

## *Chapter 5*

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# **The Skeletal System**

*Slides 5.1 – 5.77*

Lecture Slides in PowerPoint by Jerry L. Cook

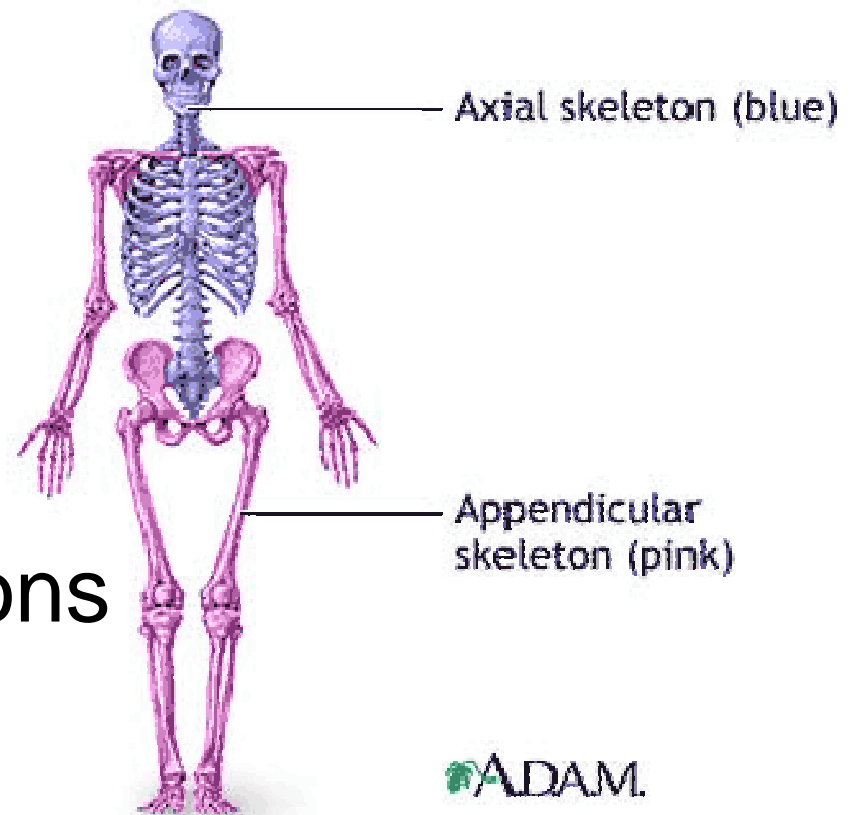
# The Skeletal System

- Parts of the skeletal system

- Bones (skeleton)
- Joints
- Cartilages
- Ligaments

- Divided into two divisions

- Axial skeleton
- Appendicular skeleton

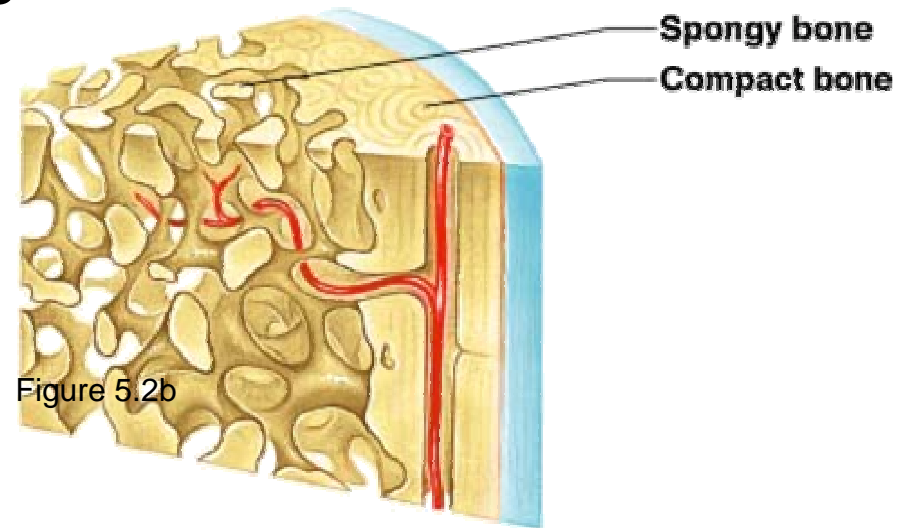


# Functions of Bones

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

# Bones of the Human Body

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



# Classification of Bones

- Bones are classified according to shape into four groups:
- Long bones
  - Typically longer than wide
  - Have a shaft with heads at both ends
  - Contain mostly compact bone
    - Examples: Femur, humerus

# Classification of Bones

- Short bones
  - Generally cube-shape
  - Contain mostly spongy bone
    - Examples: Carpals, tarsals
- Sesamoid bones – form within tendons
  - Examples: patella or kneecap

# Classification of Bones on the Basis of Shape

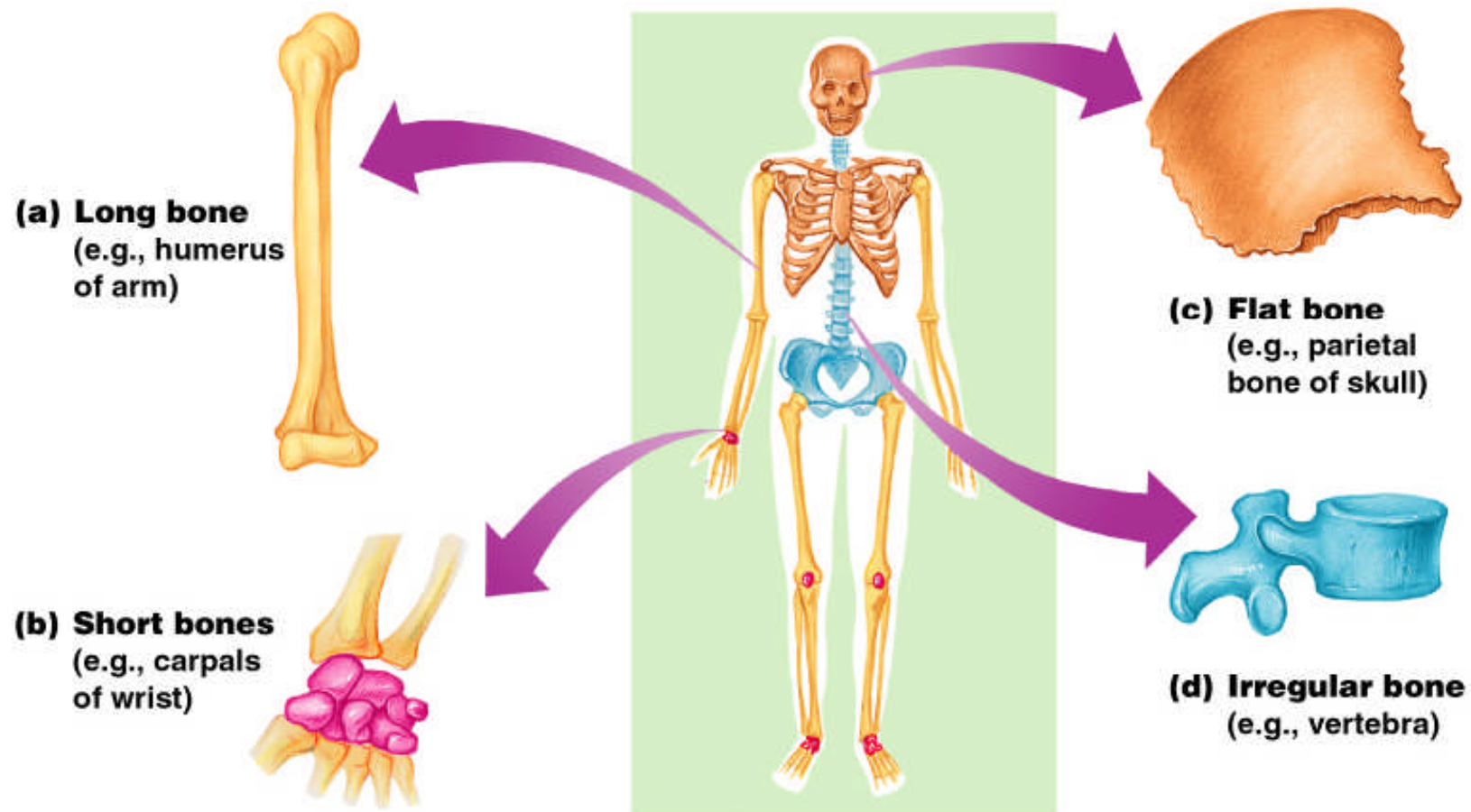


Figure 5.1

# 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



# Classification of Bones

- Irregular bones
  - Irregular shape
  - Do not fit into other bone classification categories
    - Example: Vertebrae and hip

# Classification of Bones on the Basis of Shape

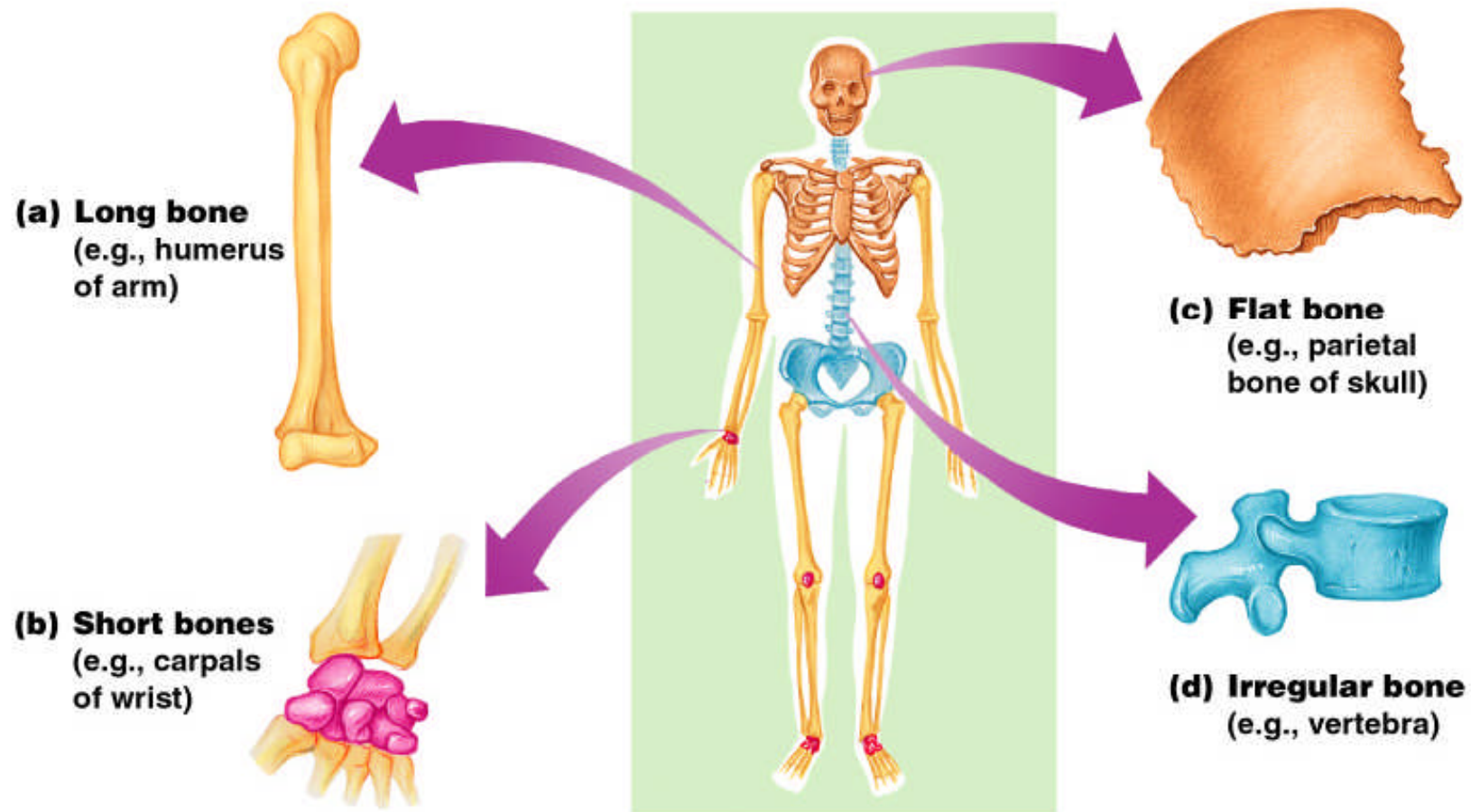


Figure 5.1

# Gross Anatomy of a Long Bone

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

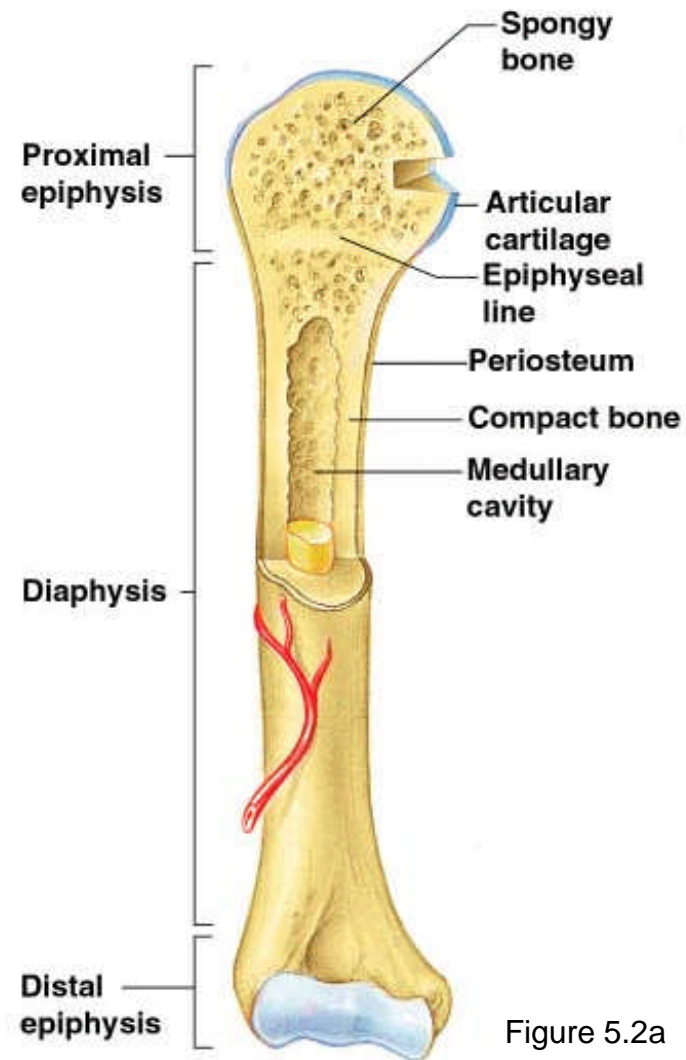


Figure 5.2a

# Structures of a Long Bone

- Periosteum
  - Outside covering of the diaphysis
  - Fibrous connective tissue membrane
- Sharpey's fibers
  - Secure periosteum to underlying bone
- Arteries
  - Supply bone cells with nutrients

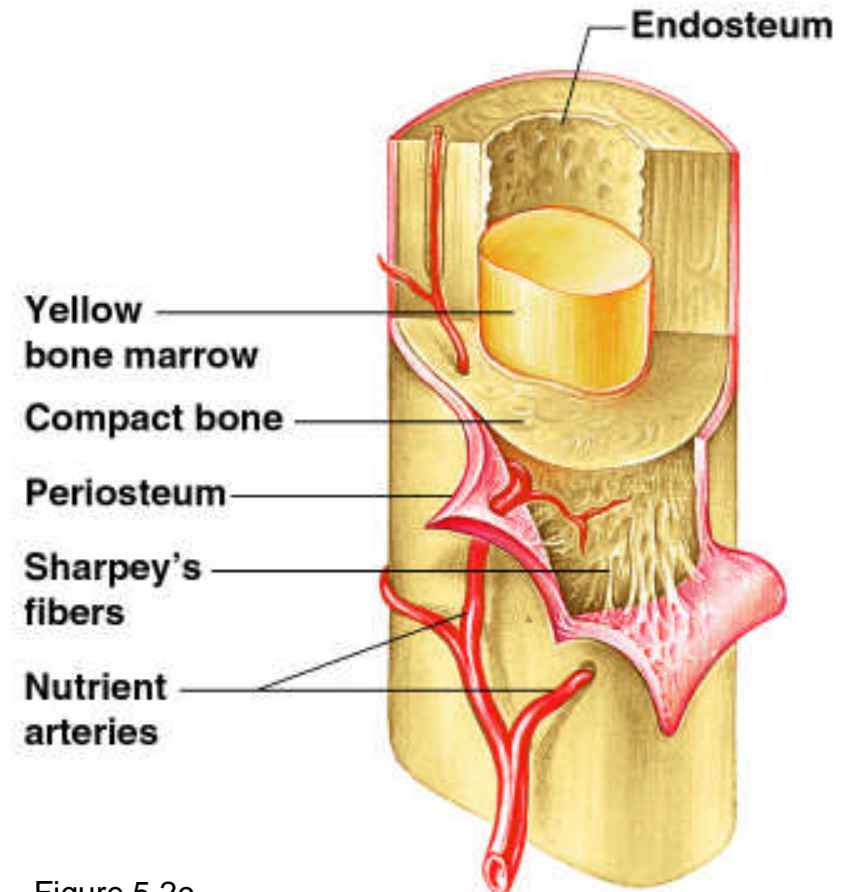


Figure 5.2c

# Structures of a Long Bone

- Articular cartilage
  - Covers the external surface of the epiphyses
  - Made of hyaline cartilage
  - Decreases friction at joint surfaces

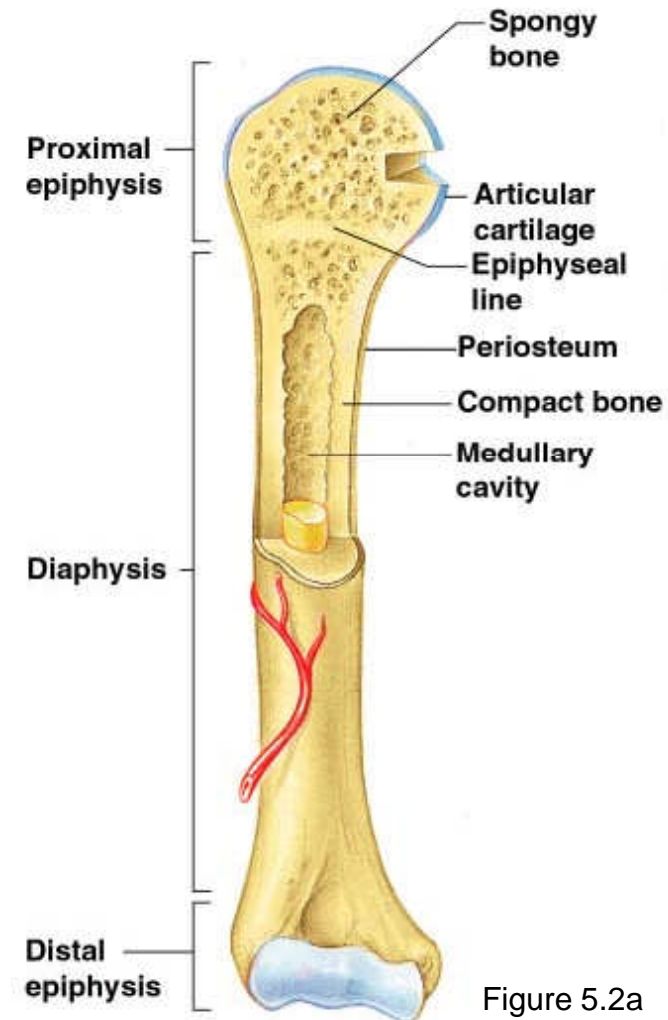
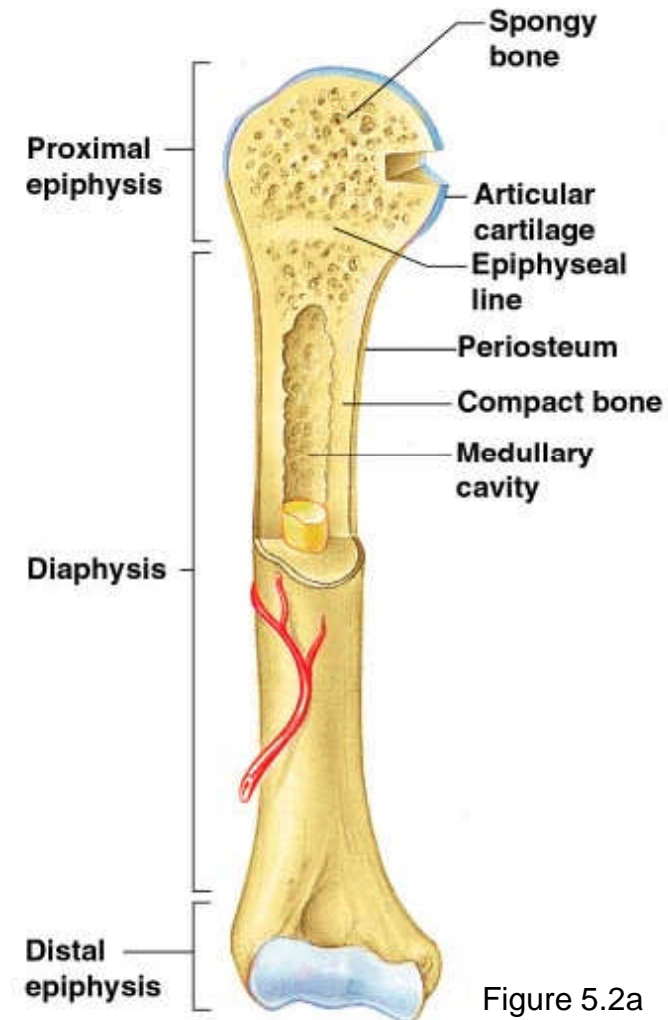


Figure 5.2a

# Structures of a Long Bone

- Medullary cavity
  - Cavity of the shaft
  - Contains yellow marrow (mostly fat) in adults
  - Contains red marrow (for blood cell formation) in infants



# Bone Markings

- Surface features of bones
- Sites of attachments for muscles, tendons, and ligaments
- Passages for nerves and blood vessels
- Categories of bone markings
  - Projections or processes – grow out from the bone surface
  - Depressions or cavities – indentations

# Microscopic Anatomy of Bone

- Osteon (Haversian System)
  - A unit of bone
- Central (Haversian) canal
  - Opening in the center of an osteon
  - Carries blood vessels and nerves
- Perforating (Volkman's) canal
  - Canal perpendicular to the central canal
  - Carries blood vessels and nerves



# Microscopic Anatomy of Bone

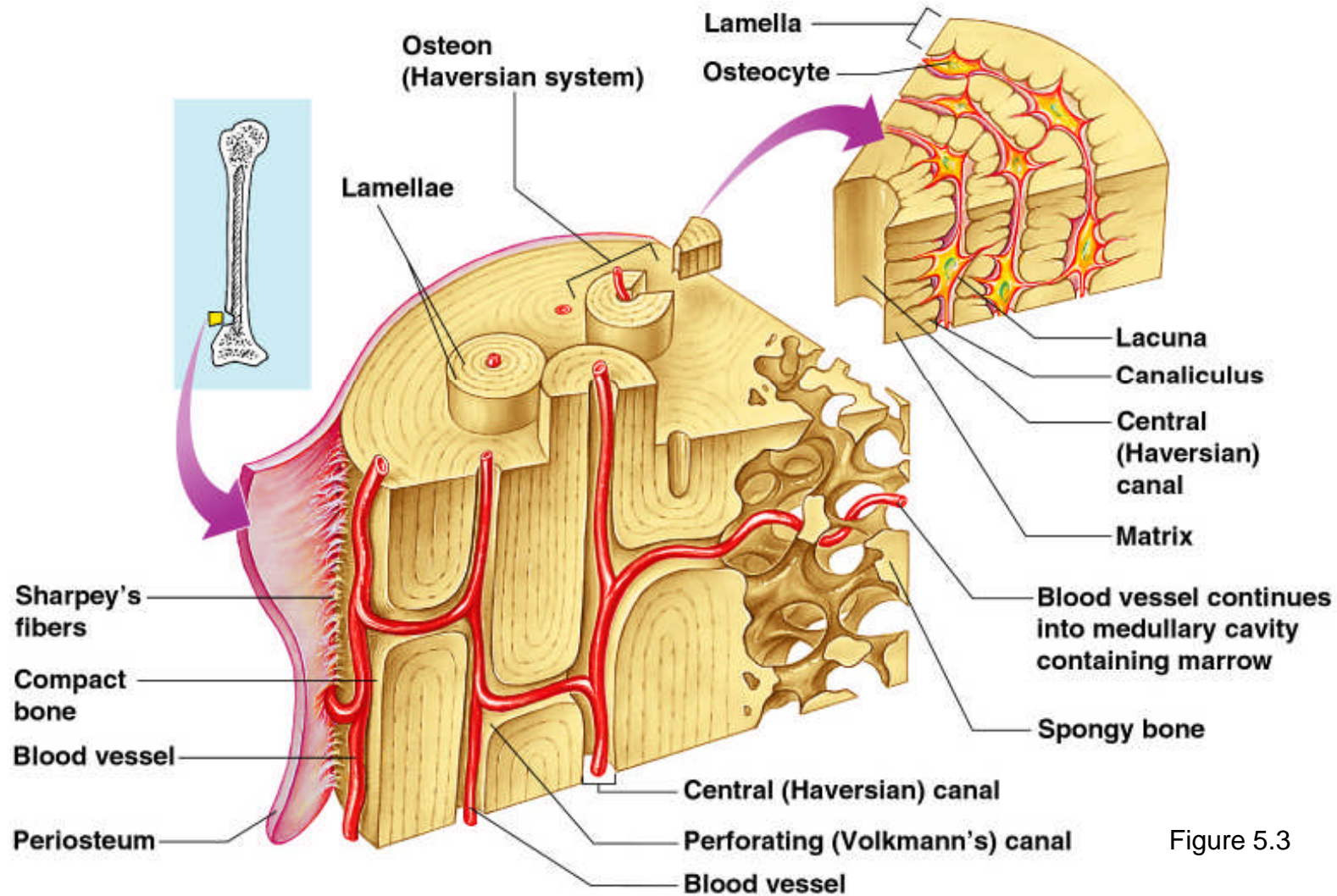


Figure 5.3

# Microscopic Anatomy of Bone

- Lacunae
  - Cavities containing bone cells (osteocytes)
  - Arranged in concentric rings
- Lamellae
  - Rings around the central canal
  - Sites of lacunae

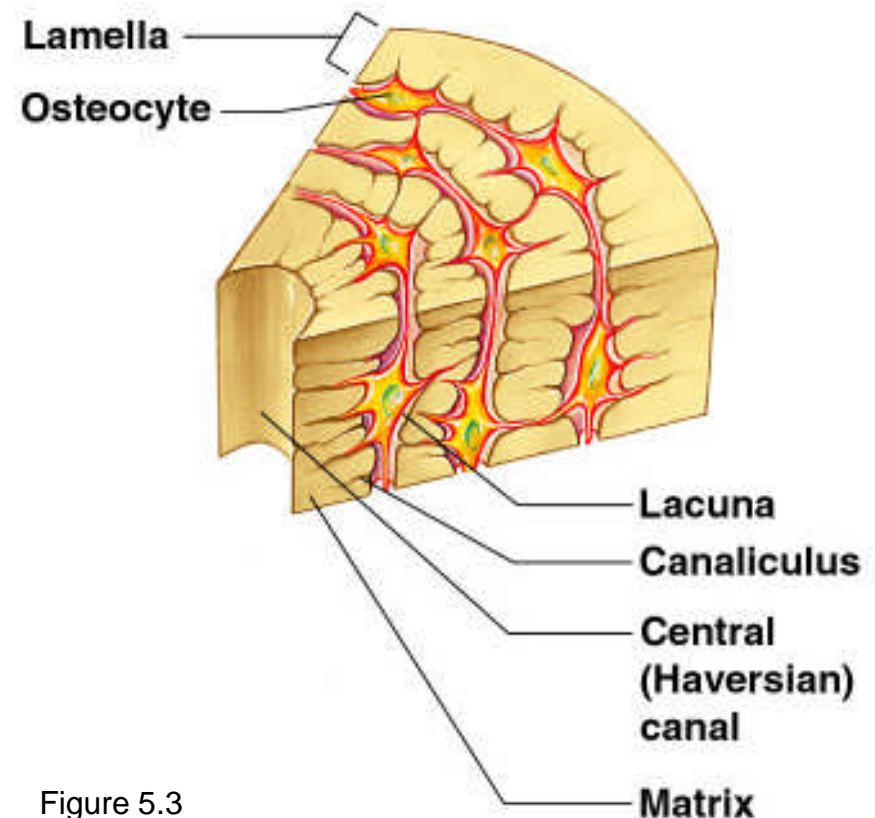


Figure 5.3

# Microscopic Anatomy of Bone

- Canaliculi
  - Tiny canals
  - Radiate from the central canal to lacunae
  - Form a transport system

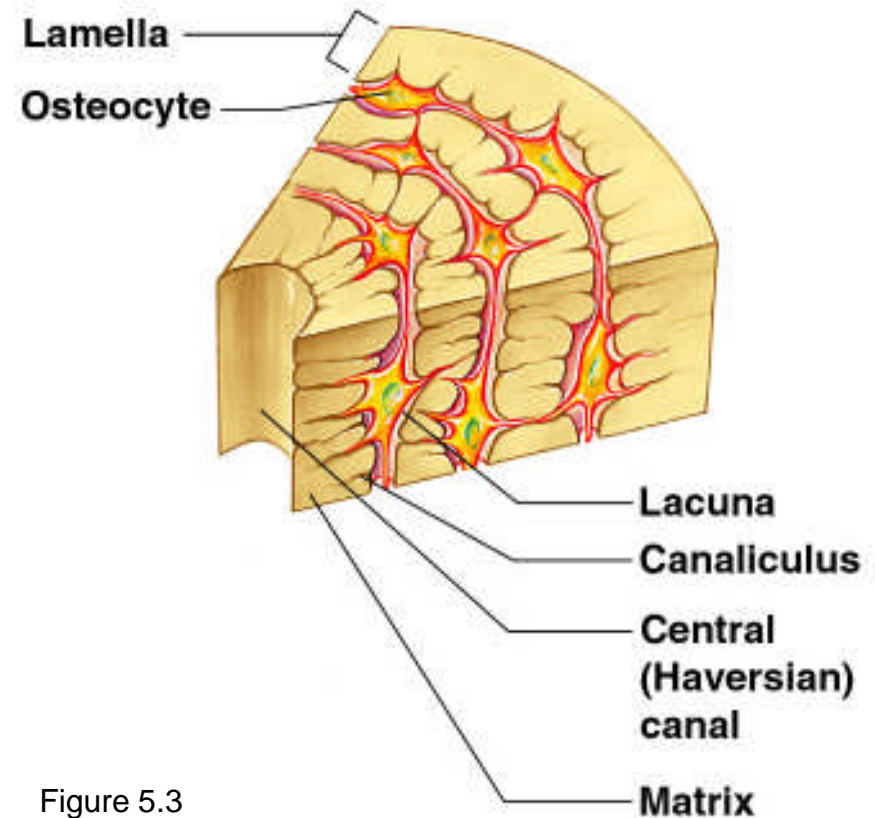


Figure 5.3

# Changes in the Human Skeleton

- In embryos, the skeleton is primarily hyaline cartilage
- During development, much of this cartilage is replaced by bone
- Cartilage remains in isolated areas
  - Bridge of the nose
  - Parts of ribs
  - Joints

# Bone Growth

- Epiphyseal plates allow for growth of long bone during childhood
  - New cartilage is continuously formed
  - Older cartilage becomes ossified
    - Cartilage is broken down
    - Bone replaces cartilage
      - Process of bone formation – ossification done by bone-forming cells called osteoblasts

# Bone Growth

- Bones are remodeled and lengthened until growth stops
  - Bones change shape somewhat
  - Bones grow in width – appositional growth
  - Growth due to growth hormones and sex hormones
- Bones are remodeled continually in response to:
  - Calcium levels in blood and pull of gravity and muscles on the bones



# Long Bone Formation and Growth

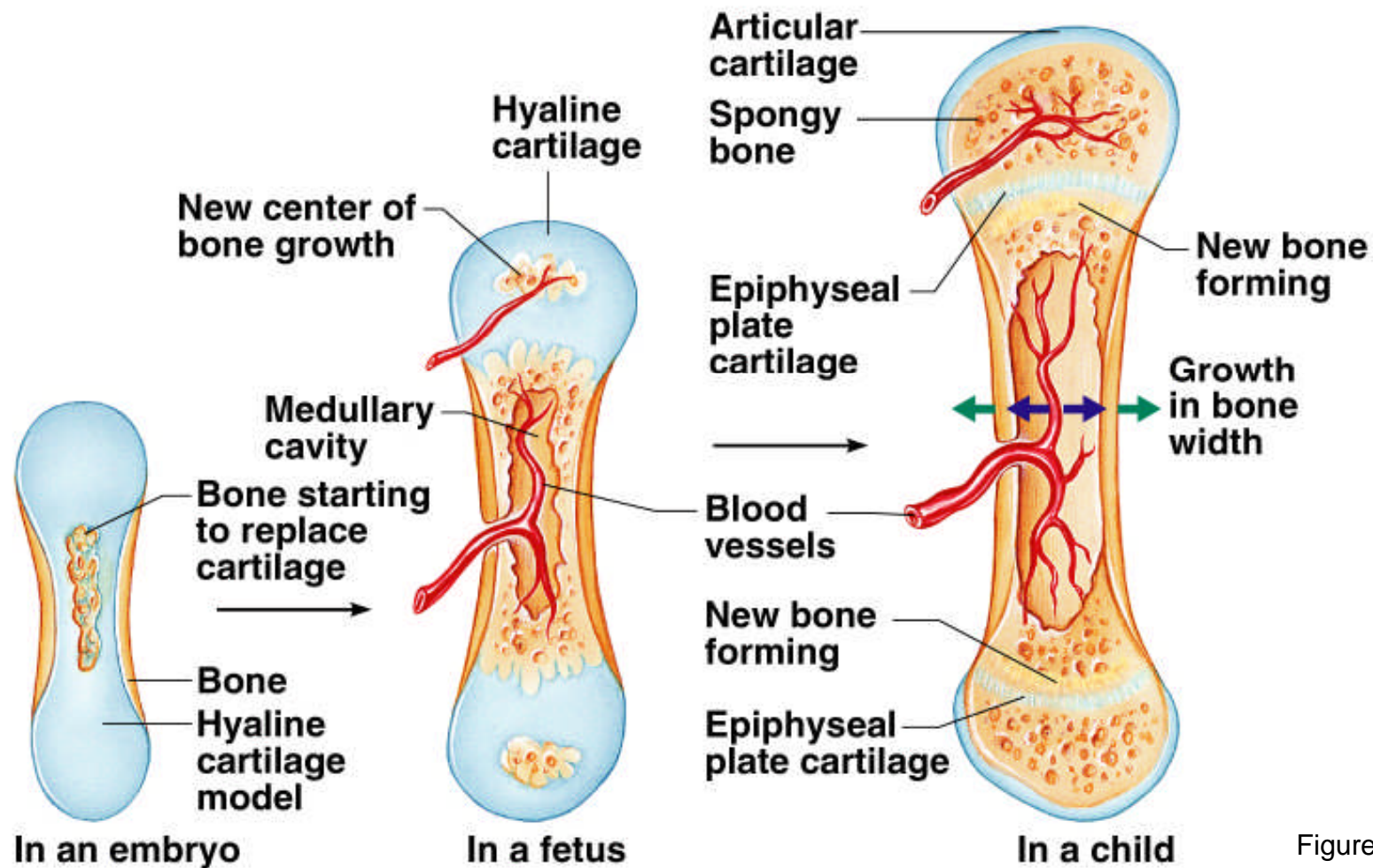


Figure 5.4a

# Long Bone Formation and Growth

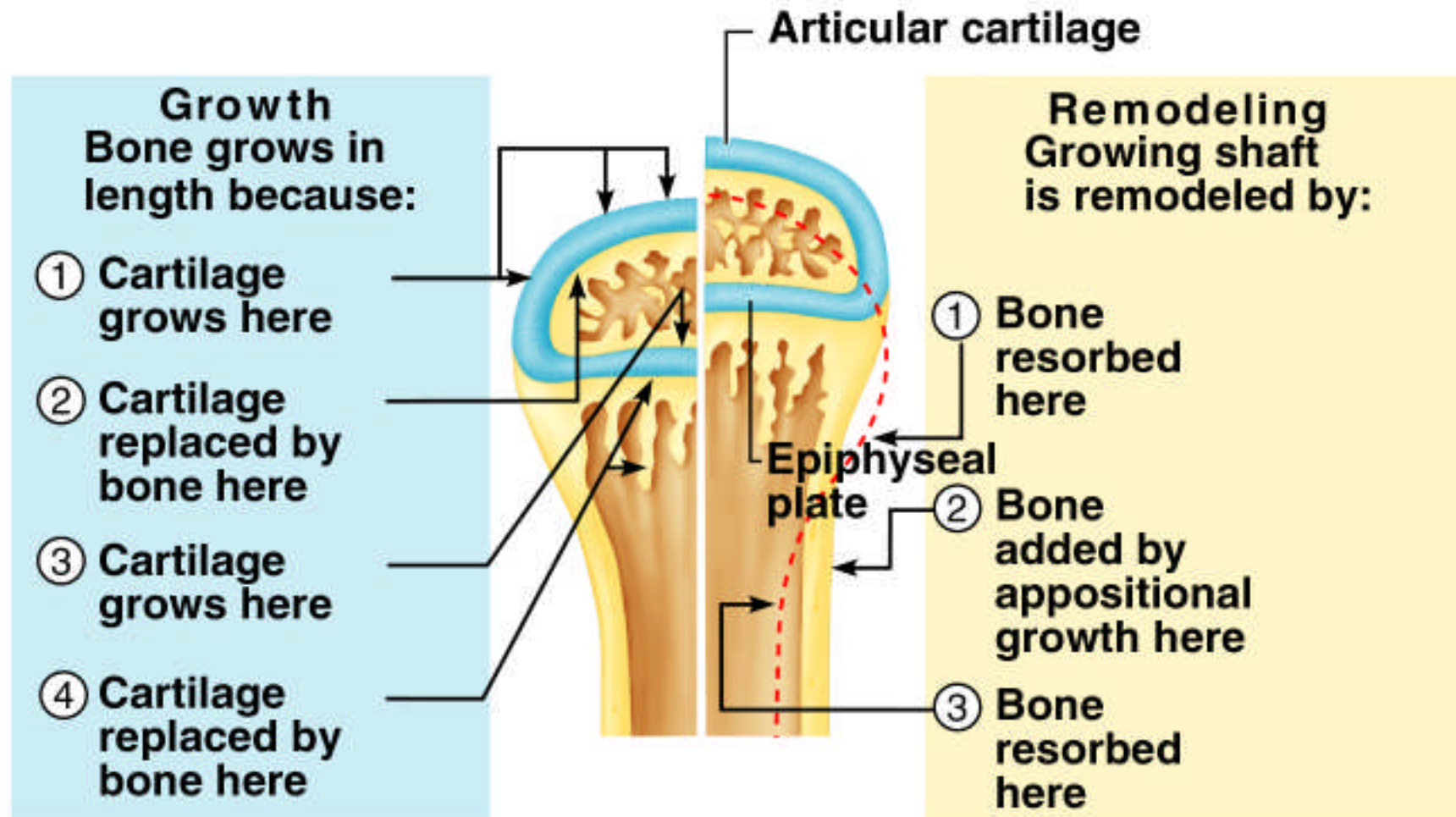


Figure 5.4b



# 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

# Bone Fractures

- A break in a bone
- Types of bone fractures
  - Closed (simple) fracture – break that does not penetrate the skin
  - Open (compound) fracture – broken bone penetrates through the skin
- Bone fractures are treated by reduction and immobilization
  - Realignment of the bone – either by physician's hands or surgery

# Common Types of Fractures





Fracture type	Illustration	Description	Comment
Comminuted		Bone breaks into many fragments.	Particularly common in the aged, whose bones are more brittle.
Compression		Bone is crushed. (i.e., osteoporotic bones).	Common in porous bones
Depressed		Broken bone portion is pressed inward.	Typical of skull fracture.
Impacted		Broken bone ends are forced into each other.	Commonly occurs when one attempts to break a fall with outstretched arms
Spiral		Ragged break occurs when excessive twisting forces are applied to a bone.	Common sports fracture.
Greenstick		Bone breaks incompletely, much in the way a green adults.	Common in children, whose bones are more flexible than those of

Table 5.2

# Repair of Bone Fractures

- Hematoma (blood-filled swelling) is formed due to broken blood vessels
- Break is splinted by fibrocartilage to form a callus – cartilage matrix, bony matrix, collagen fibers – capillaries also form again
- Fibrocartilage callus is replaced by a bony callus made of spongy bone
- Bony callus is remodeled to form a permanent patch

# Stages in the Healing of a Bone Fracture

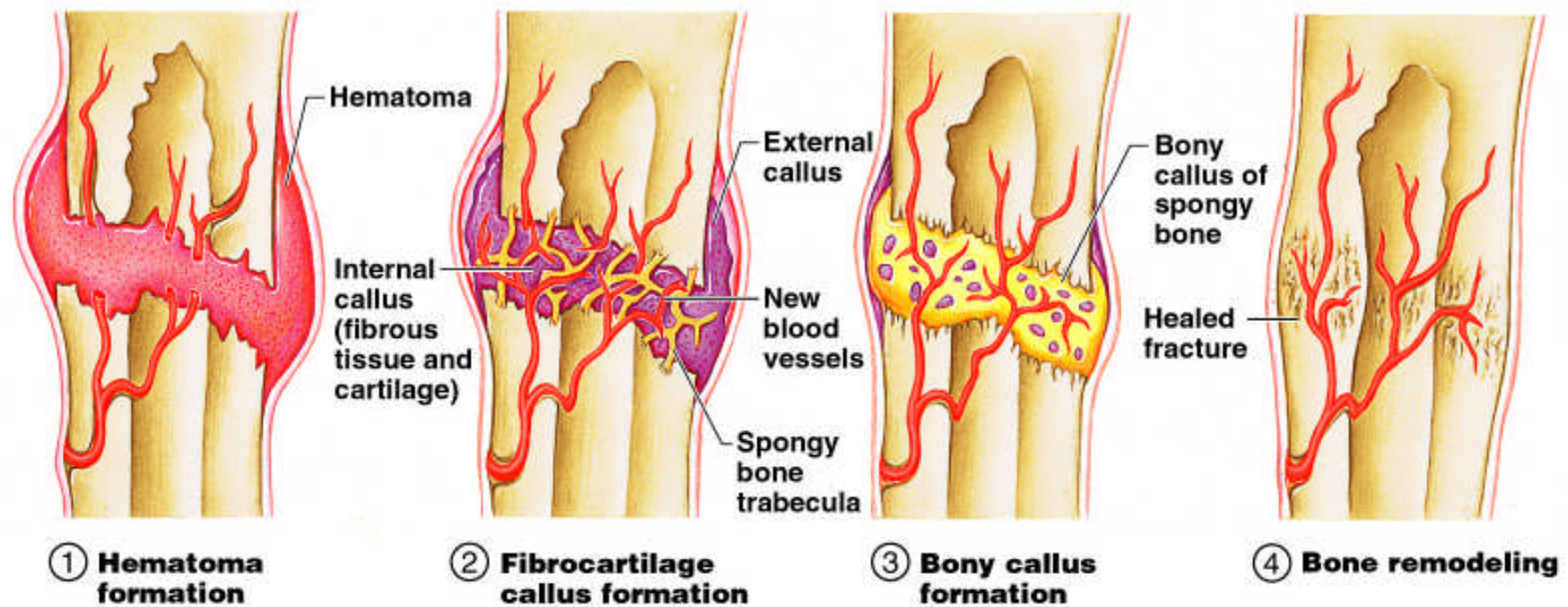


Figure 5.5

# The Axial Skeleton

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

# The Axial Skeleton

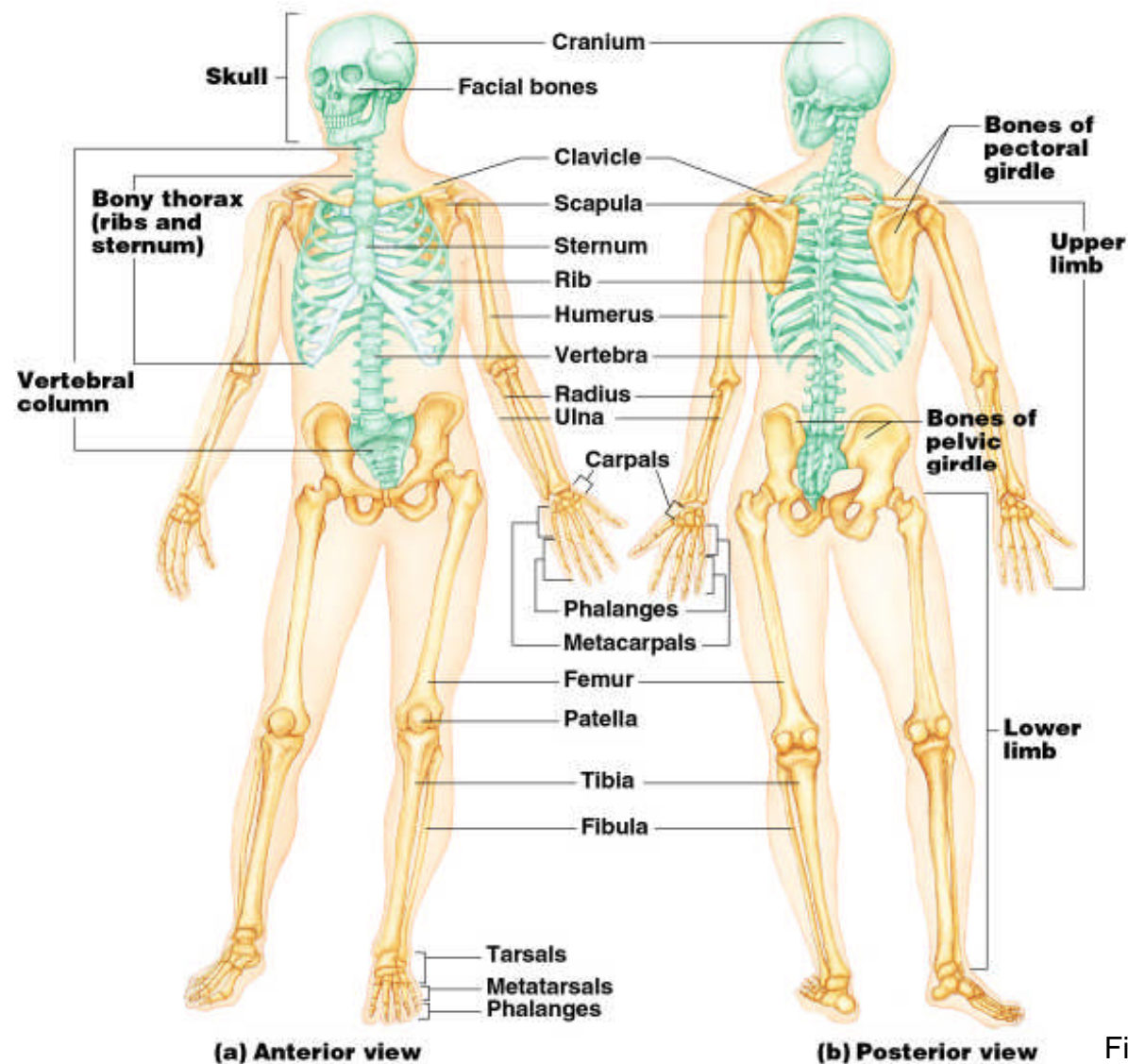


Figure 5.6



# The Skull

- Two sets of bones
  - Cranium
  - Facial bones
- Bones are joined by sutures – interlocking, immovable joints
- Only the mandible is attached by a freely movable joint



# The Skull

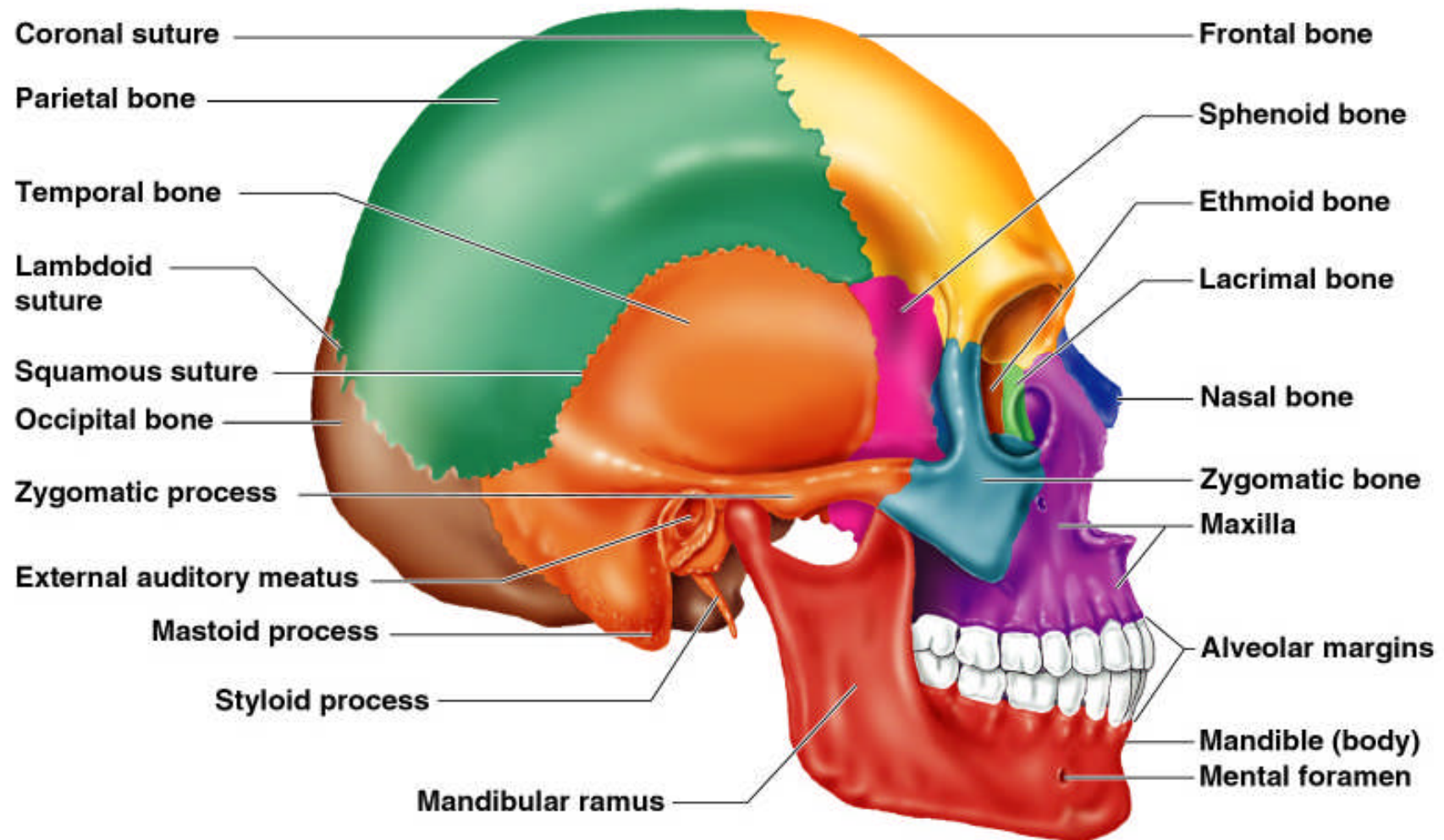


Figure 5.7

# Bones of the Skull

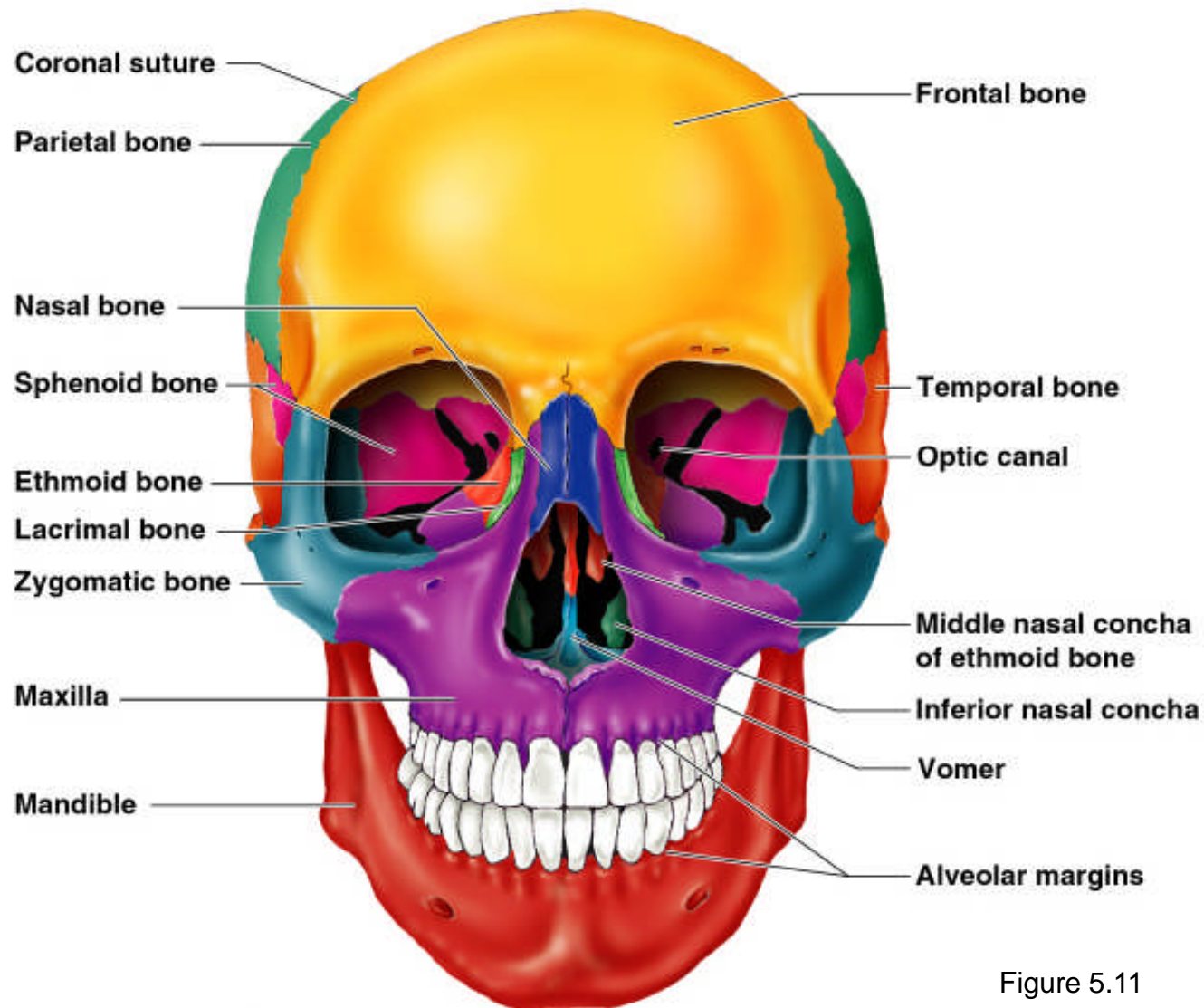


Figure 5.11

# Human Skull, Superior View

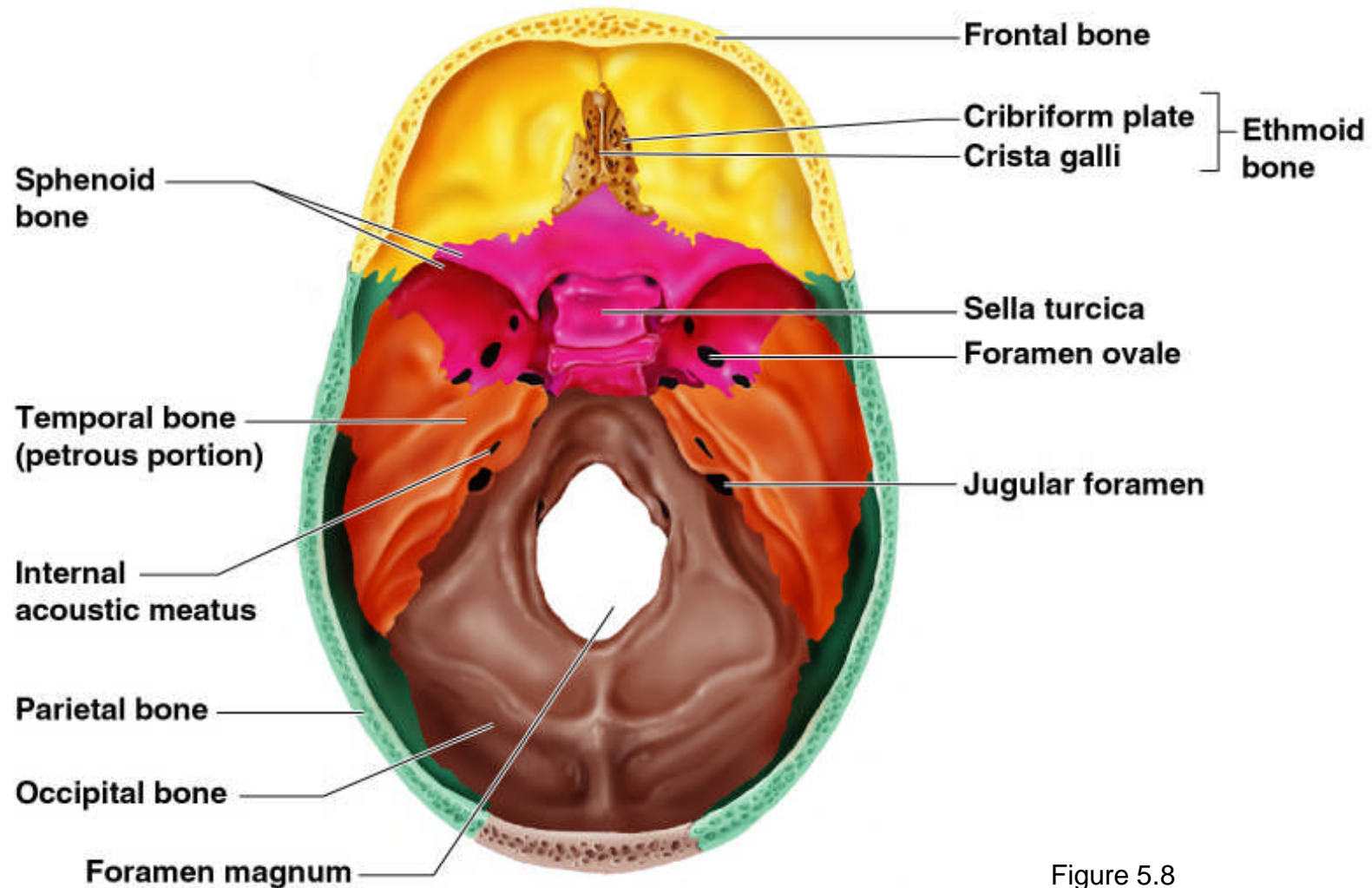


Figure 5.8



# Human Skull, Inferior View

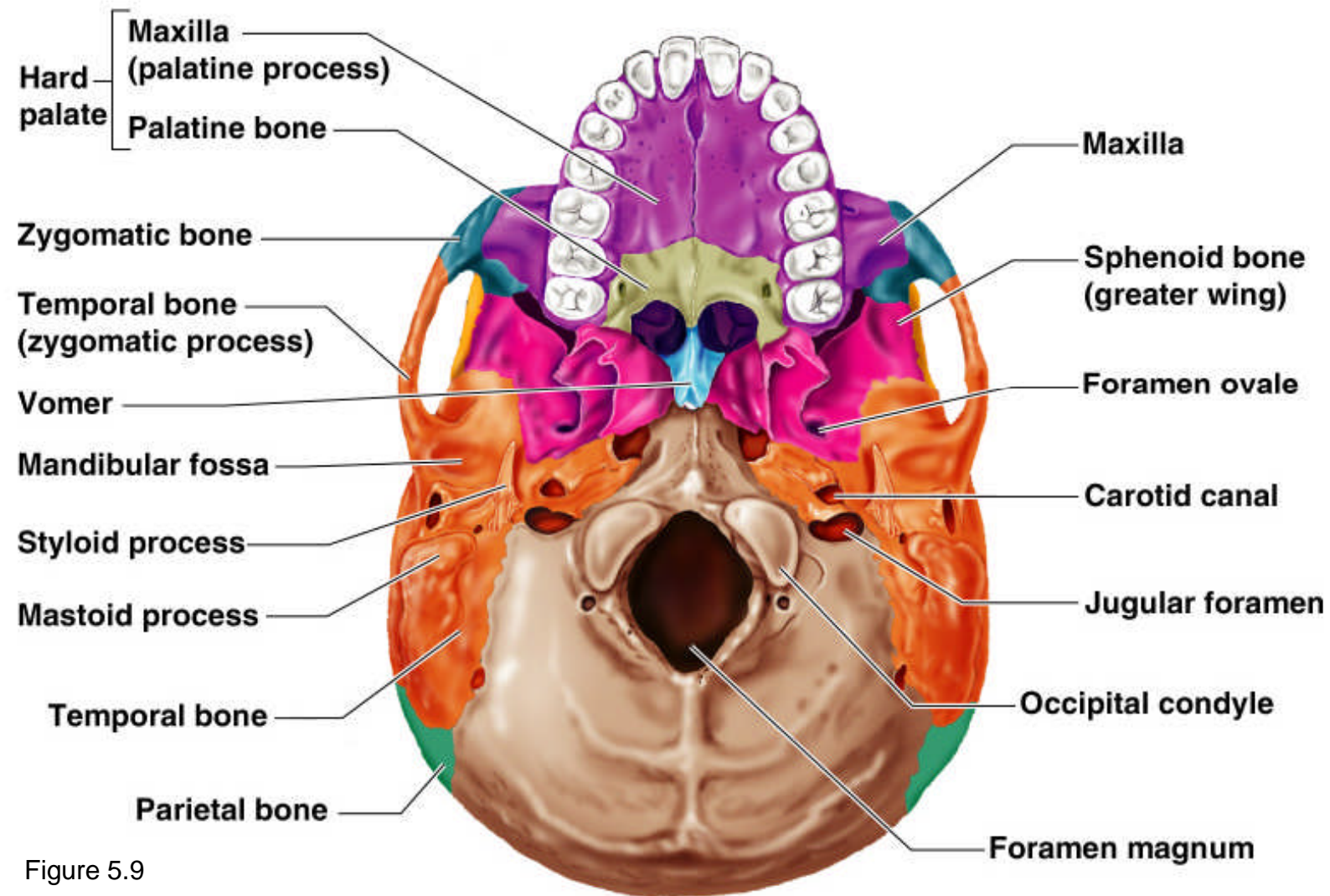


Figure 5.9

# Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity

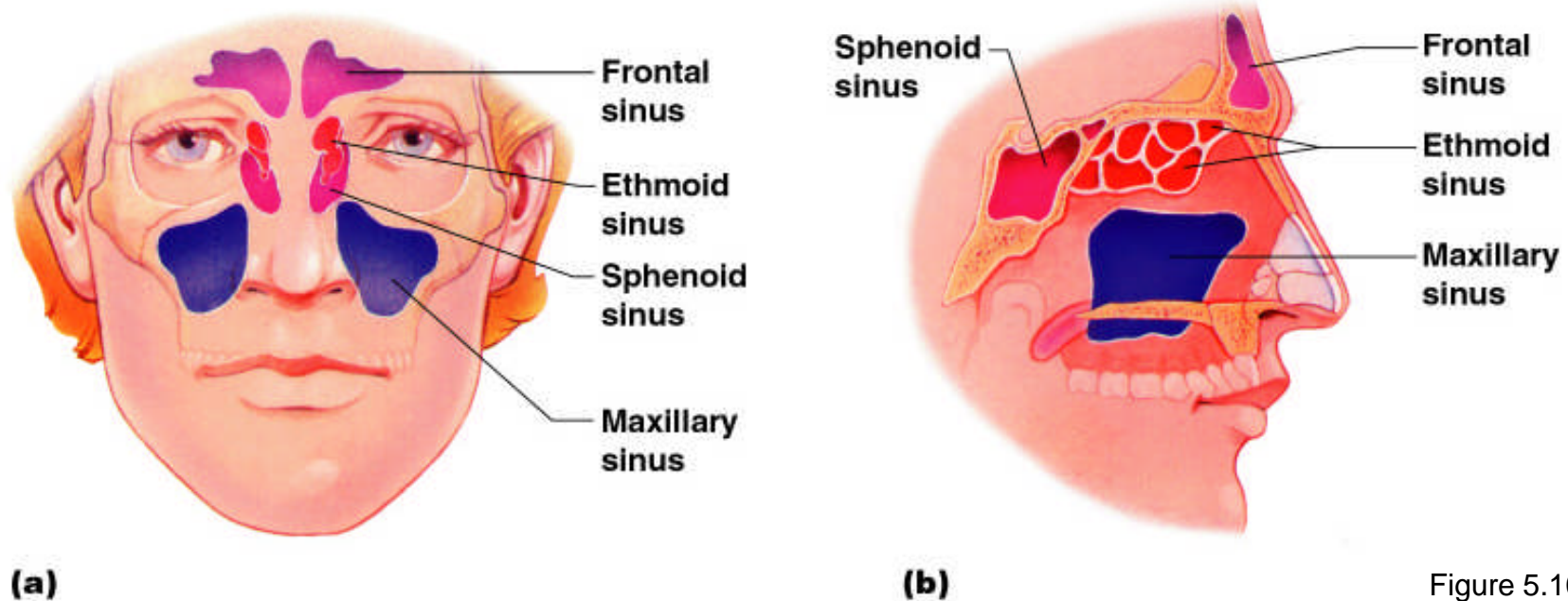


Figure 5.10

# Paranasal Sinuses

- Functions of paranasal sinuses
  - Lighten the skull
  - Give resonance and amplification to voice

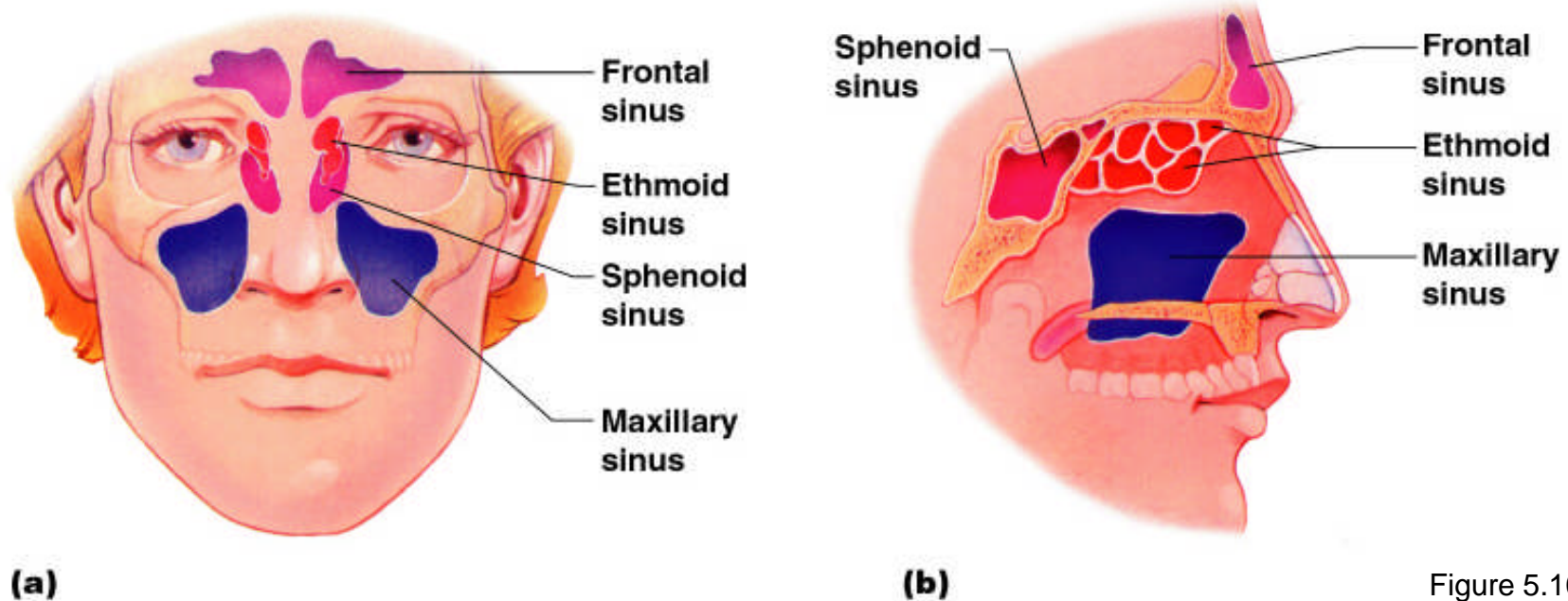


Figure 5.10

# The Hyoid Bone

- The only bone that does not articulate with another bone
- Serves as a moveable base for the tongue and as an attachment point for neck muscles that raise and lower the larynx when we swallow and speak

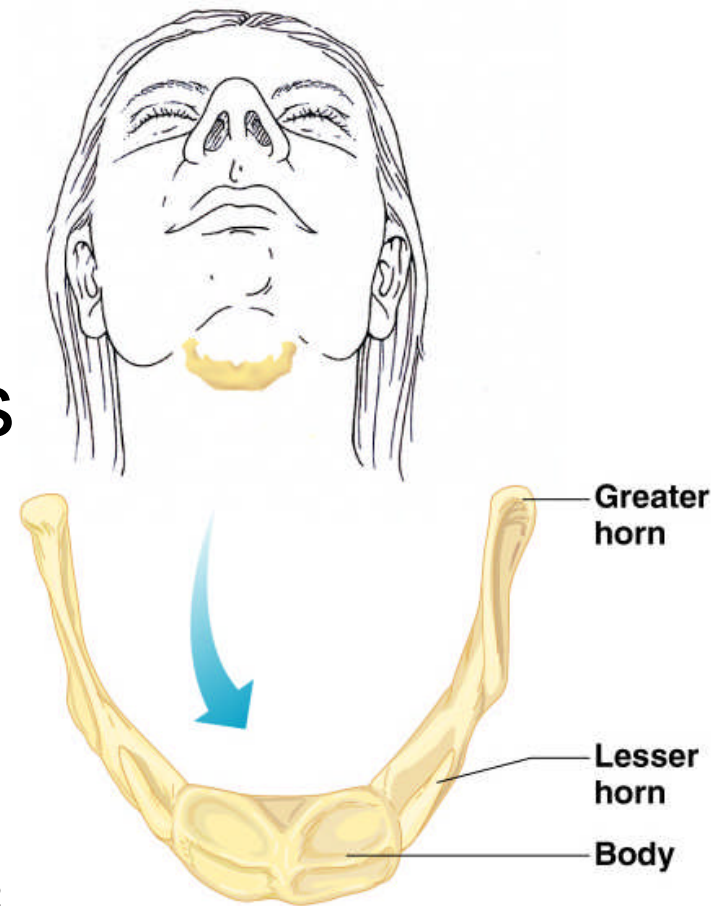


Figure 5.12



# The Fetal Skull

- The infant's face is very small compared to the size of the cranium
- The fetal skull is large compared to the infants total body length
- Skull is unfinished at birth

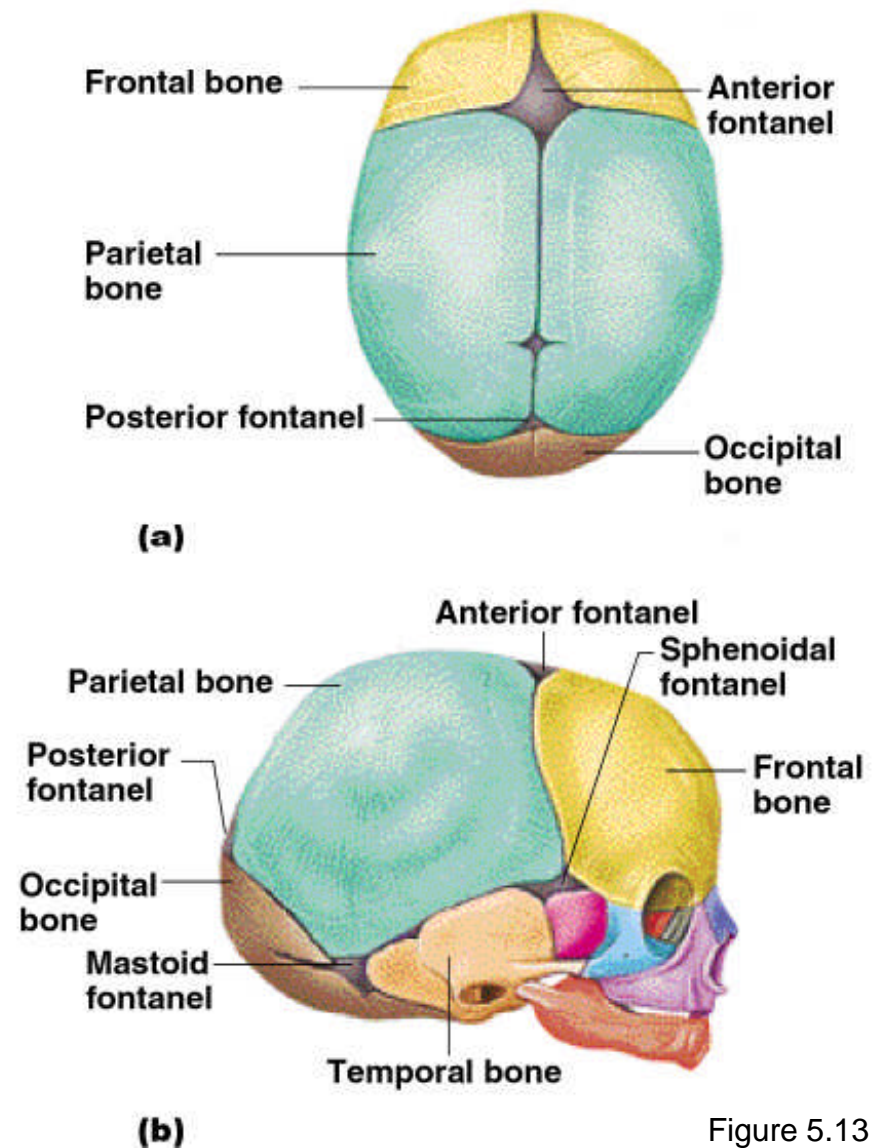


Figure 5.13

Slide 5.40



# The Fetal Skull

- Fontanelles – fibrous membranes connecting the cranial bones
  - Soft spots
  - Allow the brain to grow and for easier delivery
  - Convert to bone within 24 months after birth

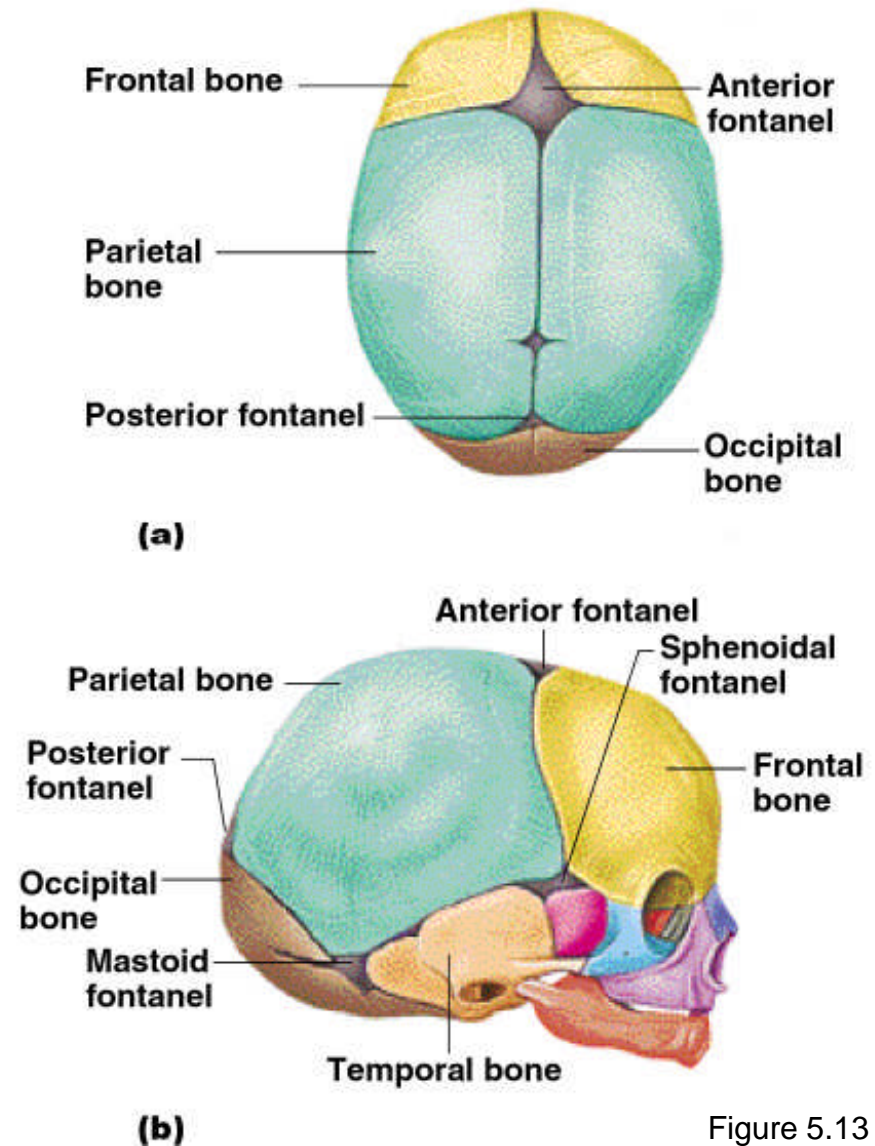


Figure 5.13

Slide 5.41

# The Vertebral Column – Spine

- Vertebrae separated by intervertebral discs
- The spine has a normal curvature
- Each vertebrae is given a name according to its location
- Before birth 33 : then 9 fuse

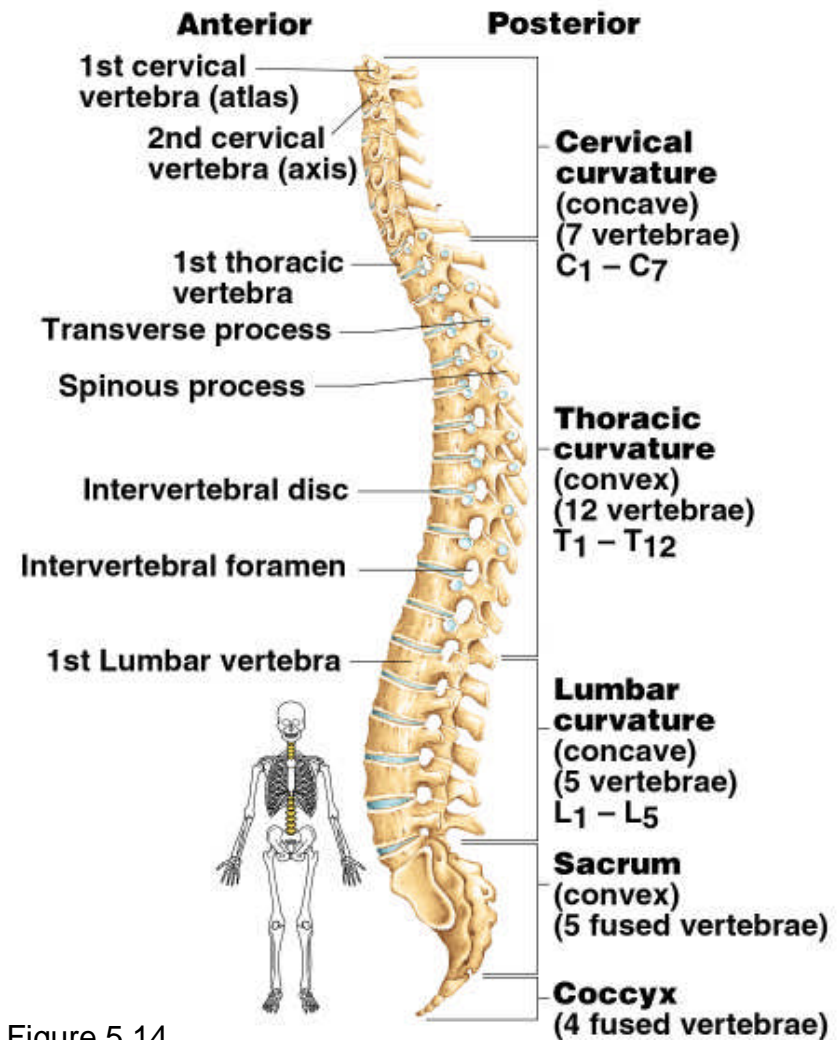


Figure 5.14

# Structure of a Typical Vertebrae

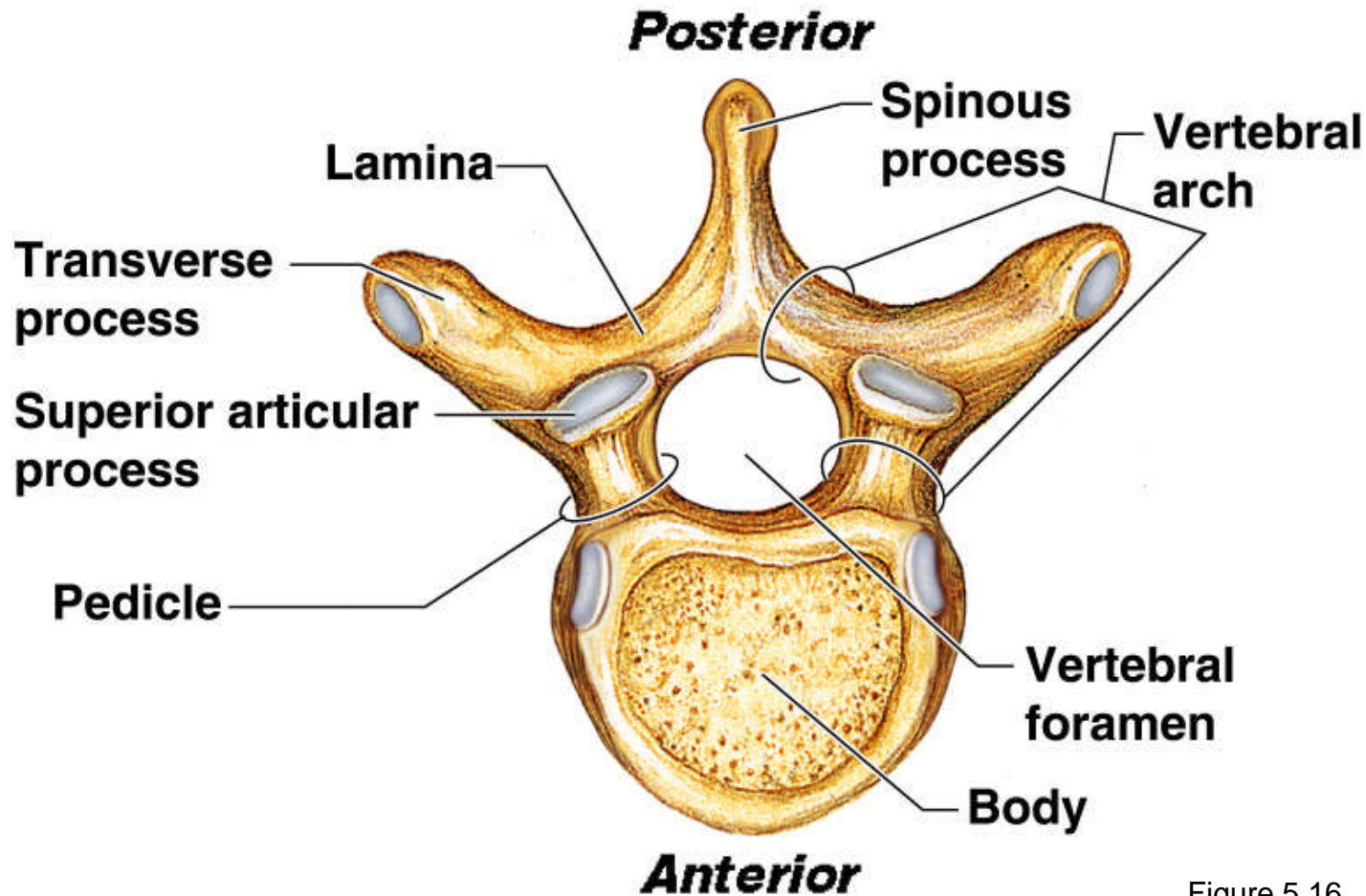


Figure 5.16

# Regional Characteristics of Vertebrae

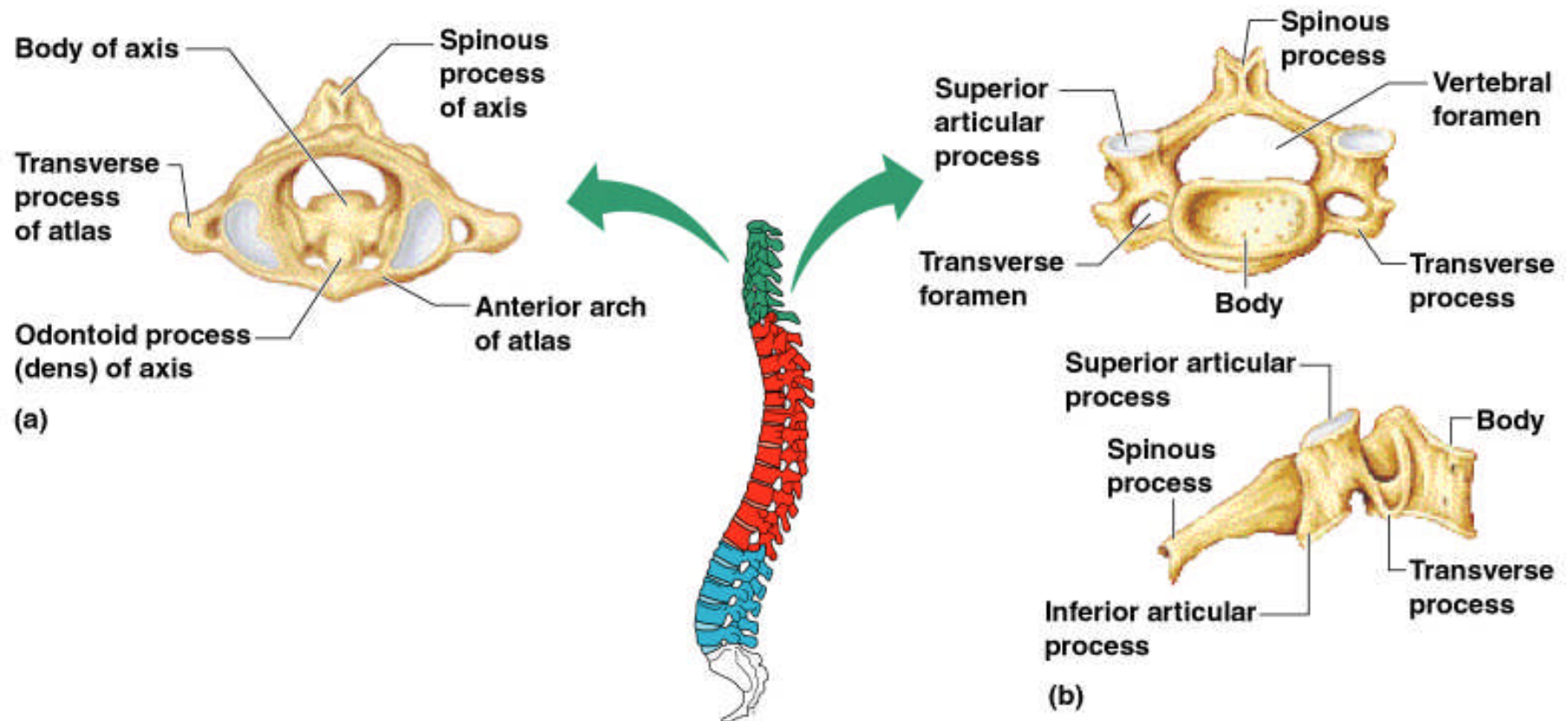


Figure 5.17a, b



# Regional Characteristics of Vertebrae

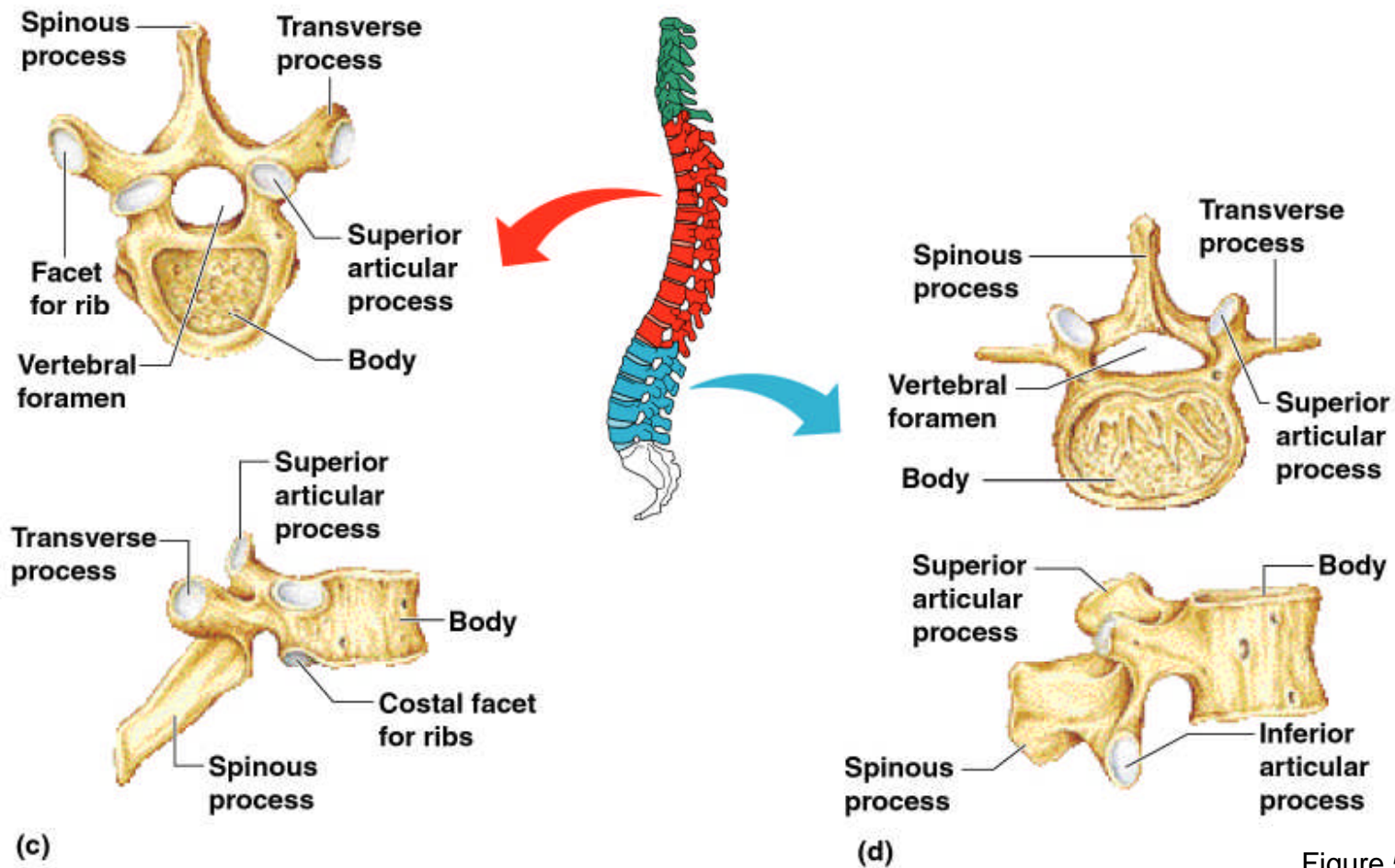


Figure 5.17c, d

Slide 5.45

# The Bony Thorax

- Forms a cage to protect major organs

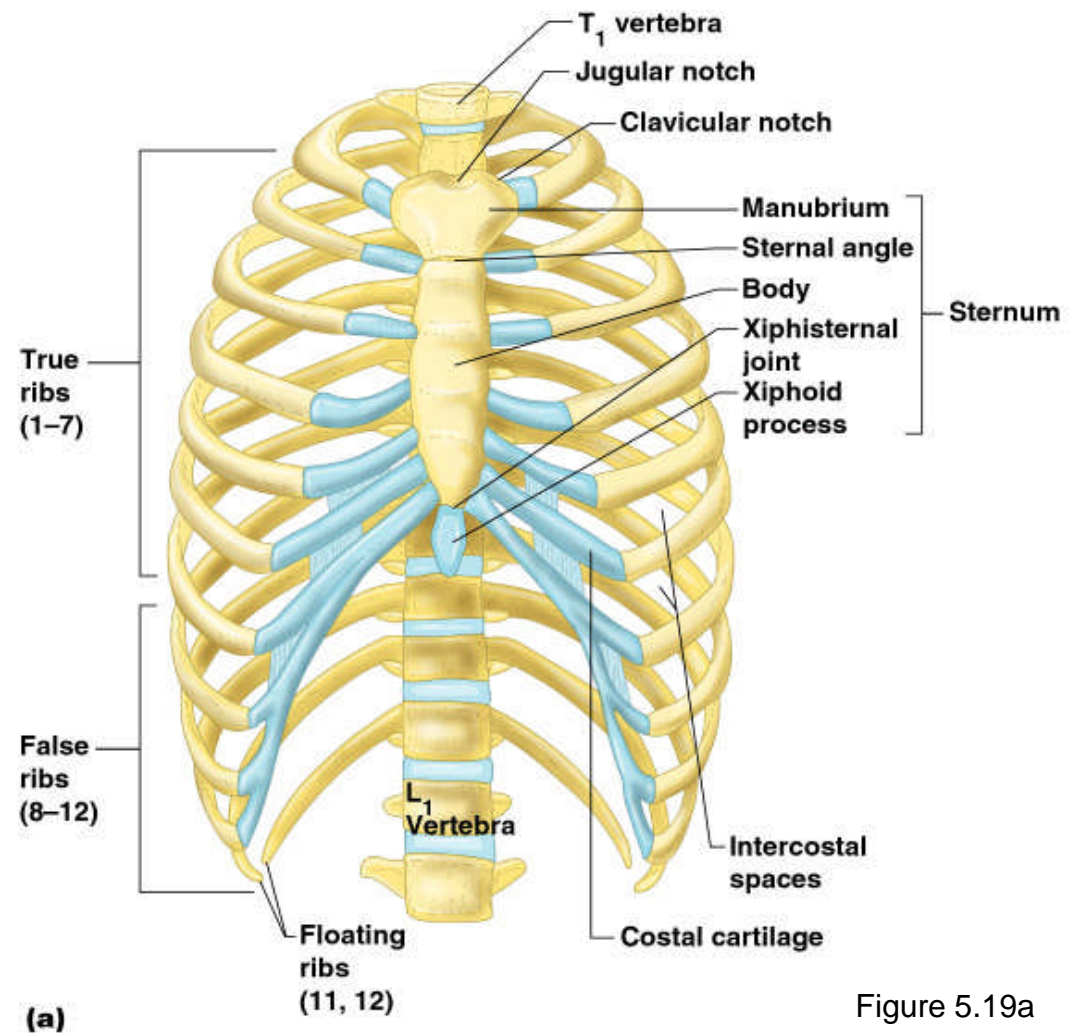


Figure 5.19a

# The Bony Thorax

- Made-up of three parts
  - Sternum
  - Ribs
  - Thoracic vertebrae

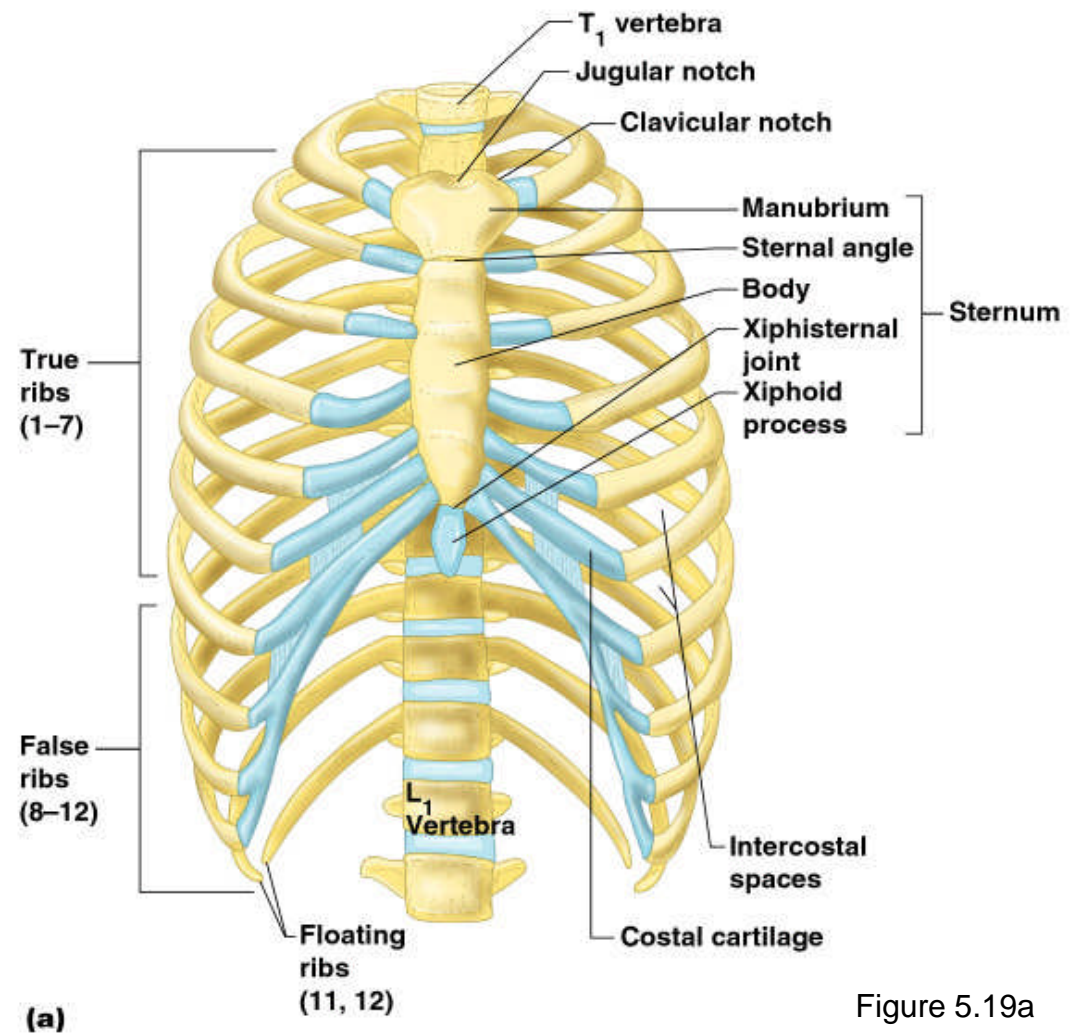


Figure 5.19a

# The Appendicular Skeleton

- 126 bones of the:
  - Limbs (appendages)
  - Pectoral girdle
  - Pelvic girdle



# The Appendicular Skeleton

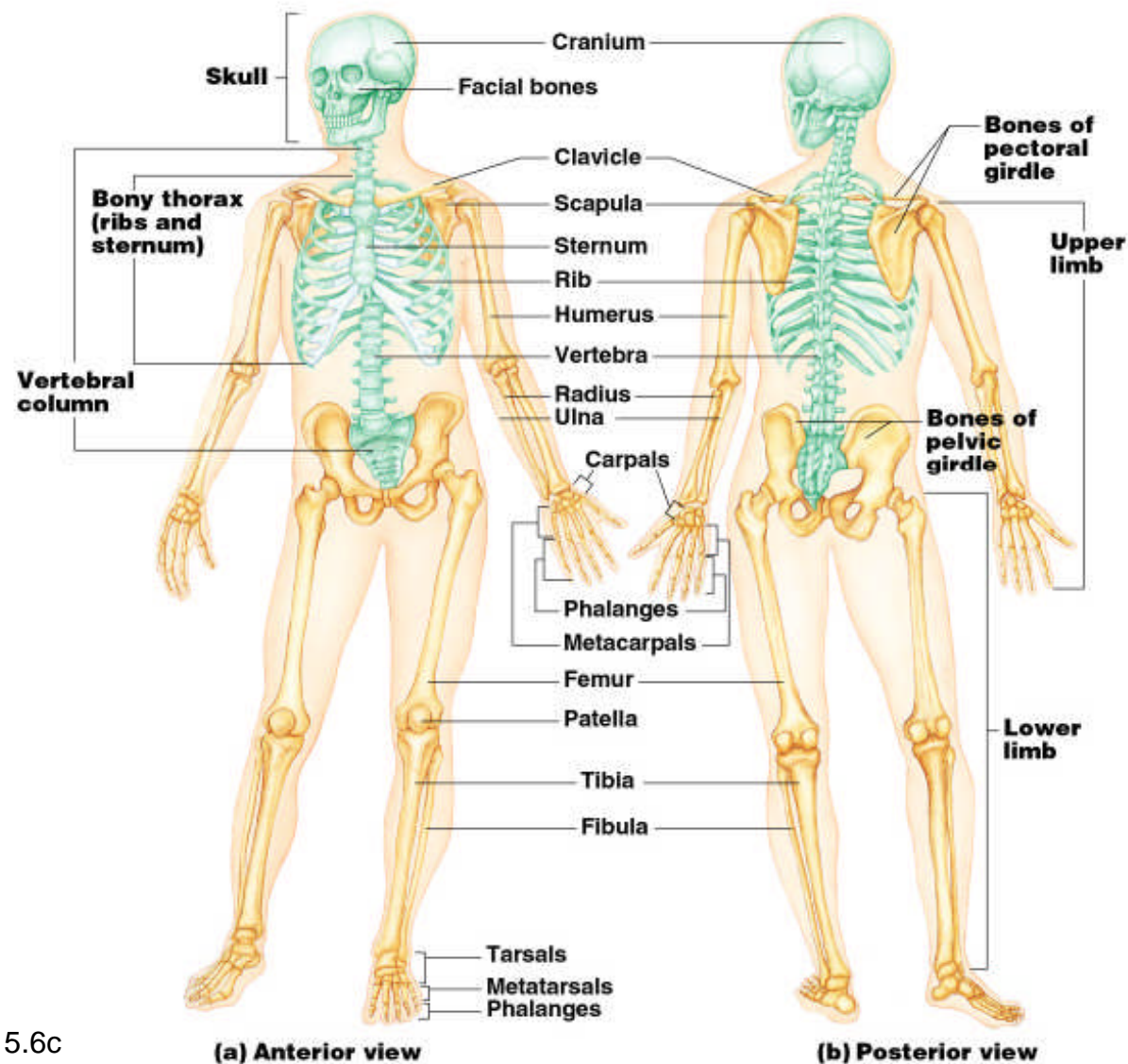
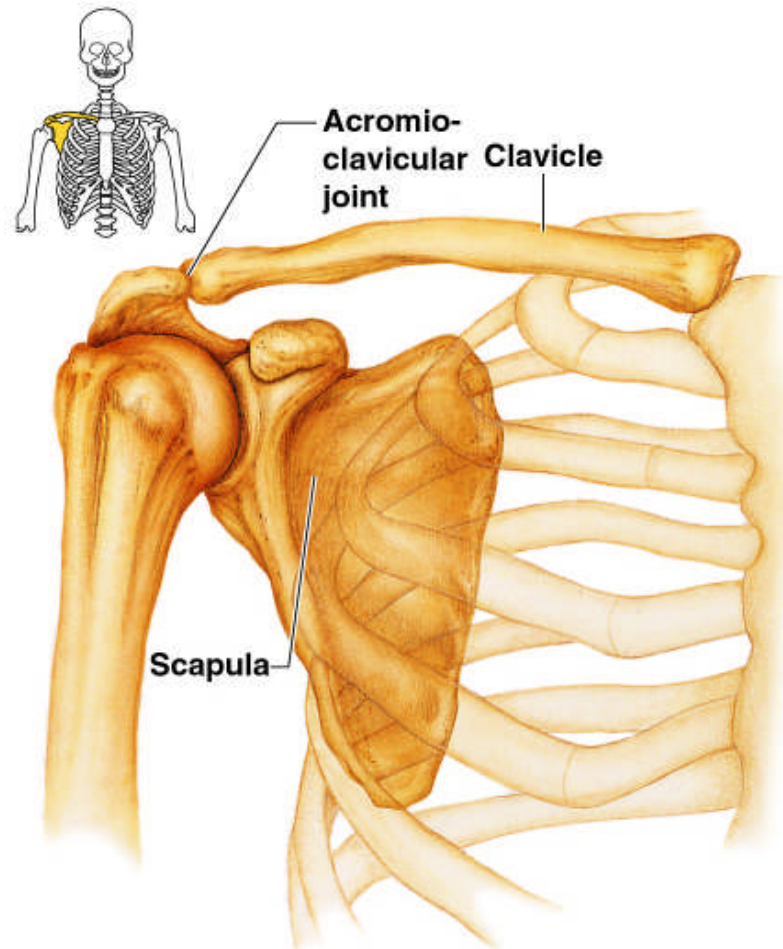


Figure 5.6c

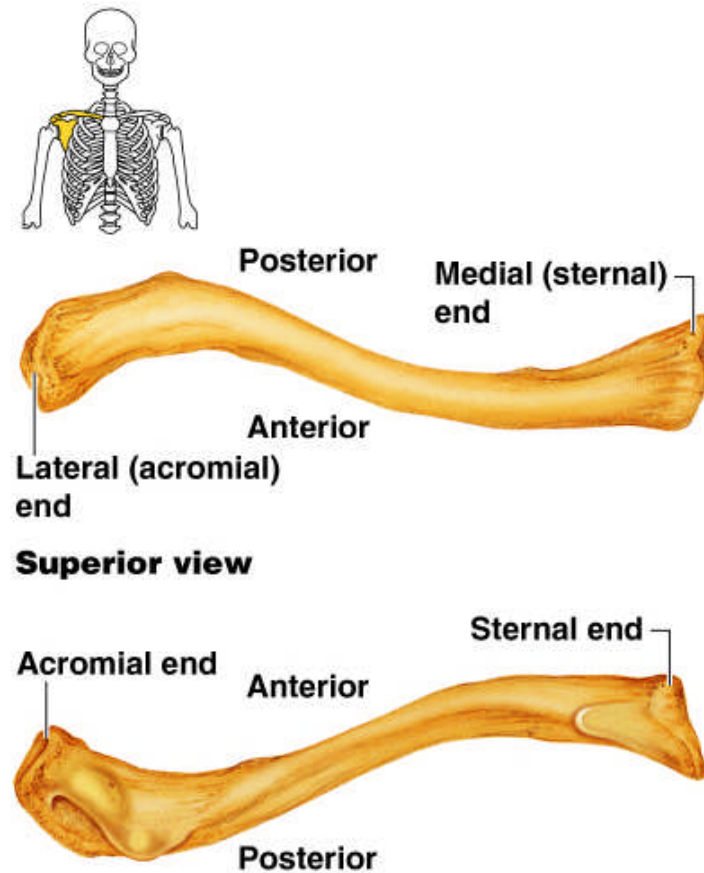
# The Pectoral (Shoulder) Girdle

- Composed of two bones
  - Clavicle – collarbone and Scapula – shoulder blade
- These bones allow the upper limb to have exceptionally free movement due to:
  - Each shoulder girdle attaches to the axial skeleton at only one point
  - Loose attachment of the scapula allows it to slide back and forth against the thorax as muscles act
  - The glenoid cavity is shallow, and the shoulder joint is poorly reinforced by ligaments

# Bones of the Shoulder Girdle



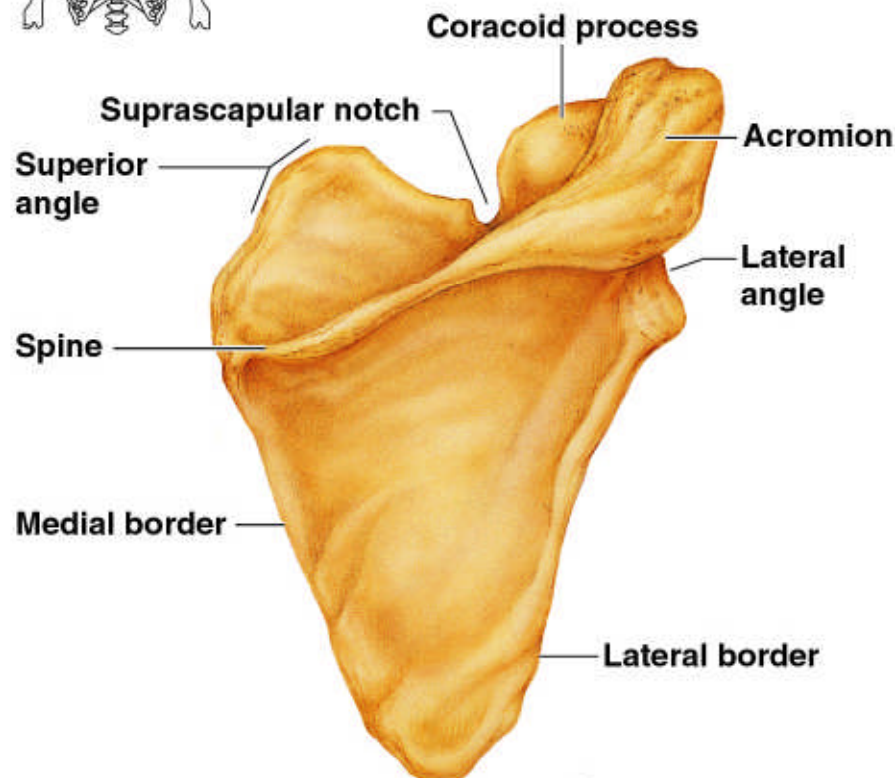
**(a) Articulated pectoral girdle**



**Inferior view**  
**(b) Right clavicle**

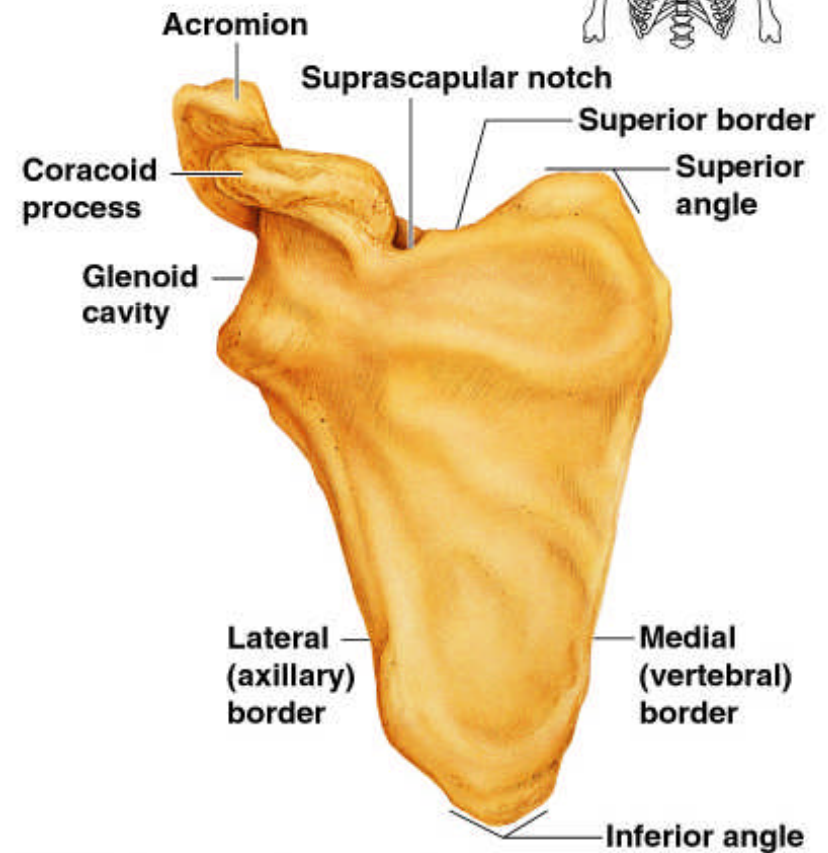
Figure 5.20a, b

# Bones of the Shoulder Girdle



**(c) Right scapula, posterior aspect**

Figure 5.20c, d



**(d) Right scapula, anterior aspect**



# Bones of the Upper Limb

- The arm is formed by a single bone
- Humerus

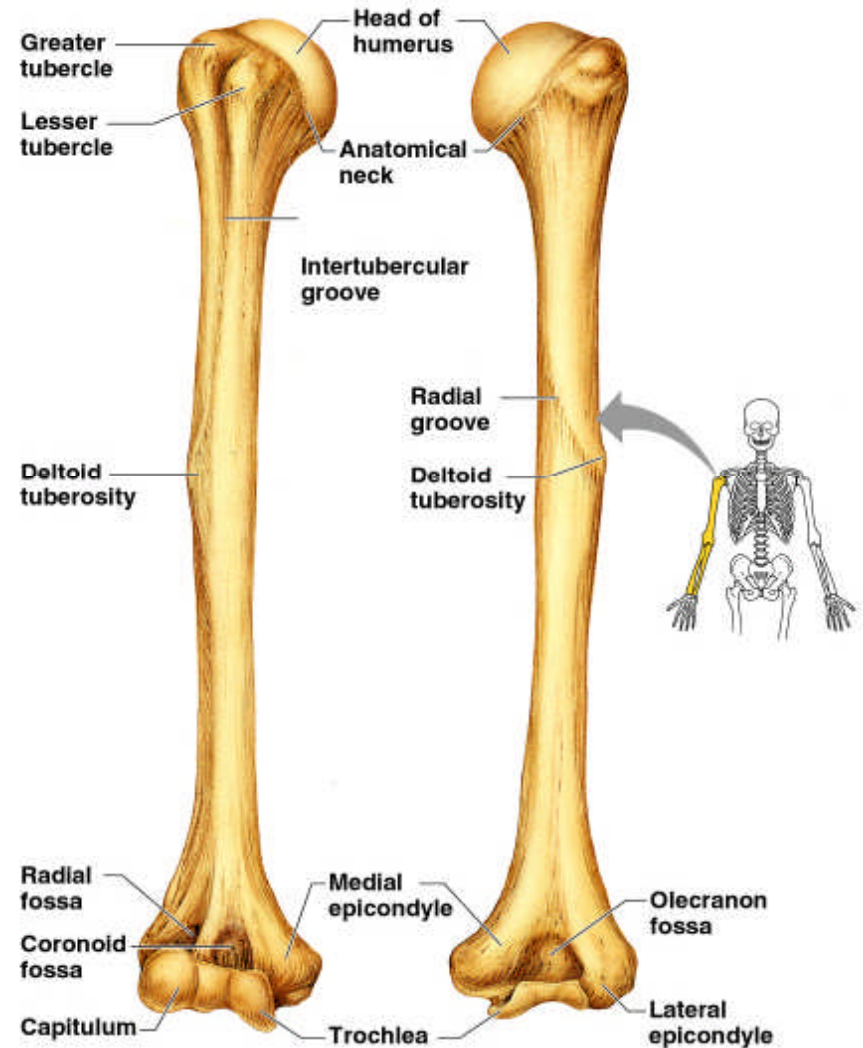


Figure 5.21a, b

# Bones of the Upper Limb

- The forearm has two bones
  - Ulna
  - Radius

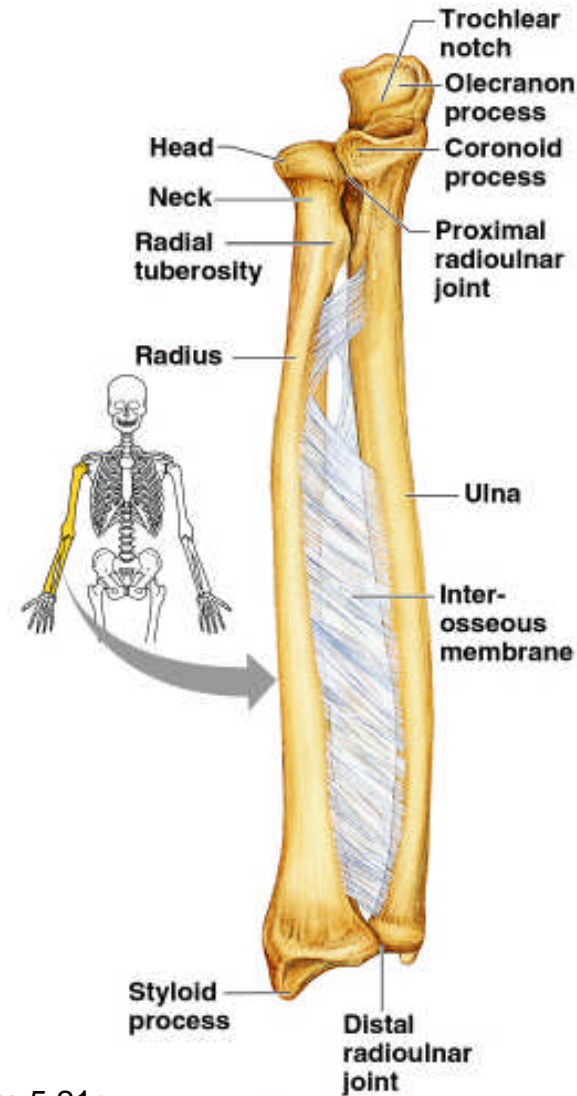


Figure 5.21c

# Bones of the Upper Limb

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

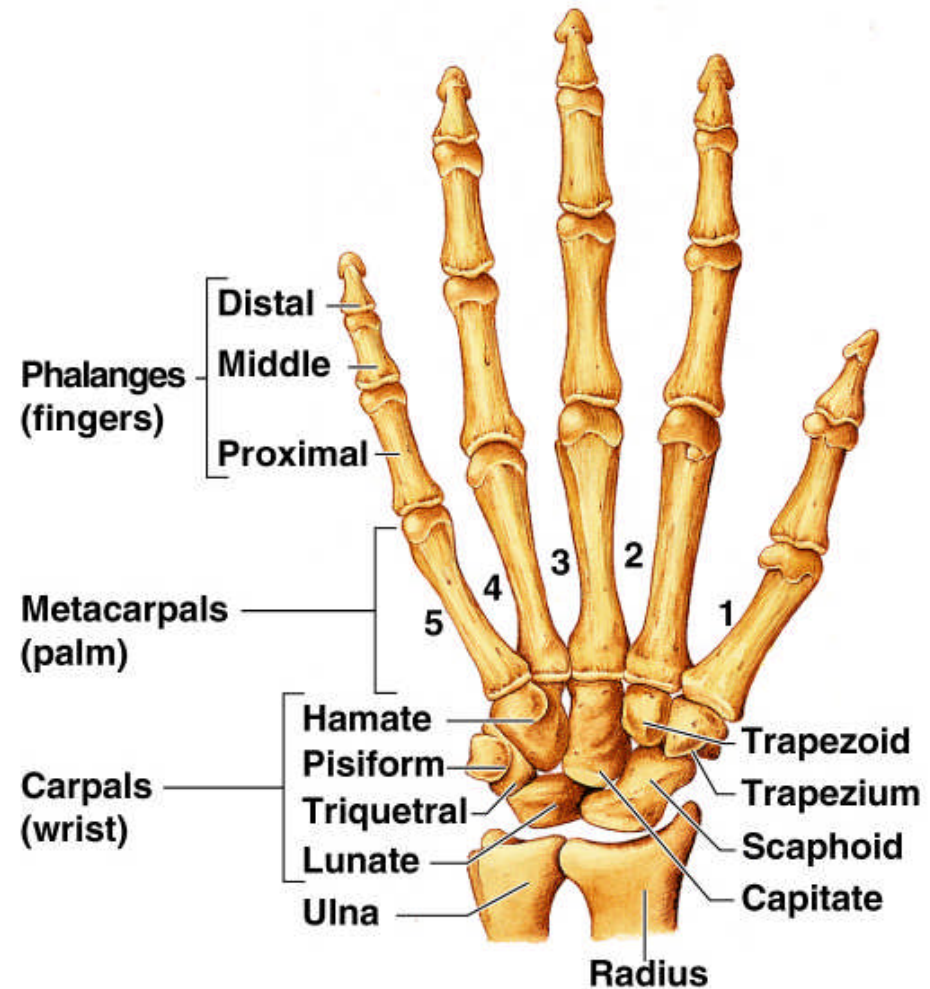


Figure 5.22

# 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

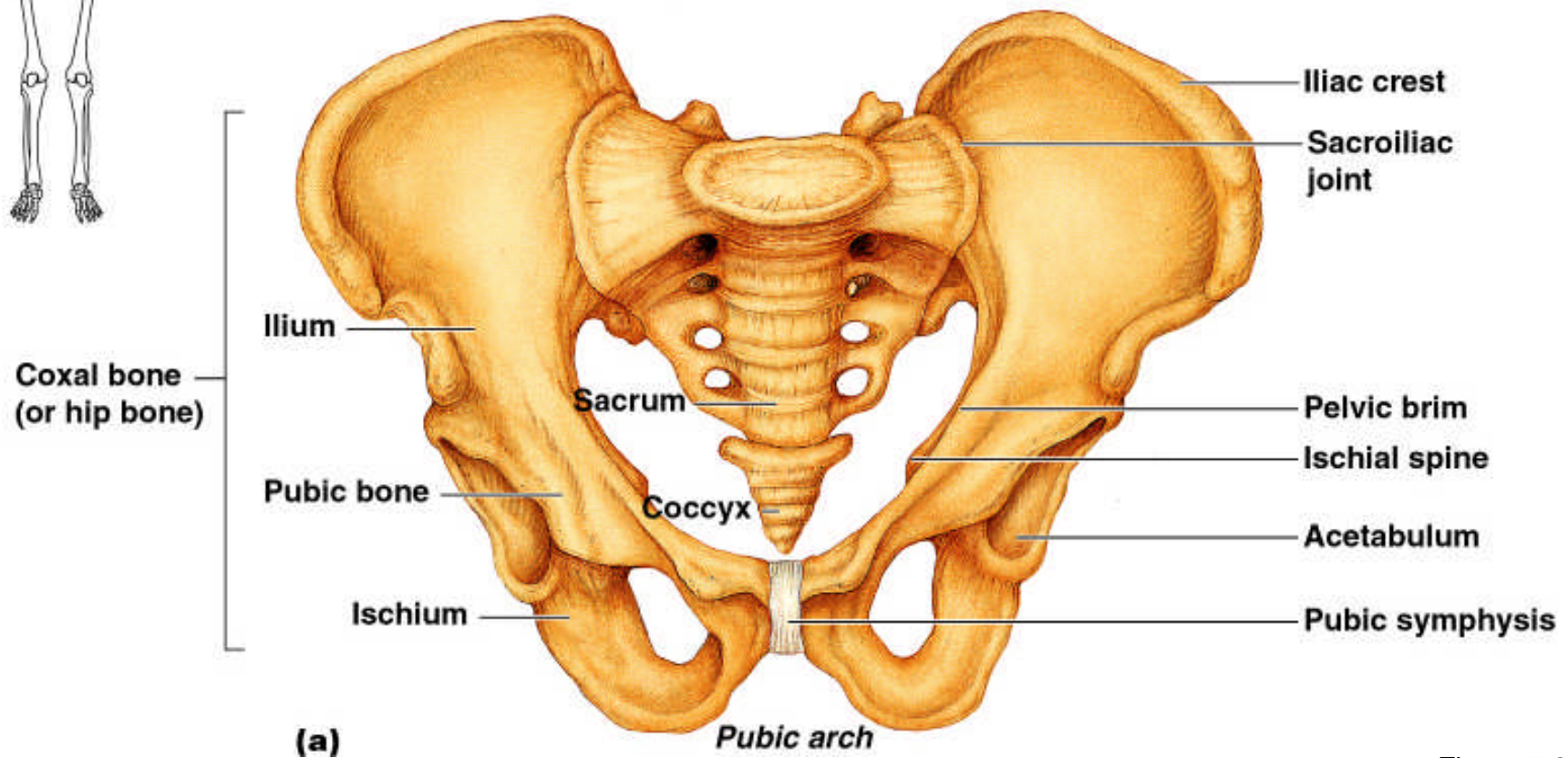


Figure 5.23a

# The Pelvis

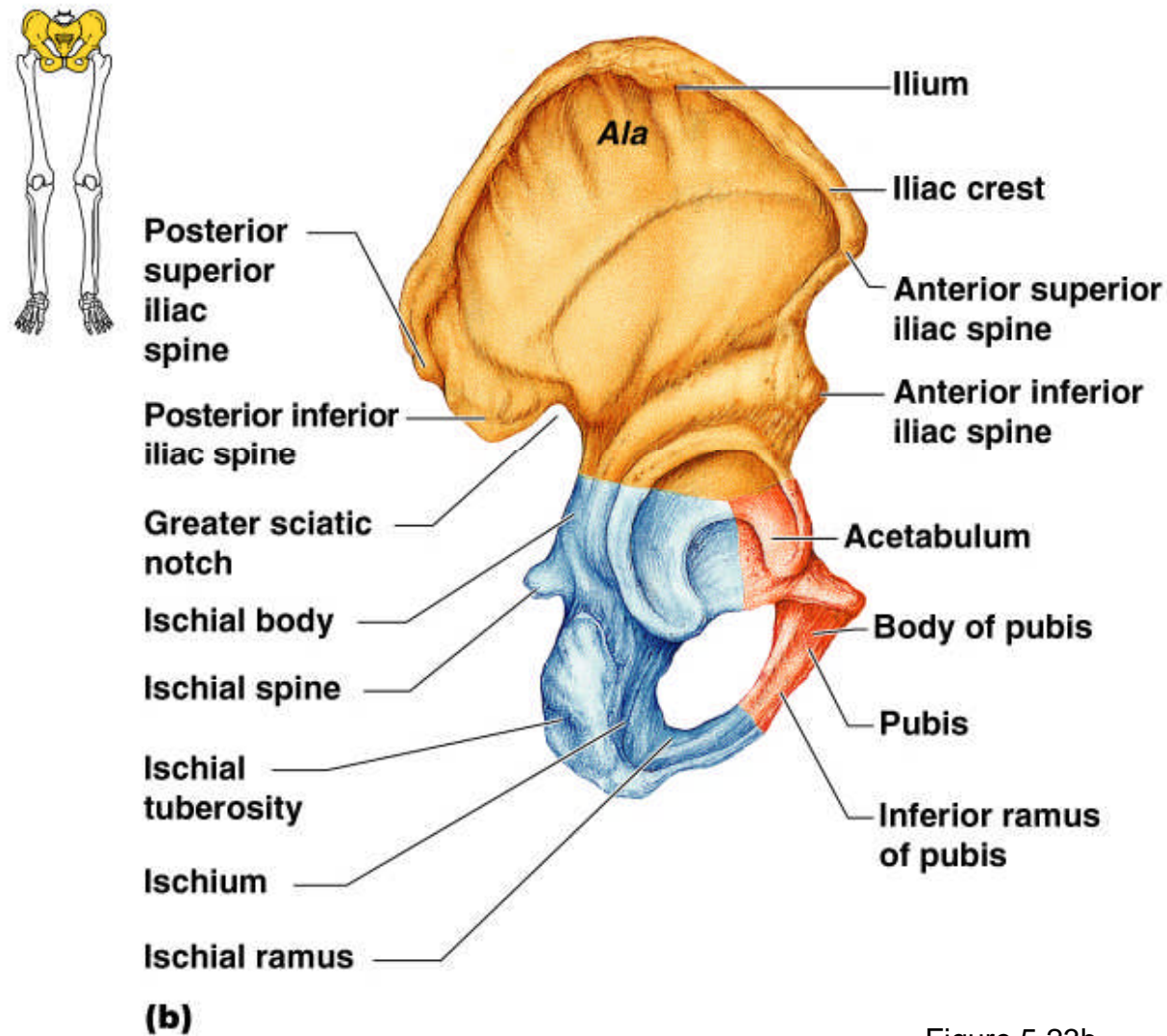


Figure 5.23b

# Gender Differences of the Pelvis

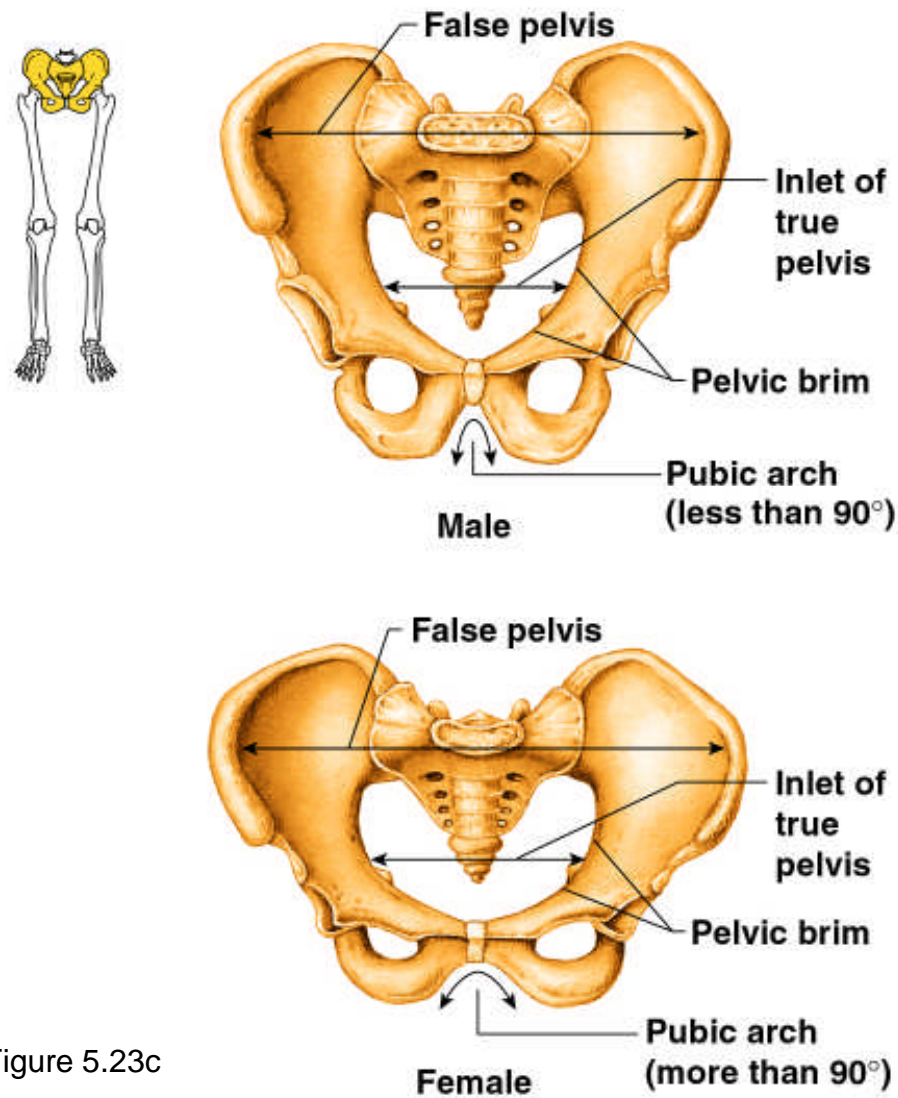


Figure 5.23c

# Bones of the Lower Limbs

- The thigh has one bone
  - Femur – thigh bone
- The heaviest and strongest bone in the body

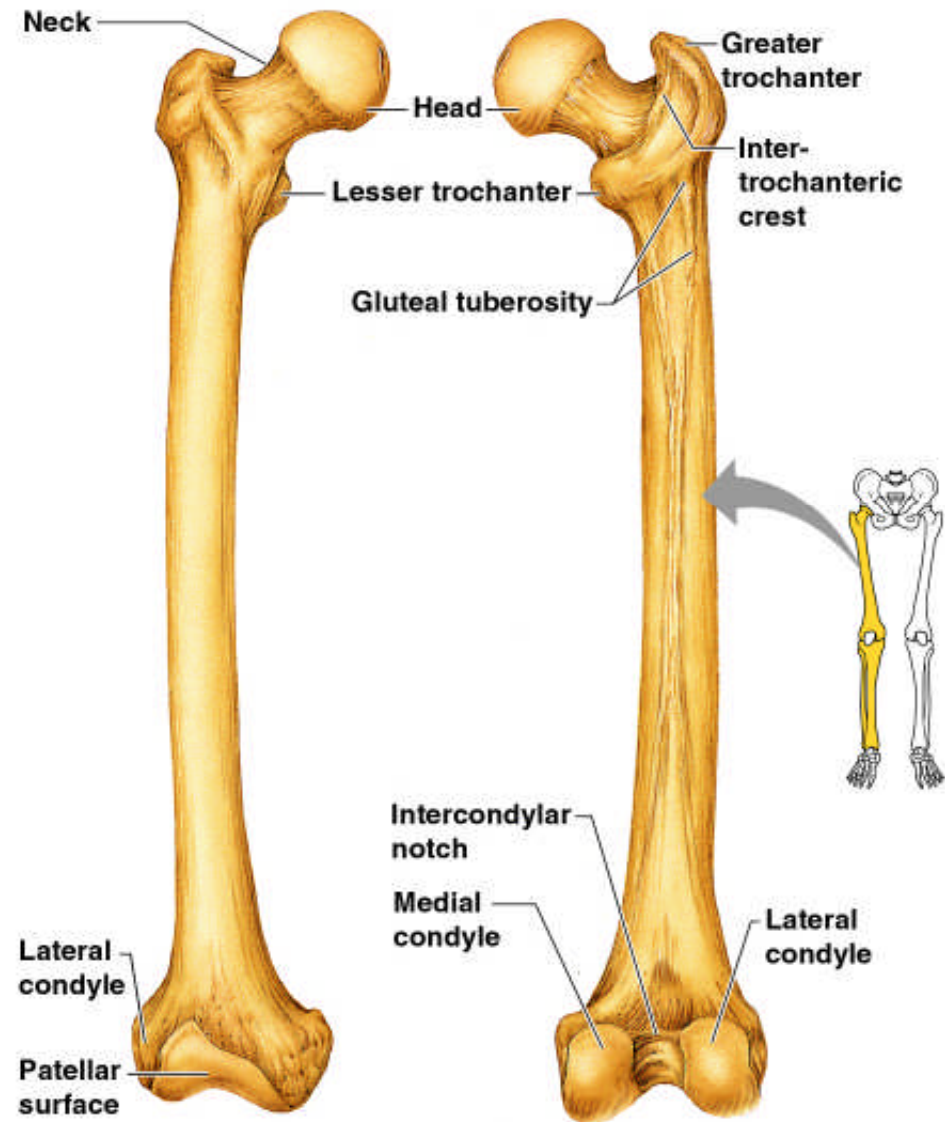


Figure 5.35a, b



# Bones of the Lower Limbs

- The leg has two bones
  - Tibia
  - Fibula

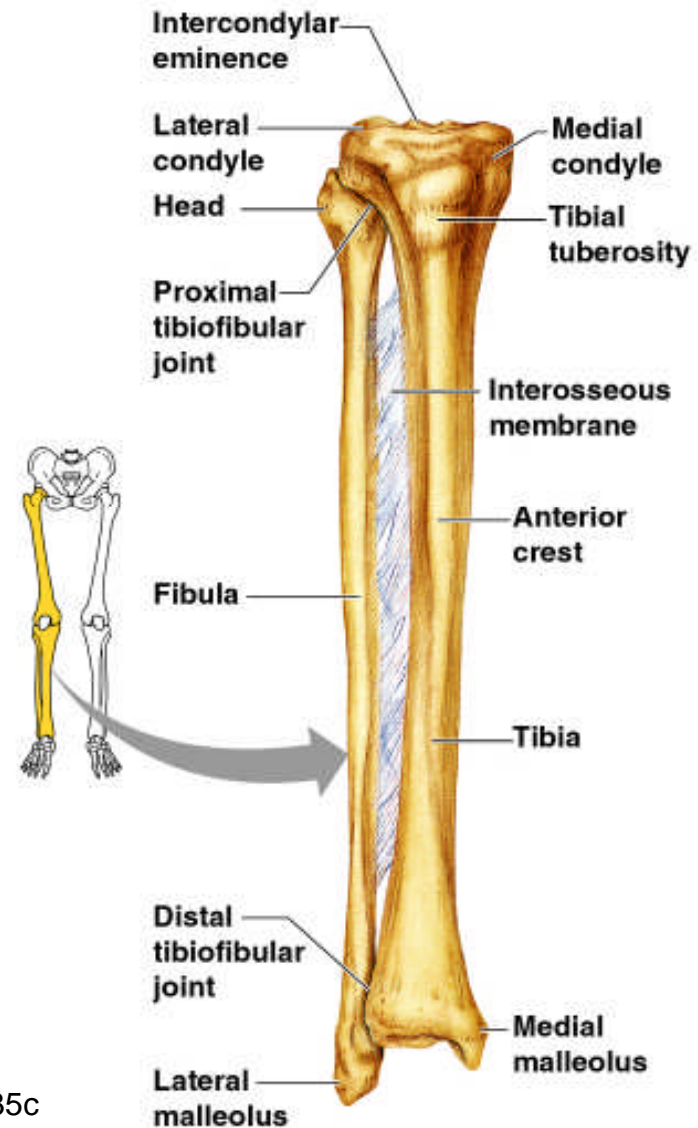


Figure 5.35c

# Bones of the Lower Limbs

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

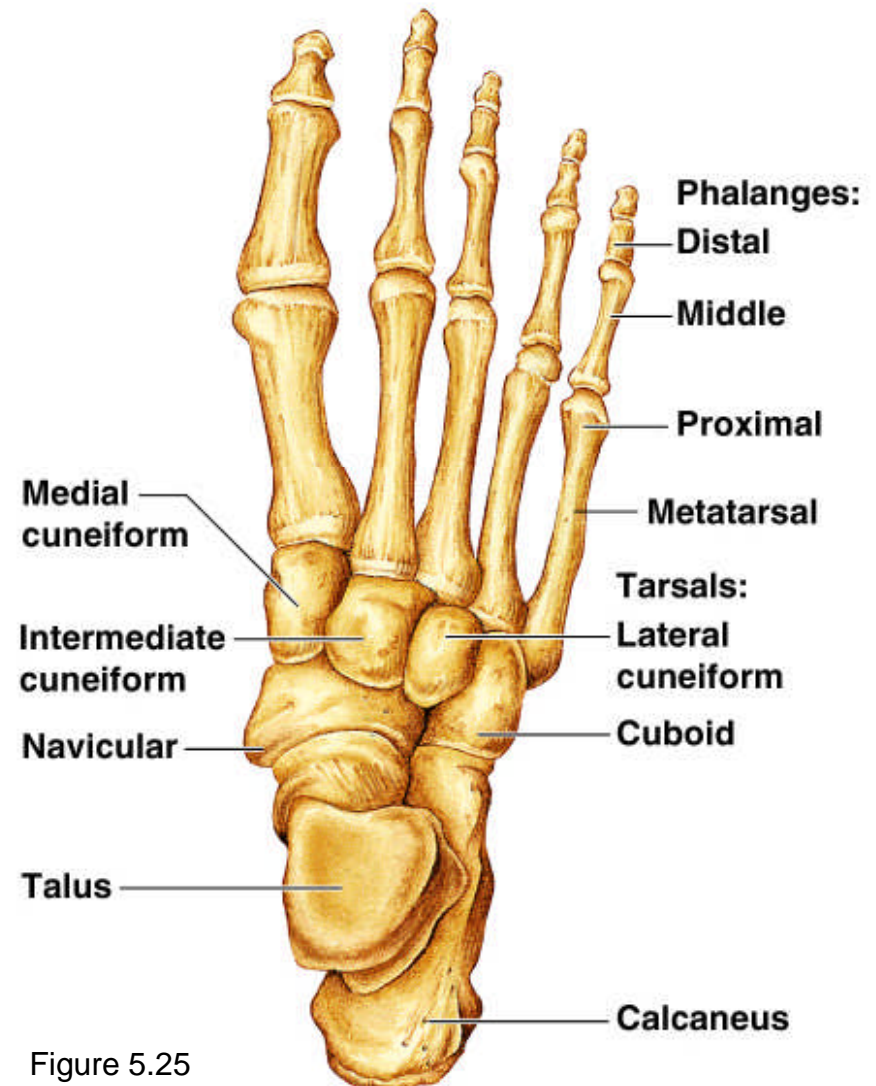


Figure 5.25

# Arches of the Foot

- Bones of the foot are arranged to form three strong arches
  - Two longitudinal
  - One transverse

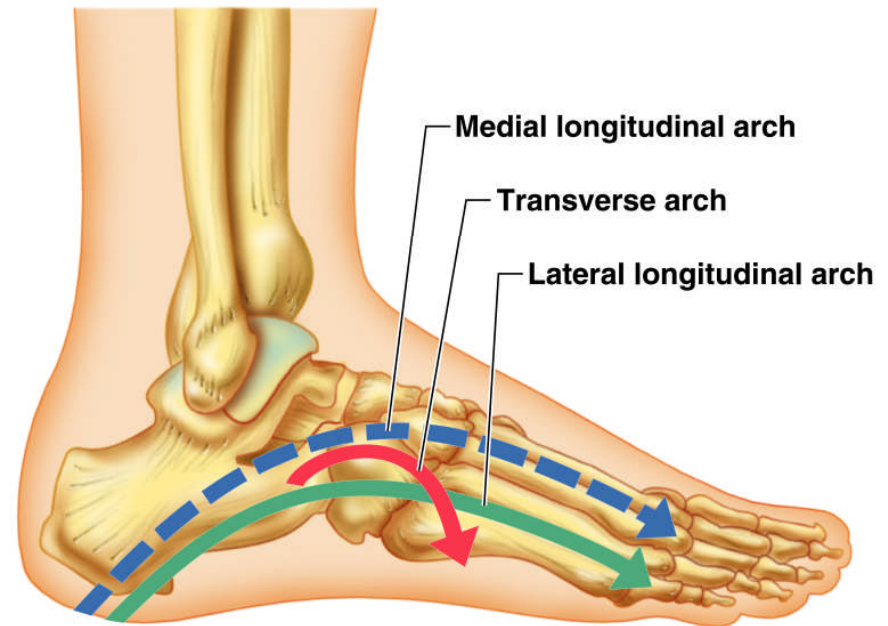


Figure 5.26

# Joints

- Articulations of bones
- Functions of joints
  - Hold bones together
  - Allow for mobility
- Ways joints are classified
  - Functionally
  - Structurally



# Functional Classification of Joints

- Synarthroses – immovable joints
- Amphiarthroses – slightly moveable joints
- Diarthroses – freely moveable joints

# Structural Classification of Joints

- Fibrous joints
  - Generally immovable
- Cartilaginous joints
  - Immovable or slightly moveable
- Synovial joints
  - Freely moveable

# Fibrous Joints

- Bones united by fibrous tissue
- Examples
  - Sutures in skull
  - Syndesmoses
    - Allows more movement than sutures because fibers are longer
    - Example: distal end of tibia and fibula

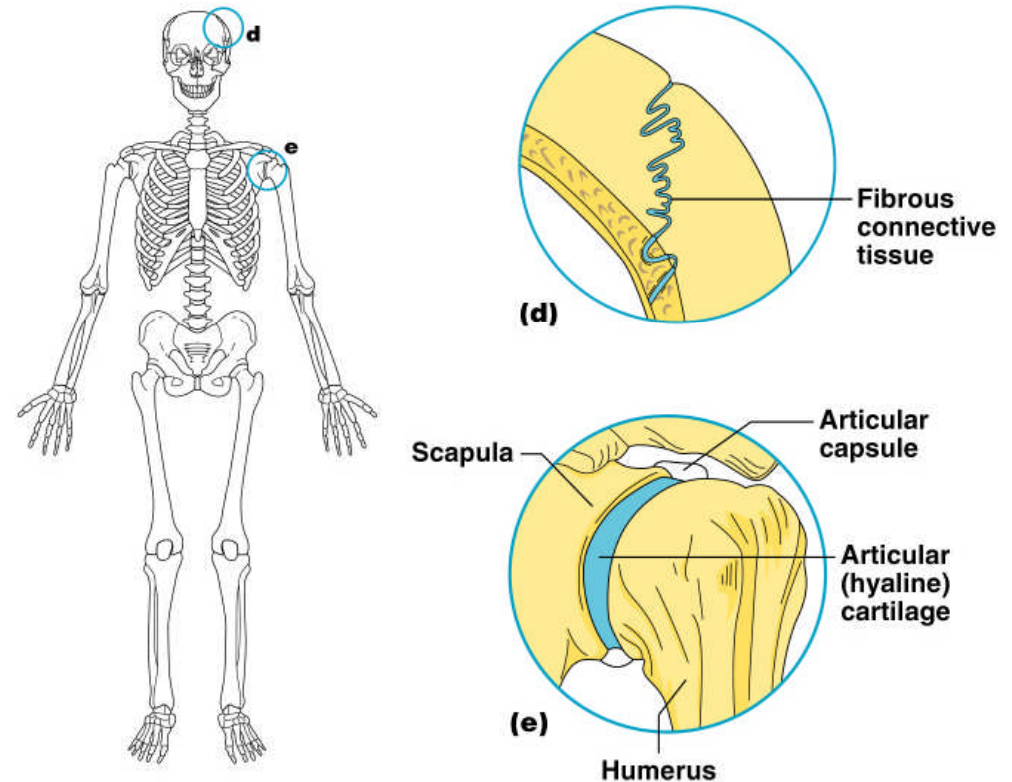


Figure 5.27d, e

# Cartilaginous Joints

- Bones connected by cartilage
- Examples
  - Pubic symphysis - pelvis
  - Intervertebral joints – spinal column

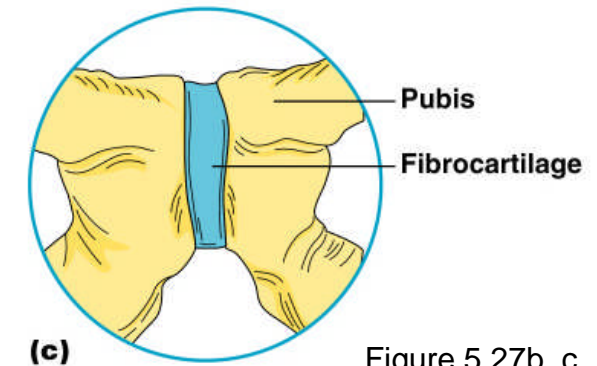
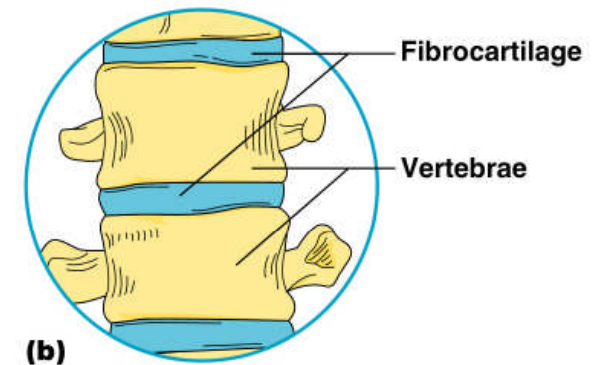
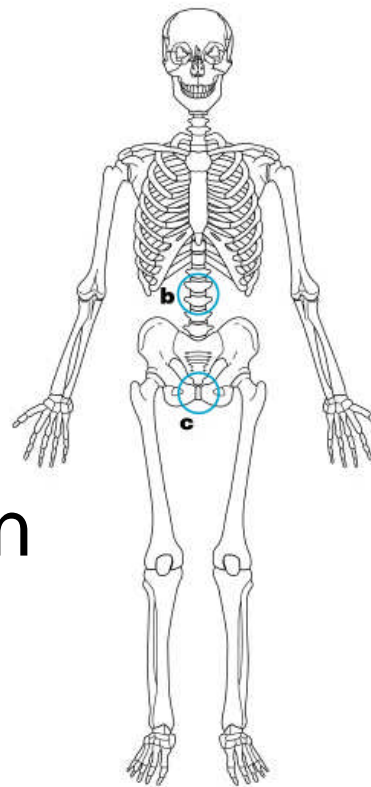


Figure 5.27b, c

# Synovial Joints

- Articulating bones are separated by a joint cavity
- Synovial fluid is found in the joint cavity

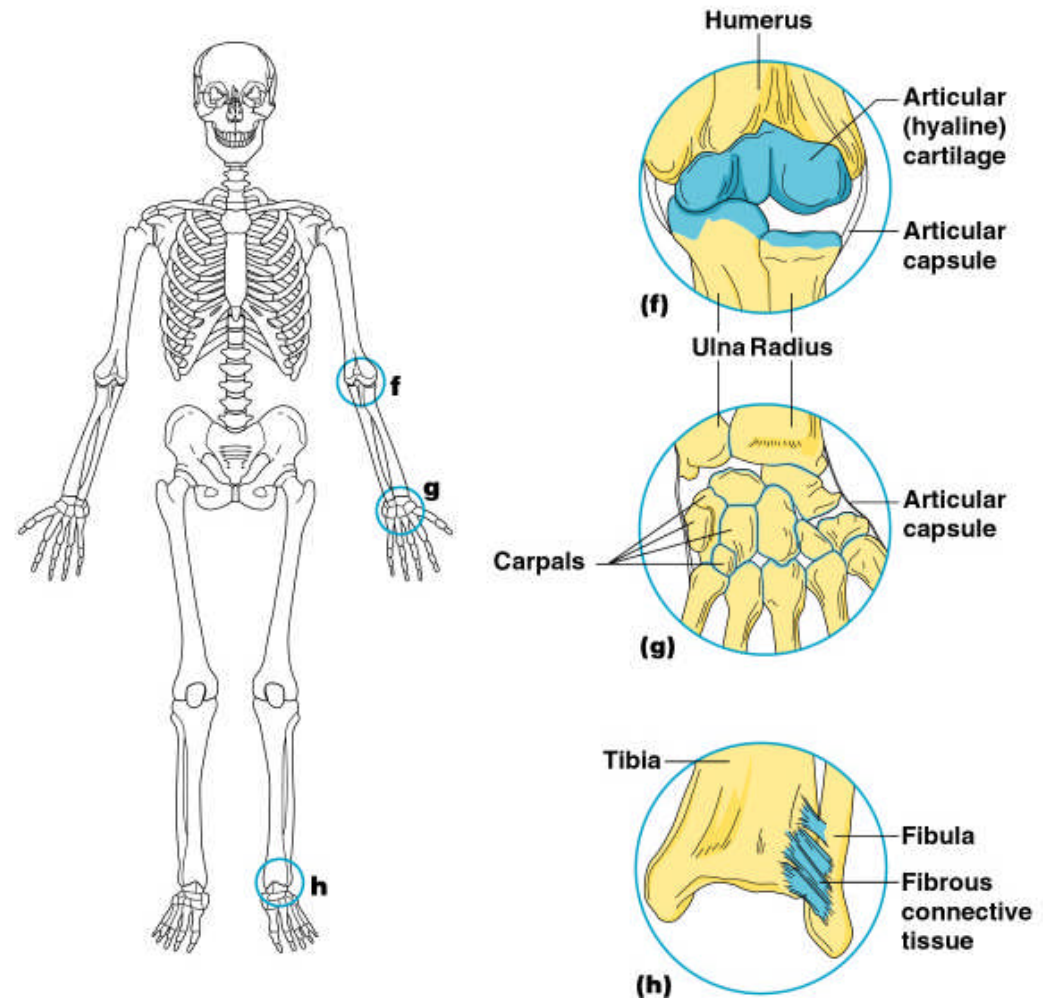


Figure 5.27f-h

# Features of Synovial Joints

- Articular cartilage (hyaline cartilage) covers the ends of bones
- Joint surfaces are enclosed by a fibrous articular capsule
- Have a joint cavity filled with synovial fluid
- Ligaments reinforce the joint



# Structures Associated with the Synovial Joint

- Bursae – flattened fibrous sacs
  - Lined with synovial membranes
  - Filled with synovial fluid
  - Not actually part of the joint and common where ligaments, muscles, skin, tendons, or bones rub together
- Tendon sheath
  - Elongated bursa that wraps around a tendon

# The Synovial Joint

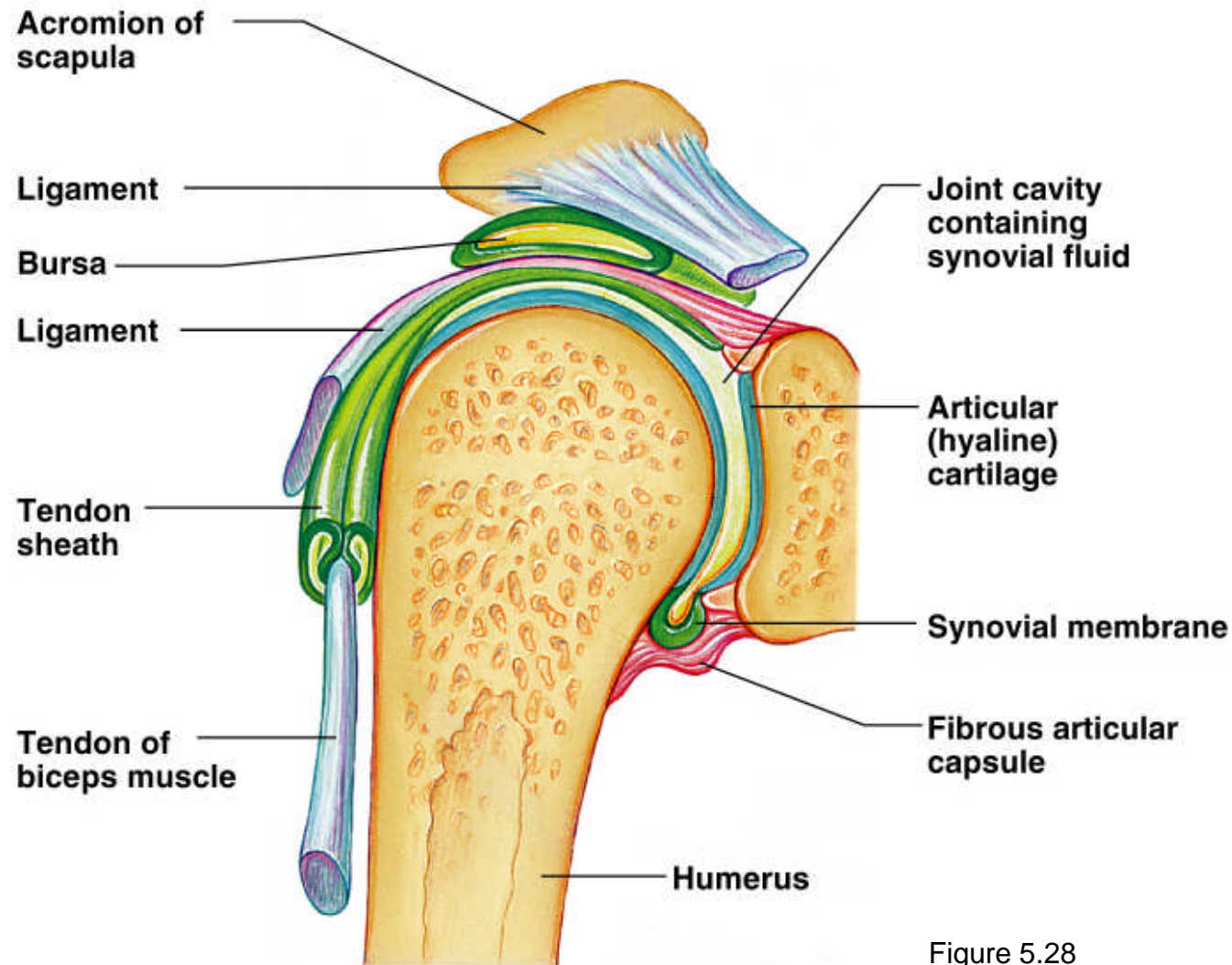


Figure 5.28

# Types of Synovial Joints Based on Shape

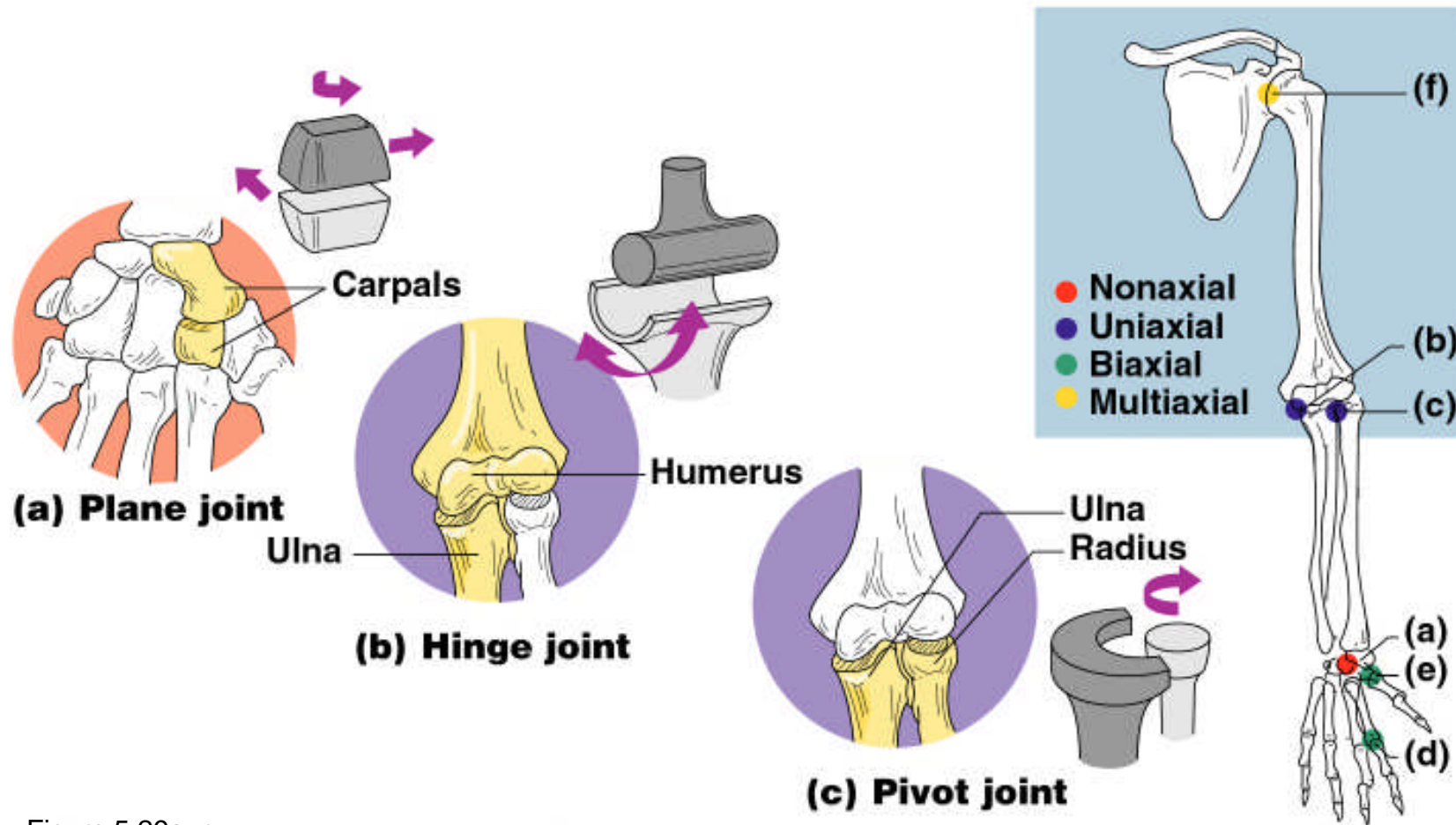


Figure 5.29a–c

# Types of Synovial Joints Based on Shape

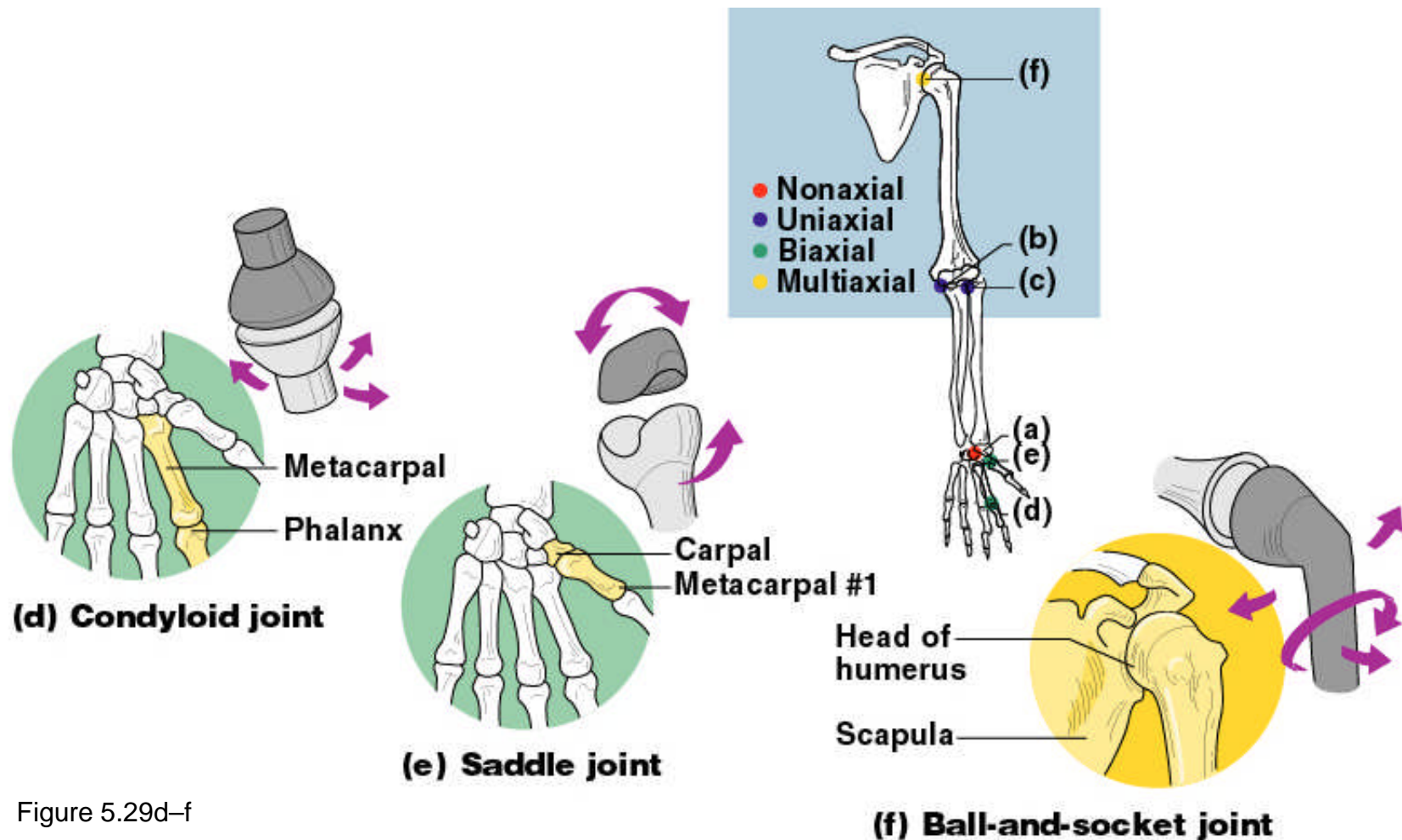


Figure 5.29d–f

# Inflammatory Conditions Associated with Joints

- Bursitis – inflammation of a bursa usually caused by a blow or friction to the knee
- Tendonitis – inflammation of tendon sheaths - sprain
- Arthritis – inflammatory or degenerative diseases of joints
  - Over 100 different types
  - The most widespread crippling disease in the United States

# Clinical Forms of Arthritis

- Osteoarthritis – wear-and-tear arthritis
  - Most common chronic arthritis
  - Probably related to normal aging processes
- Rheumatoid arthritis
  - An autoimmune disease – the immune system attacks the joints
  - Symptoms begin with bilateral inflammation of certain joints
  - Often leads to deformities



# Clinical Forms of Arthritis

- Gouty Arthritis - Gout
  - Inflammation of joints is caused by an accumulation in blood and deposition of urate crystals (uric acid) from the blood
  - Usually affects only one joint
  - Can usually be controlled with diet