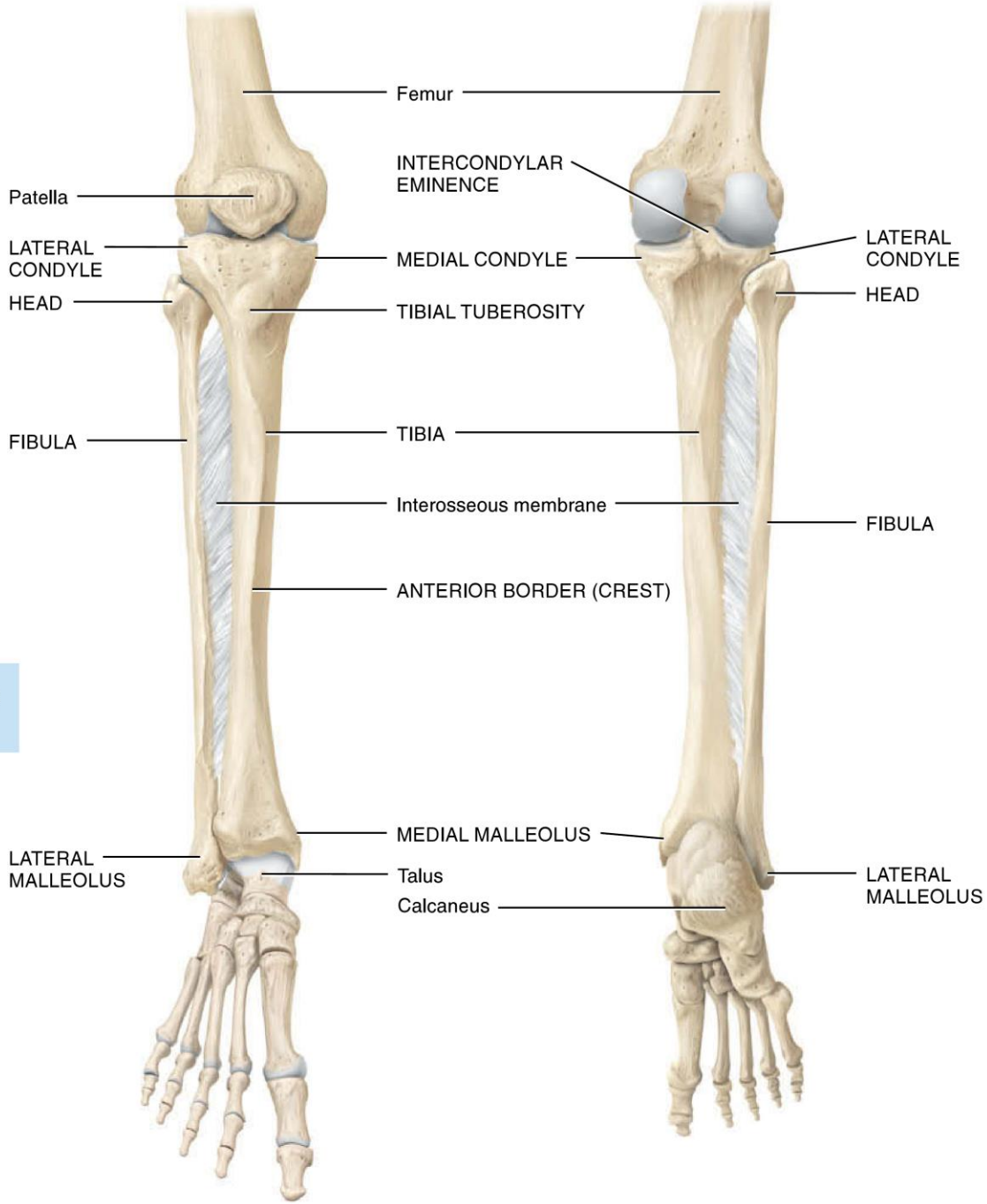
(b) Posterior view



Anterosuperior view of pelvic girdle

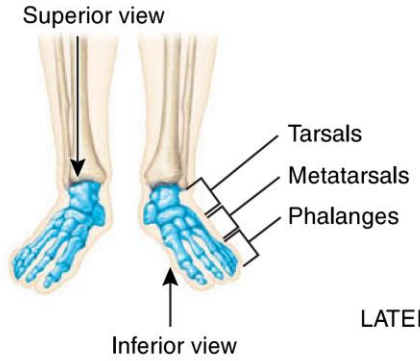

Femur
Hip bone
GREATER TROCHANTER
HEAD
NECK
GREATER TROCHANTER
INTERTROCHANTERIC LINE
CREST
GLUTEAL TUBEROSITY
LESSER TROCHANTER
FEMUR
LINEA ASPERA
BODY (SHAFT)
ADDUCTOR TUBERCLE
LATERAL EPICONDYLE
MEDIAL EPICONDYLE
LATERAL EPICONDYLE
MEDIAL CONDYLE
INTERCONDYLAR FOSSA
LATERAL CONDYLE
Patella
LATERAL CONDYLE
Fibula
Tibia
Fibula
(a) Anterior view
(b) Posterior view

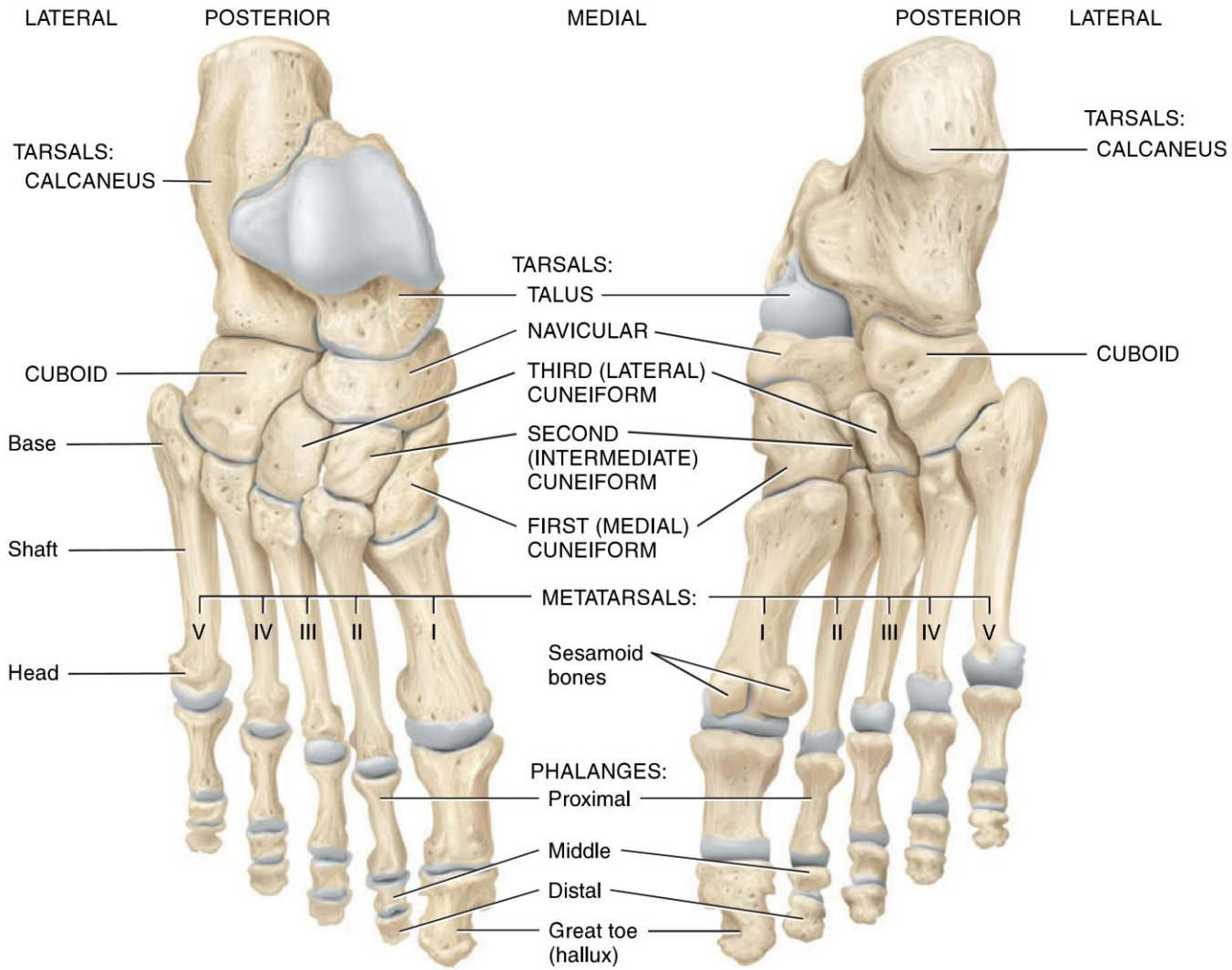
MNEMONIC for location of tibia and fibula:
The fibu**LA** is **LA**teral.



(a) Anterior view

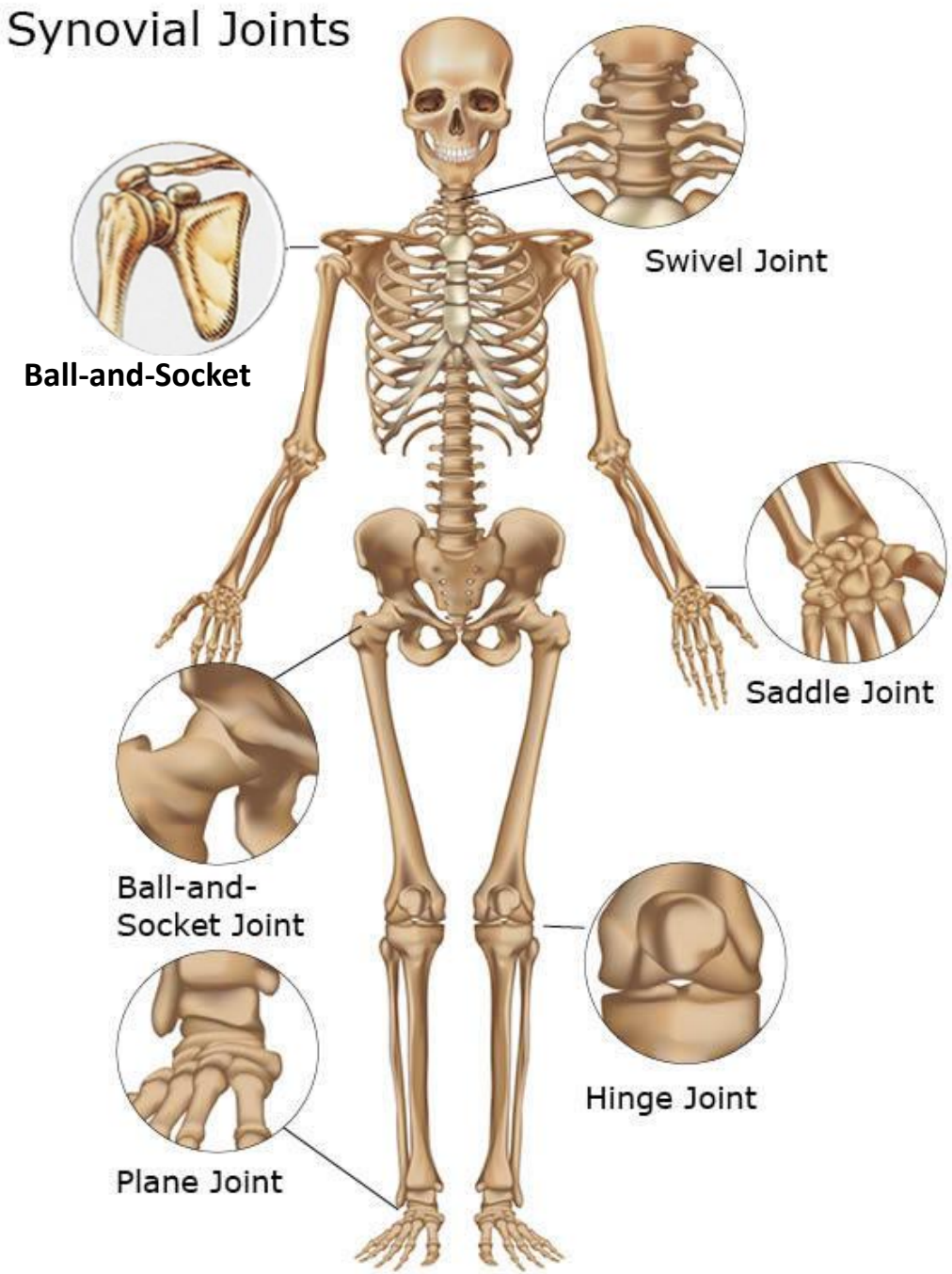
(b) Posterior view





(a) Superior view

(b) Inferior view



Joints

- A **joint** is a place where two bones meet. Pads of cartilage cushion the ends of the bones of a joint, enabling the joint to withstand great pressure and stress.

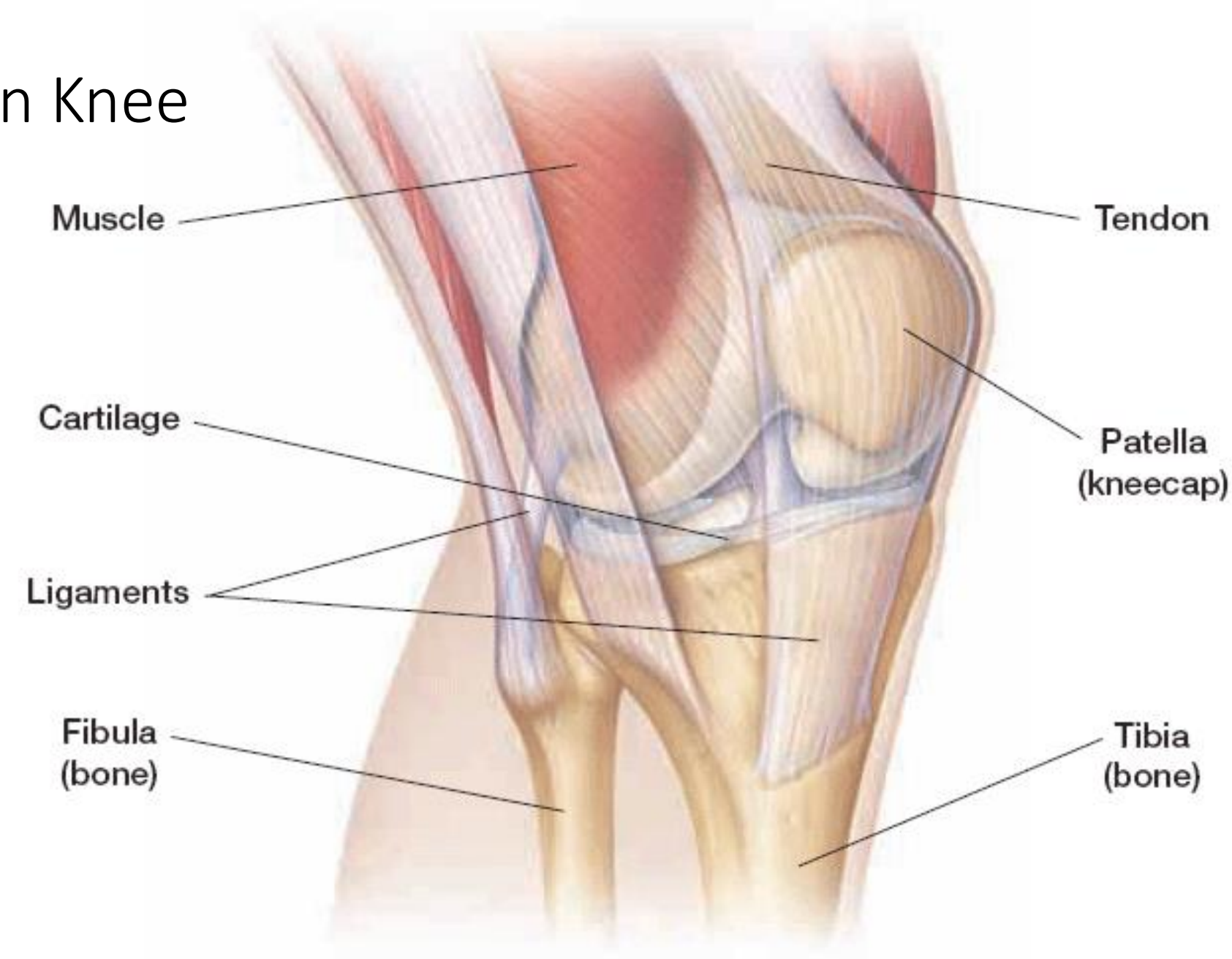
- The bones of a joint are held together by strong bands of connective tissue called **ligaments.**

Joints, *continued*

Three Main Types of Joints

- Immovable joints permit little or no movement of the bones they join (ex. cranial bones).
- Slightly movable joints permit limited movement of the bones they join (ex. rib cage).
- Freely movable joints (ex. knee) permit movement. The direction of bone movement is determined by the structure of the joint.

The Human Knee



Joints, *continued*

Disorders of Joints

- When a disease afflicts the bones, connective tissue, or lubricating tissues in a freely movable joint, the joint's ability to move may be impaired.

- Rheumatoid arthritis is a painful inflammation of freely movable joints. Osteoarthritis is a disorder that causes the degeneration of cartilage that covers the surfaces of bones.