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

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

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

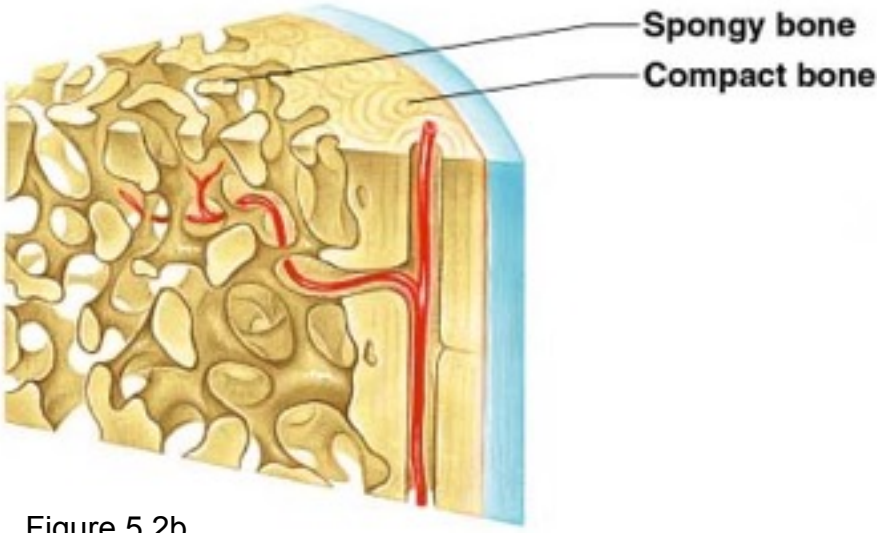


Figure 5.2b

Classification of Bones

- 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

Classification of Bones on the Basis of Shape

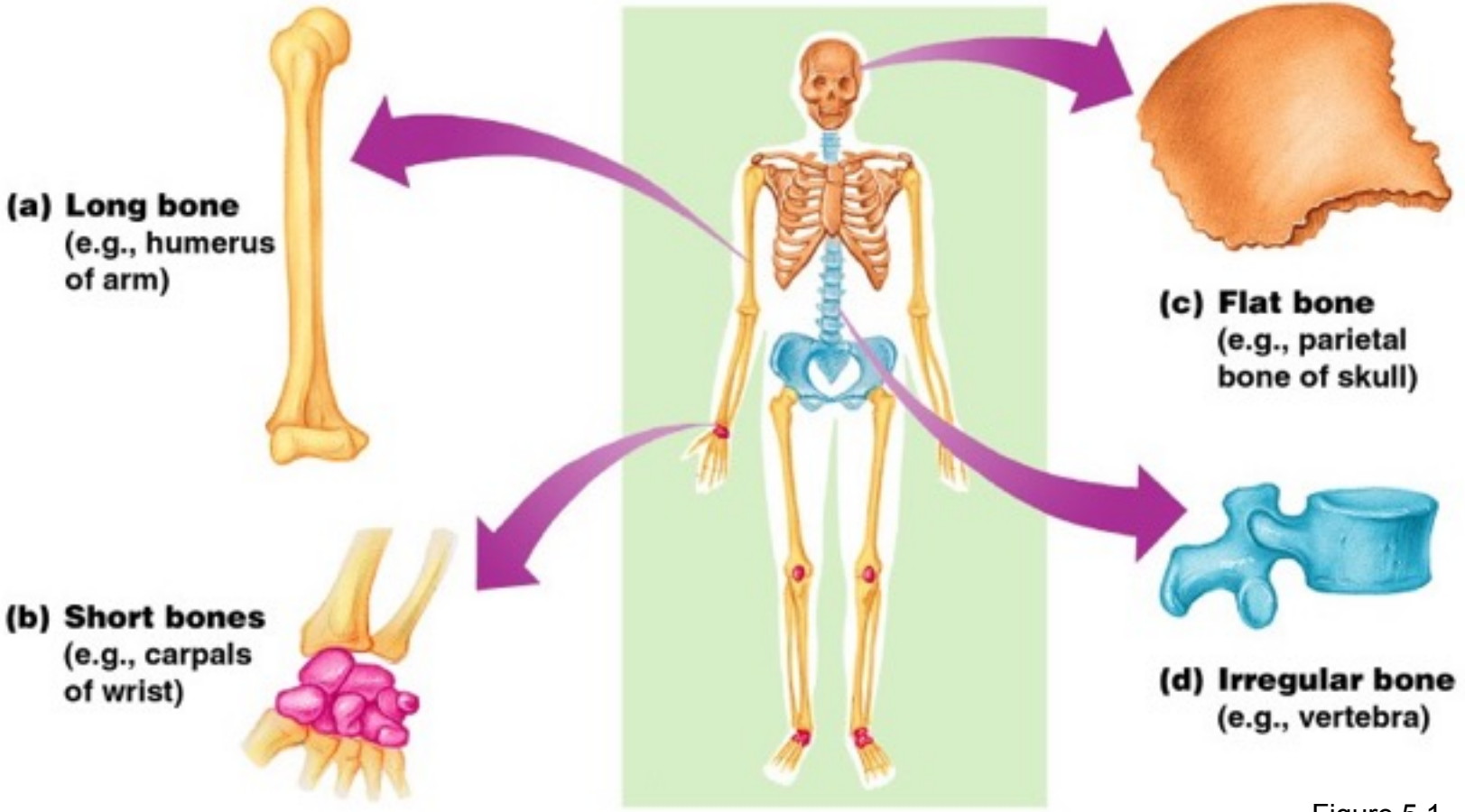


Figure 5.1

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

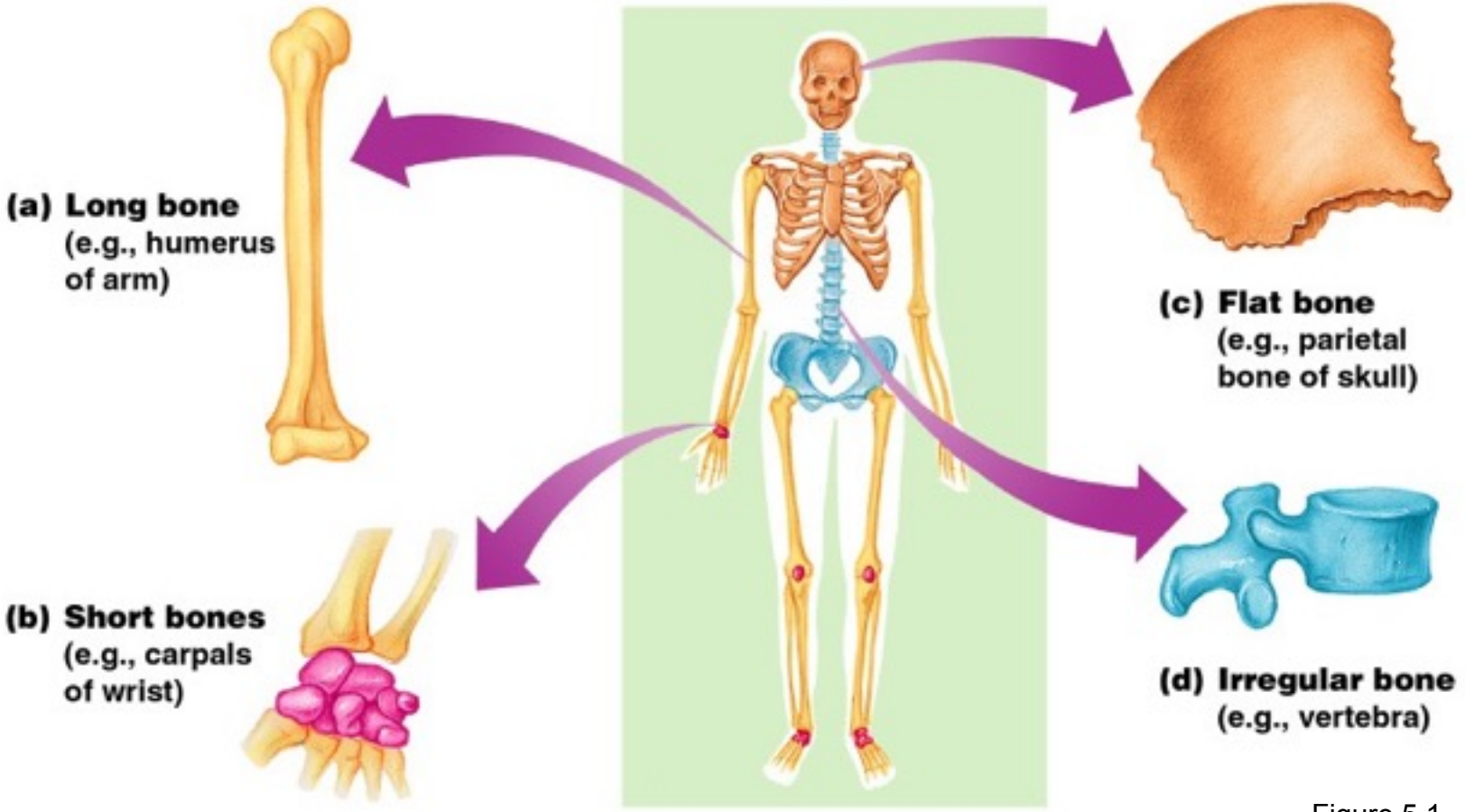


Figure 5.1

Gross Anatomy of a Long Bone

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

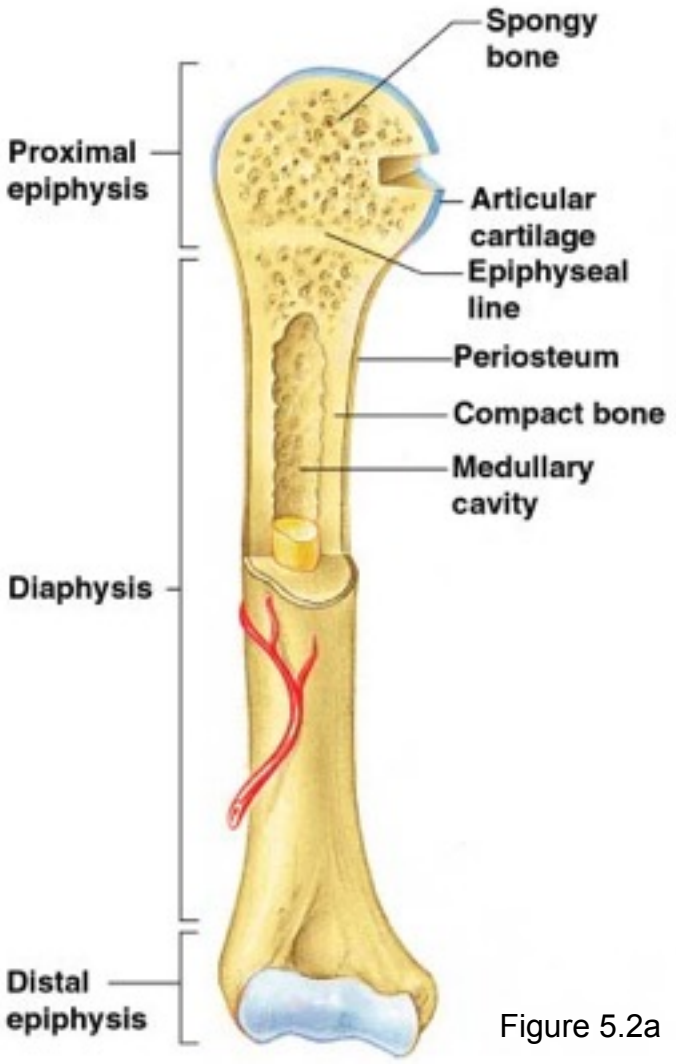


Figure 5.2a

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

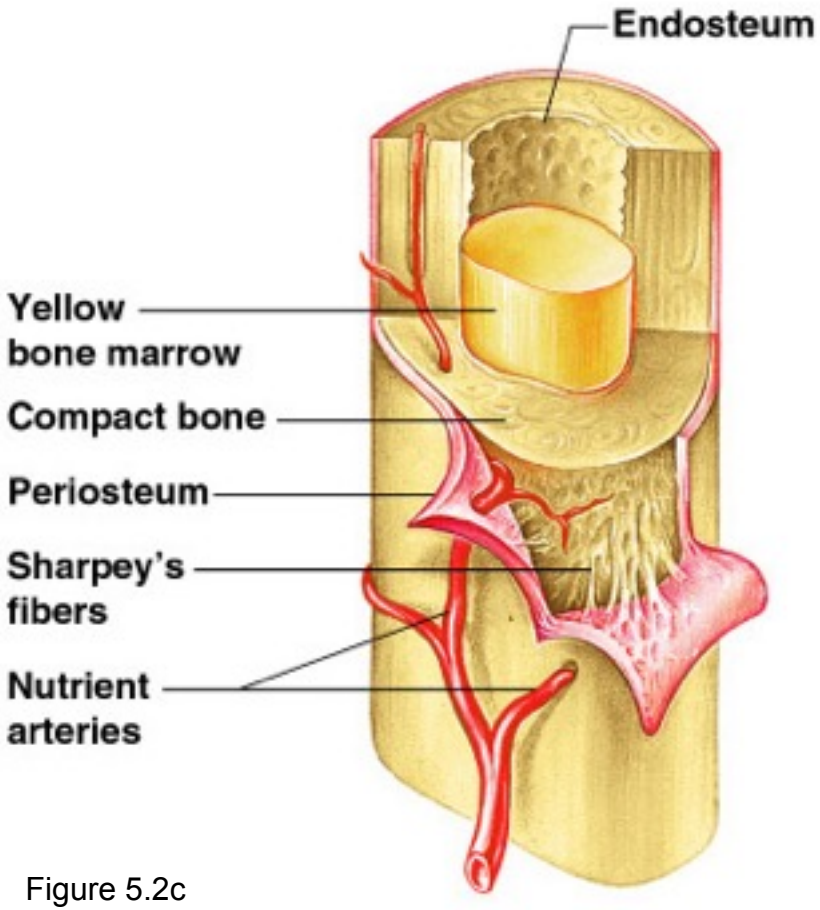


Figure 5.2c

Structures of a Long Bone

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

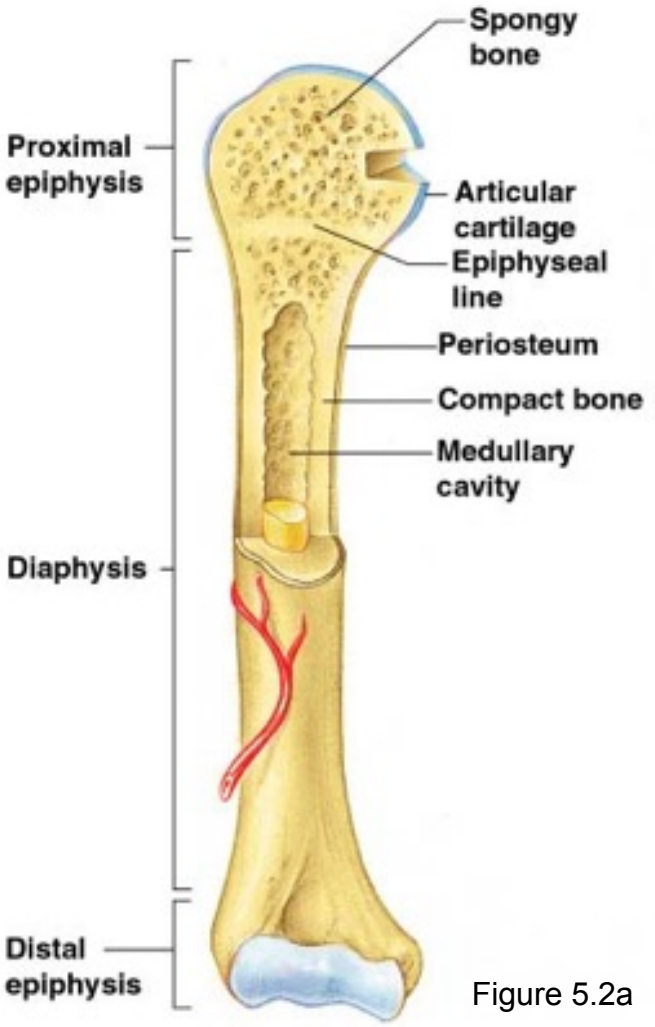


Figure 5.2a

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

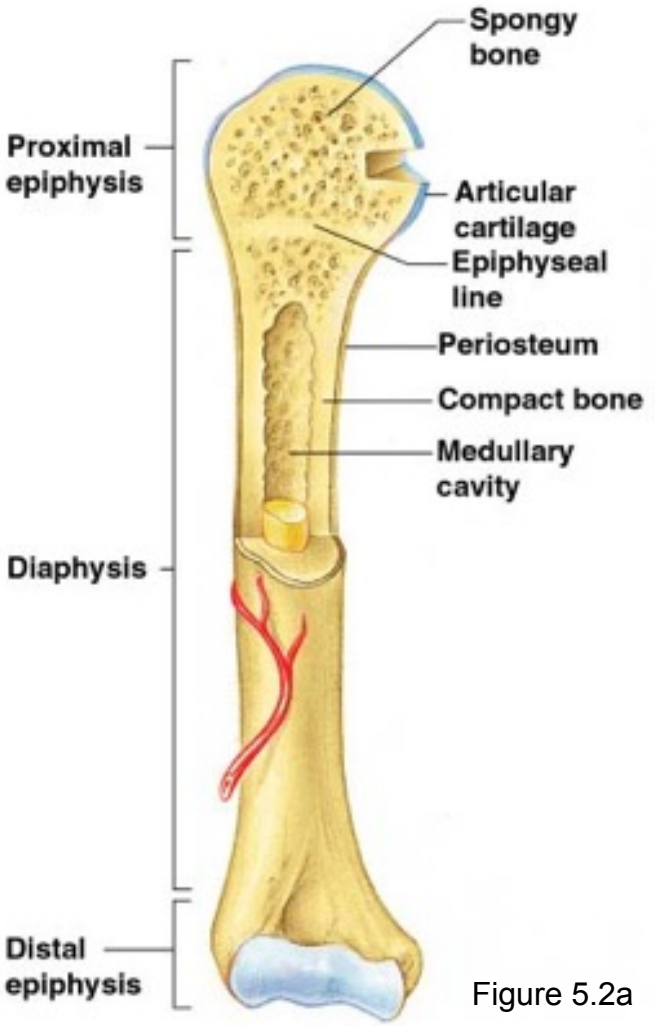


Figure 5.2a

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 and 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

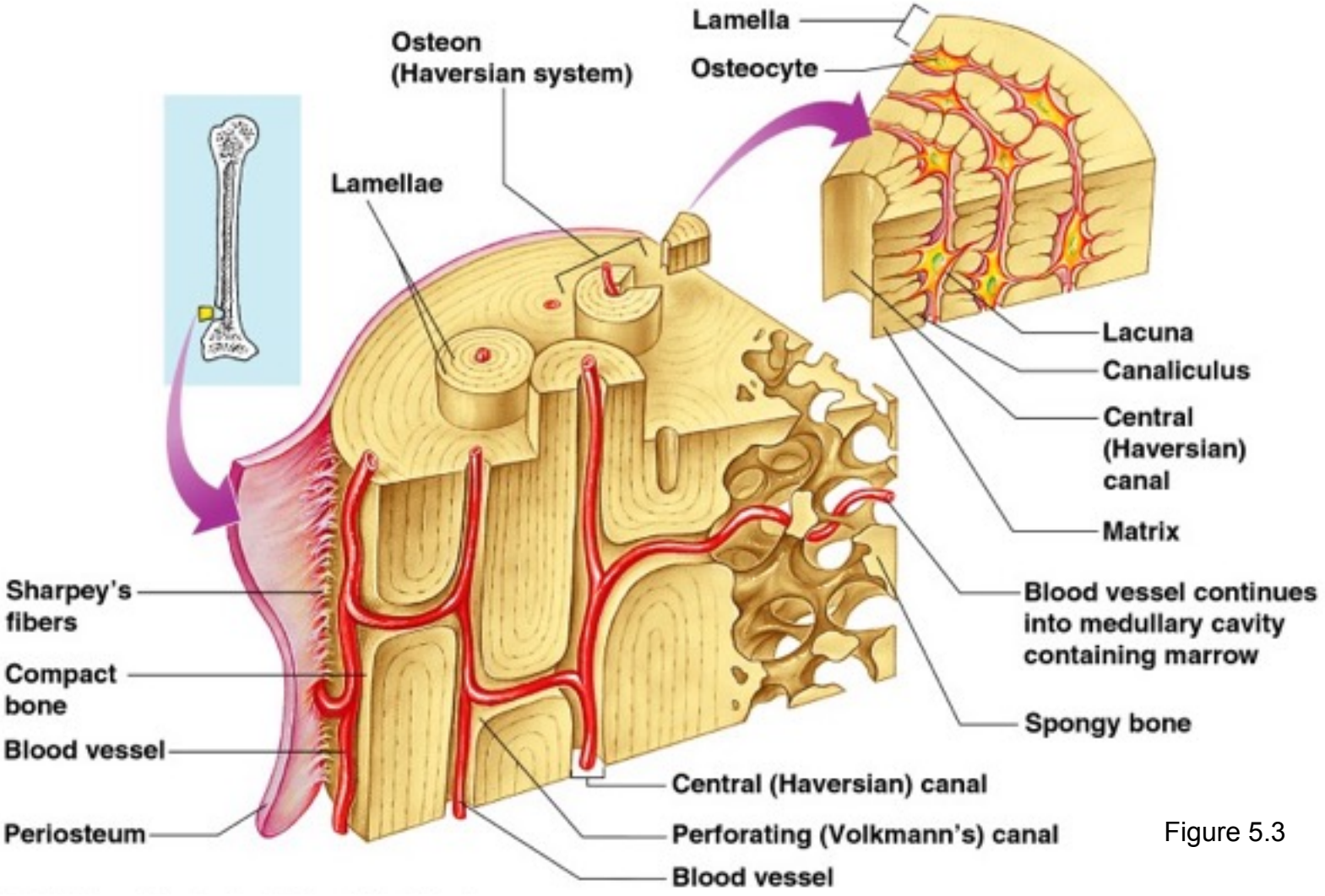


Figure 5.3

Microscopic Anatomy of Bone

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

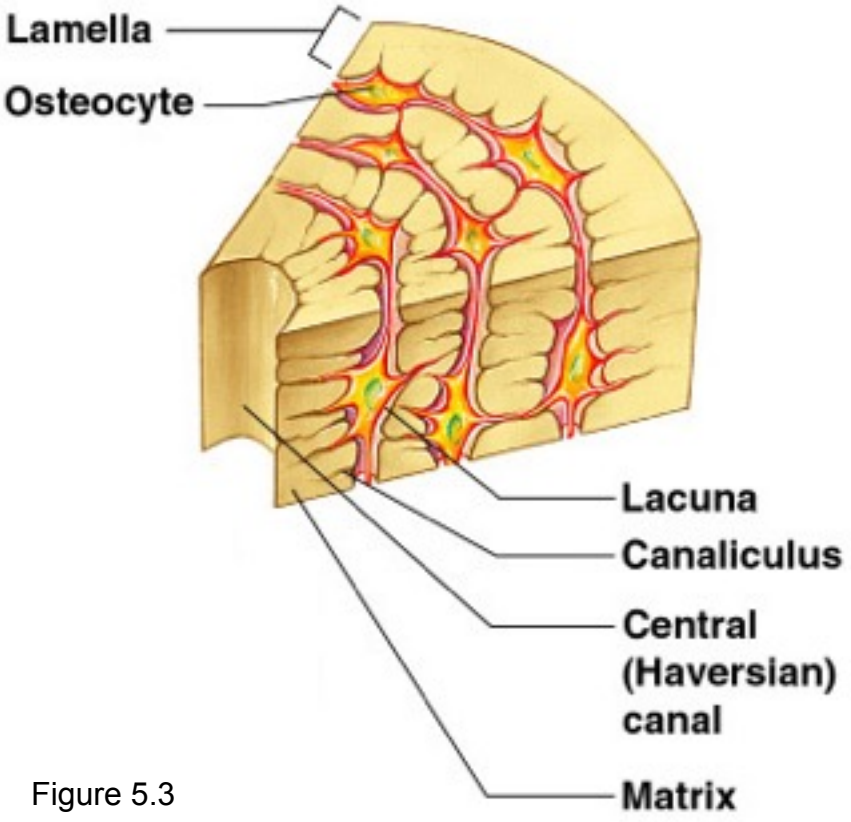


Figure 5.3

Microscopic Anatomy of Bone

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

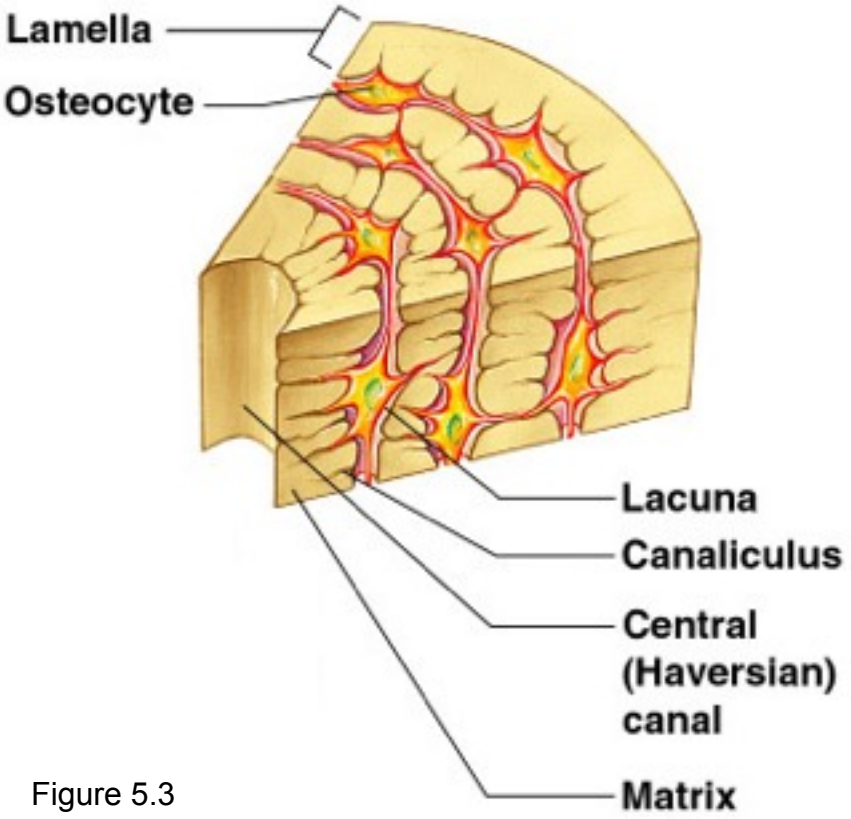


Figure 5.3

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

Bone Growth

- Bones are remodeled and lengthened until growth stops
  - Bones change shape somewhat
  - Bones grow in width

Long Bone Formation and Growth

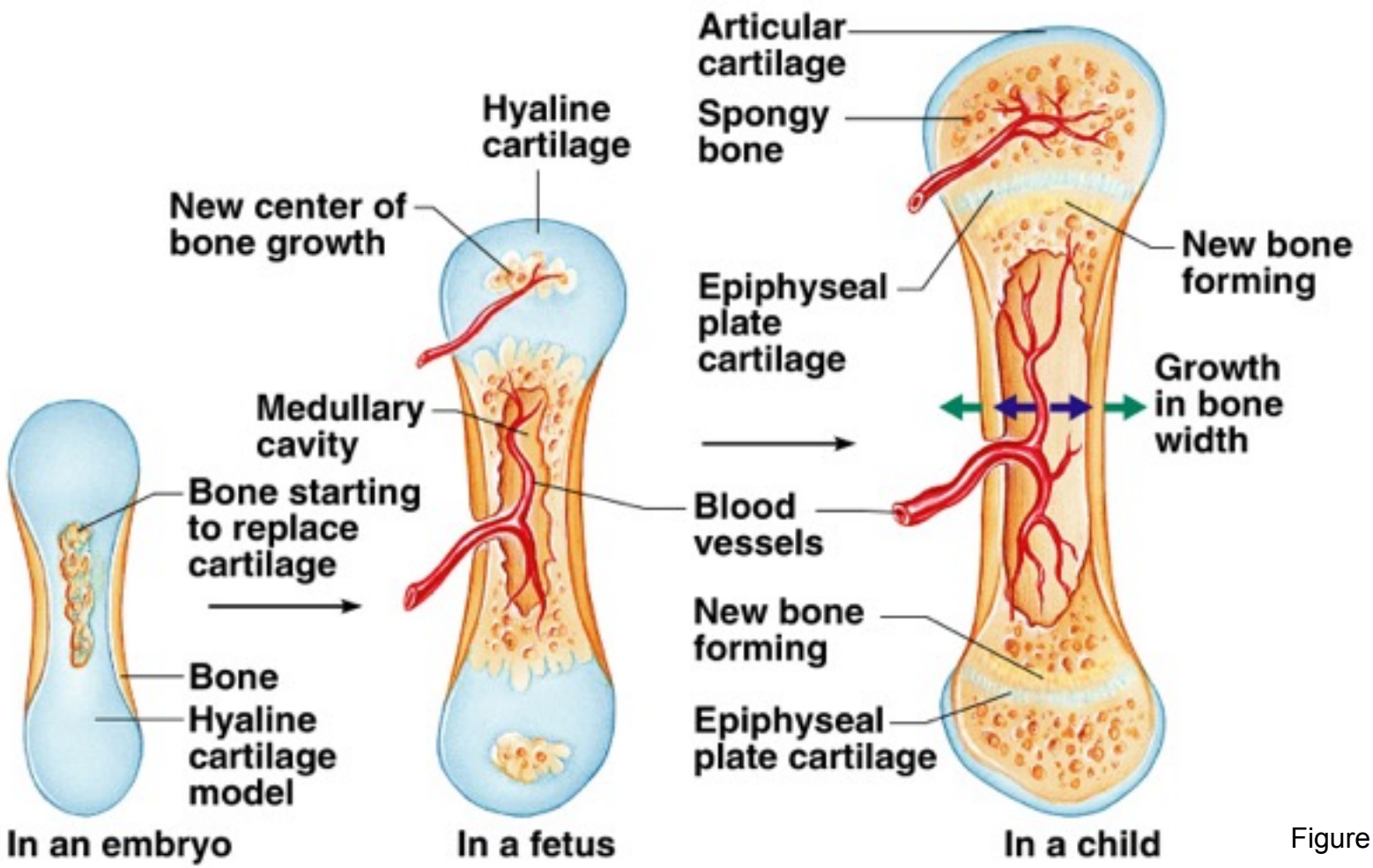


Figure 5.4a

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

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
- Break is splinted by fibrocartilage to form a callus
- Fibrocartilage callus is replaced by a bony callus
- Bony callus is remodeled to form a permanent patch

Stages in the Healing of a Bone Fracture

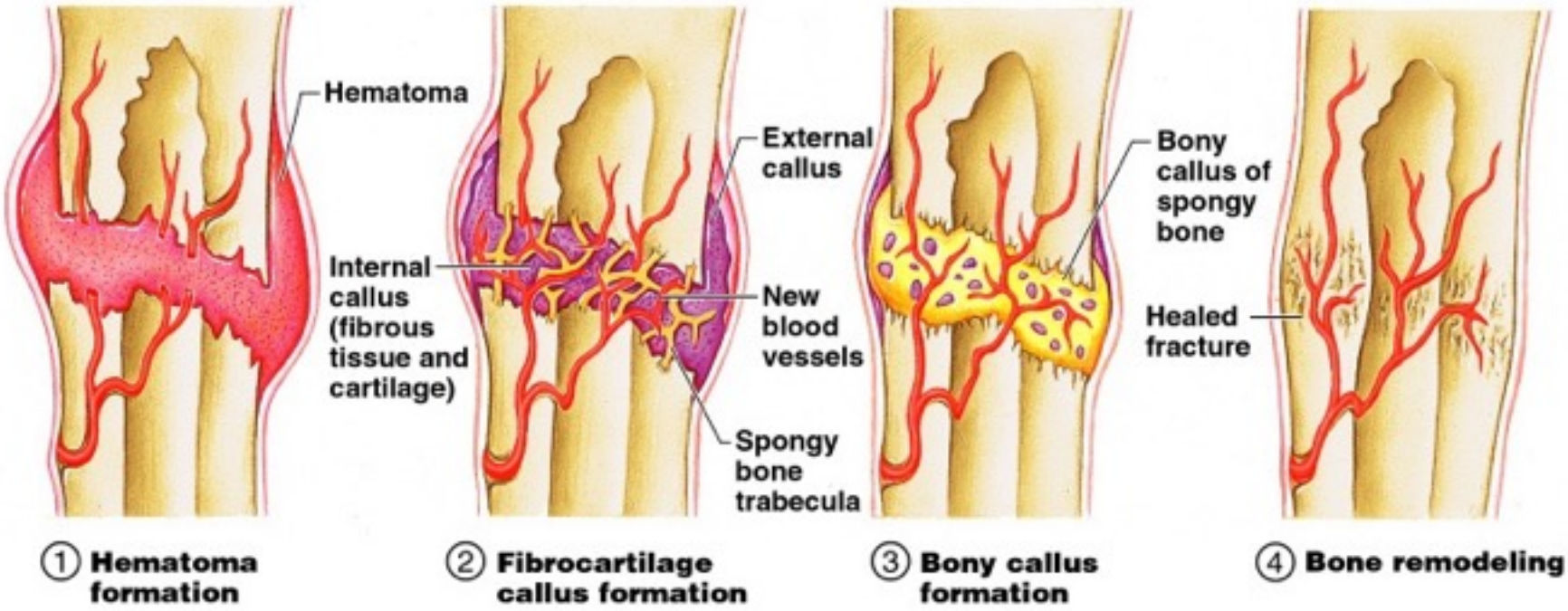


Figure 5.5

The Axial Skeleton

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

The Axial Skeleton

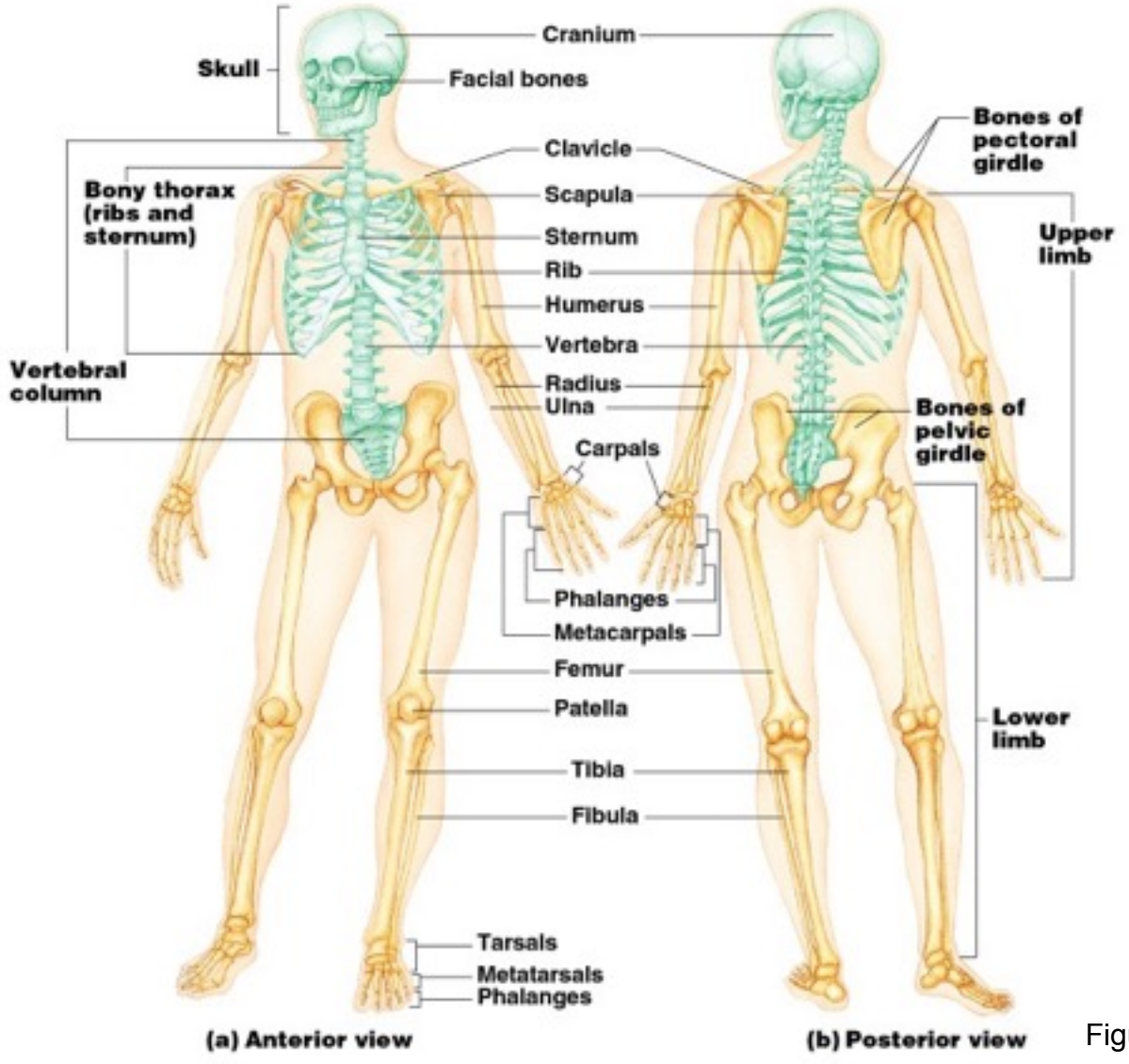


Figure 5.6

The Skull

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

The Skull

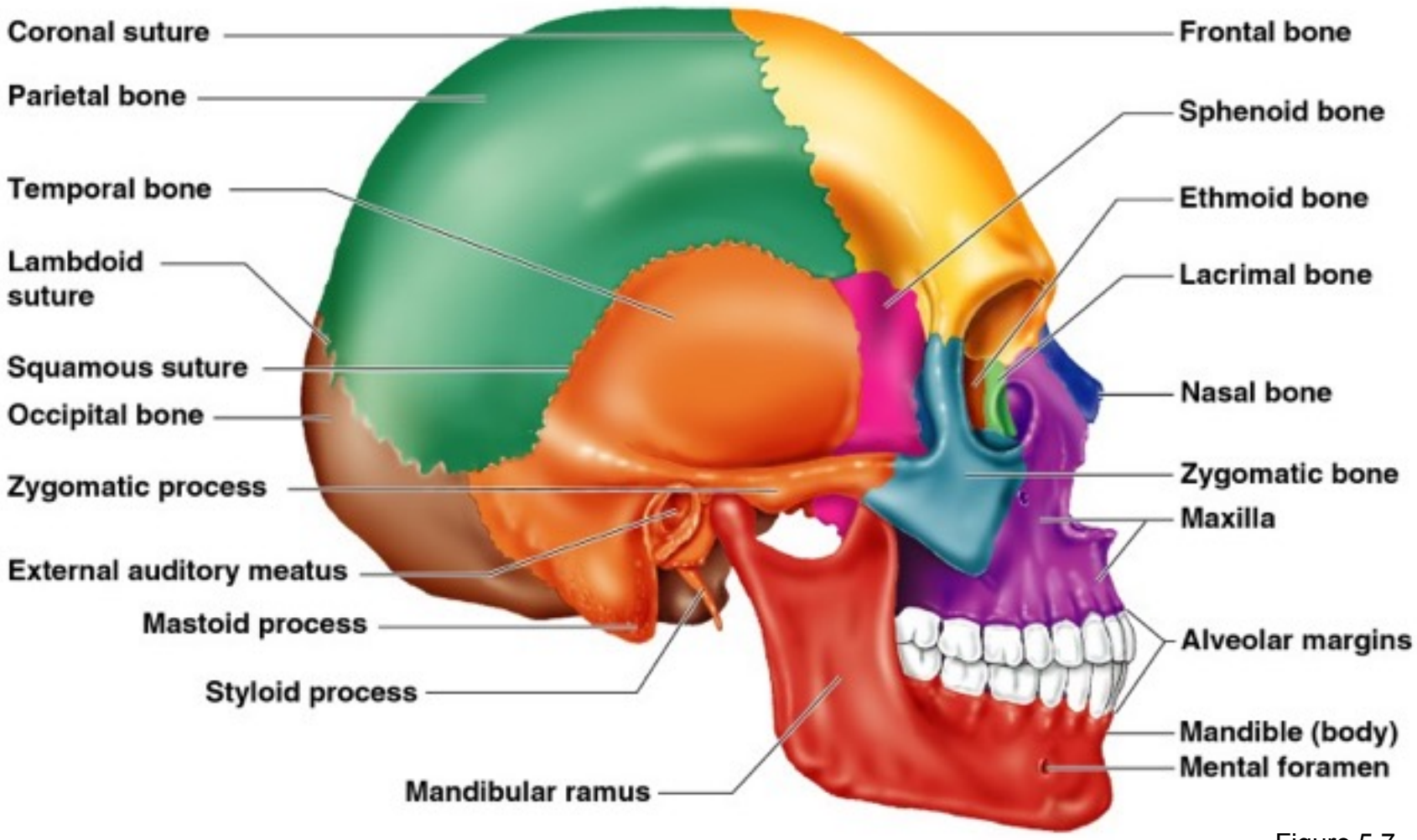


Figure 5.7

Bones of the Skull

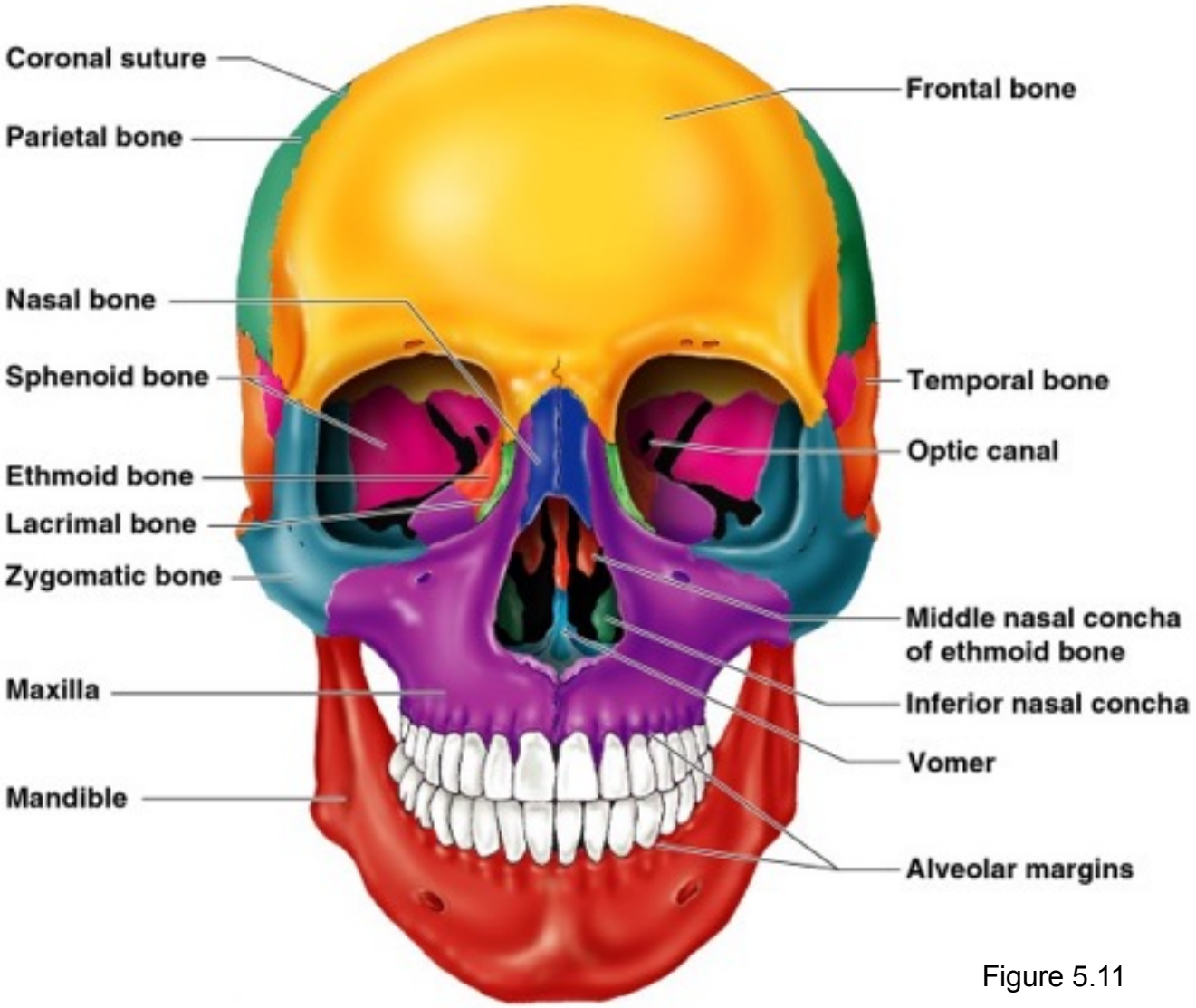


Figure 5.11

Human Skull, Superior View

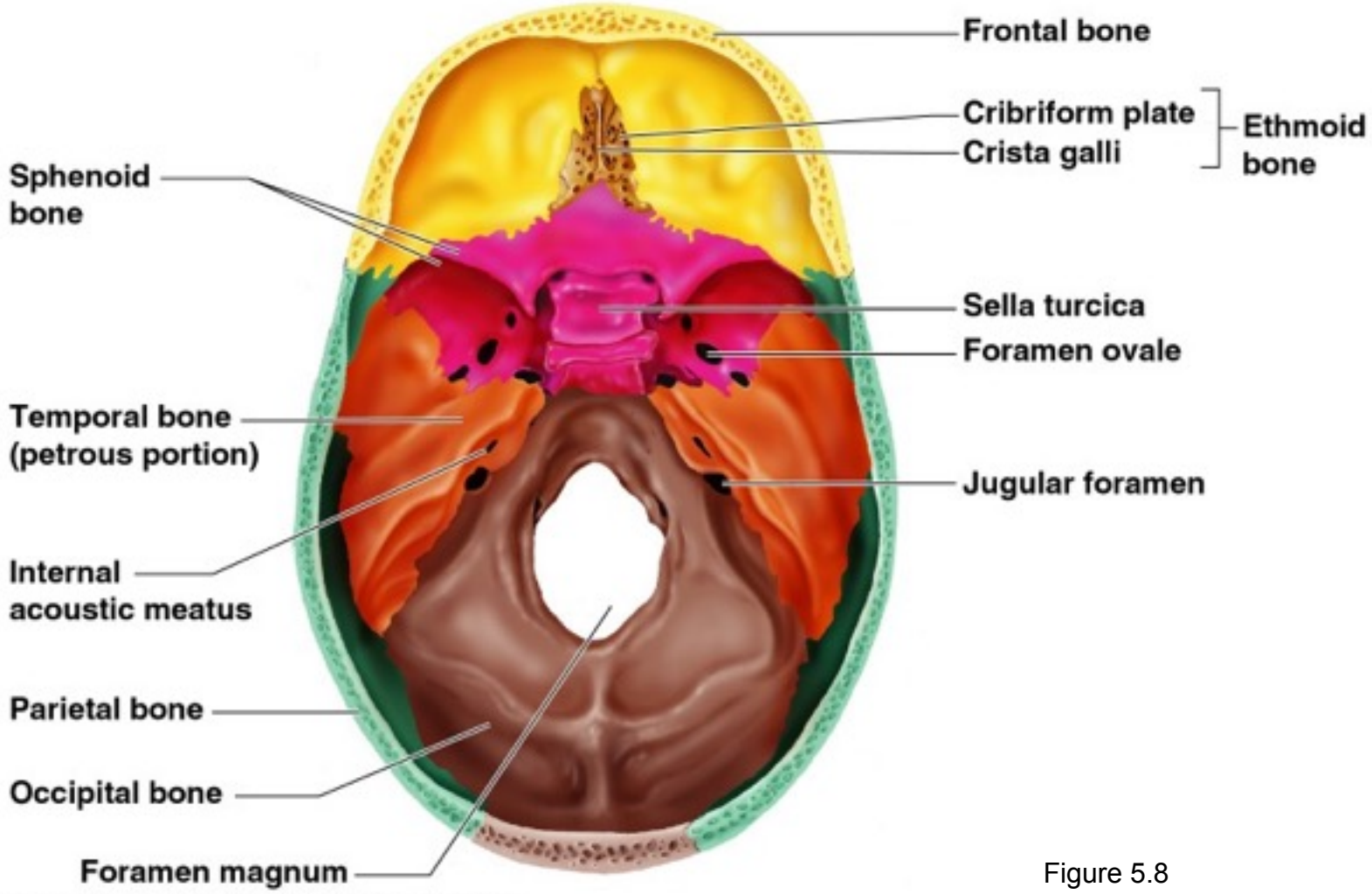


Figure 5.8

Human Skull, Inferior View

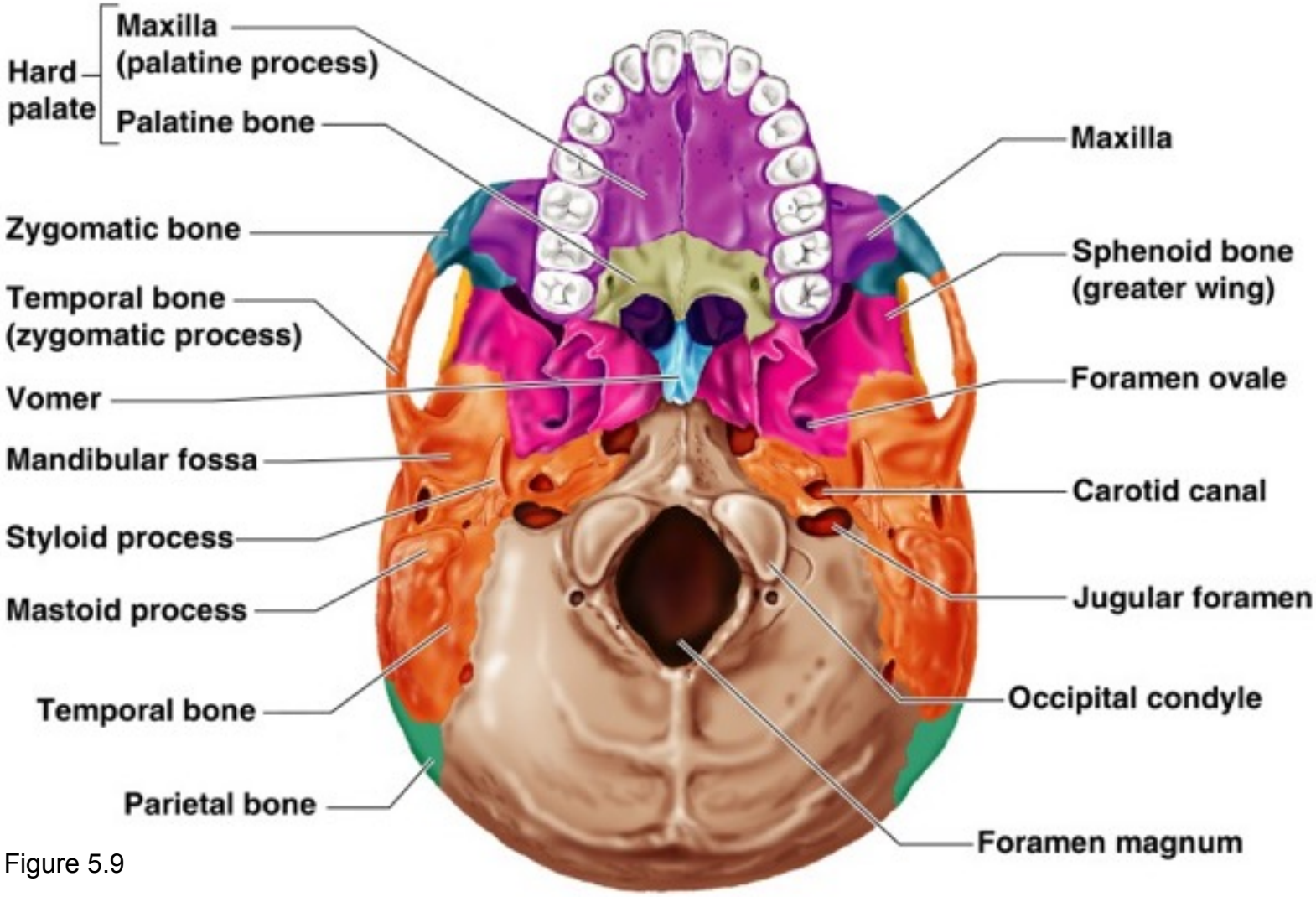


Figure 5.9

Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity

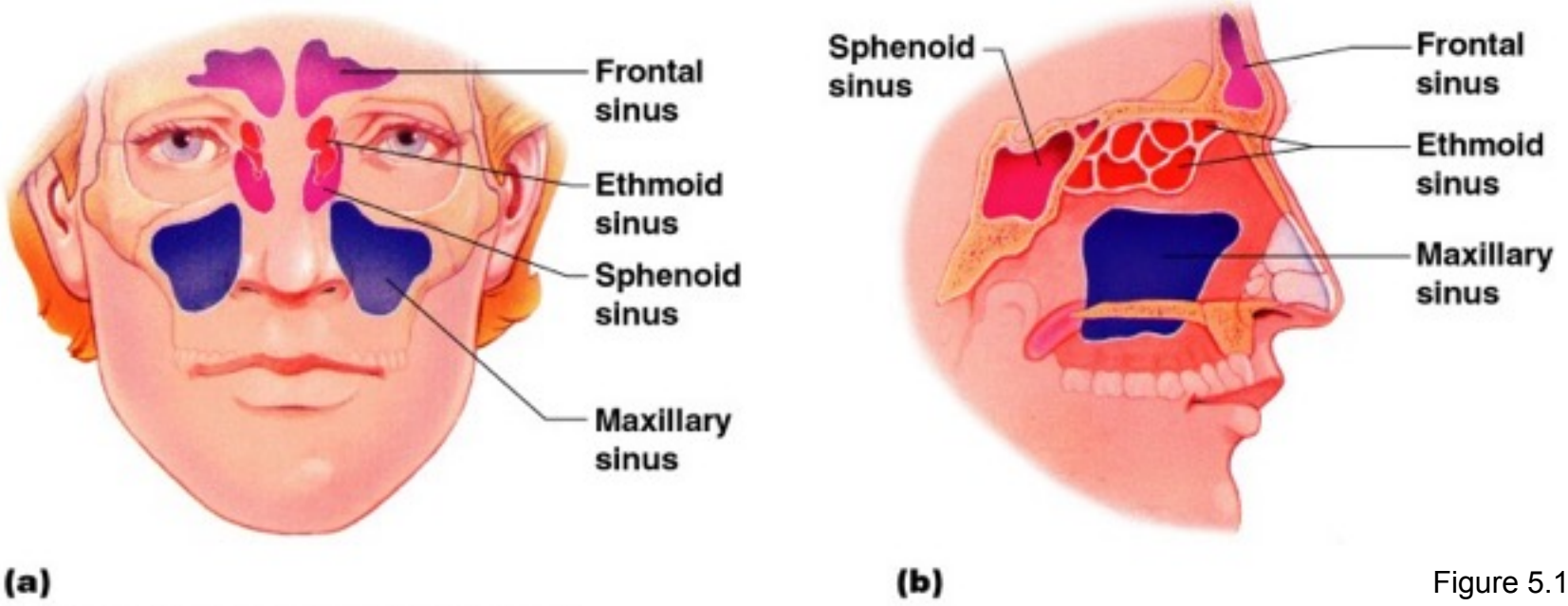


Figure 5.10

Paranasal Sinuses

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

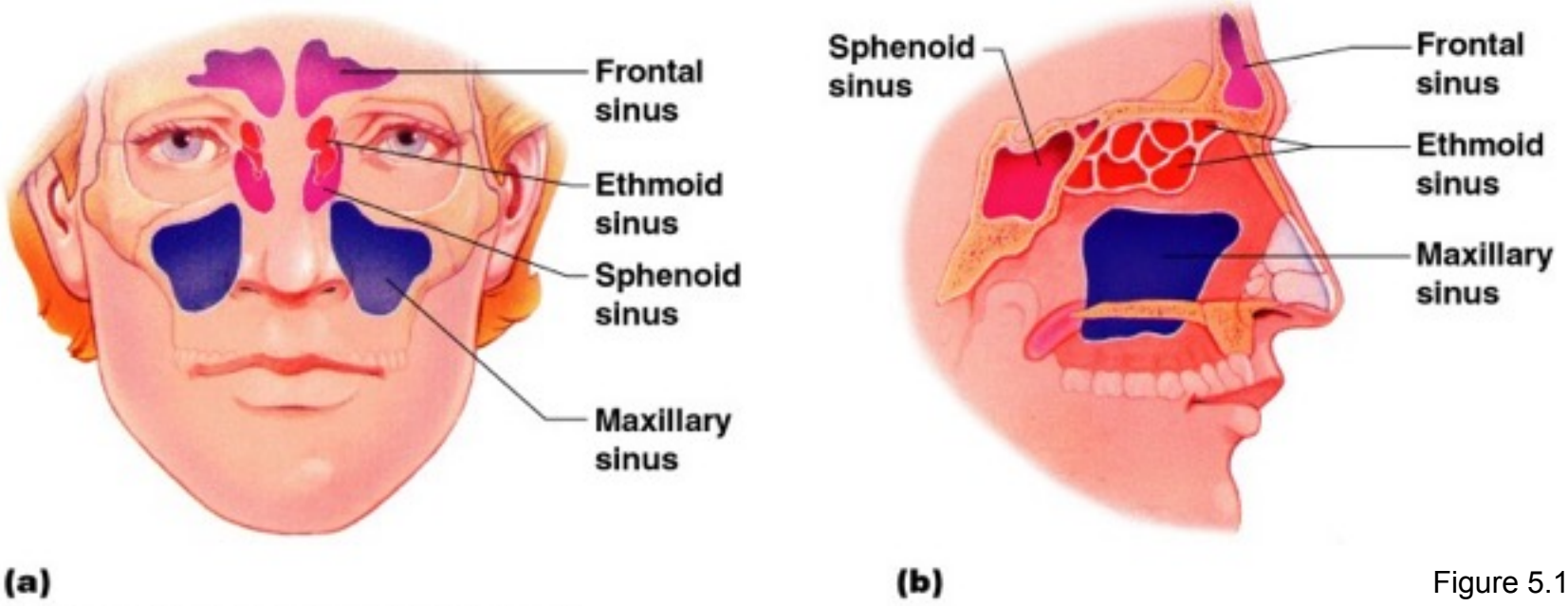


Figure 5.10

The Hyoid Bone

- The only bone that does not articulate with another bone
- Serves as a moveable base for the tongue

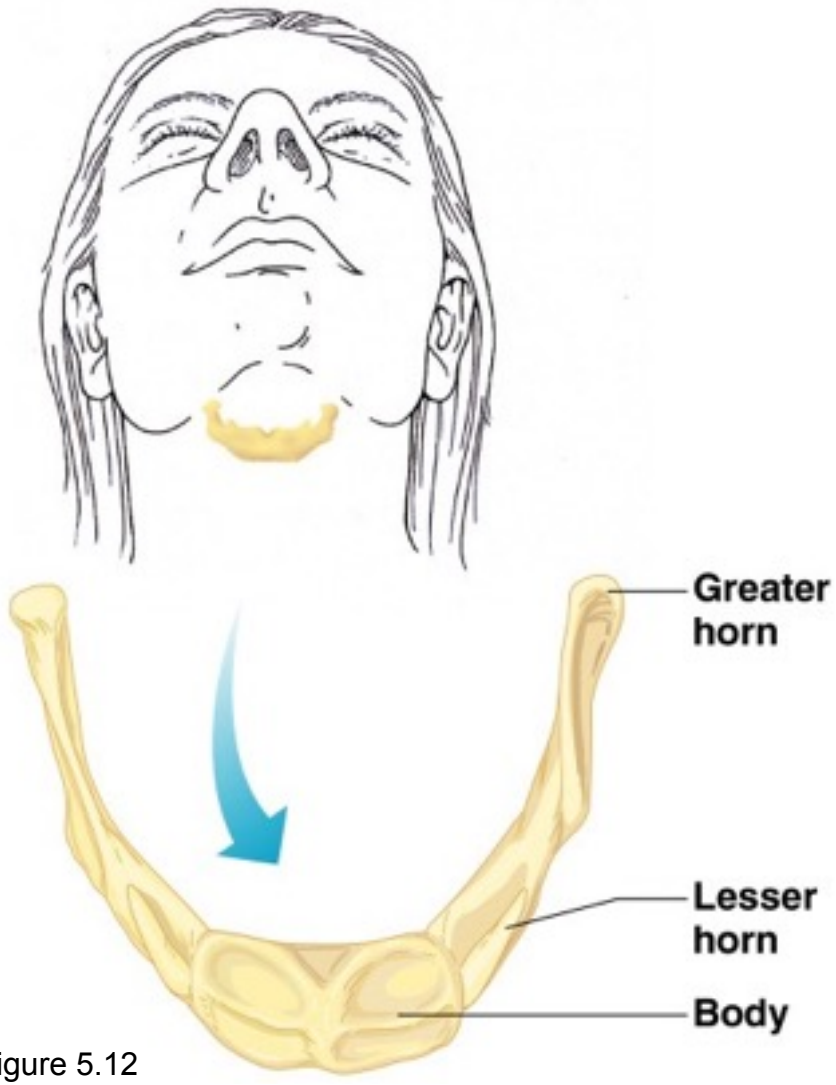


Figure 5.12

The Fetal Skull

- The fetal skull is large compared to the infants total body length

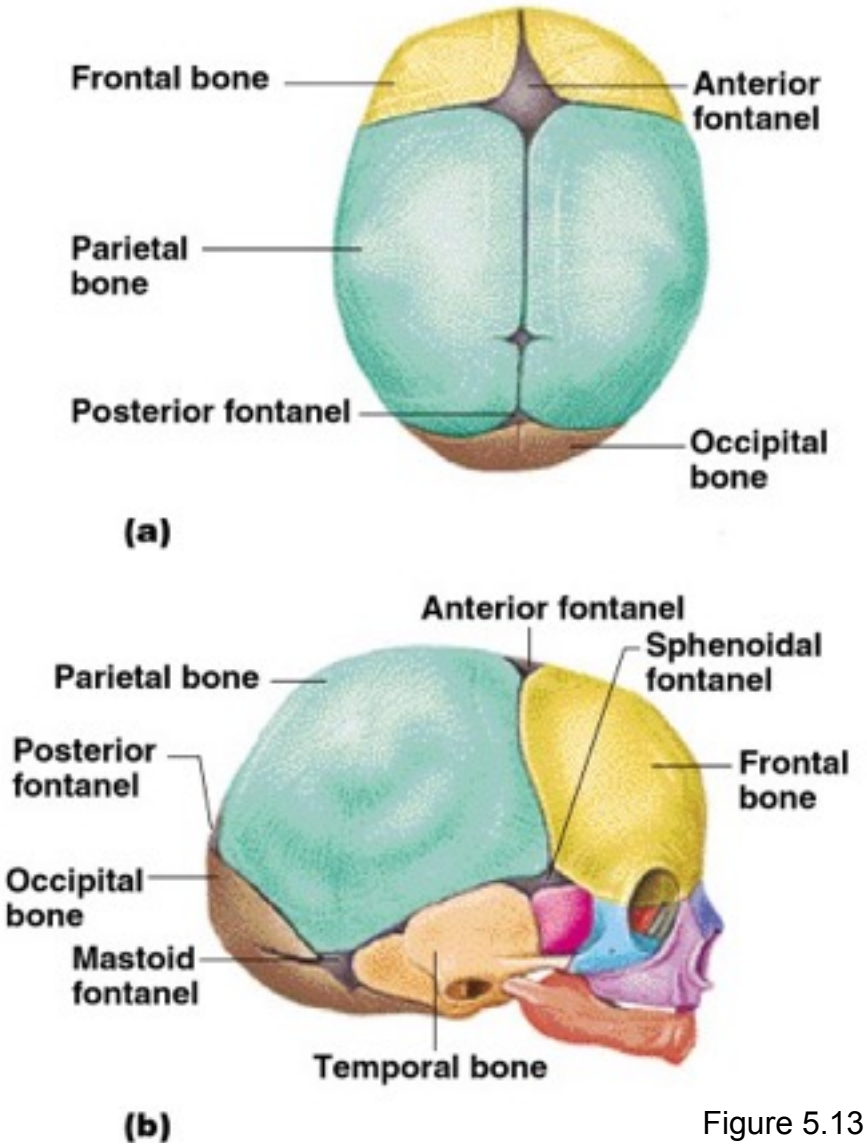


Figure 5.13

The Fetal Skull

- Fontanelles – fibrous membranes connecting the cranial bones
  - Allow the brain to grow
  - Convert to bone within 24 months after birth

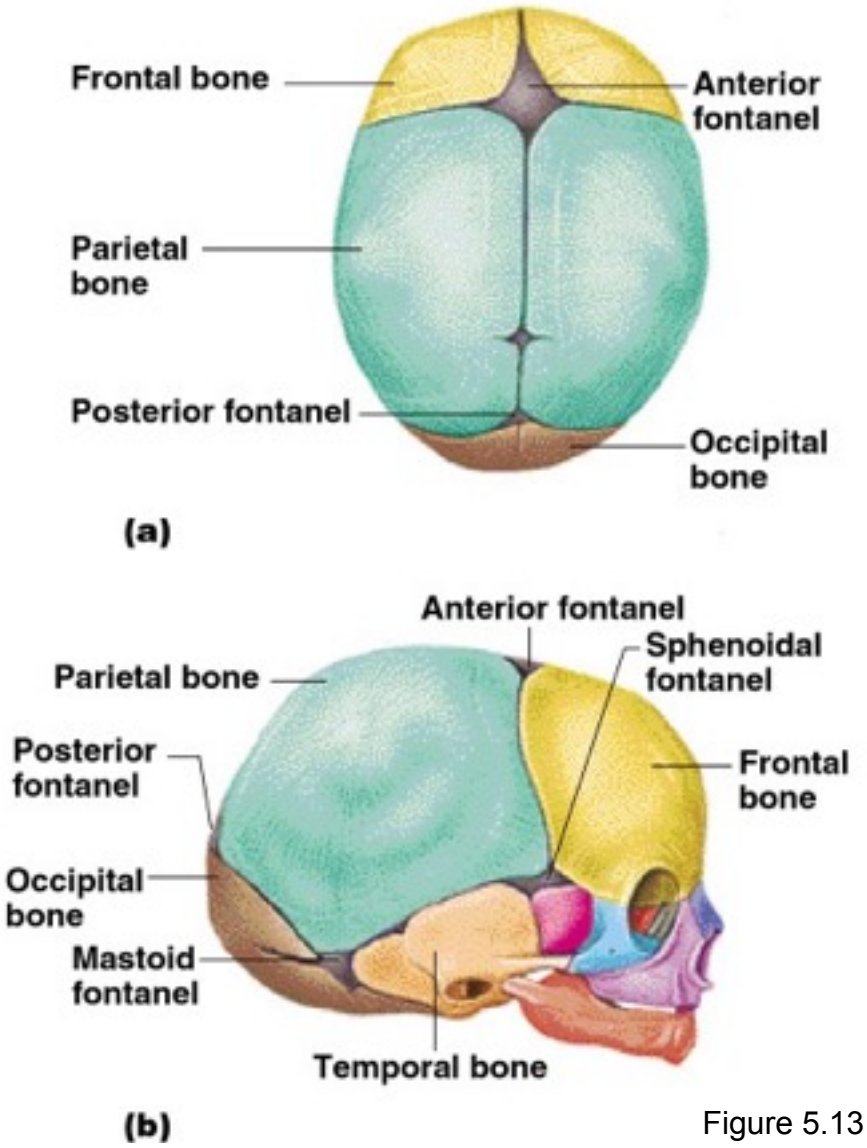


Figure 5.13

The Vertebral Column

- Vertebrae separated by intervertebral discs
- The spine has a normal curvature
- Each vertebrae is given a name according to its location

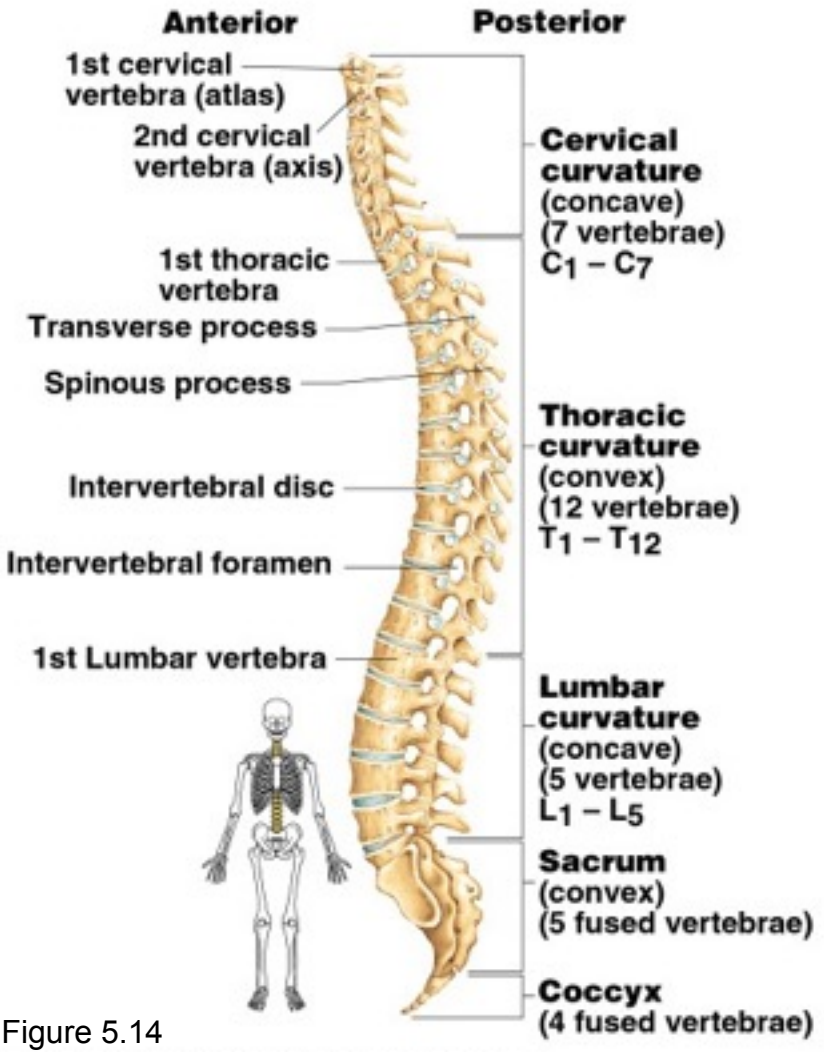


Figure 5.14

Structure of a Typical Vertebrae

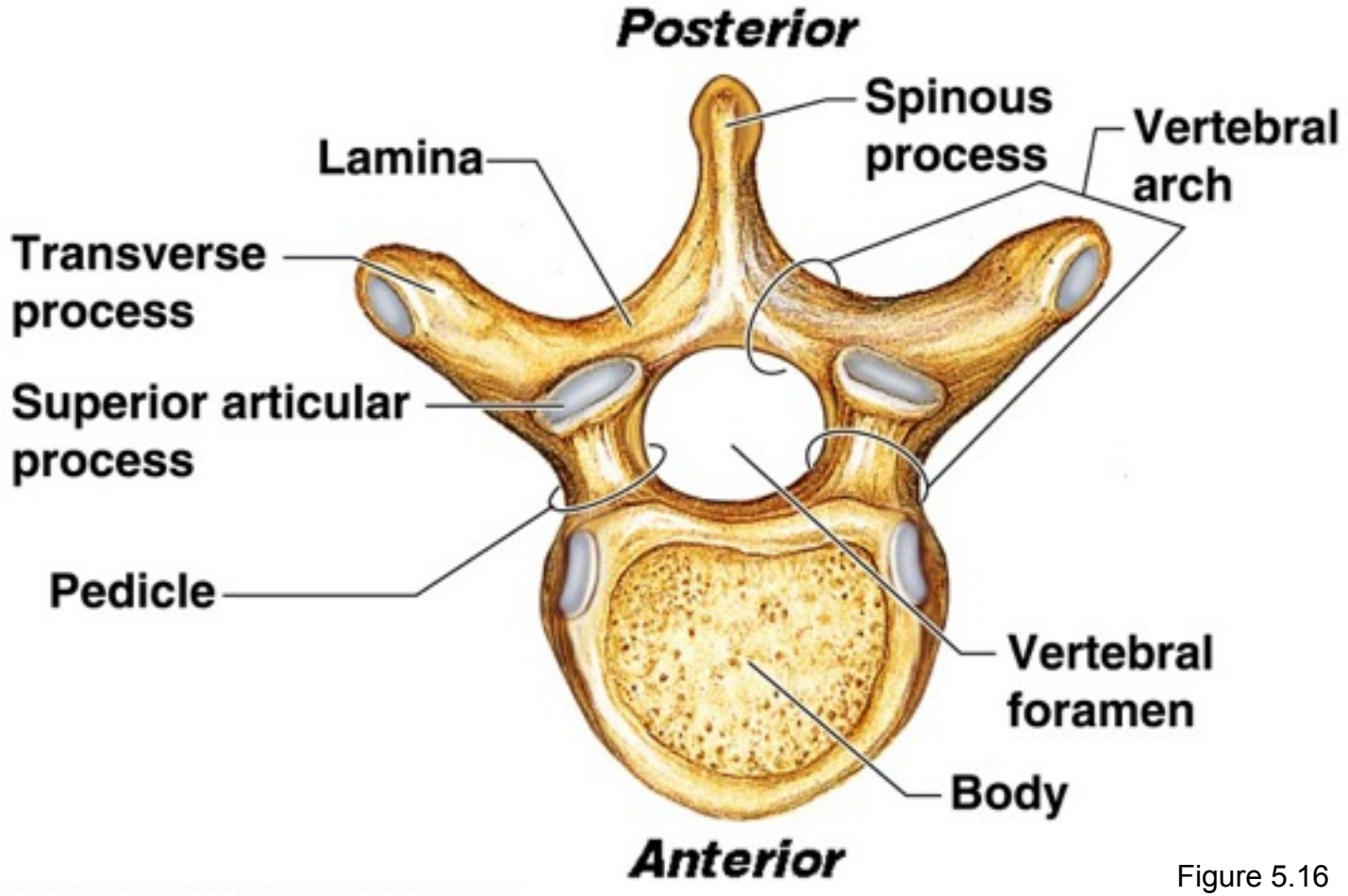


Figure 5.16

The Bony Thorax

- Forms a cage to protect major organs

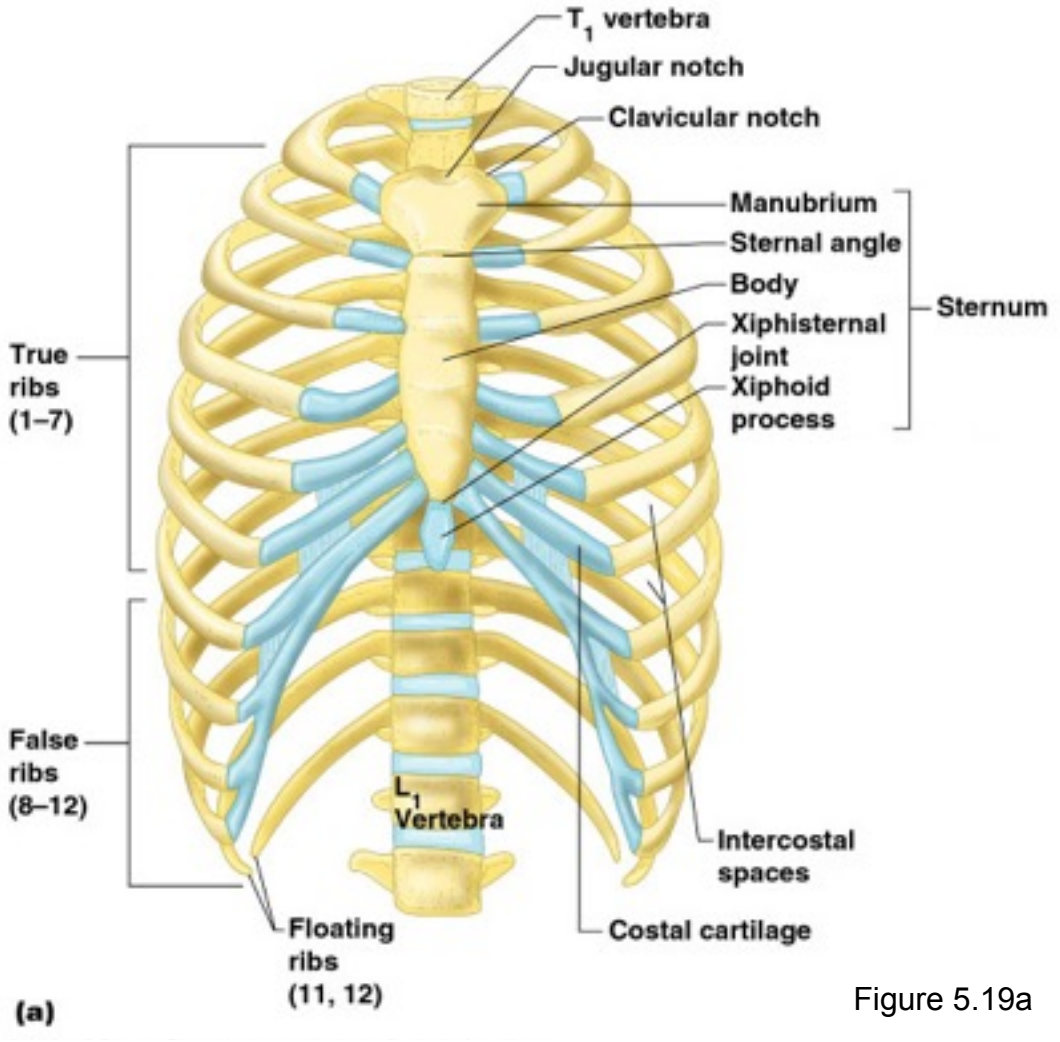


Figure 5.19a

The Bony Thorax

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

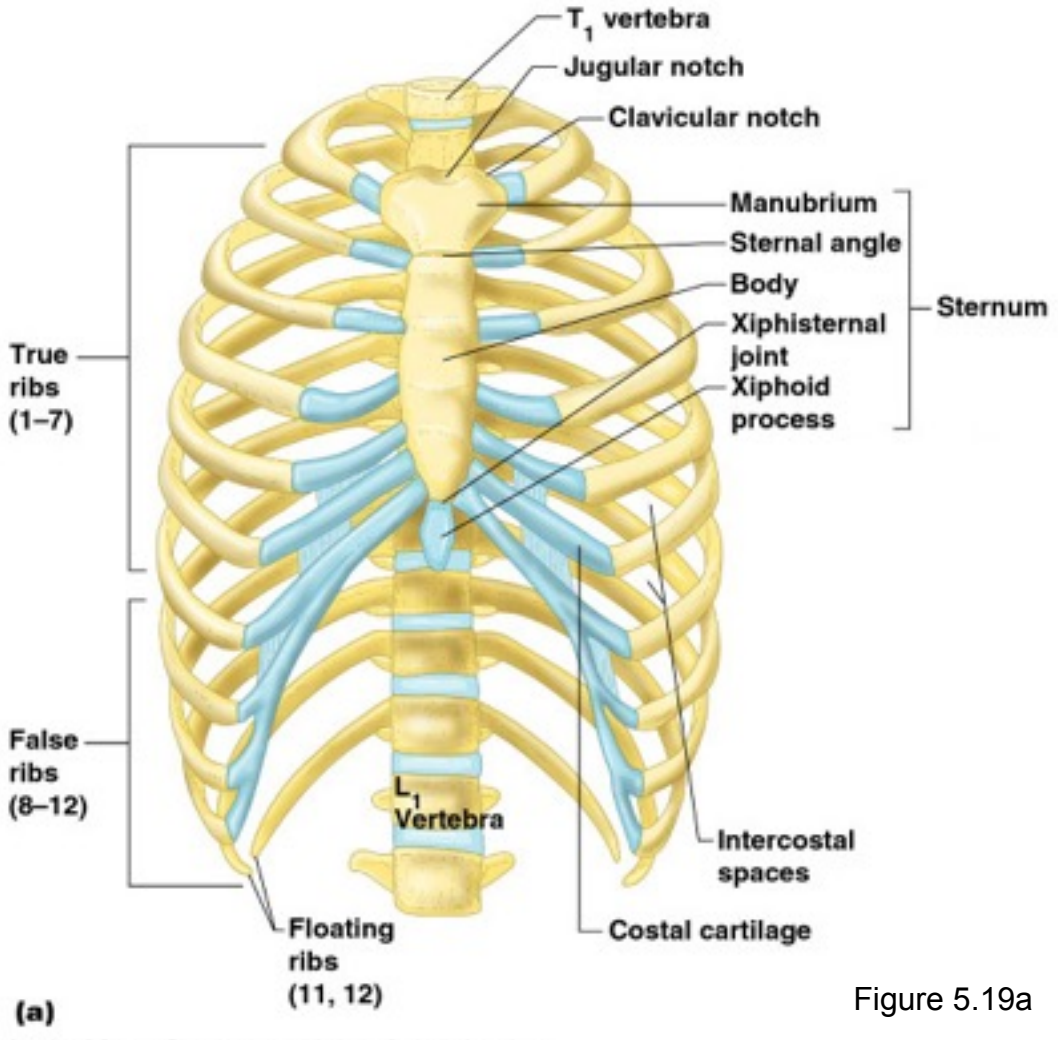


Figure 5.19a

The Appendicular Skeleton

- Limbs (appendages)
- Pectoral girdle
- Pelvic girdle

The Appendicular Skeleton

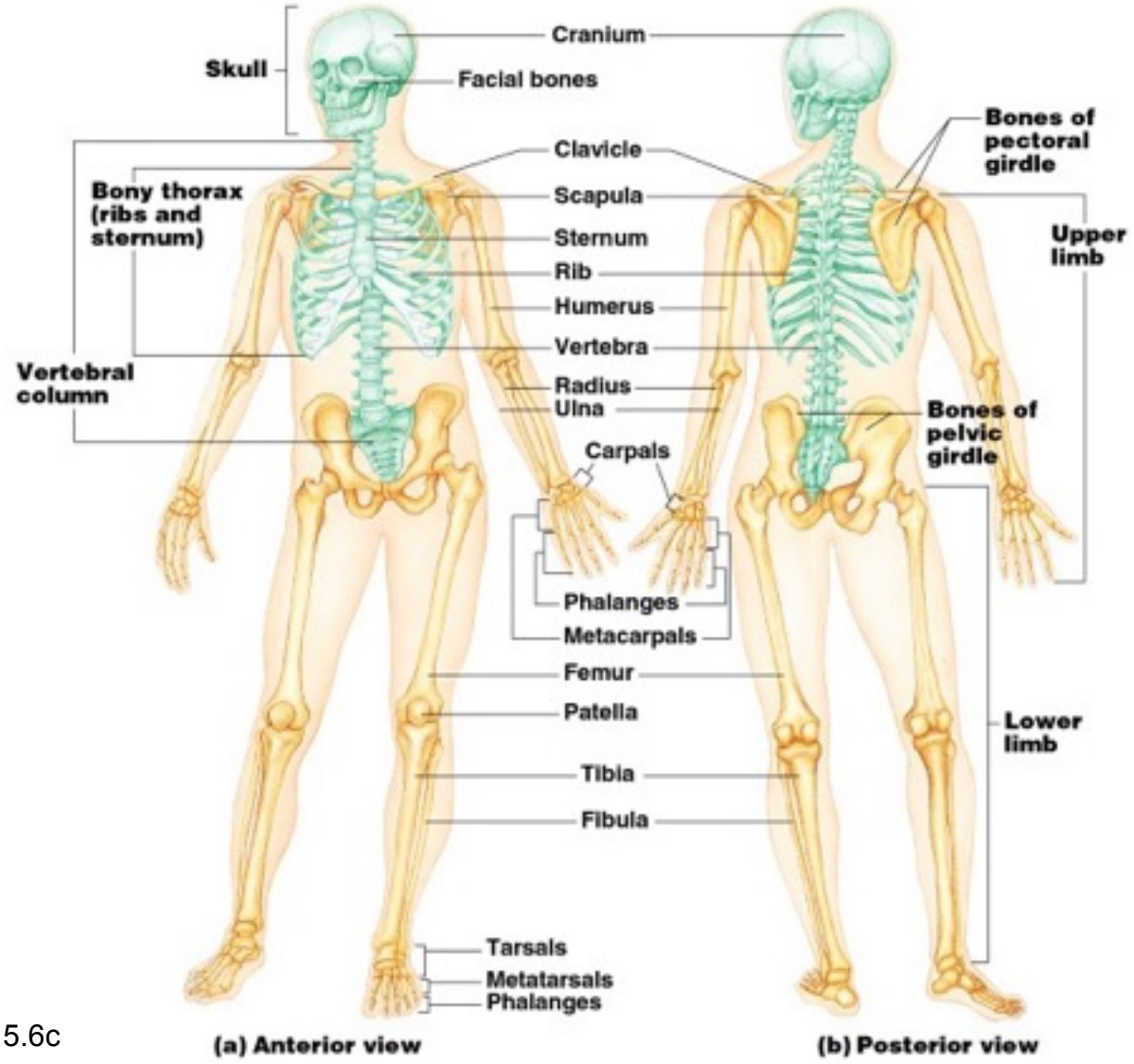
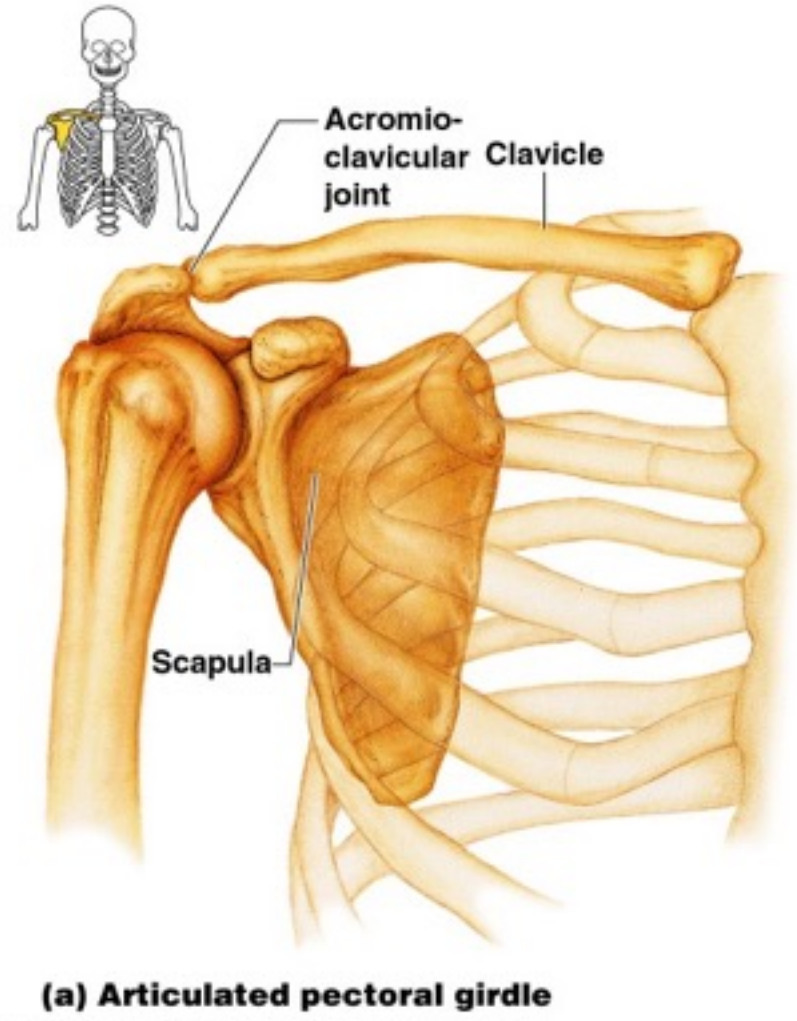


Figure 5.6c

The Pectoral (Shoulder) Girdle

- Composed of two bones
  - Clavicle – collarbone
  - Scapula – shoulder blade
- These bones allow the upper limb to have exceptionally free movement

Bones of the Shoulder Girdle



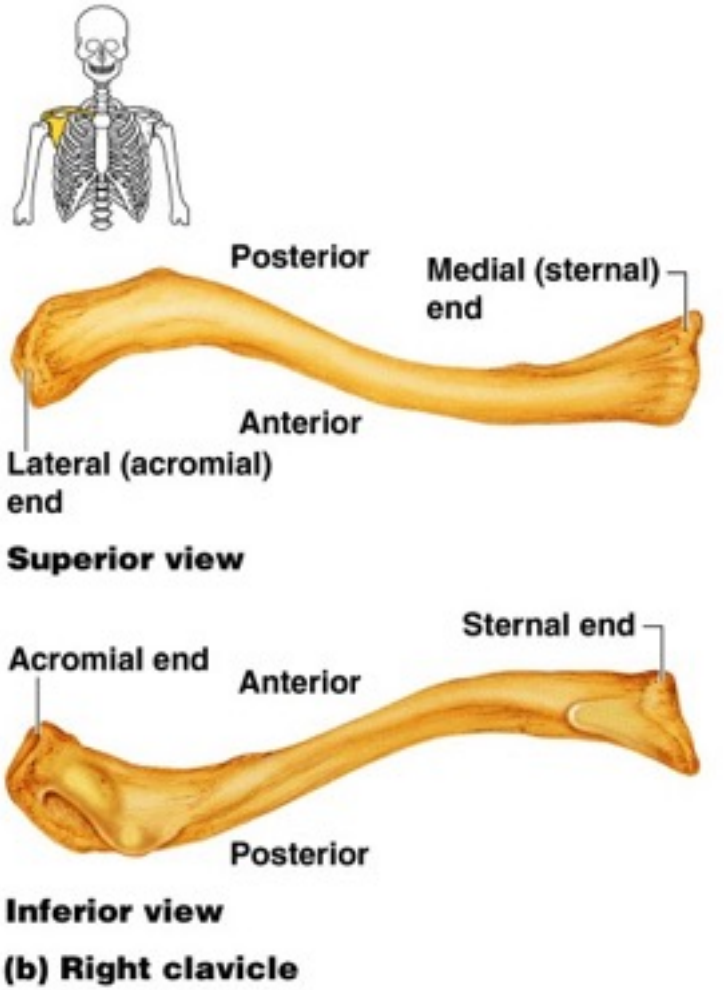


Figure 5.20a, b

Bones of the Upper Limb

- The arm is formed by a single bone
  - Humerus

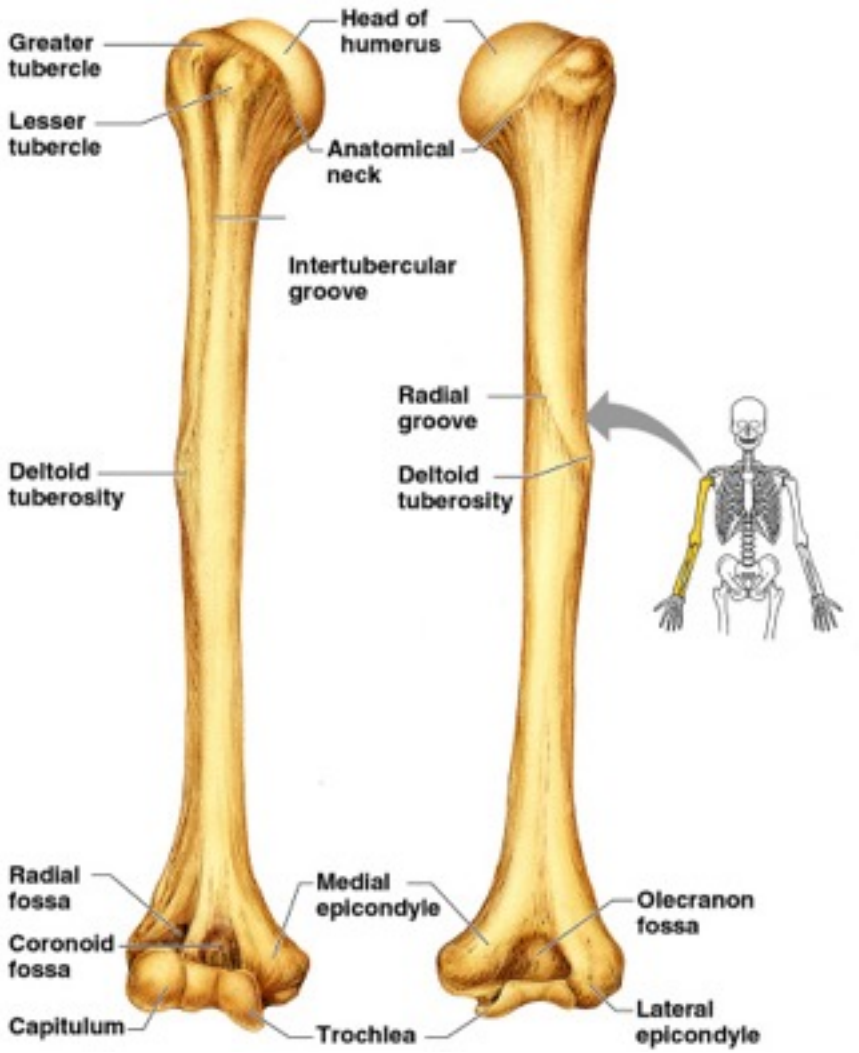


Figure 5.21a, b

Bones of the Upper Limb

- The forearm has two bones
  - Ulna
  - Radius

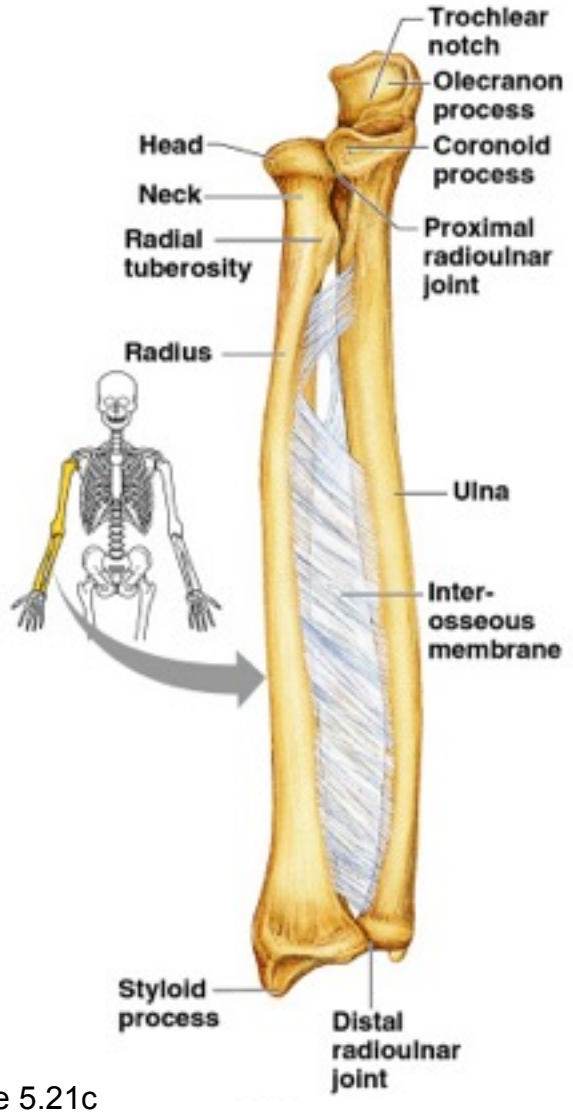


Figure 5.21c

Bones of the Upper Limb

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

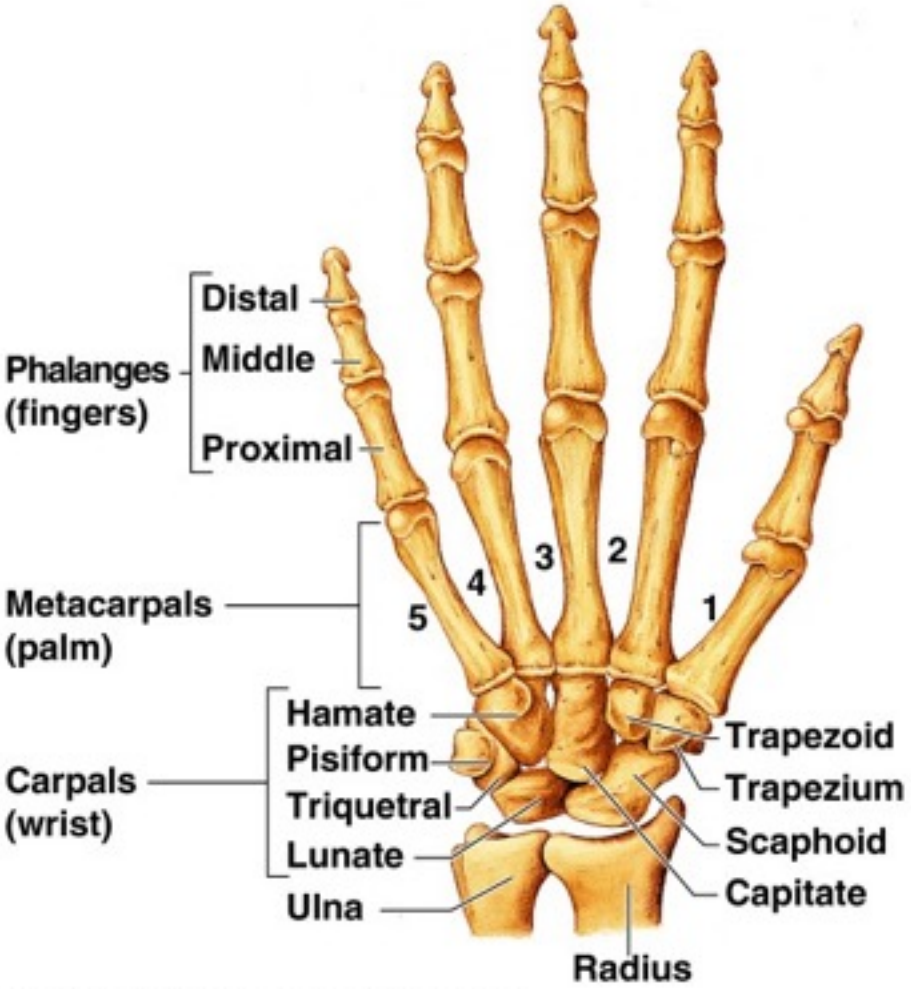


Figure 5.22

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

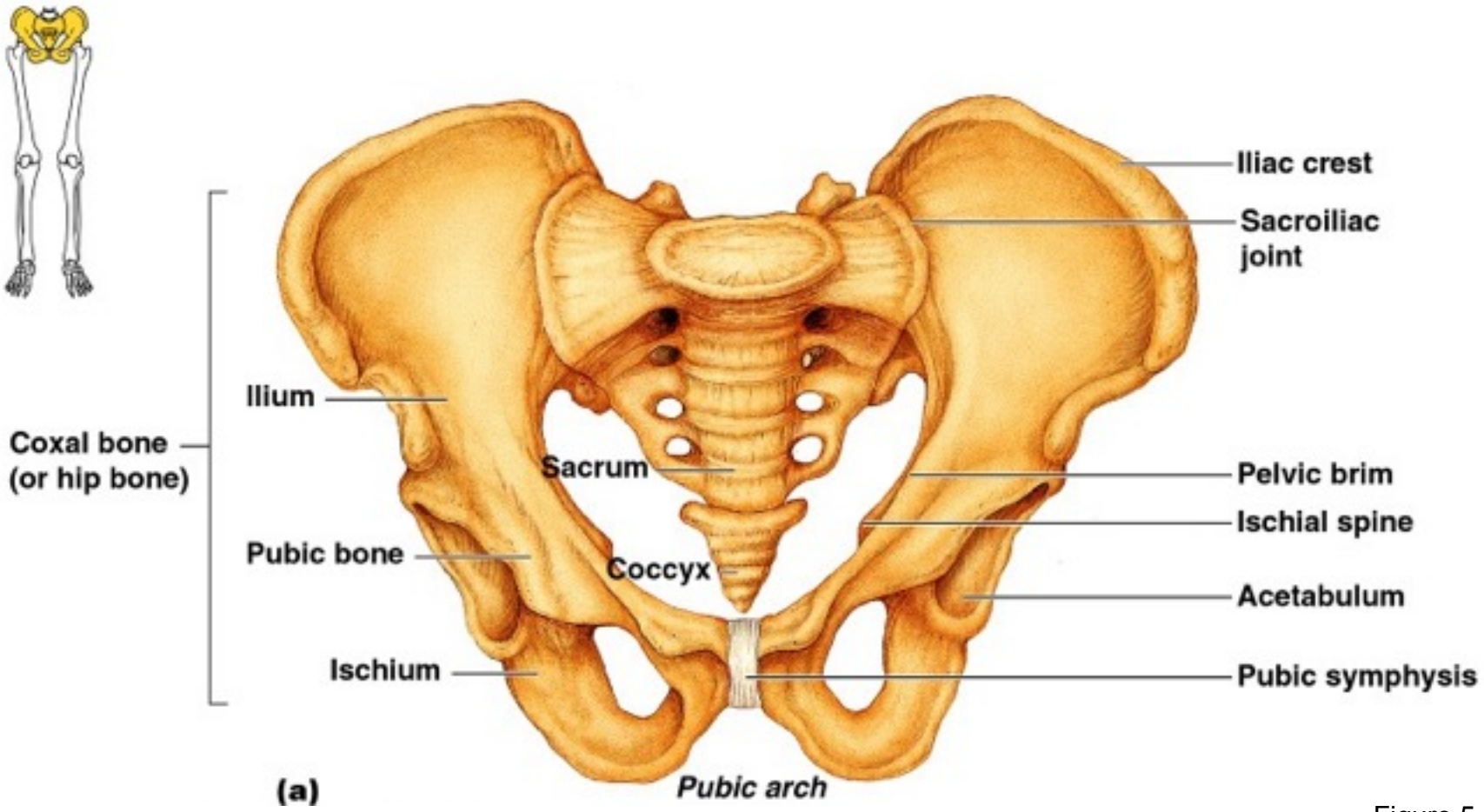


Figure 5.23a

Gender Differences of the Pelvis

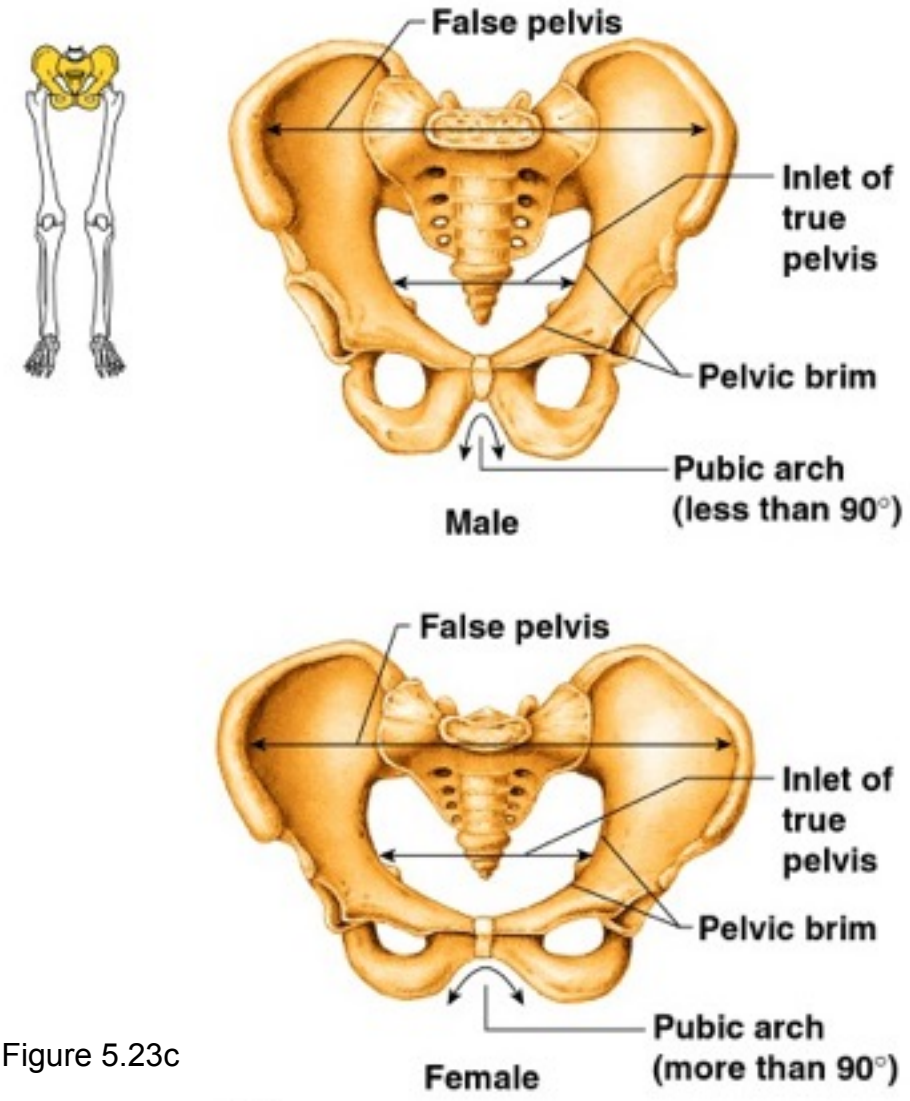


Figure 5.23c

Bones of the Lower Limbs

- The thigh has one bone
  - Femur – thigh bone

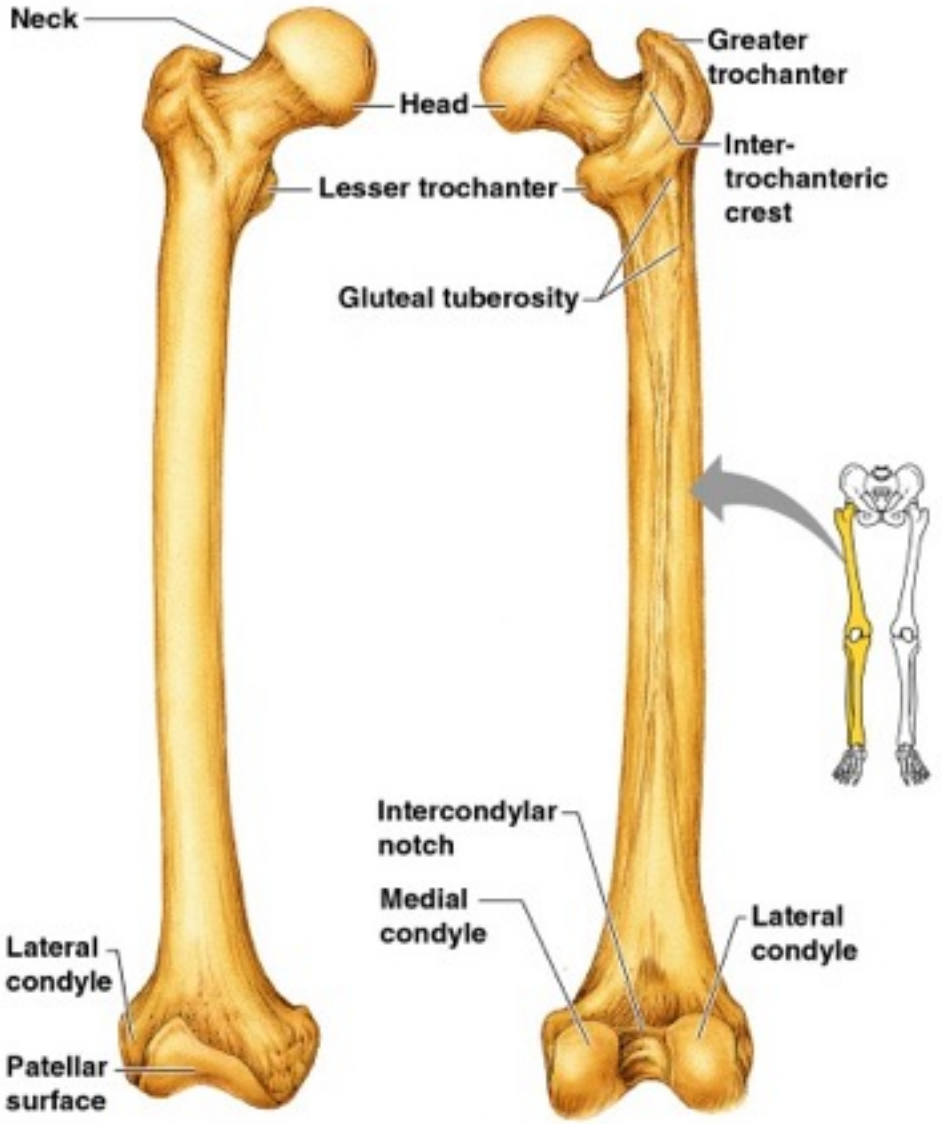


Figure 5.35a, b

Bones of the Lower Limbs

- The leg has two bones
  - Tibia
  - Fibula

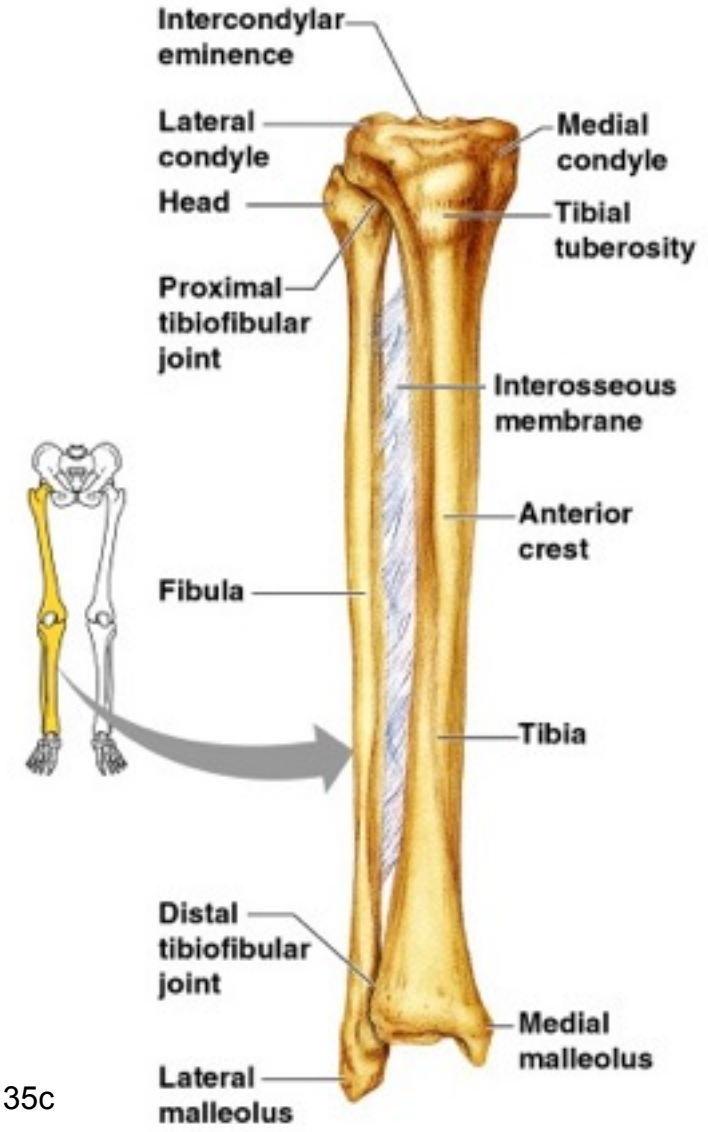


Figure 5.35c

Bones of the Lower Limbs

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

Figure 5.25

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 – synarthrosis or largely immovable.

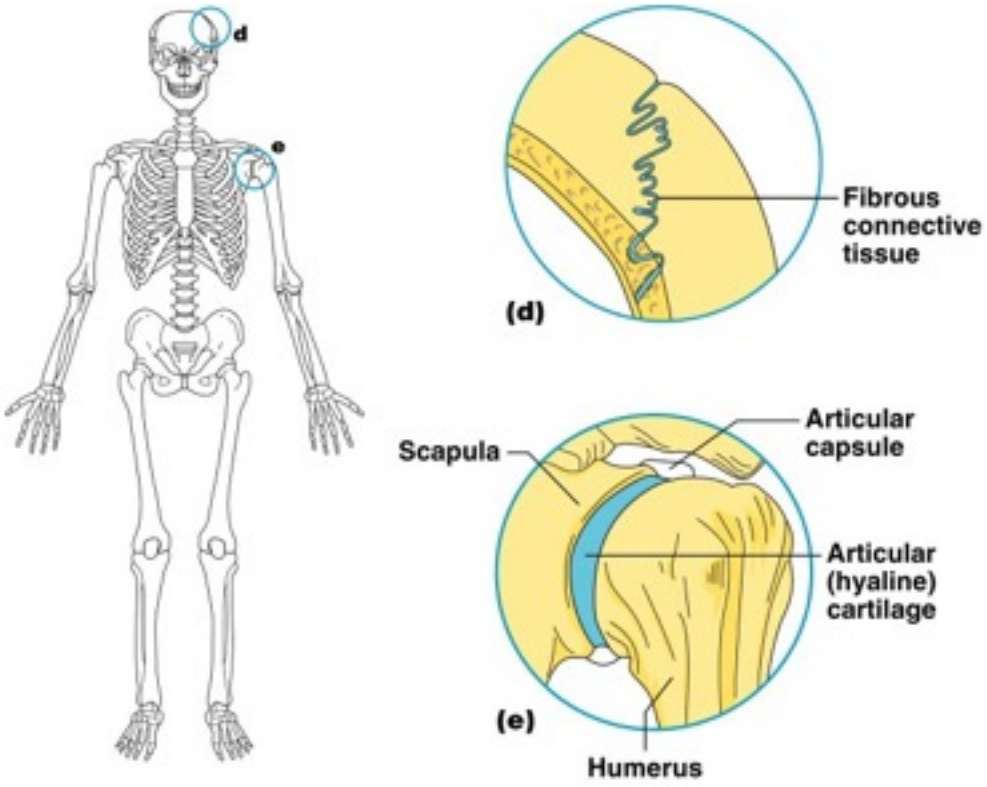


Figure 5.27d, e

Cartilaginous Joints – mostly amphiarthrosis

- Bones connected by cartilage
- Examples
  - Pubic symphysis
  - Intervertebral joints

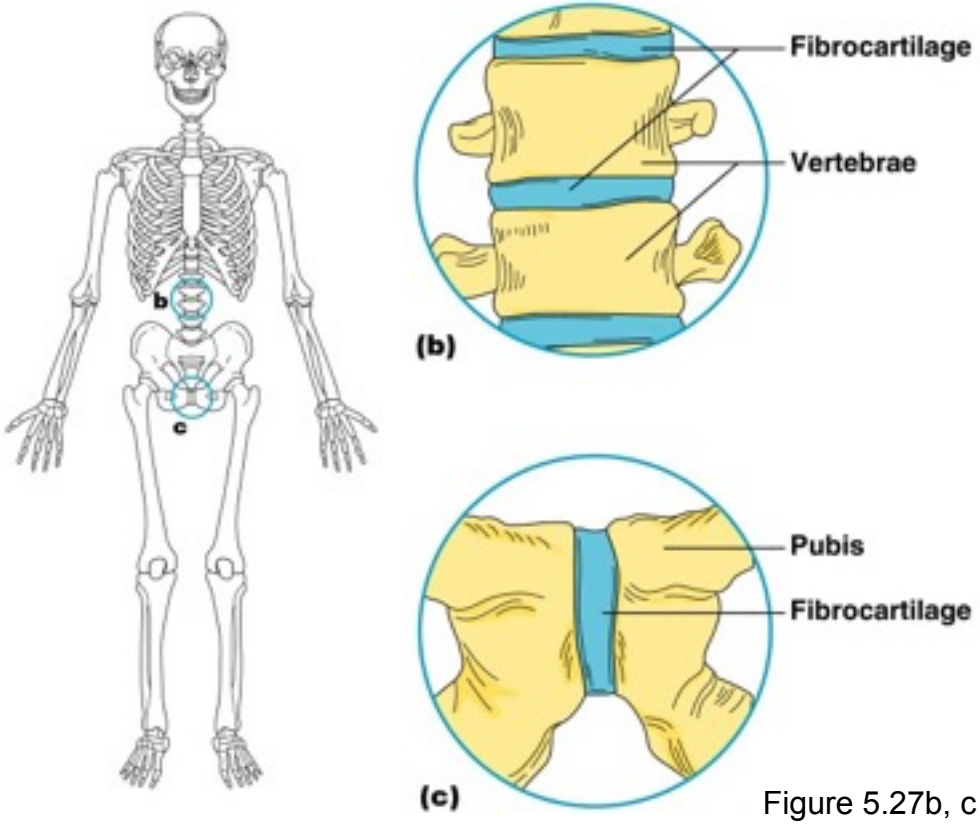


Figure 5.27b, c

Synovial Joints

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

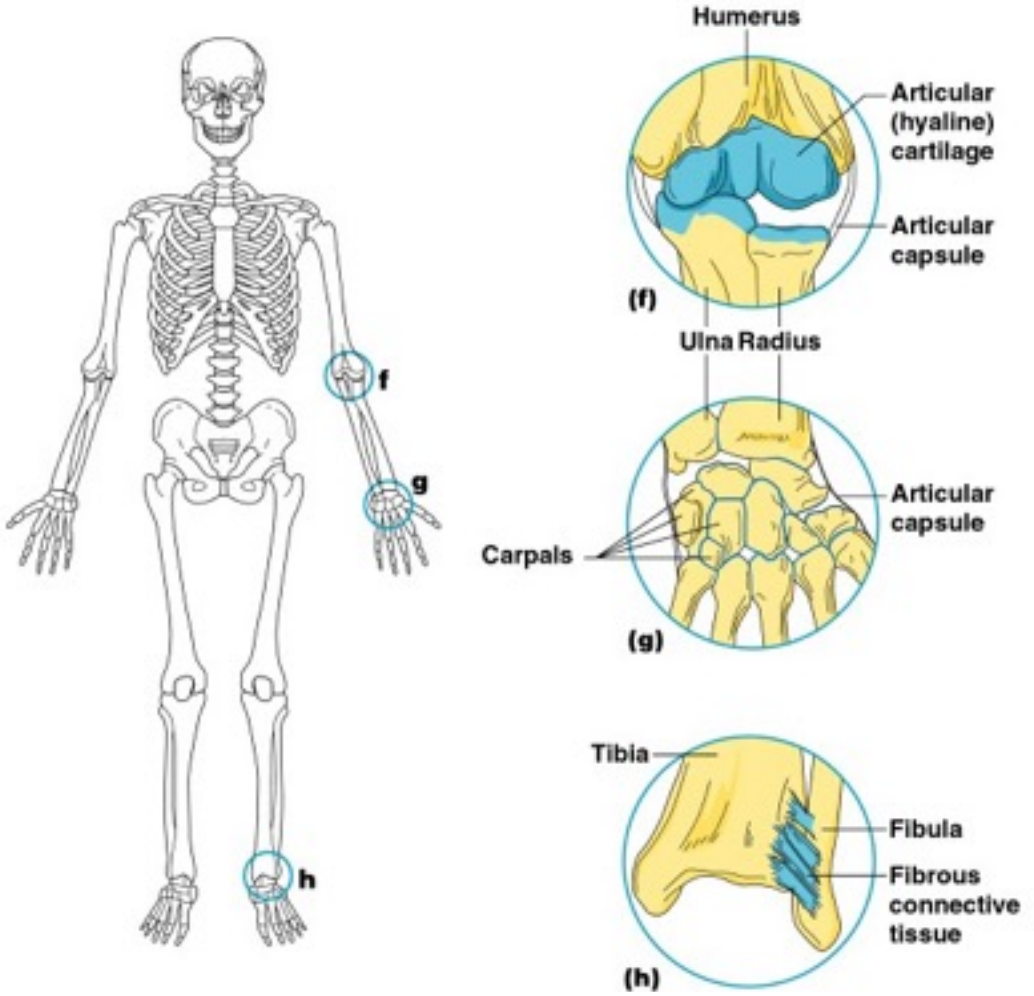


Figure 5.27f–h

Features of Synovial Joints-Diarthroses

- 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
- Tendon sheath
  - Elongated bursa that wraps around a tendon

The Synovial Joint

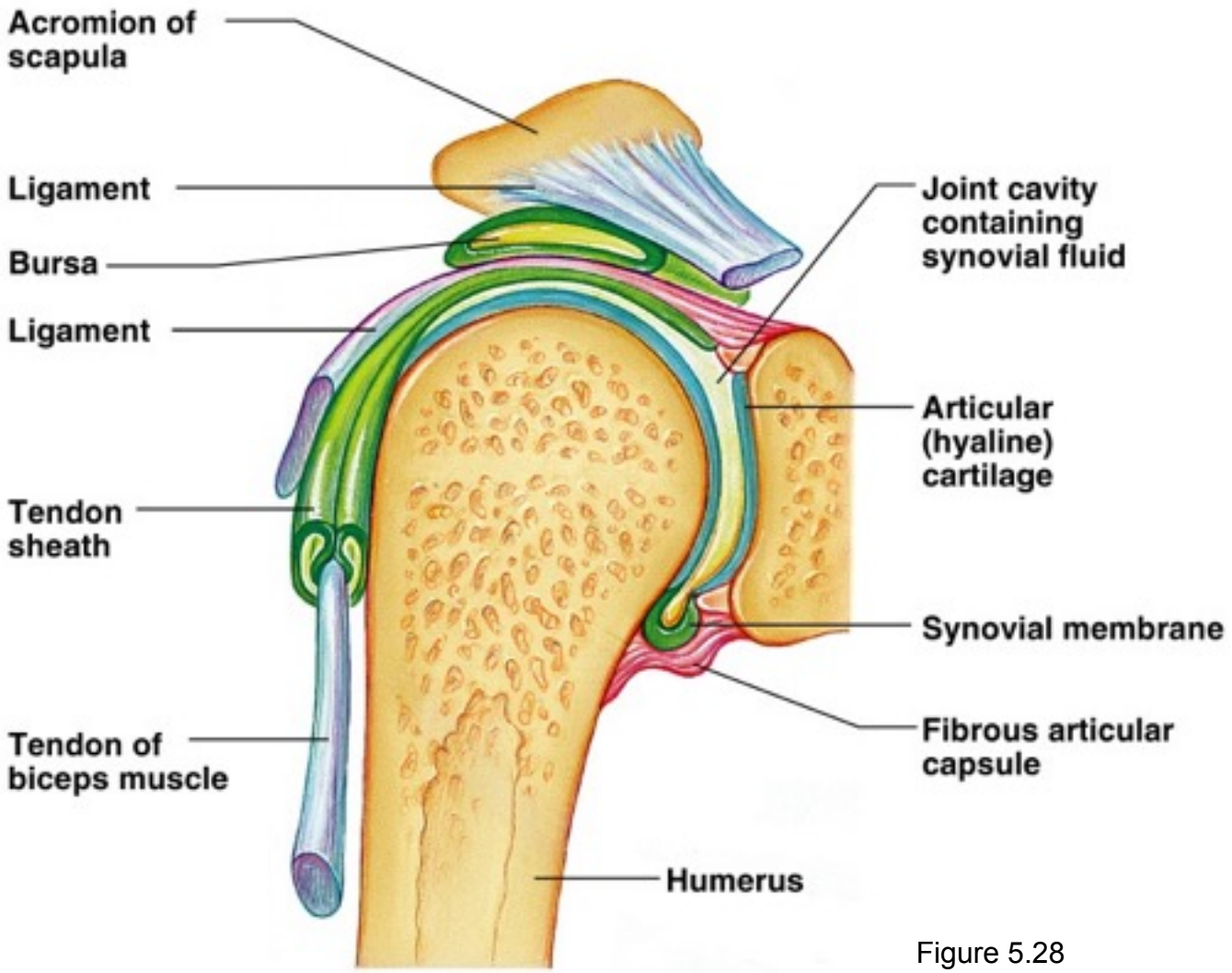


Figure 5.28

Types of Synovial Joints Based on Shape

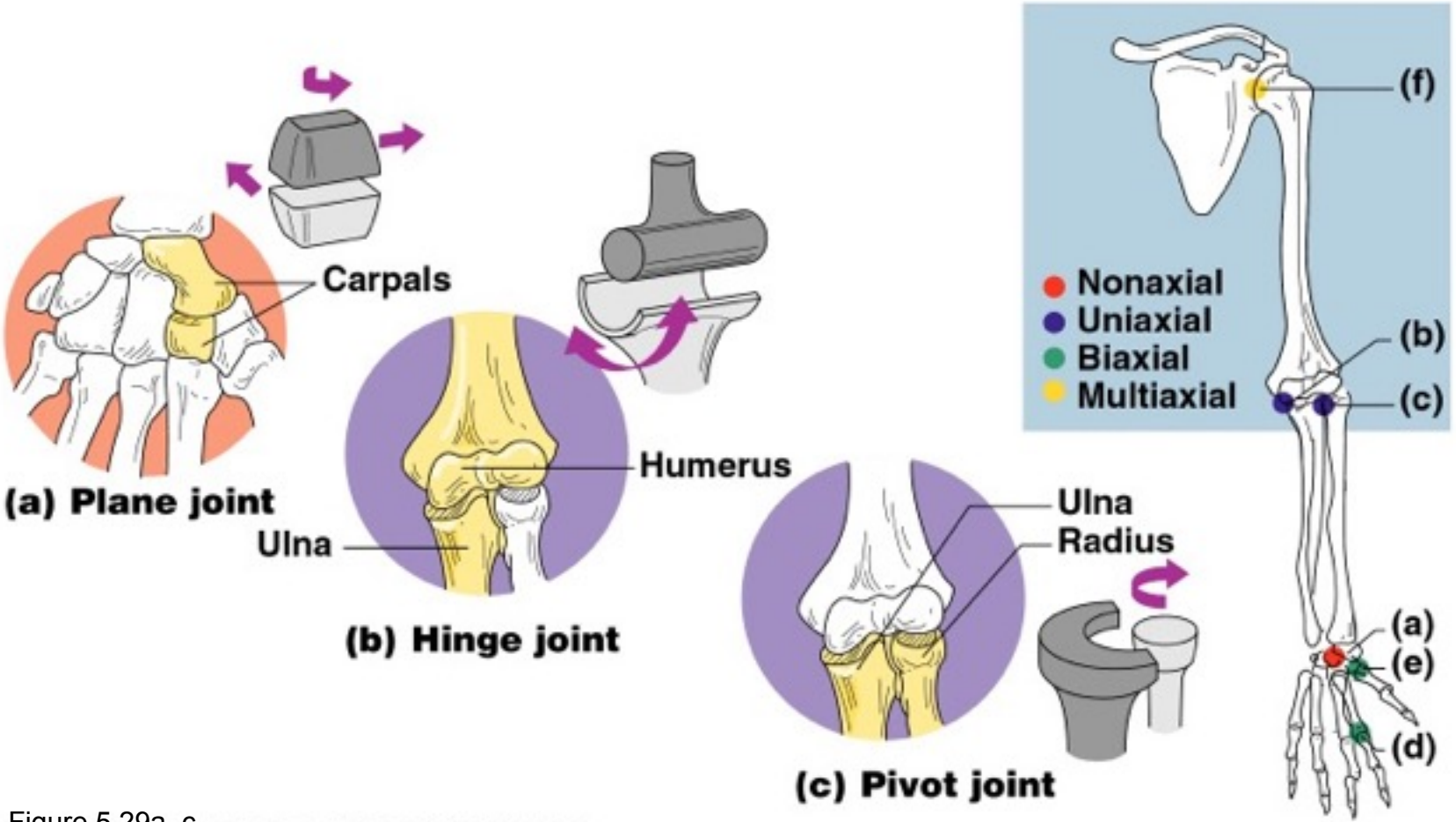


Figure 5.29a–c

Types of Synovial Joints Based on Shape

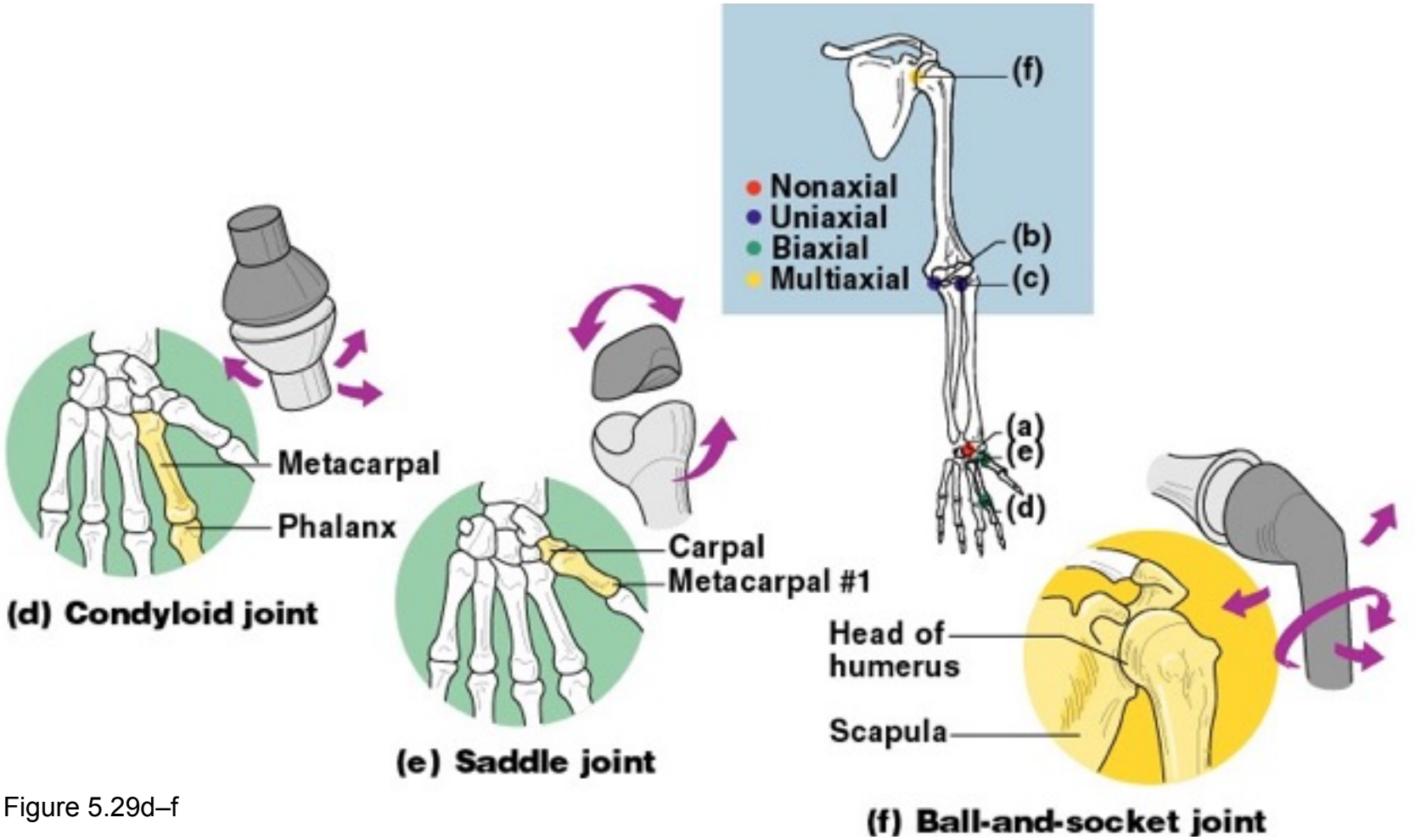


Figure 5.29d–f

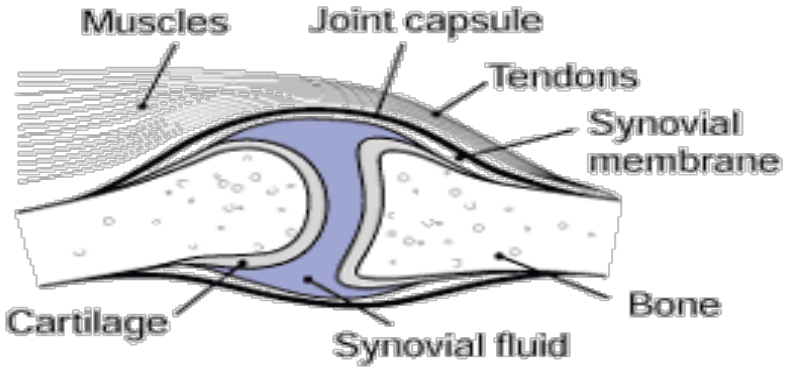
Inflammatory Conditions Associated with Joints

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

Clinical Forms of Arthritis

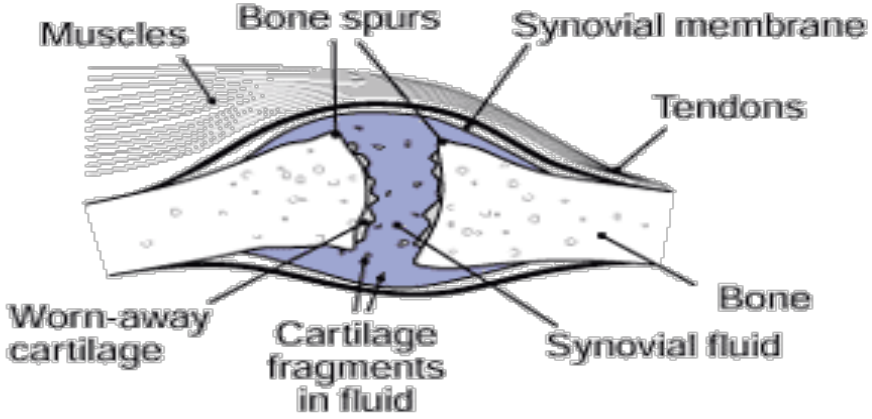
- Osteoarthritis
  - Most common chronic arthritis
  - Probably related to normal aging processes
- Rheumatoid arthritis
  - An autoimmune disease – the immune system attacks the joints
  - Symptoms begin with bilateral inflammation of certain joints
  - Often leads to deformities

A Healthy Joint



In a healthy joint, the ends of bones are encased in smooth cartilage. Together, they are protected by a joint capsule lined with a synovial membrane that produces synovial fluid. The capsule and fluid protect the cartilage, muscles, and connective tissues.

A Joint With Osteoarthritis



With osteoarthritis, the cartilage becomes worn away. Spurs grow out from the edge of the bone, and synovial fluid increases. Altogether, the joint feels stiff and sore.


Nightly News

Clinical Forms of Arthritis

- Gouty Arthritis
  - Inflammation of joints is caused by a deposition of urate crystals from the blood
  - Can usually be controlled with diet