

Hole's Human Anatomy and Physiology

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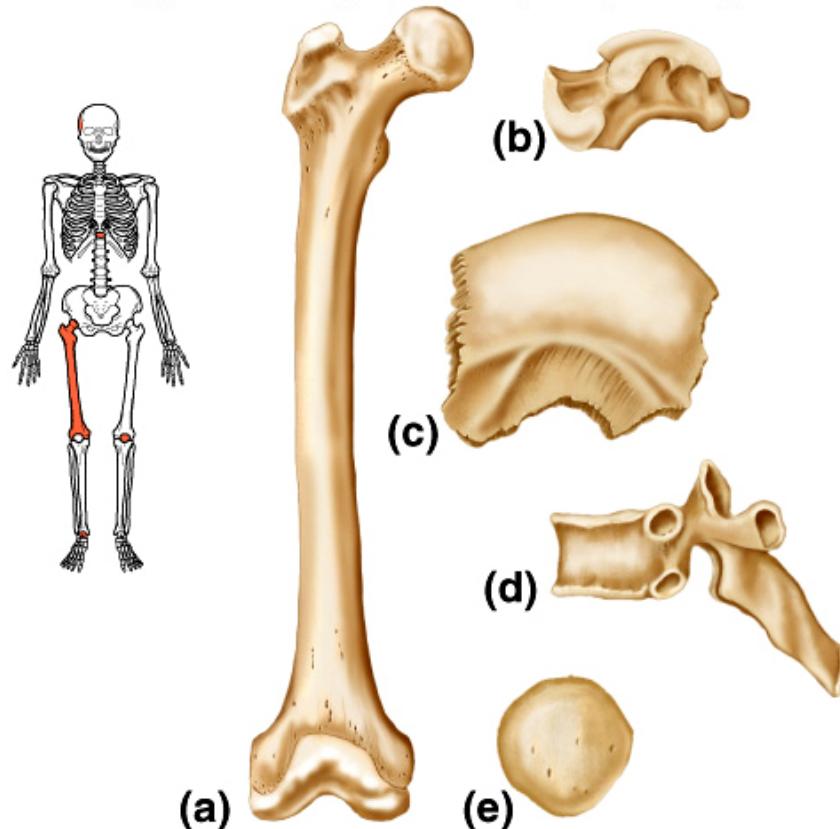
Chapter 7

Skeletal System

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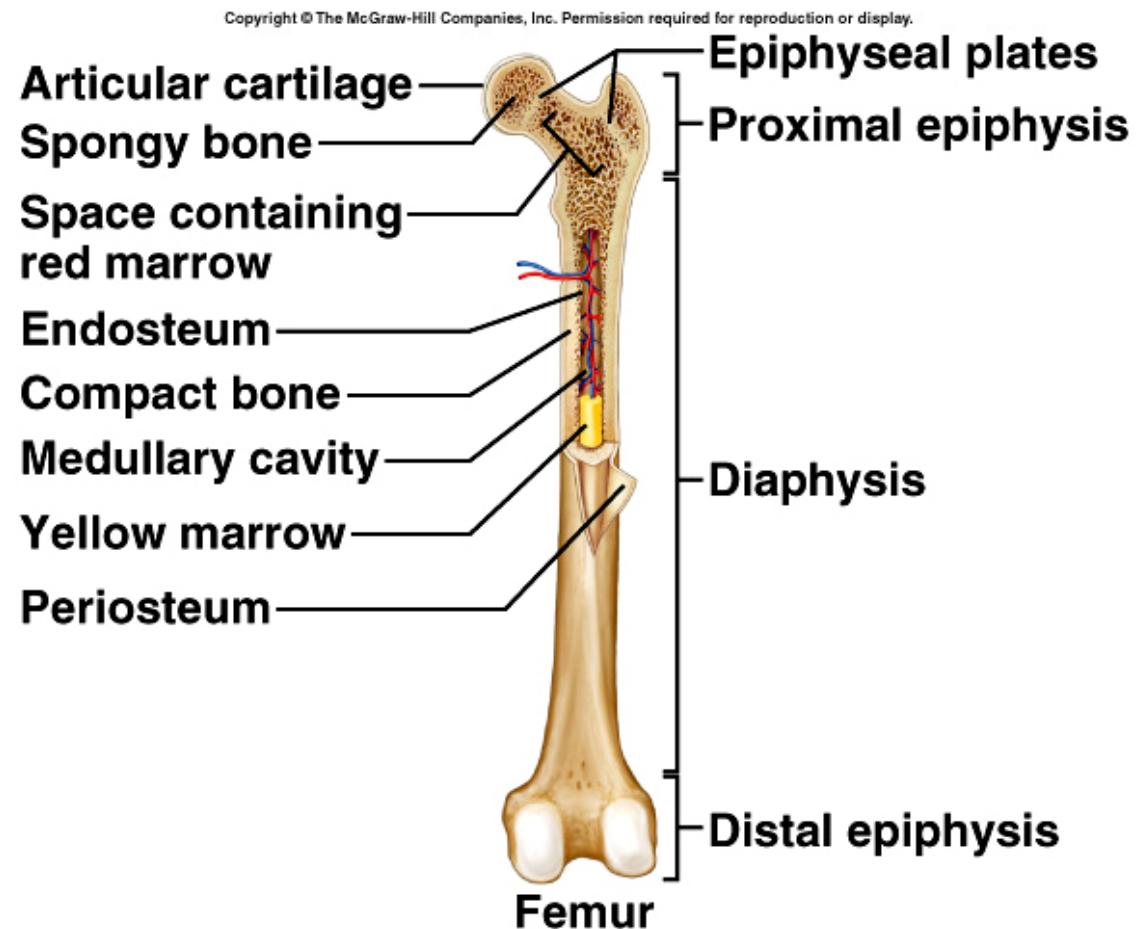
Bone Classification

- Long Bones
- Short Bones
- Flat Bones
- Irregular Bones
- Sesamoid (Round) Bones



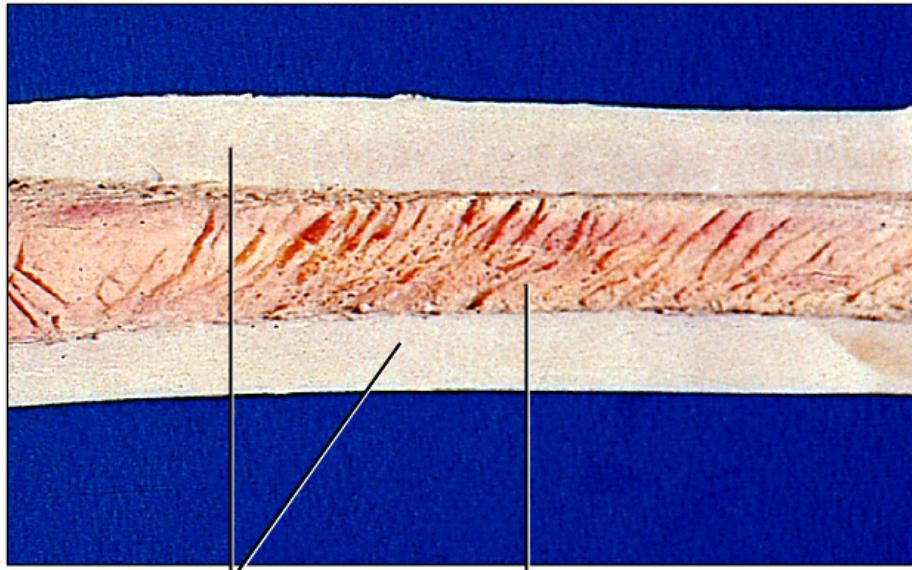
Parts of a Long Bone

- **epiphysis**
 - distal
 - proximal
- **diaphysis**
- **compact** bone
- **spongy** bone
- **articular** cartilage
- **periosteum**
- **endosteum**
- **medullary cavity**
- **trabeculae**
- **marrow**
 - red
 - yellow



Compact and Spongy Bone

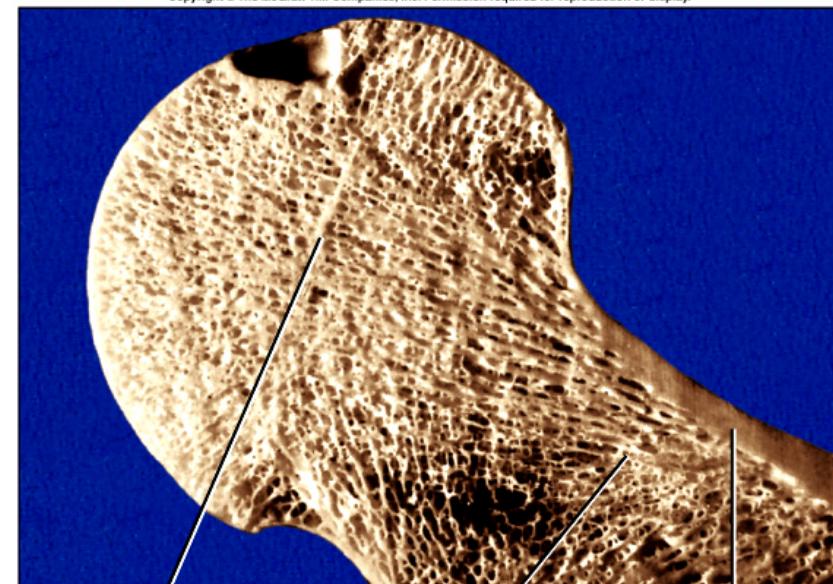
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Compact bone

Yellow marrow in
medullary cavity

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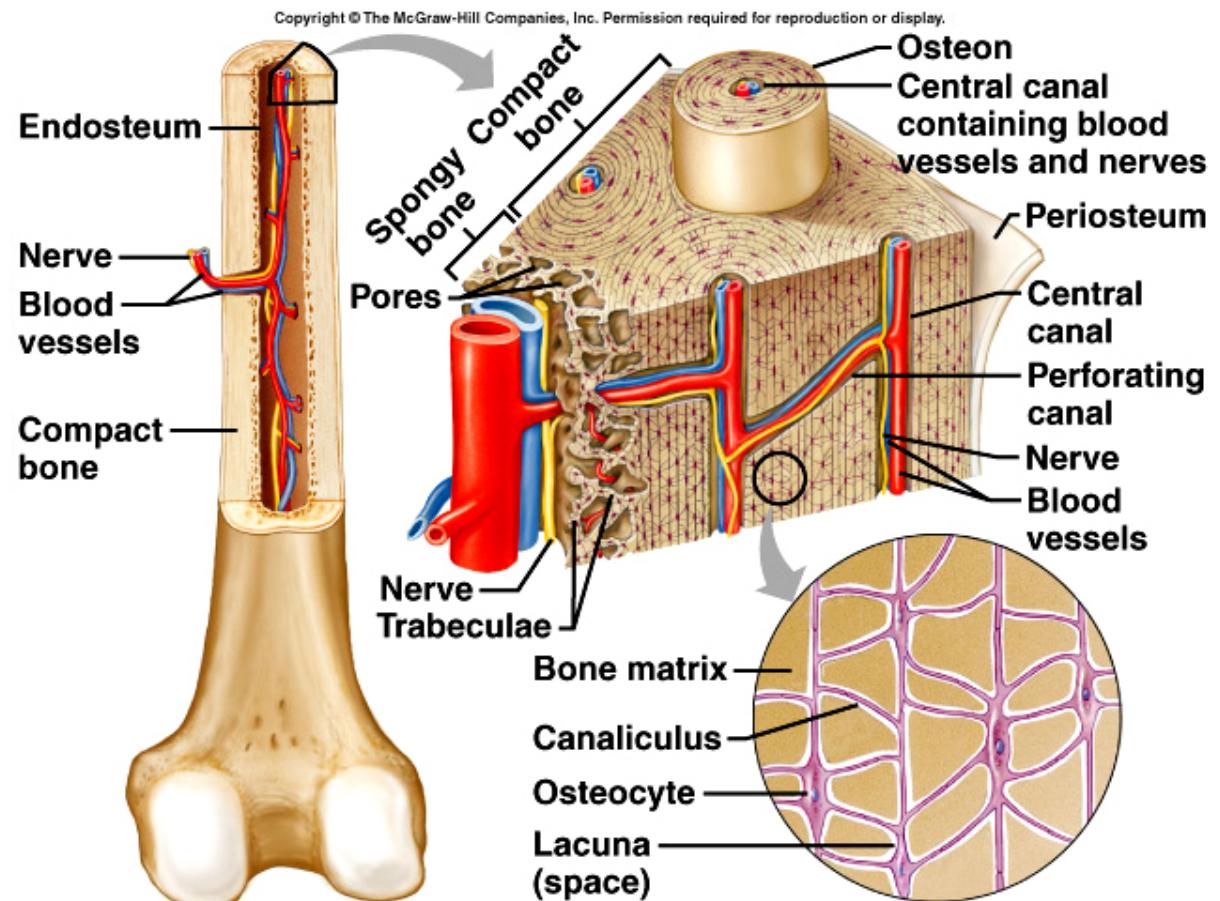
Remnant of
epiphyseal plate

Spongy
bone

Compact
bone

Microscopic Structure of Compact Bone

- **osteon**
- **central canal**
- **perforating canal**
- **osteocyte**
- **lacuna**
- **bone matrix**
- **canalculus**



Bone Development

Intramembranous Ossification

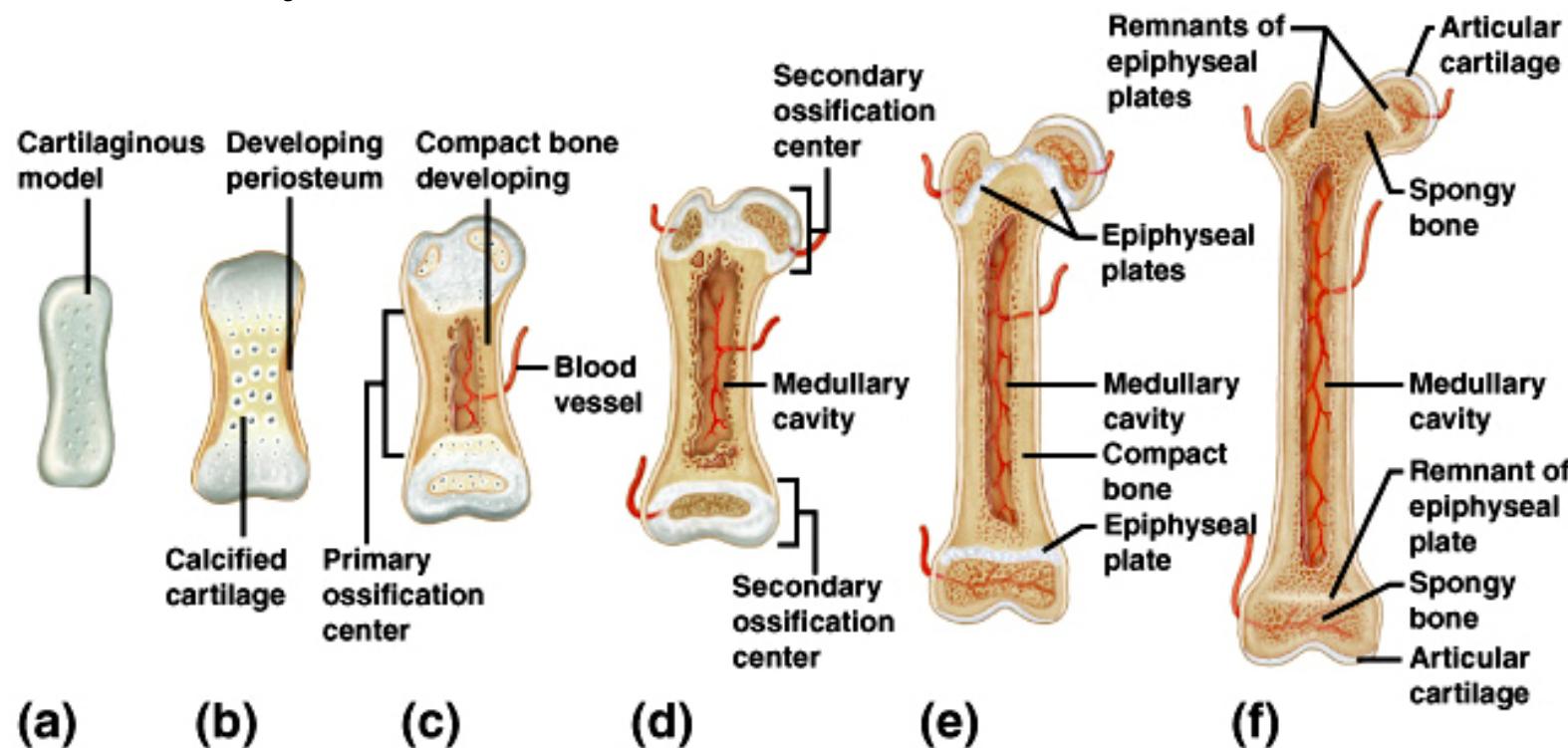
- bones originate within sheetlike layers of connective tissues
- broad, flat bones
 - skull bones (except mandible)
- intramembranous bones

Endochondral Ossification

- bones begin as hyaline cartilage
 - form models for future bones
- most bones of the skeleton
- endochondral bones

Endochondral Ossification

- hyaline cartilage model
- primary ossification center
- secondary ossification centers
- epiphyseal plate
- osteoblasts vs. osteoclasts



Growth at the Epiphyseal Plate

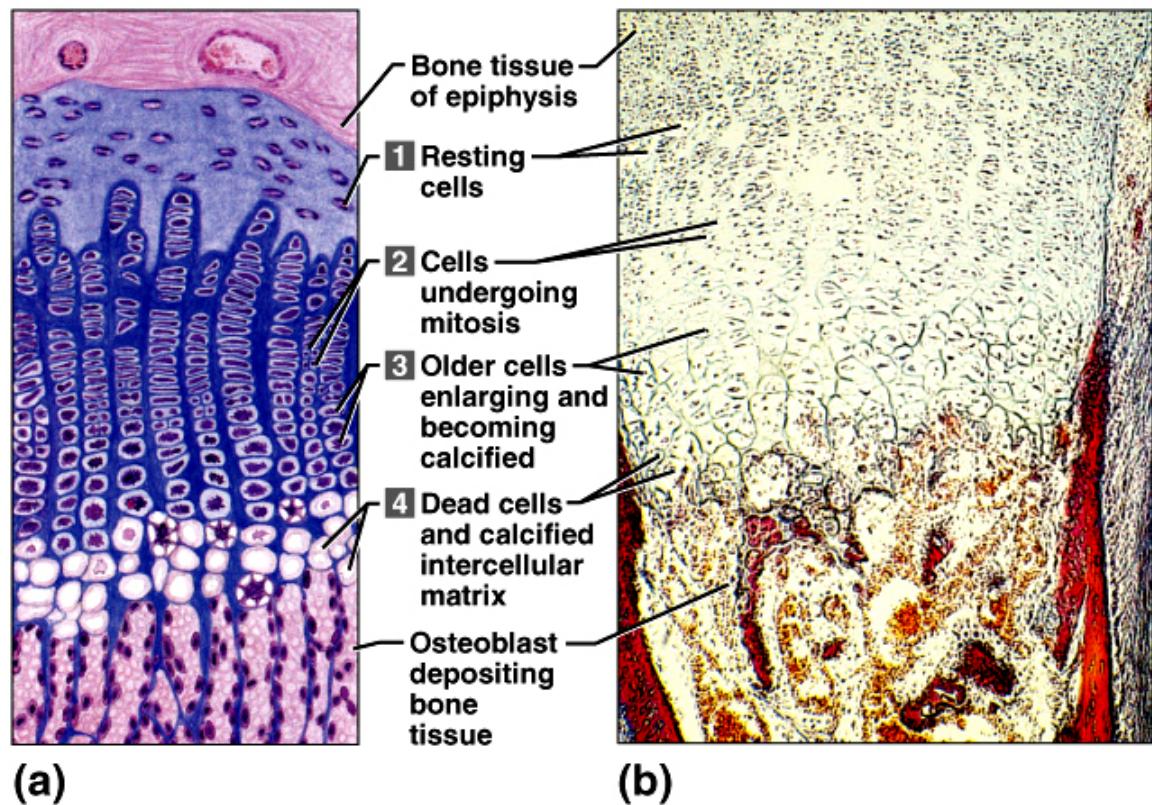
First layer of cells

- closest to the end of epiphysis
- resting cells
- anchors epiphyseal plate to epiphysis

Second layer of cells

- many rows of young cells
- undergoing mitosis

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Growth at the Epiphyseal Plate

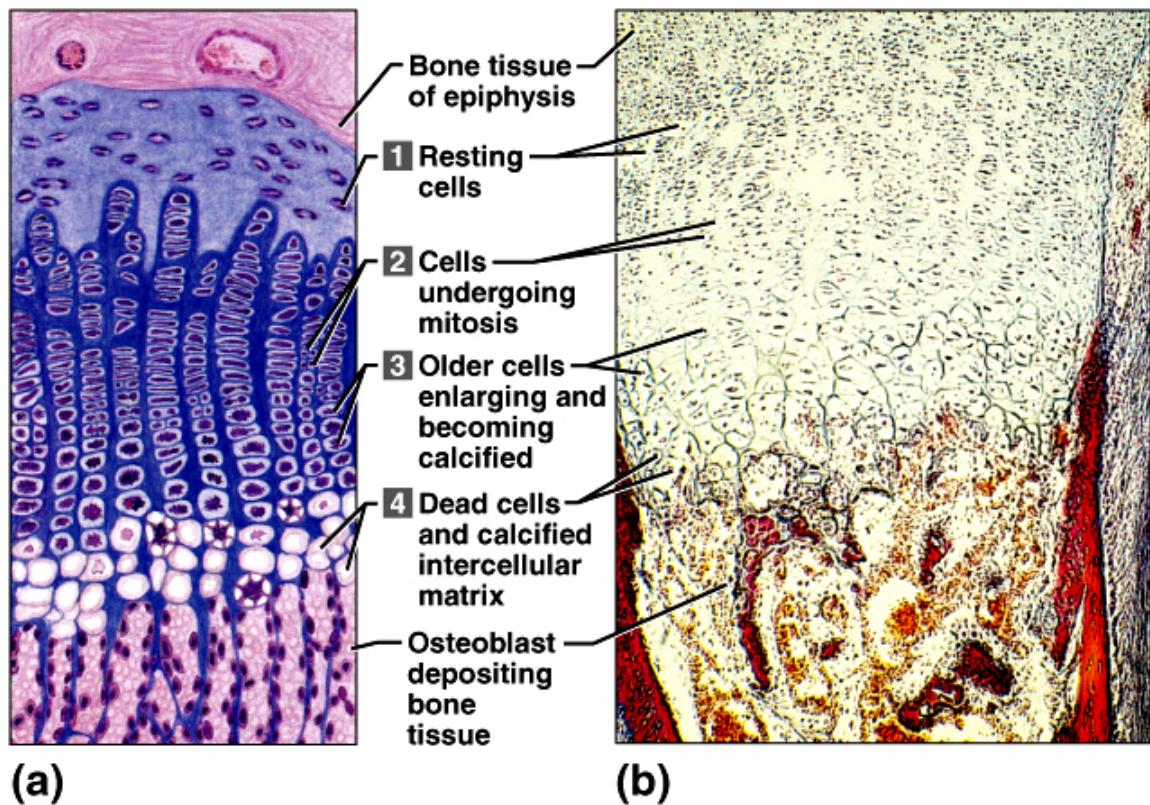
Third layer of cells

- older cells
- left behind when new cells appear
- cells enlarging and becoming calcified

Fourth layer of cells

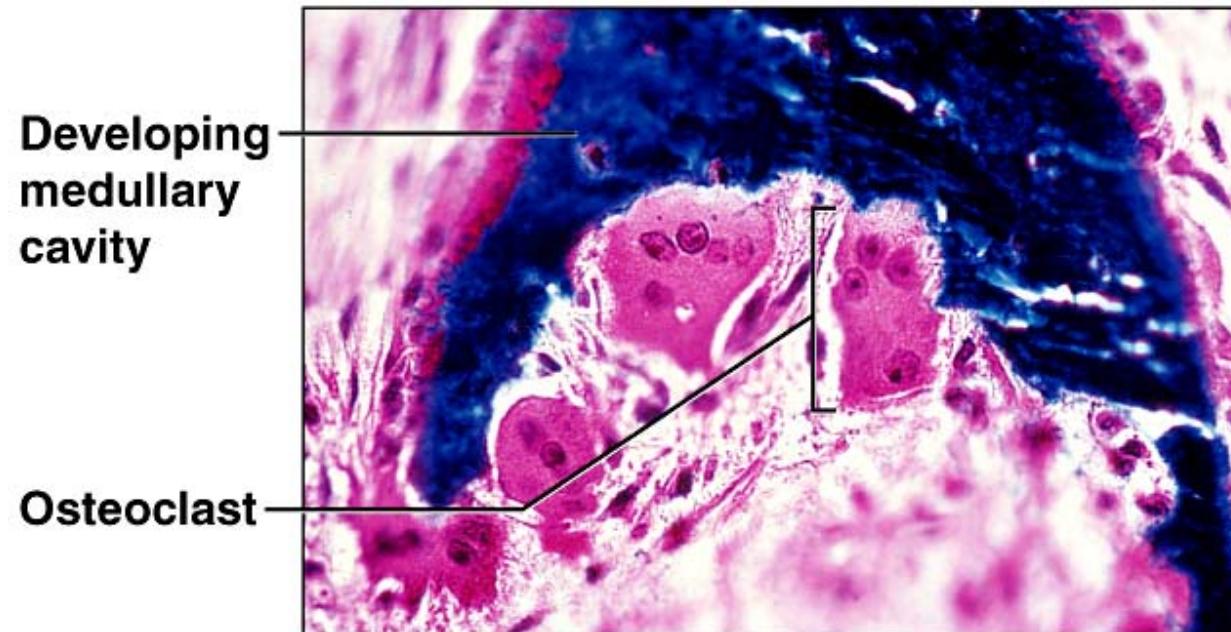
- thin
- dead cells
- calcified extracellular matrix

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Homeostasis of Bone Tissue

- Bone **Resorption** – action of osteoclasts and parathyroid hormone
- Bone **Deposition** – action of osteoblasts and calcitonin



Factors Affecting Bone Development, Growth, and Repair

- Deficiency of Vitamin A – retards bone development
- Deficiency of Vitamin C – results in fragile bones
- Deficiency of Vitamin D – rickets, osteomalacia
- Insufficient Growth Hormone – dwarfism
- Excessive Growth Hormone – gigantism, acromegaly
- Insufficient Thyroid Hormone – delays bone growth
- Sex Hormones – promote bone formation; stimulate ossification of epiphyseal plates
- Physical Stress – stimulates bone growth

Bone Function

- Support, Movement & Protection
 - gives shape to head, etc.
 - supports body's weight
 - protects lungs, etc.
 - bones and muscles interact when limbs or body parts move
- Blood Cell Formation
 - hematopoiesis
 - red marrow
- Inorganic Salt Storage
 - calcium
 - phosphate
 - magnesium
 - sodium
 - potassium

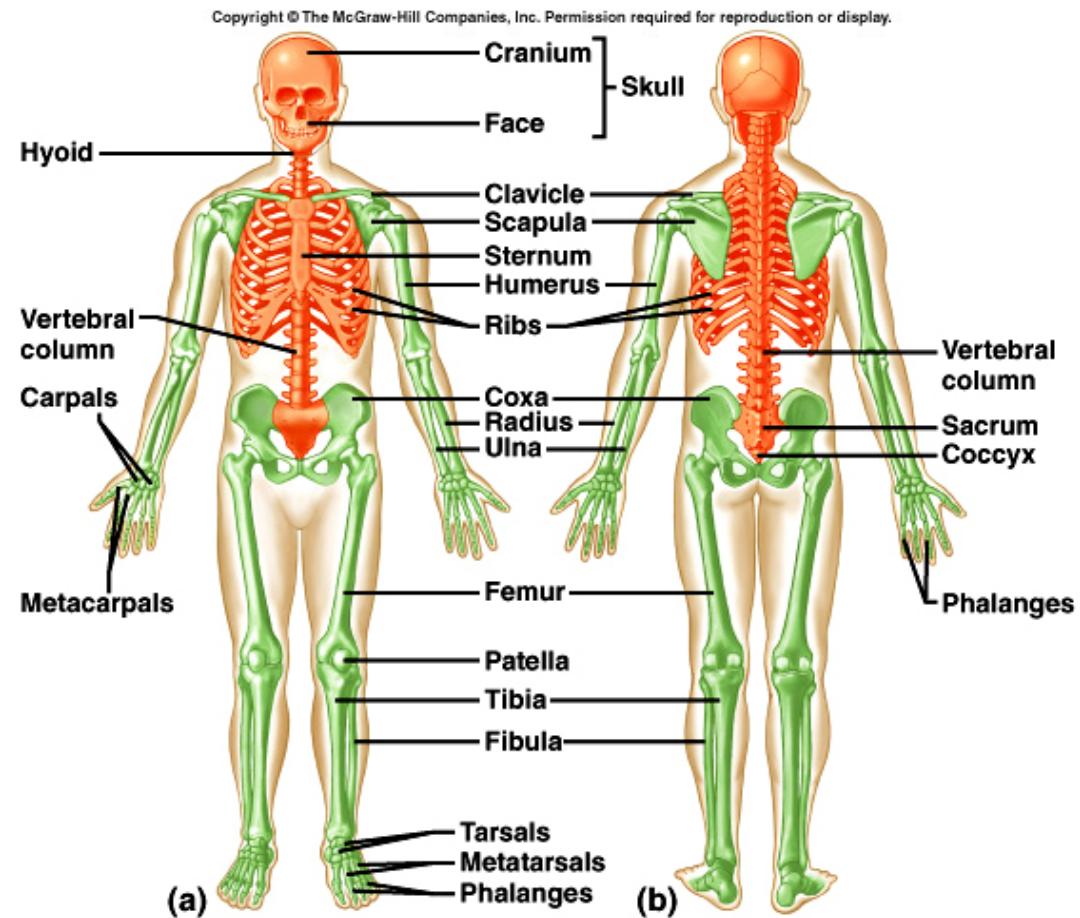
Skeletal Organization

Axial Skeleton

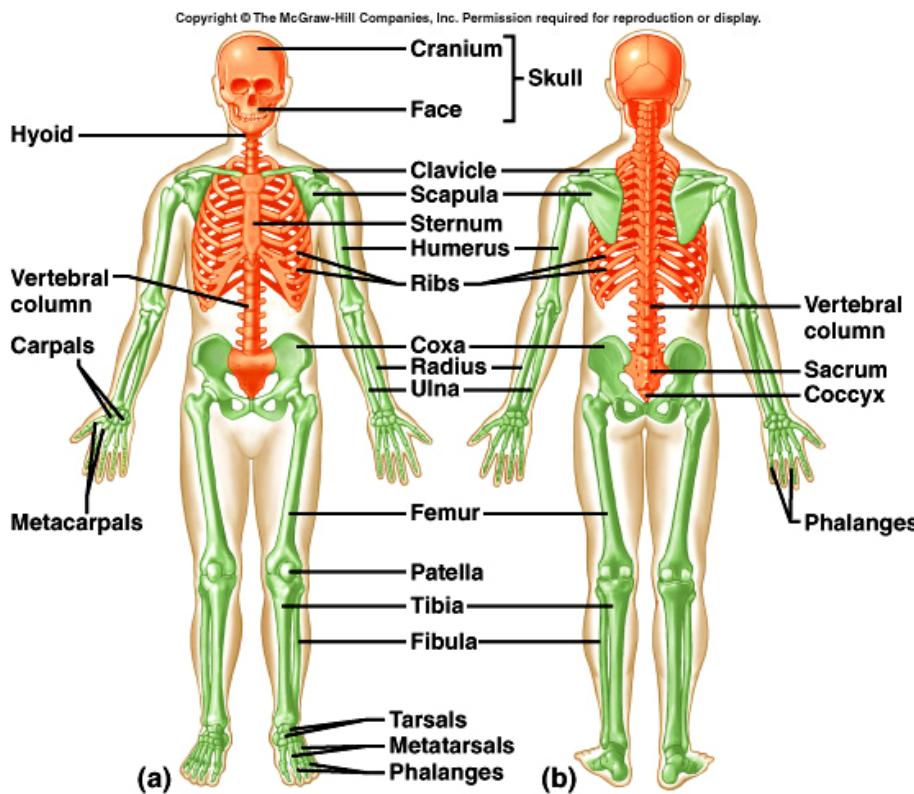
- head
- neck
- trunk

Appendicular Skeleton

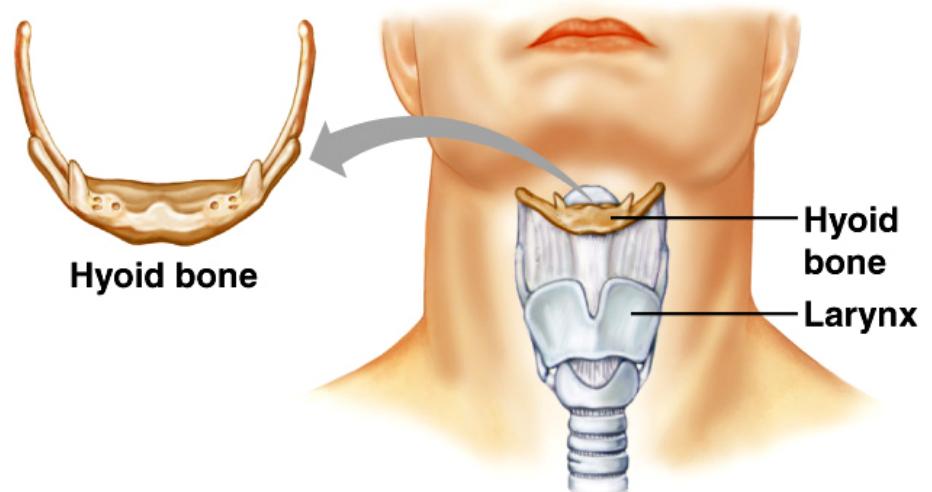
- upper limbs
- lower limbs
- pectoral girdle
- pelvic girdle



Skeletal Organization

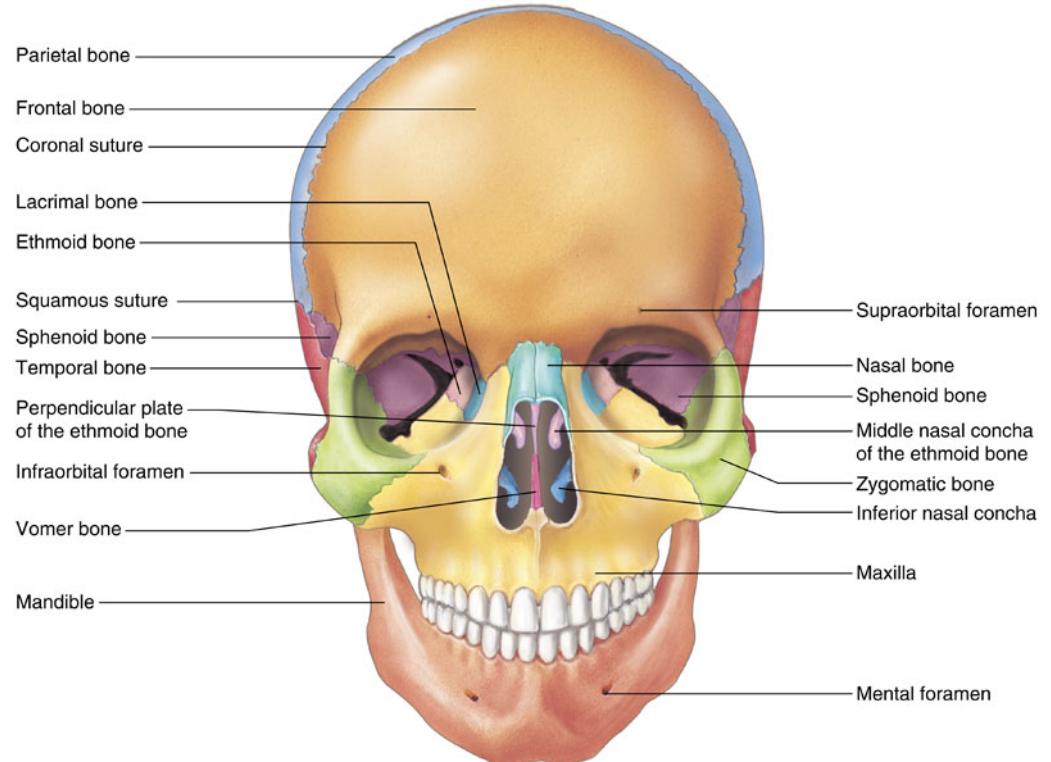


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Cranium

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Frontal (1)

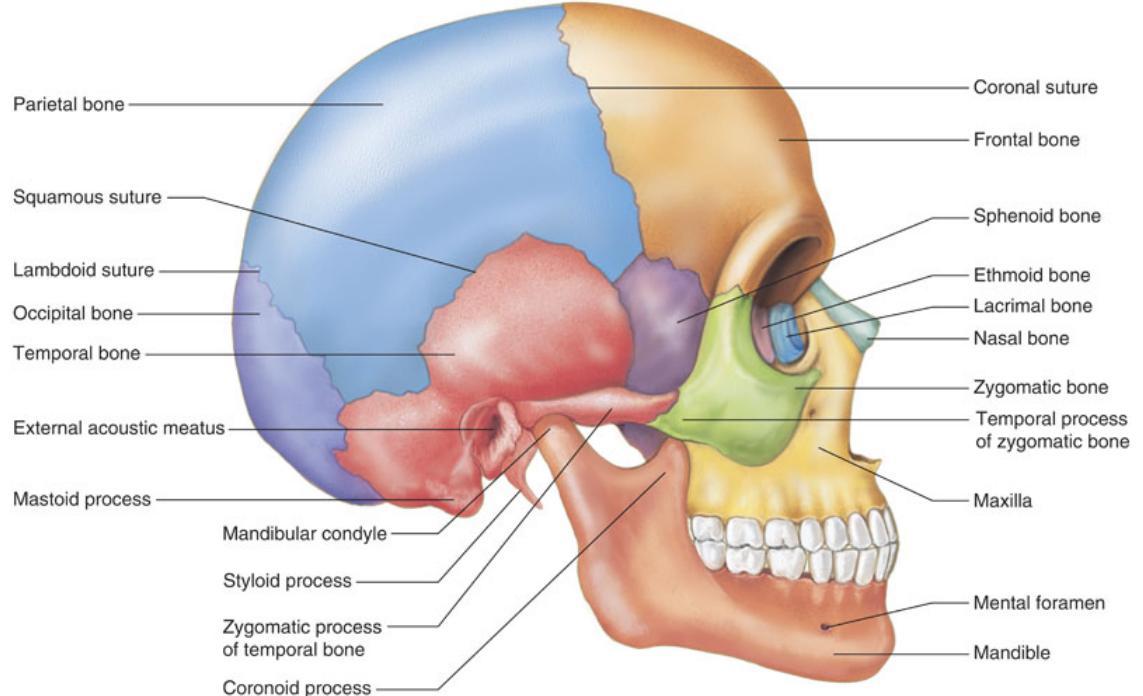
- forehead
- roof of nasal cavity
- roofs of orbits
- frontal sinuses
- supraorbital foramen
- coronal suture

Cranium

Parietal (2)

- side walls of cranium
- roof of cranium
- sagittal suture

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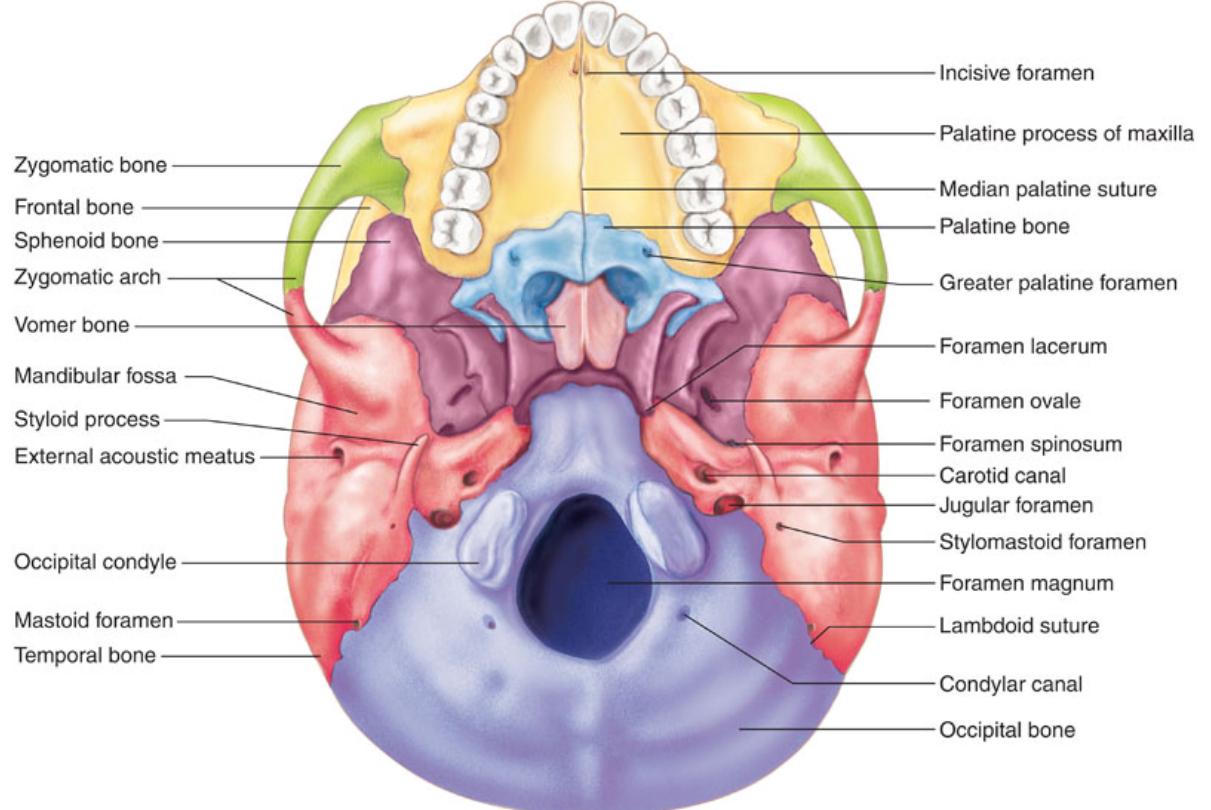


Cranium

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Occipital (1)

- back of skull
- base of cranium
- foramen magnum
- occipital condyles
- lambdoid suture

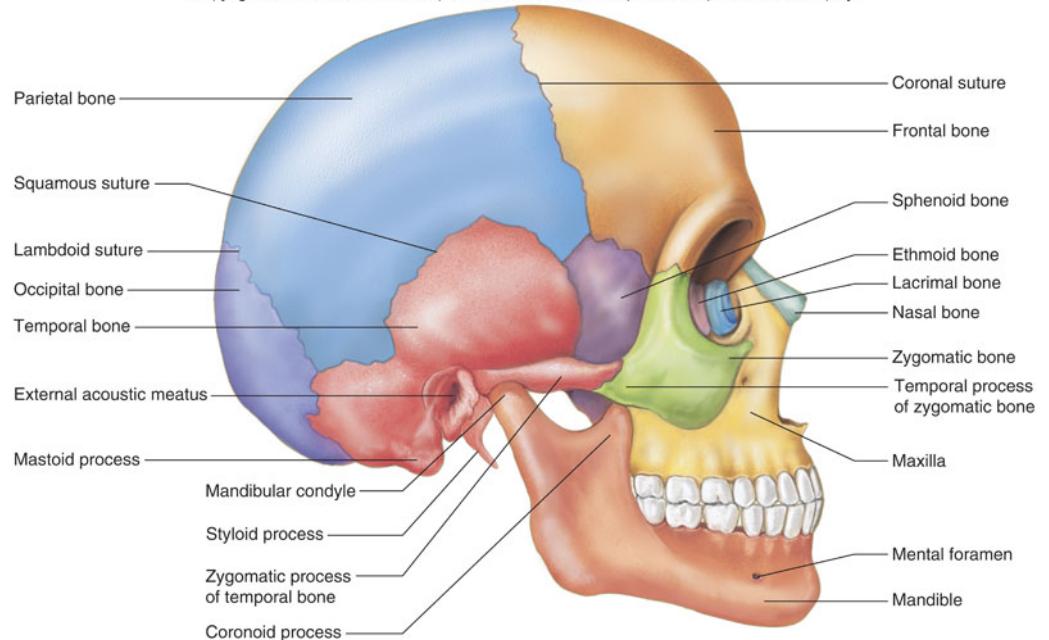


Cranium

Temporal (2)

- side walls of cranium
- floor of cranium
- floors and sides of orbits
- squamous suture
- external acoustic meatus
- mandibular fossa
- mastoid process
- styloid process
- zygomatic process

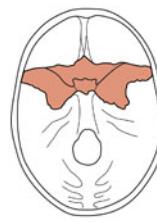
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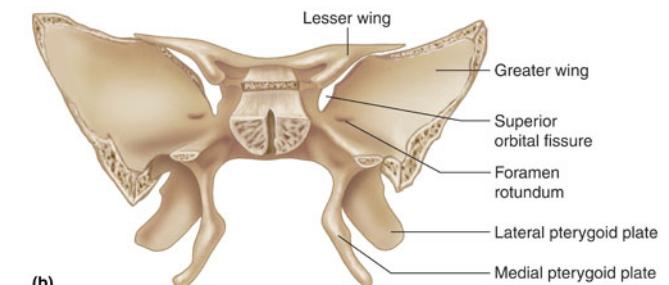
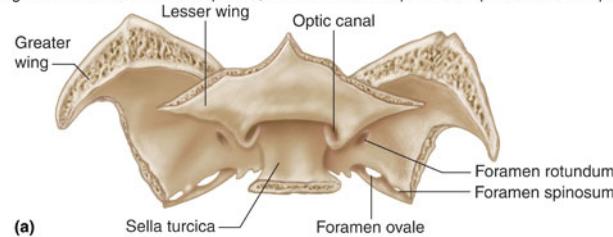
Sphenoid (1)

- base of cranium
- sides of skull
- floors and sides of orbits
- sella turcica
- sphenoidal sinuses



Transverse section

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Cranium

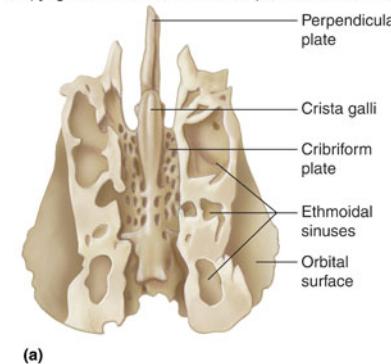
Ethmoid (1)

- roof and walls of nasal cavity
- floor of cranium
- wall of orbits
- cribiform plates
- perpendicular plate
- superior and middle nasal conchae
- ethmoidal sinuses
- crista galli

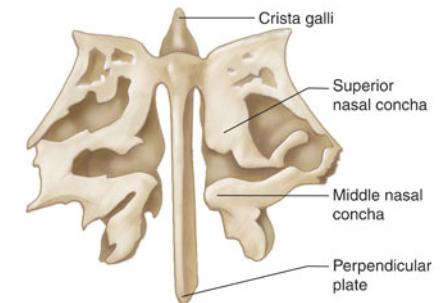


Transverse section

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(a)



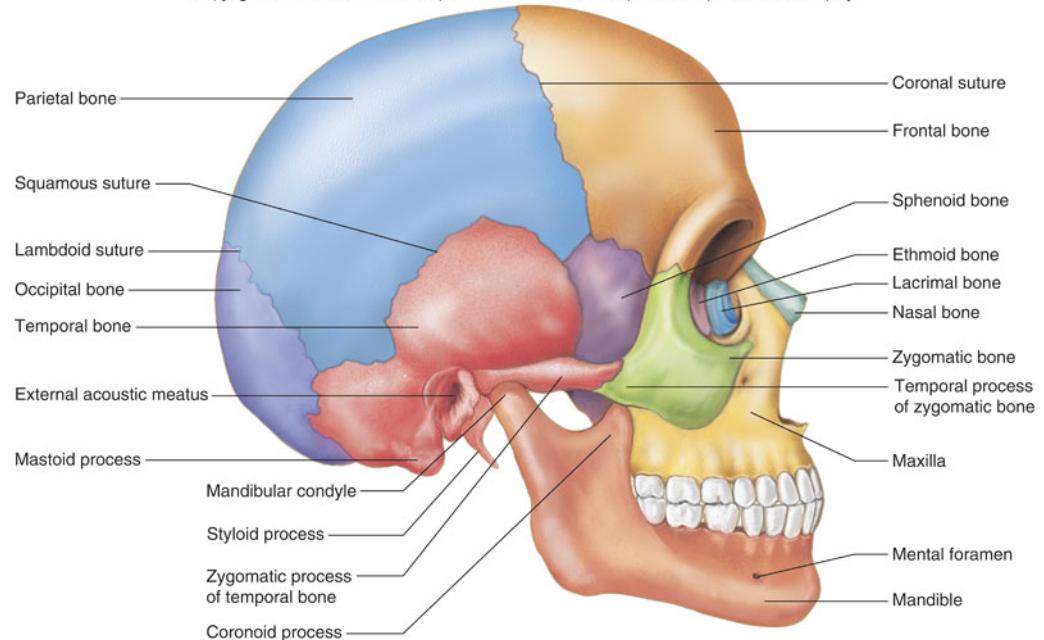
(b)

Facial Skeleton

Maxillary (2)

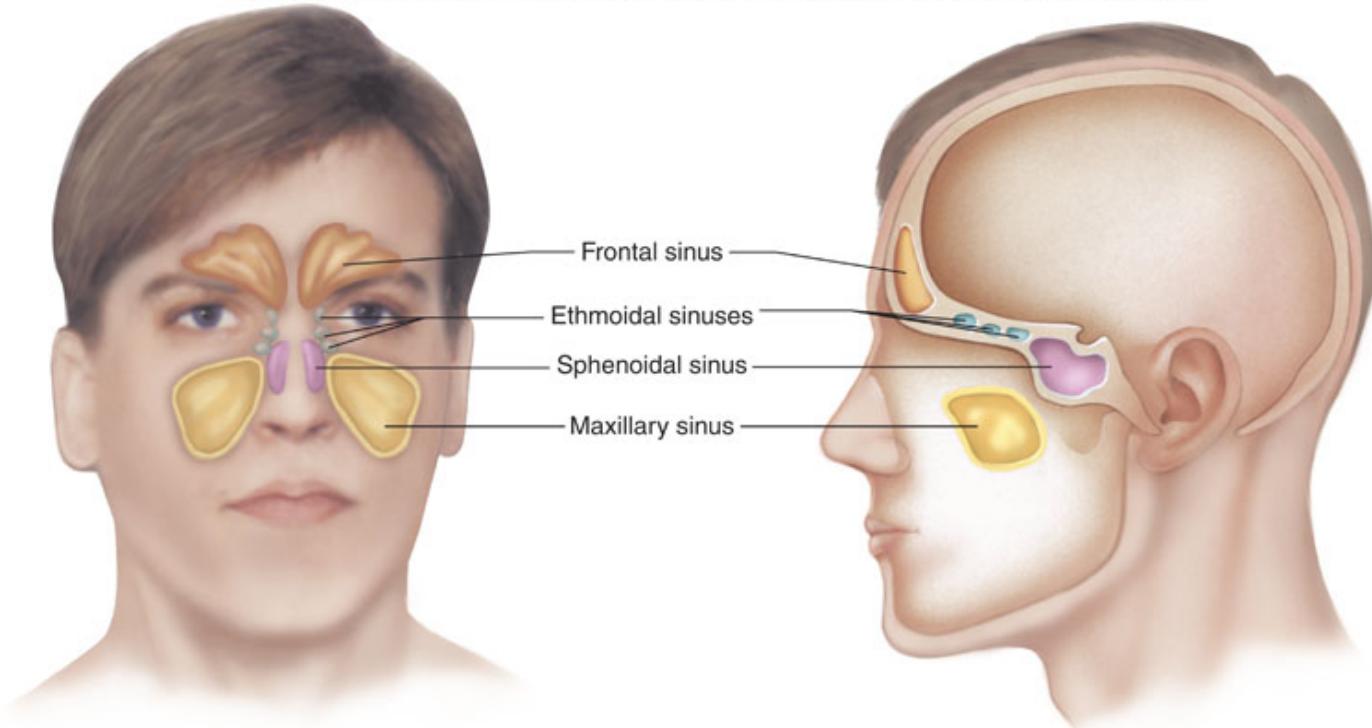
- upper jaw
- anterior roof of mouth
- floors of orbits
- sides of nasal cavity
- floors of nasal cavity
- alveolar processes
- maxillary sinuses
- palatine process

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Facial Skeleton

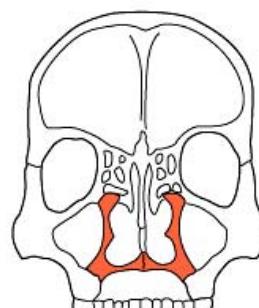
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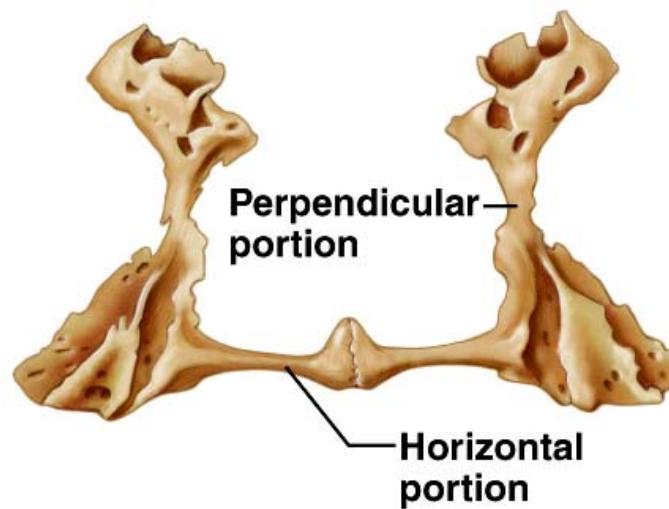
Facial Skeleton

Palatine (2)

- L shaped bones located behind the maxillae
- posterior section of hard palate
- floor of nasal cavity
- lateral walls of nasal cavity



Coronal
section

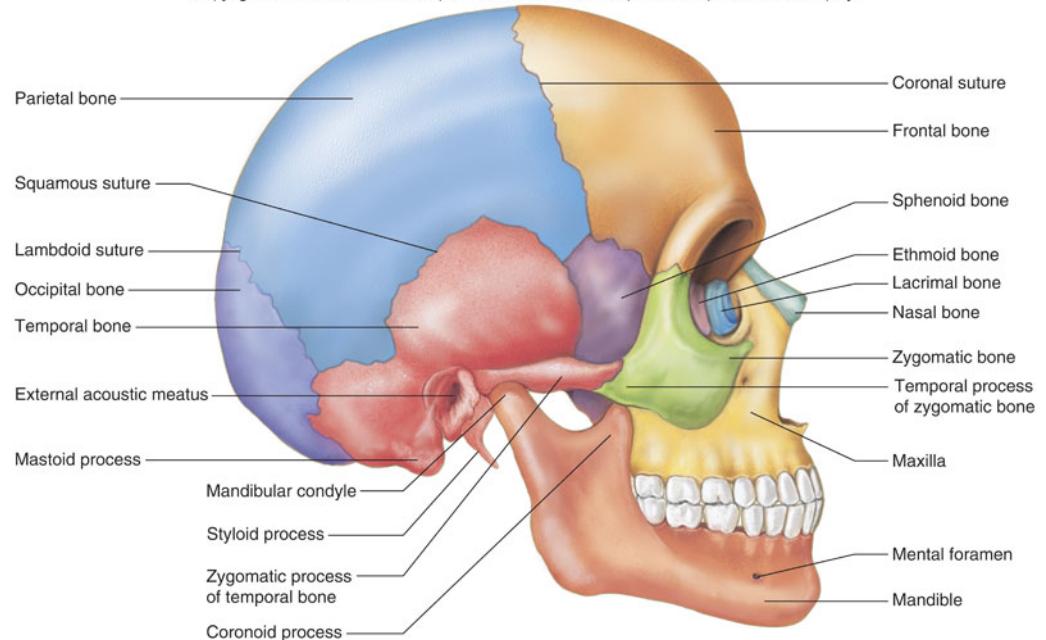


Facial Skeleton

Zygomatic (2)

- prominences of cheeks
- lateral walls of orbits
- floors of orbits
- temporal process

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Facial Skeleton

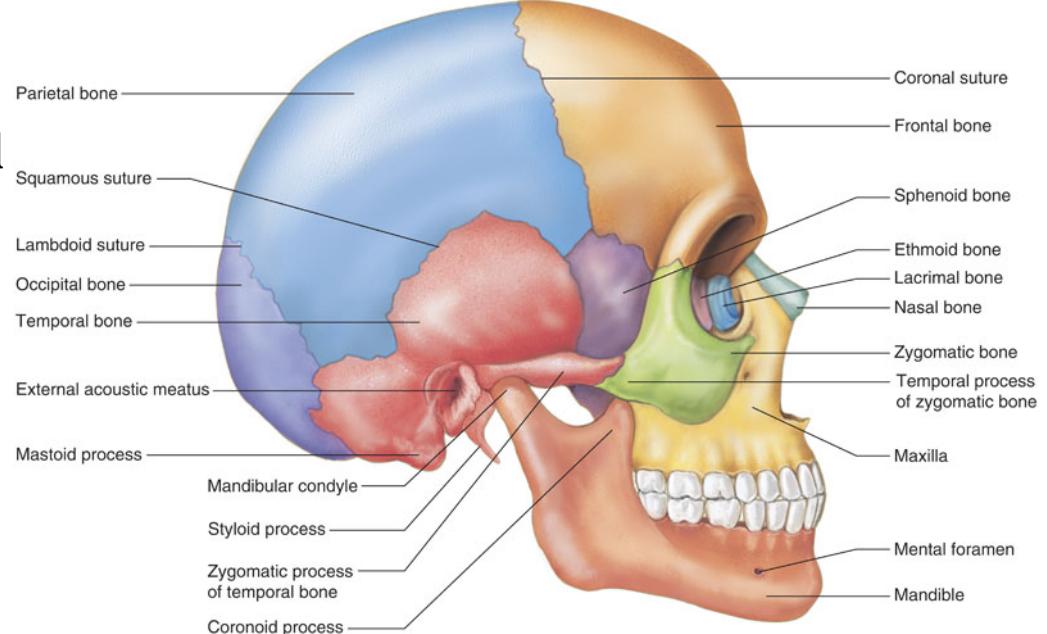
Lacrimal (2)

- medial walls of orbits
- groove from orbit to nasal cavity

Nasal (2)

- bridge of nose

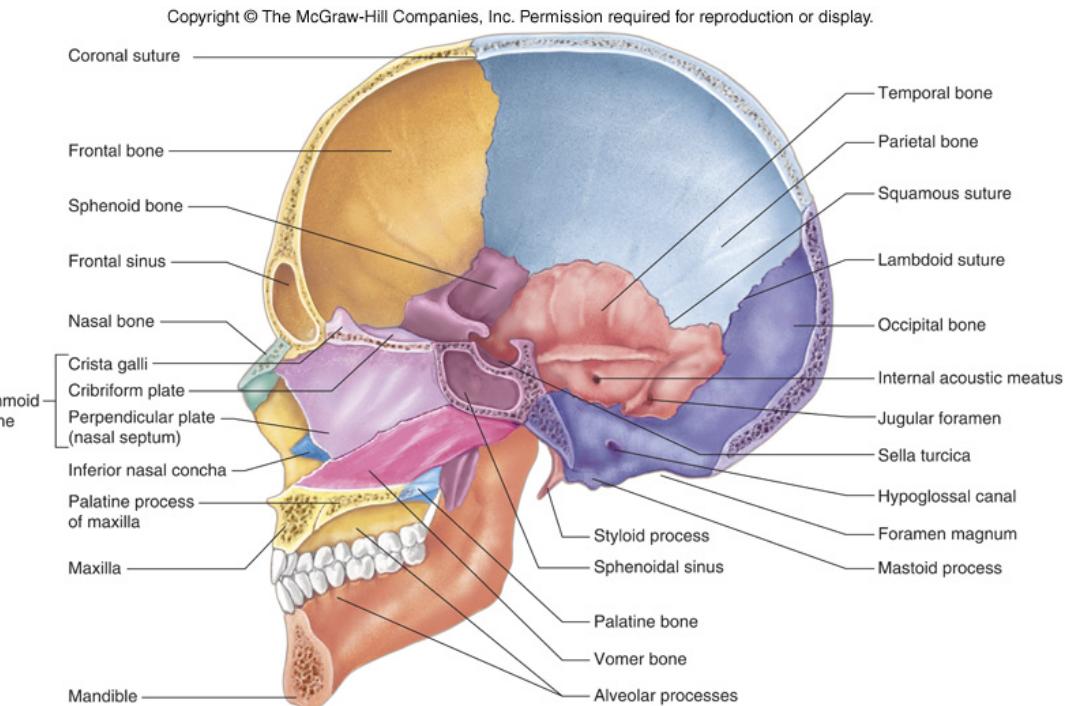
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Facial Skeleton

Vomer (1)

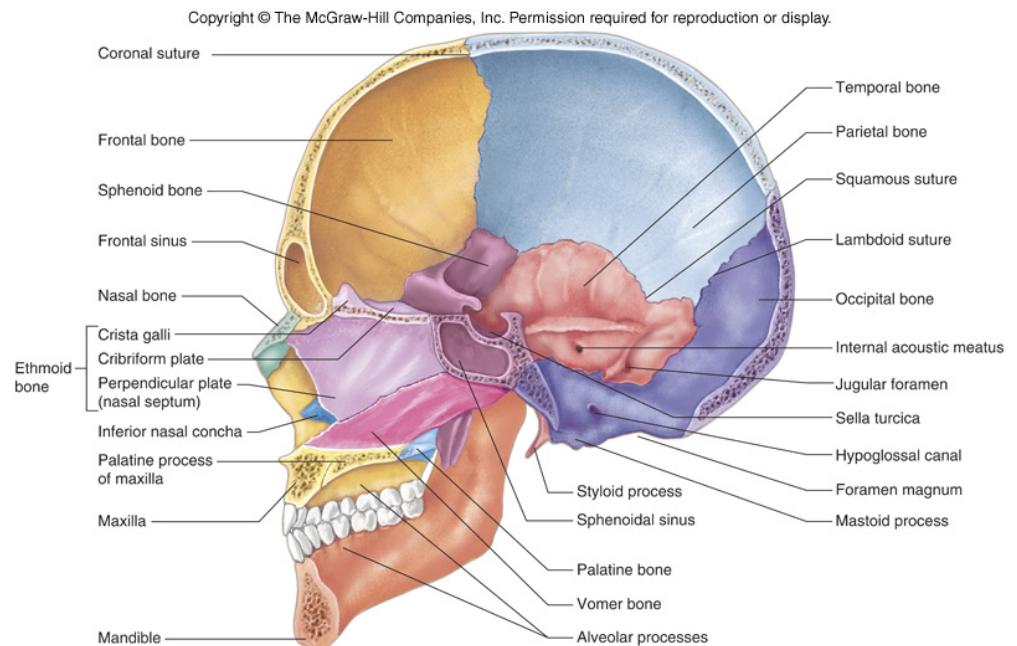
- inferior portion of nasal septum



Facial Skeleton

Inferior Nasal Conchae (2)

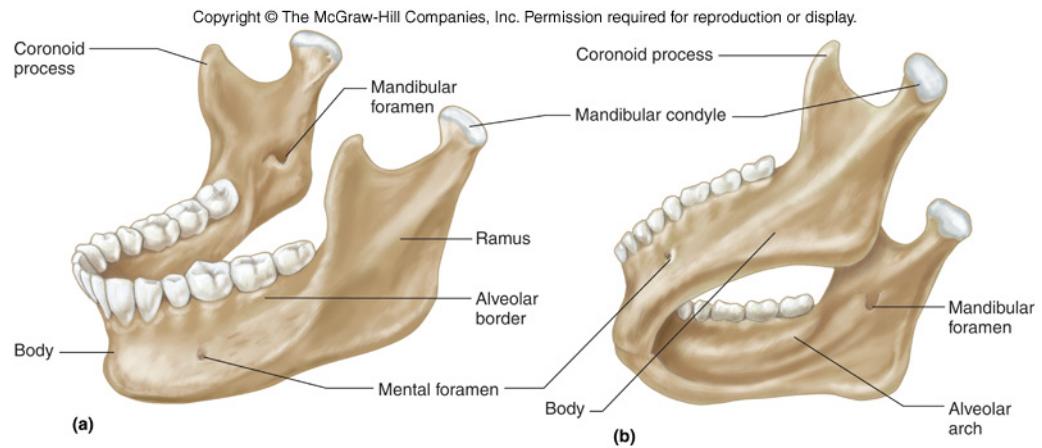
- extend from lateral walls of nasal cavity



Facial Skeleton

Mandible (1)

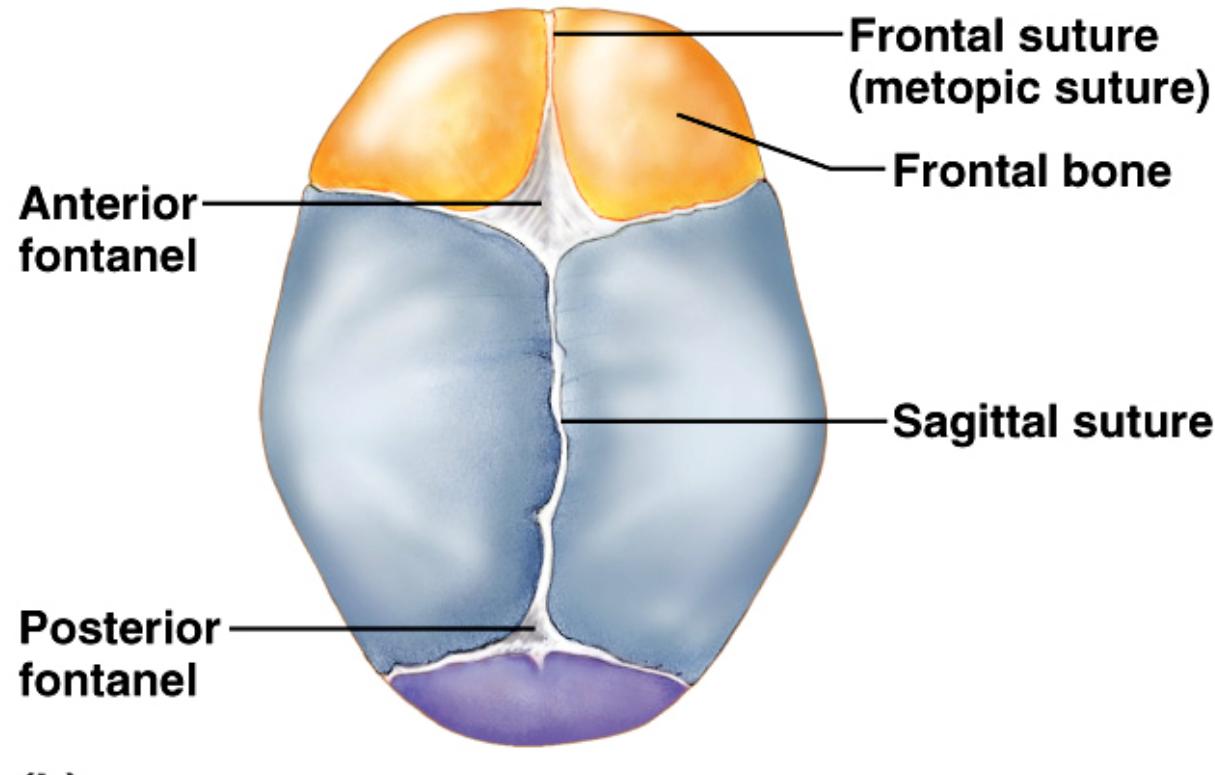
- lower jaw
- body
- ramus
- mandibular condyle
- coronoid process
- alveolar process
- mandibular foramen
- mental foramen



Infantile Skull

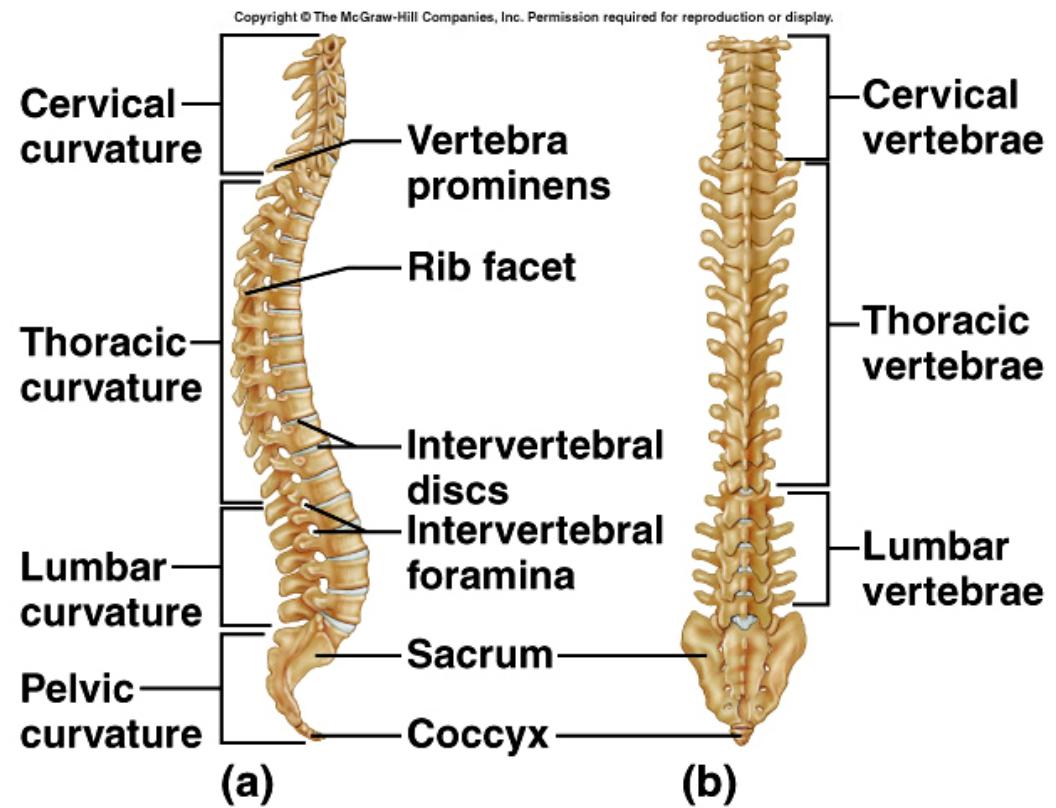
Fontanelles – fibrous membranes

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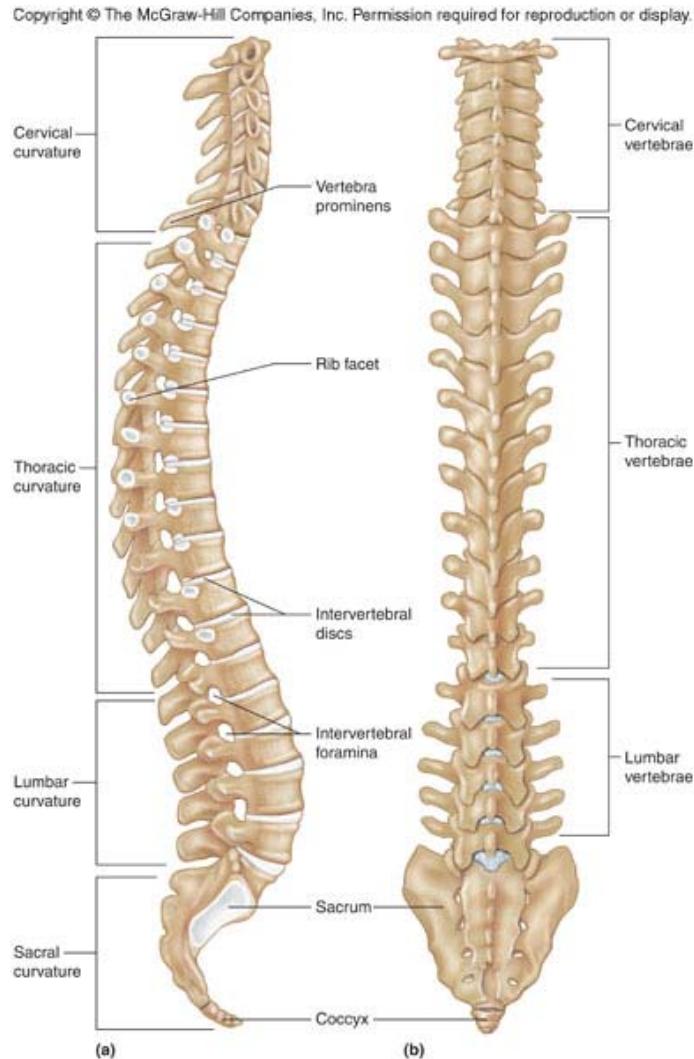
Vertebral Column

- cervical vertebrae (7)
- thoracic vertebrae (12)
- lumbar vertebrae (5)
- sacrum
- coccyx



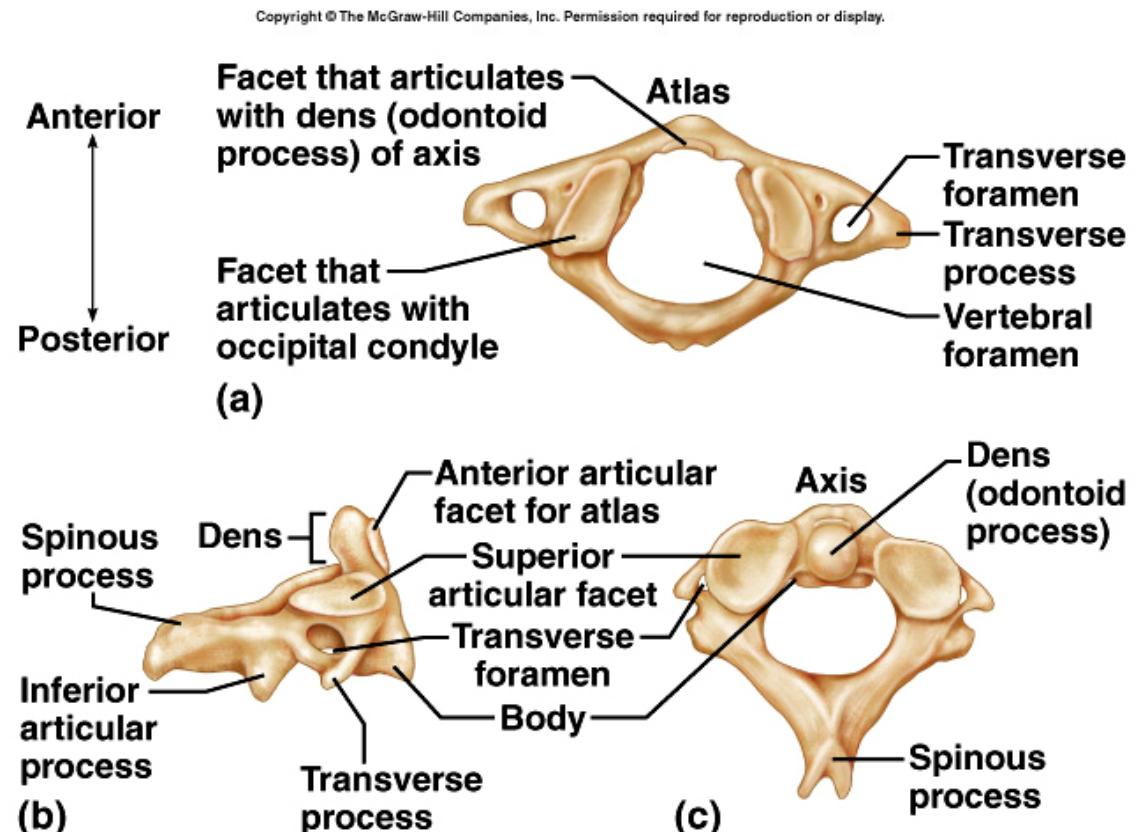
Vertebral Column

- cervical curvature
- thoracic curvature
- lumbar curvature
- sacral curvature
- rib facets
- vertebra prominens
- intervertebral discs
- intervertebral foramina



Cervical Vertebrae

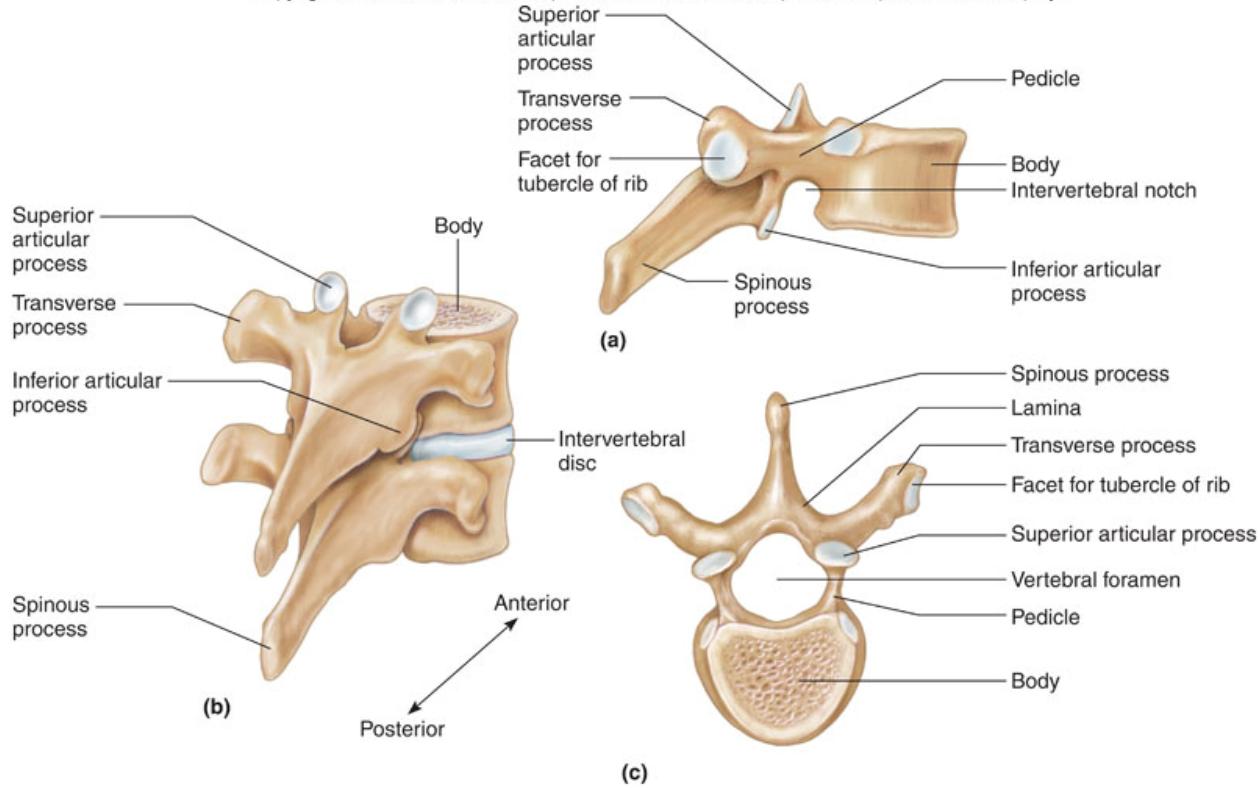
- **Atlas** – 1st; supports head
- **Axis** – 2nd; dens pivots to turn head
- transverse foramina
- bifid spinous processes
- vertebral prominens – useful landmark



Thoracic Vertebrae

- long spinous processes
- rib facets

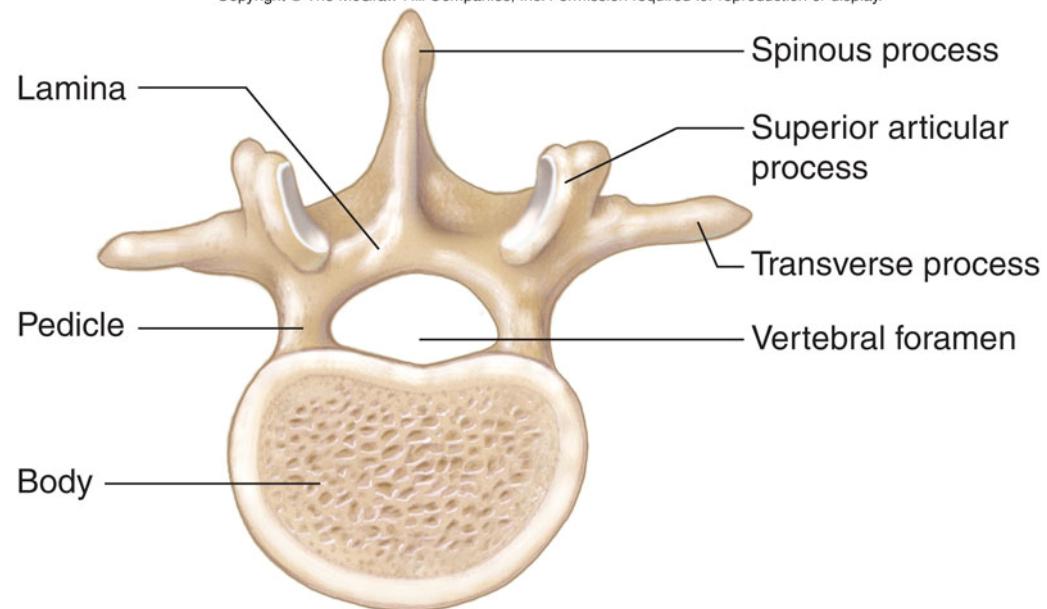
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Lumbar Vertebrae

- large bodies
- thick, short spinous processes

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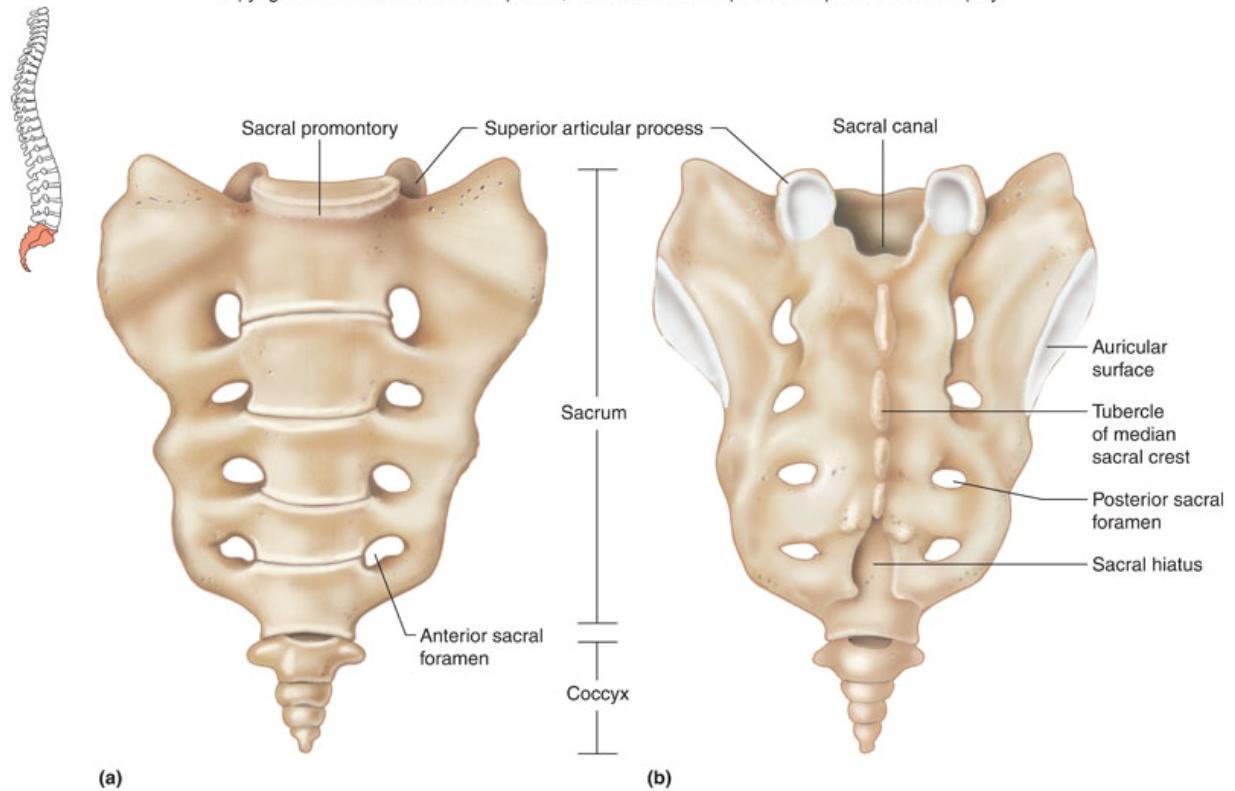


(c) Lumbar vertebra

Sacrum

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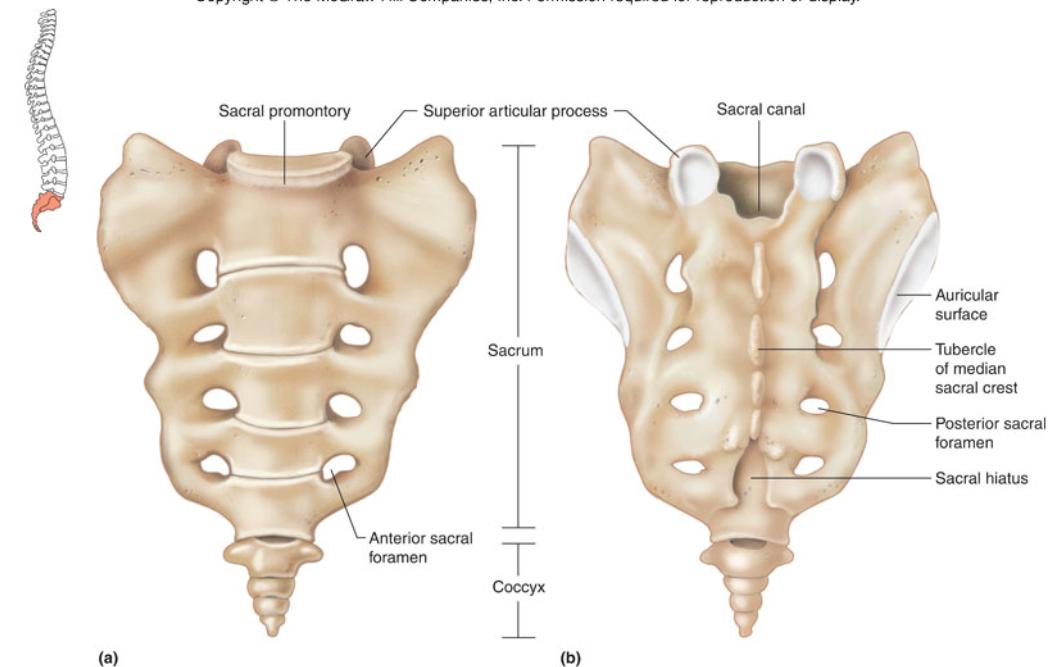
- five fused vertebrae
- median sacral crest
- posterior sacral foramina
- posterior wall of pelvic cavity
- sacral promontory



Coccyx

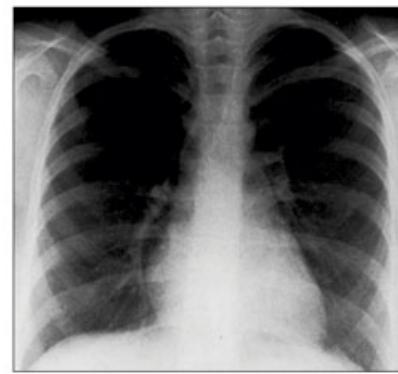
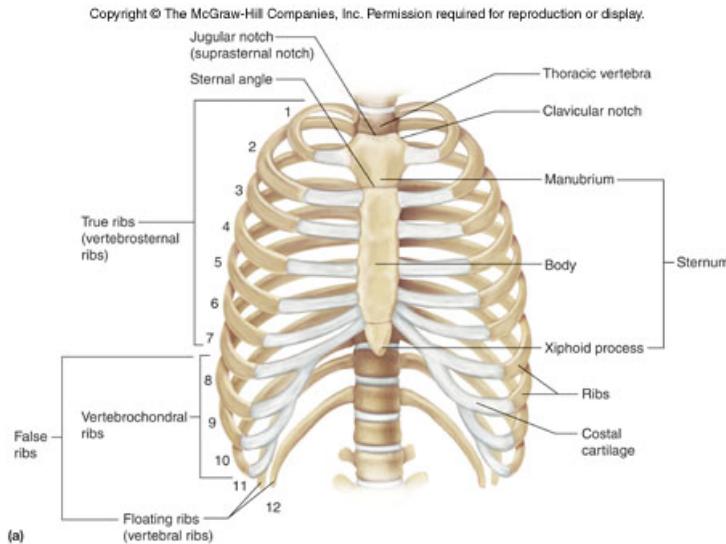
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- tailbone
- four fused vertebrae



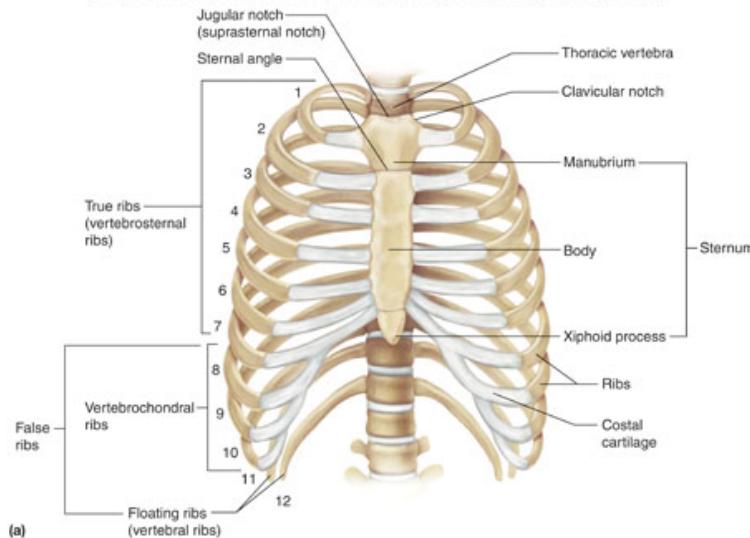
Thoracic Cage

- Ribs
- Sternum
- Thoracic vertebrae
- Costal cartilages
- Supports shoulder girdle and upper limbs
- Protects viscera
- Role in breathing

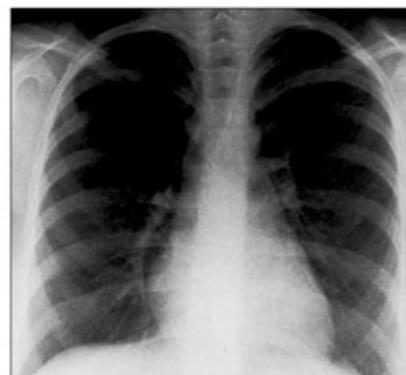


Ribs

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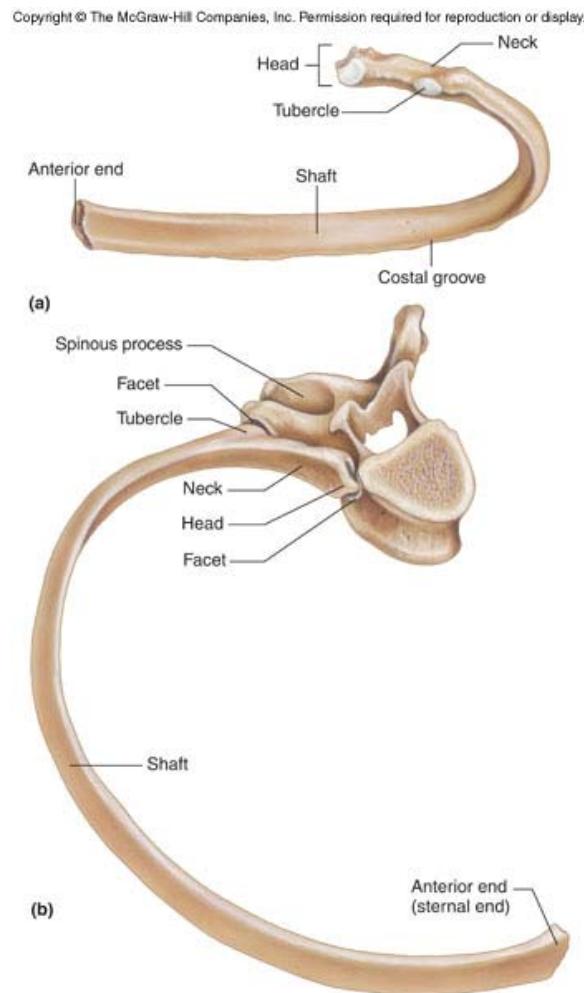
- **True ribs (7)**
- **False ribs (5)**
 - floating (2)



(b)

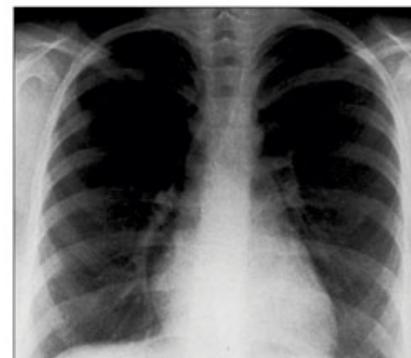
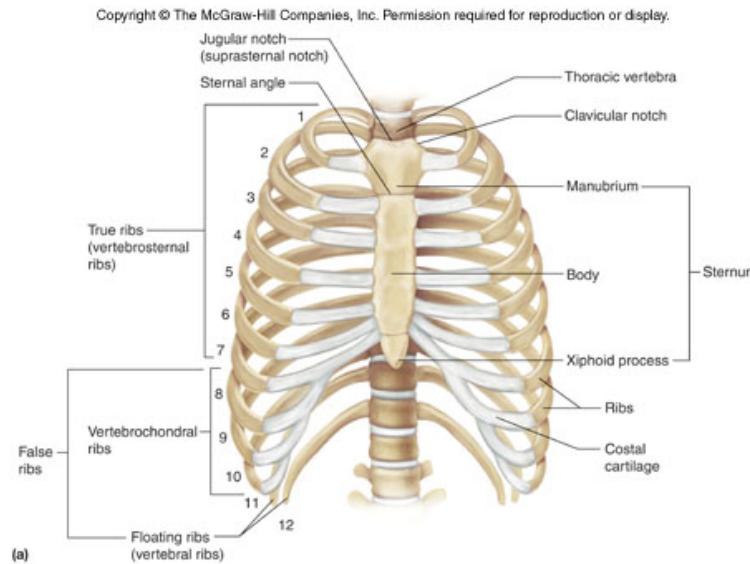
Rib Structure

- **Shaft**
- **Head** – posterior end; articulates with vertebrae
- **Tubercle** – articulates with vertebrae
- **Costal cartilage** – hyaline cartilage



Sternum

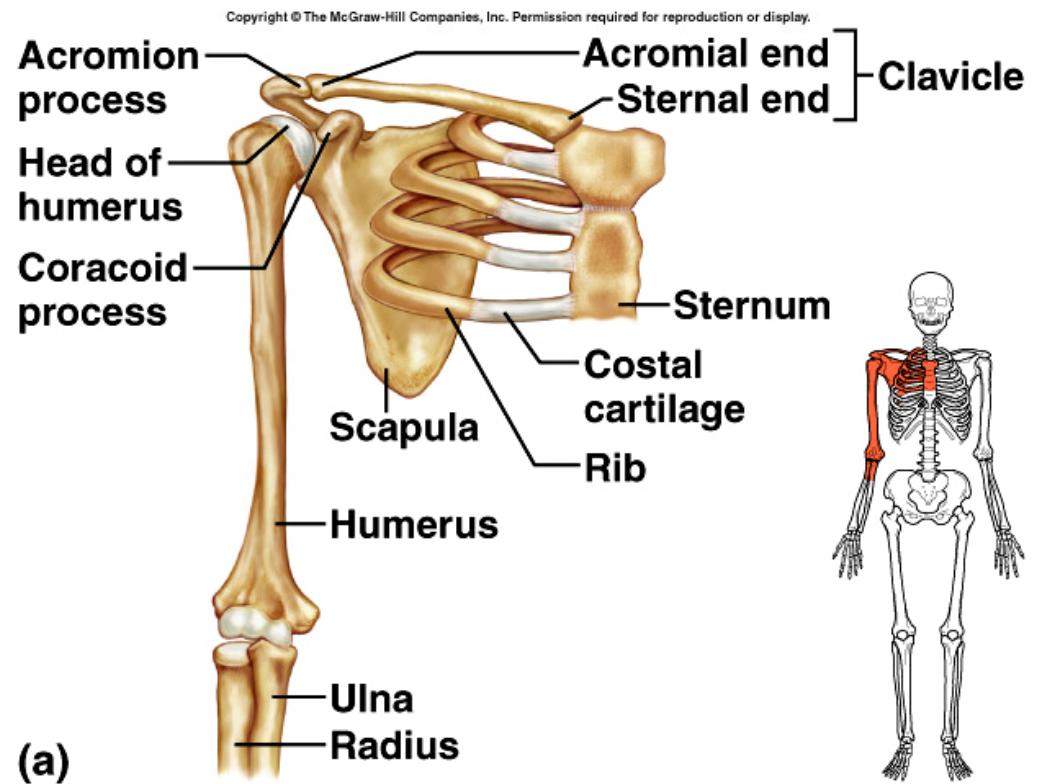
- Manubrium
- Body
- Xiphoid process



(b)

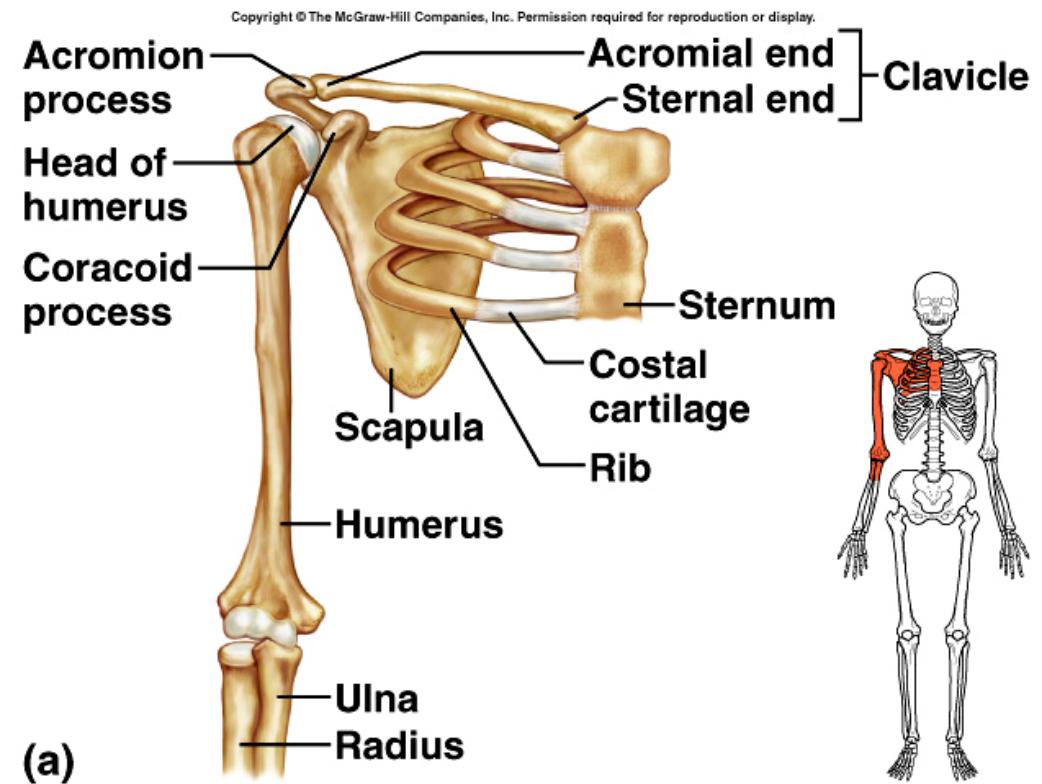
Pectoral Girdle

- shoulder girdle
- clavicles
- scapulae
- supports upper limbs



Clavicles

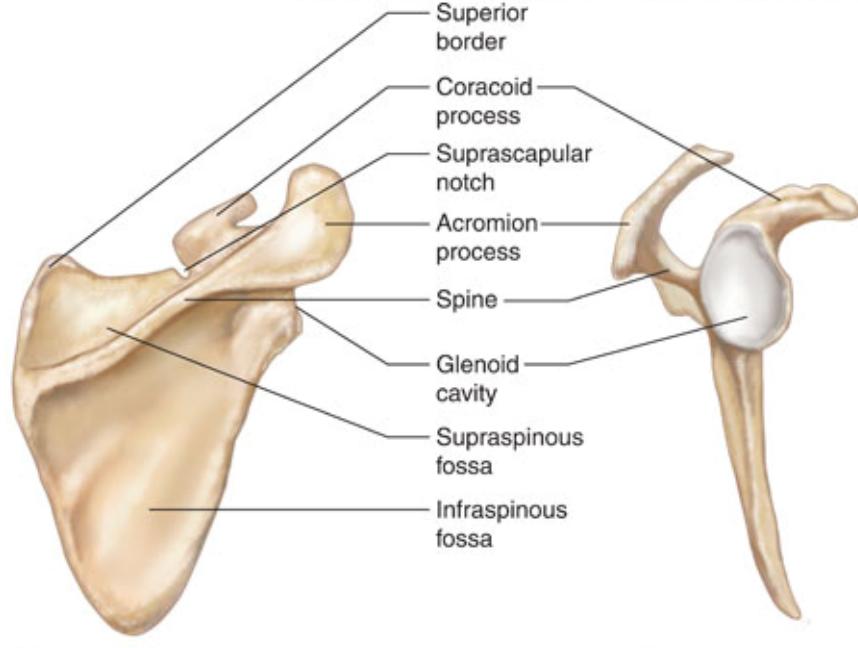
- articulate with manubrium
- articulate with scapulae (acromion process)



Scapulae

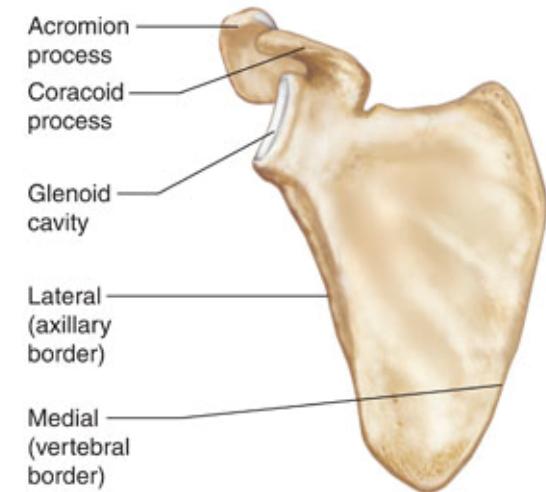
- spine
- supraspinous fossa
- infraspinous fossa
- acromion process
- coracoid process
- glenoid cavity

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(a)

(b)

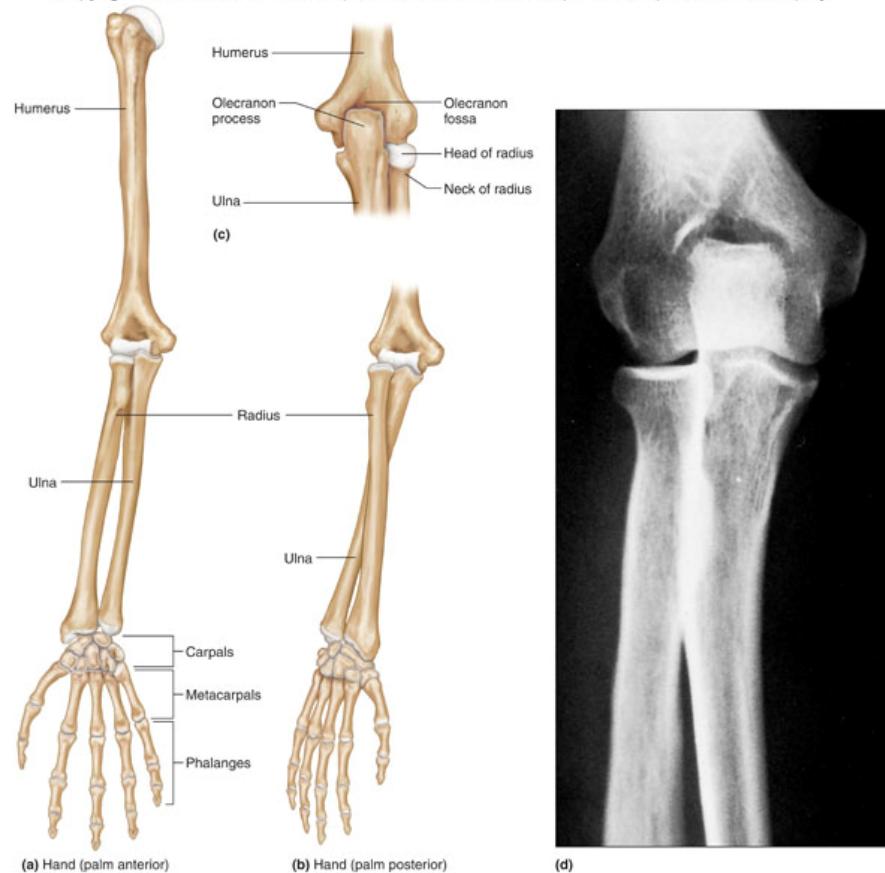


(c)

Upper Limb

- Humerus
- Radius
- Ulna
- Carpals
- Metacarpals
- Phalanges

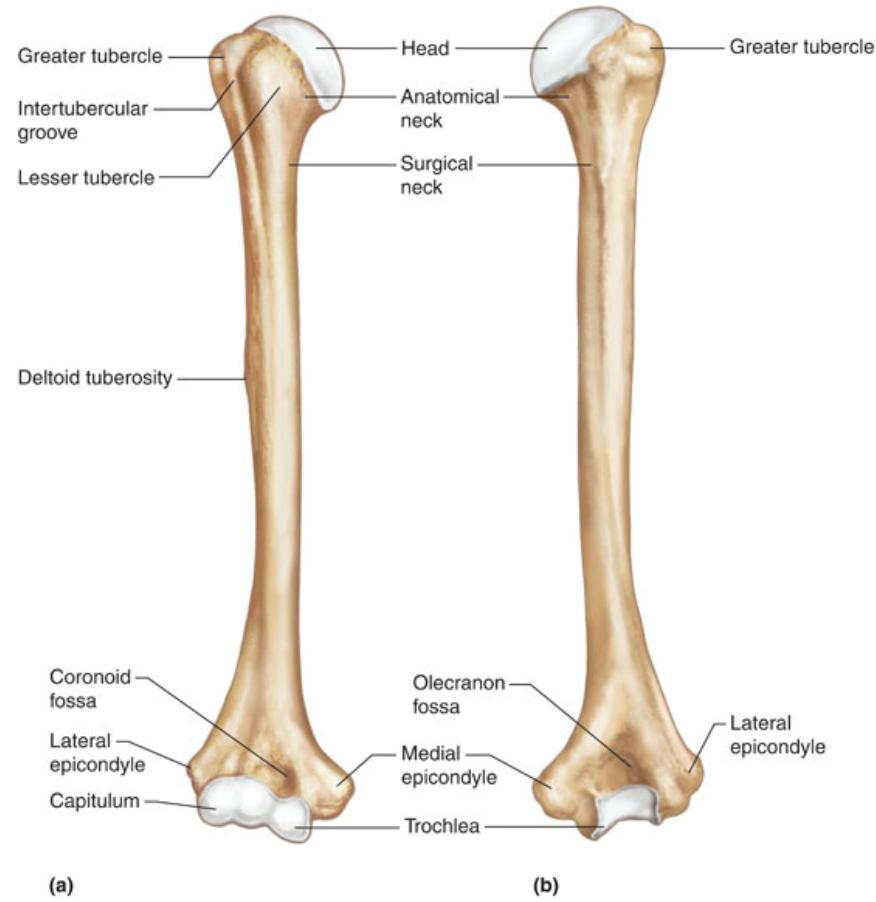
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Humerus

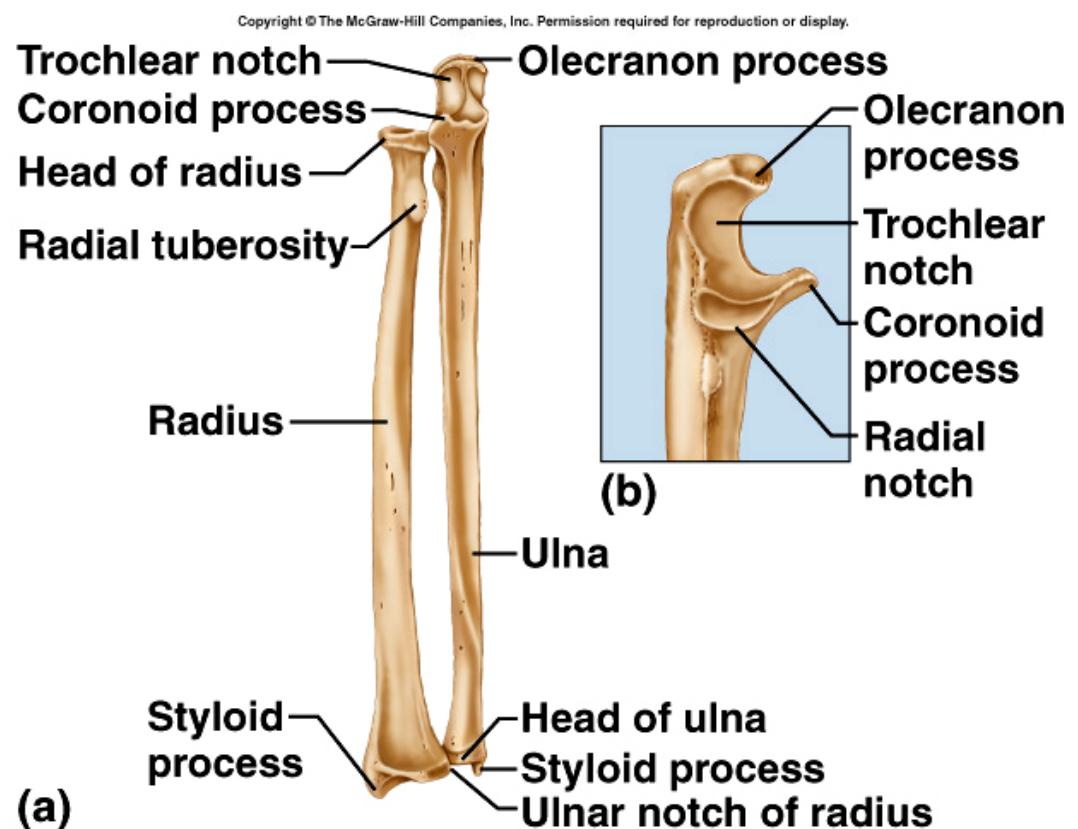
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- head
- greater tubercle
- lesser tubercle
- anatomical neck
- surgical neck
- deltoid tuberosity
- capitulum
- trochlea
- coronoid fossa
- olecranon fossa



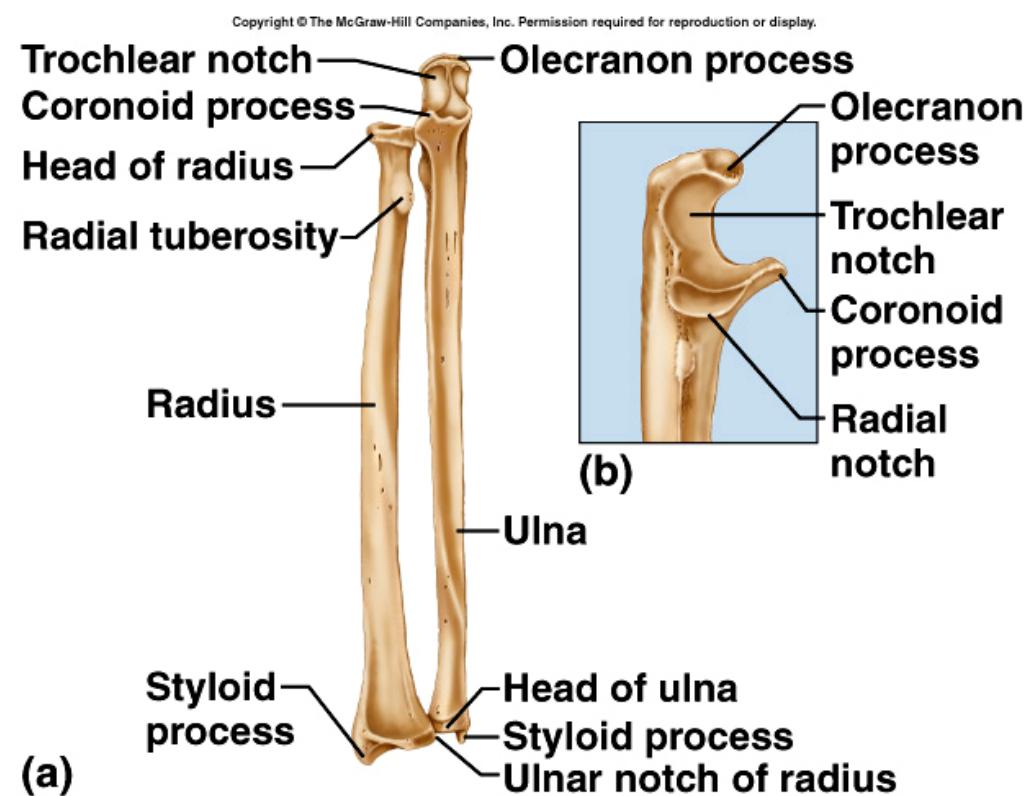
Radius

- lateral forearm bone
- head
- radial tuberosity
- styloid process



Ulna

- medial forearm bone
- trochlear notch
- olecranon process
- coronoid process
- styloid process



Wrist and Hand

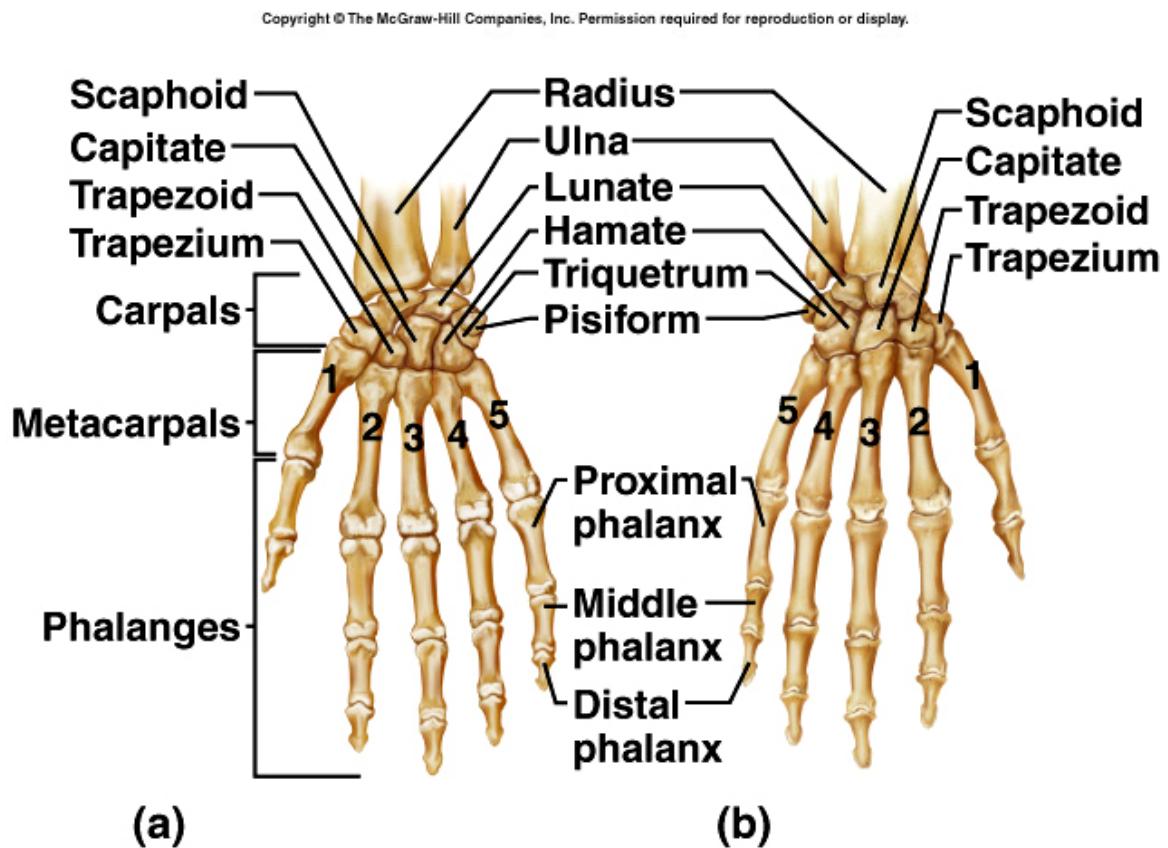
- **Carpals (16)**

- trapezium
- trapezoid
- capitate
- scaphoid
- pisiform
- triquetrum
- hamate
- lunate

- **Metacarpals (10)**

- **Phalanges (28)**

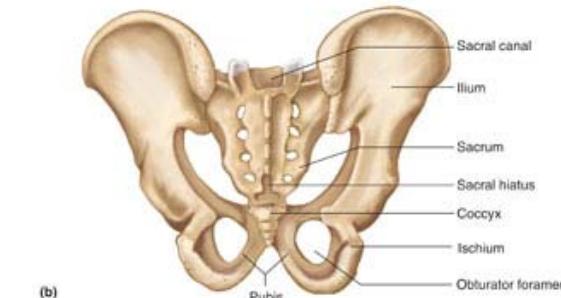
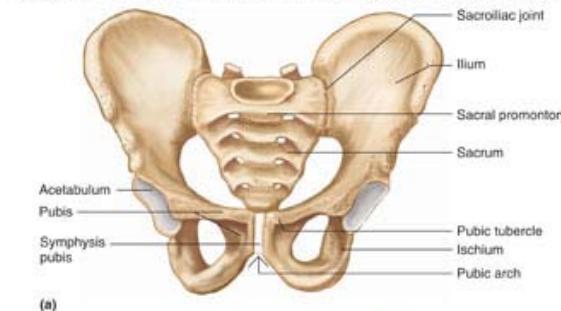
- proximal phalanx
- middle phalanx
- distal phalanx



Pelvic Girdle

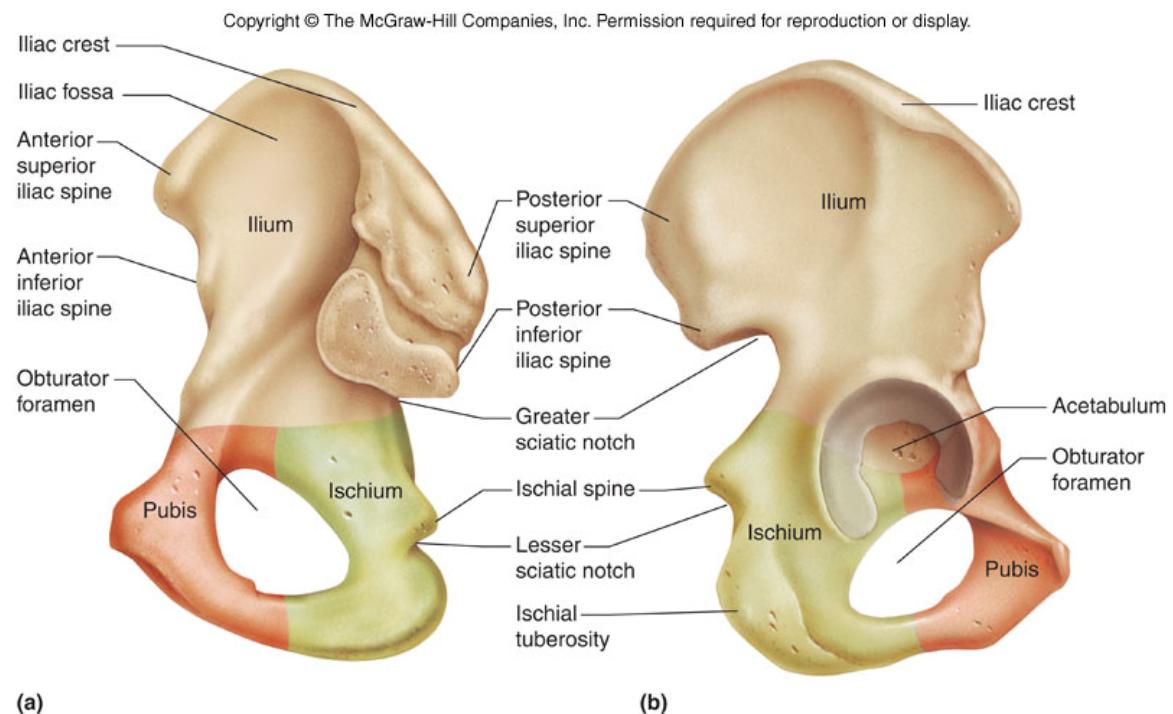
- **Coxae (2)**
- supports trunk of body
- protects viscera

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Coxae

- hip bones
 - acetabulum
- ilium
 - iliac crest
 - iliac spines
 - greater sciatic notch
- ischium
 - ischial spines
 - lesser sciatic notch
 - ischial tuberosity
- pubis
 - obturator foramen
 - symphysis pubis
 - pubic arch



Greater and Lesser Pelves

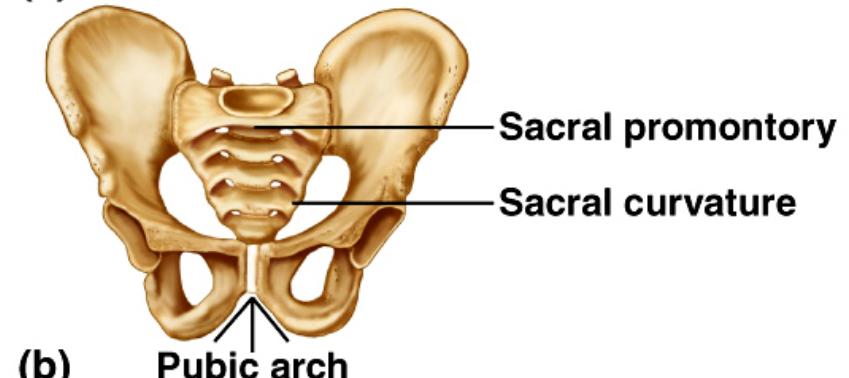
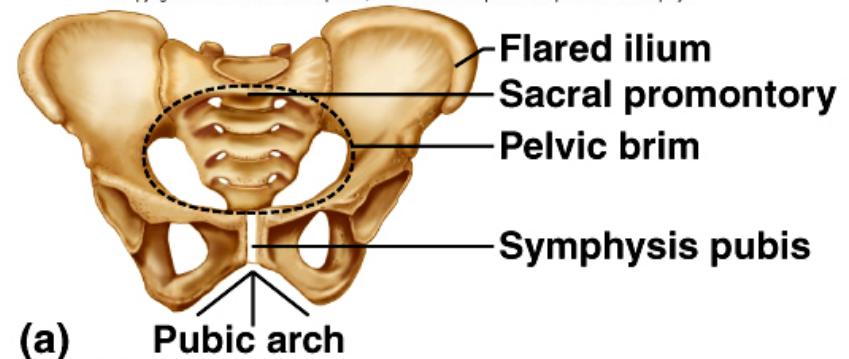
Greater Pelvis

- lumbar vertebrae posteriorly
- iliac bones laterally
- abdominal wall anteriorly

Lesser Pelvis

- sacrum and coccyx posteriorly
- lower ilium, ischium, and pubis bones laterally and anteriorly

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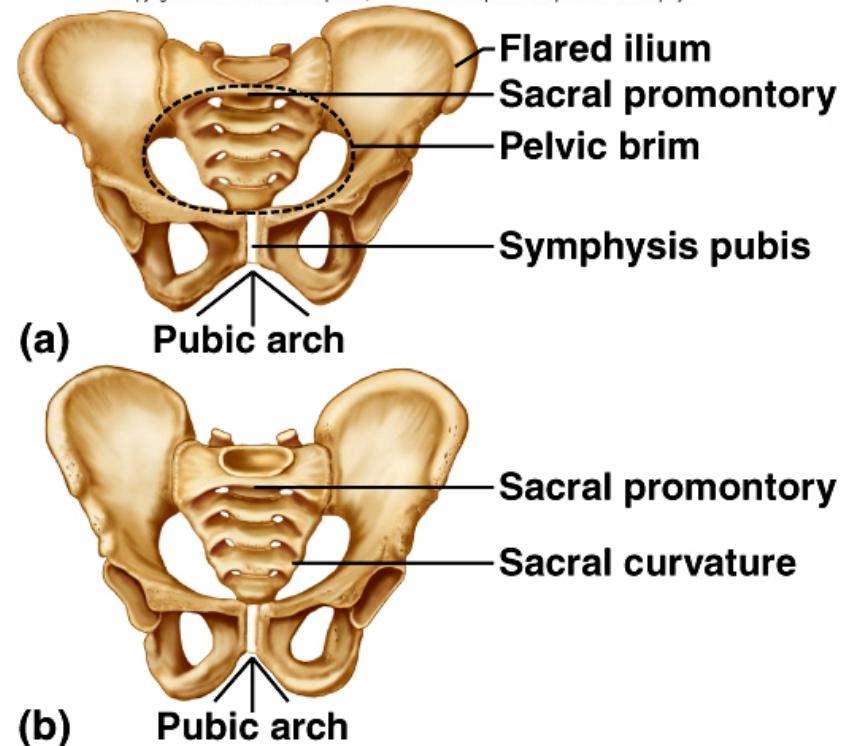


Male and Female Pelves

Female

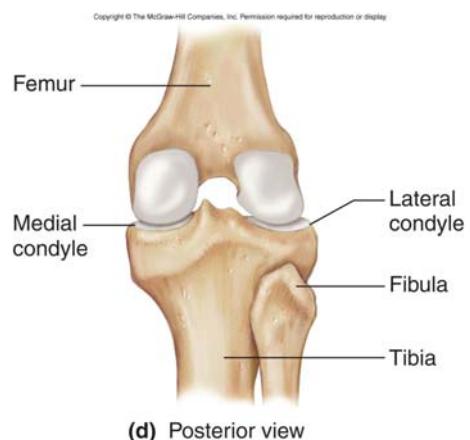
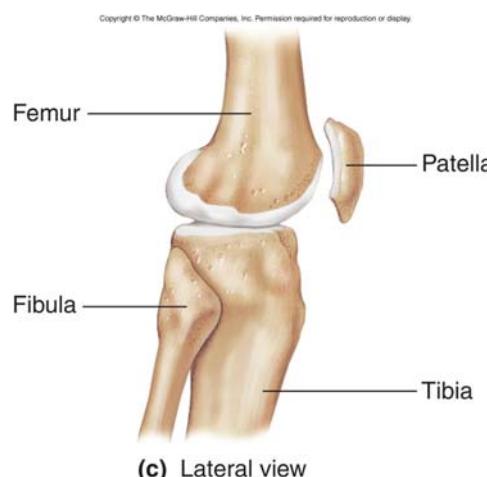
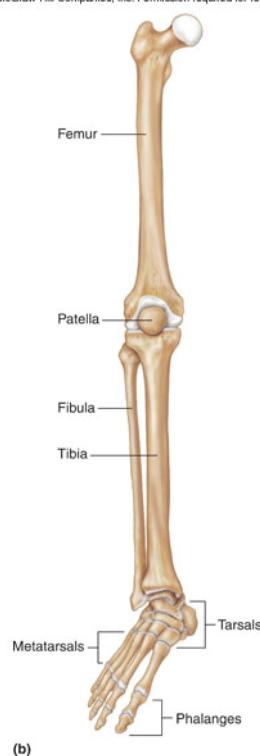
- iliac bones more flared
- broader hips
- pubic arch angle greater
- more distance between ischial spines and ischial tuberosities
- sacral curvature shorter and flatter
- lighter bones

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Lower Limb

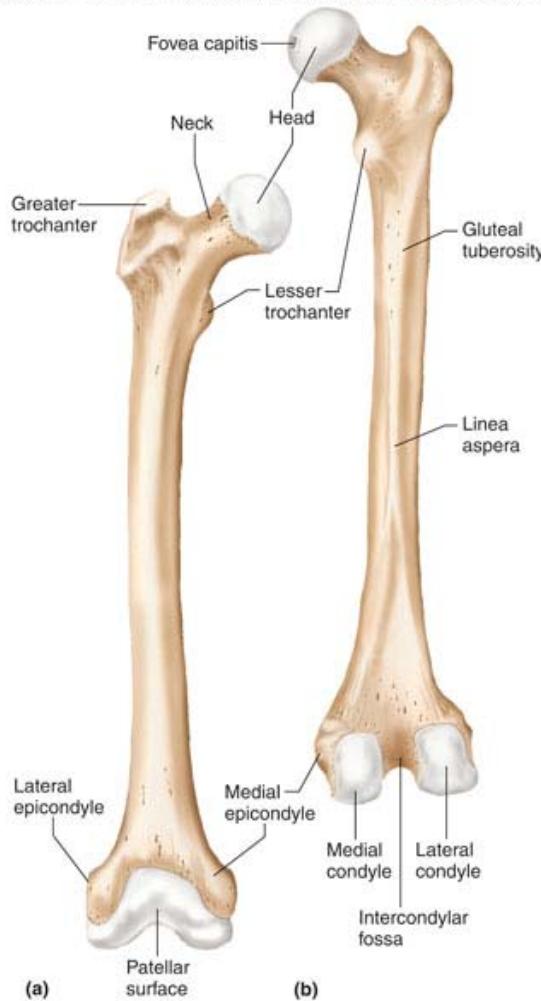
- Femur
- Patella
- Tibia
- Fibula
- Tarsals
- Metatarsals
- Phalanges



Femur

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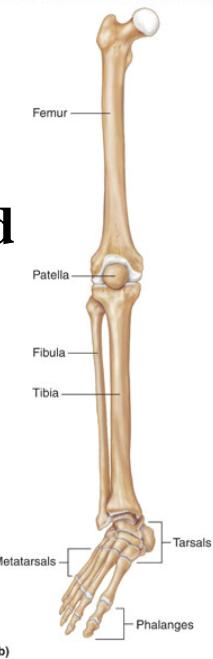
- longest bone of body
- head
- fovea capitis
- neck
- greater trochanter
- lesser trochanter
- linea aspera
- condyles
- epicondyles



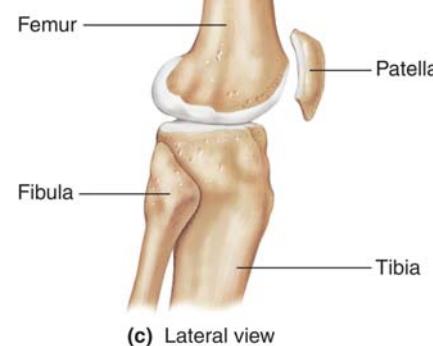
Patella

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- kneecap
- anterior surface of knee
- flat sesamoid bone located in a tendon

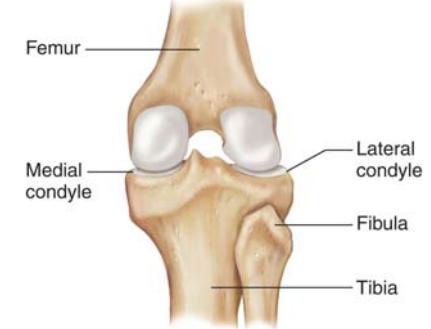


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(c) Lateral view

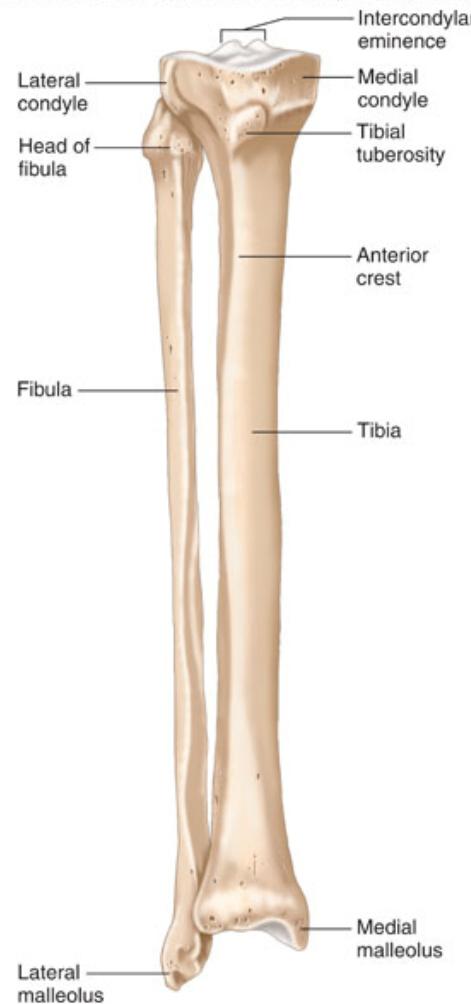
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(d) Posterior view

Tibia

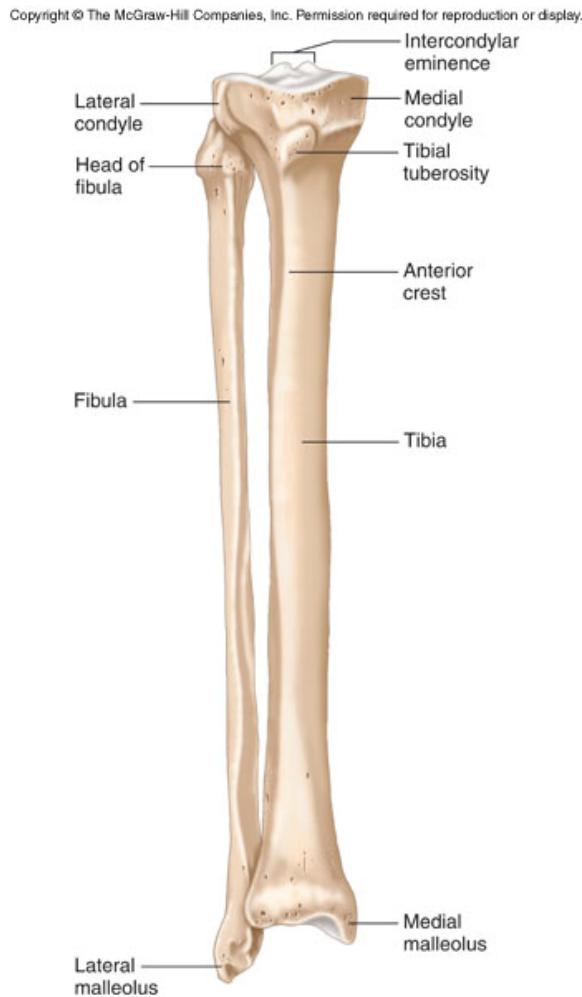
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- shin bone
- medial to fibula
- condyles
- tibial tuberosity
- anterior crest
- medial malleolus

Fibula

- lateral to tibia
- long, slender
- head
- lateral malleolus
- does not bear any body weight



Ankle and Foot

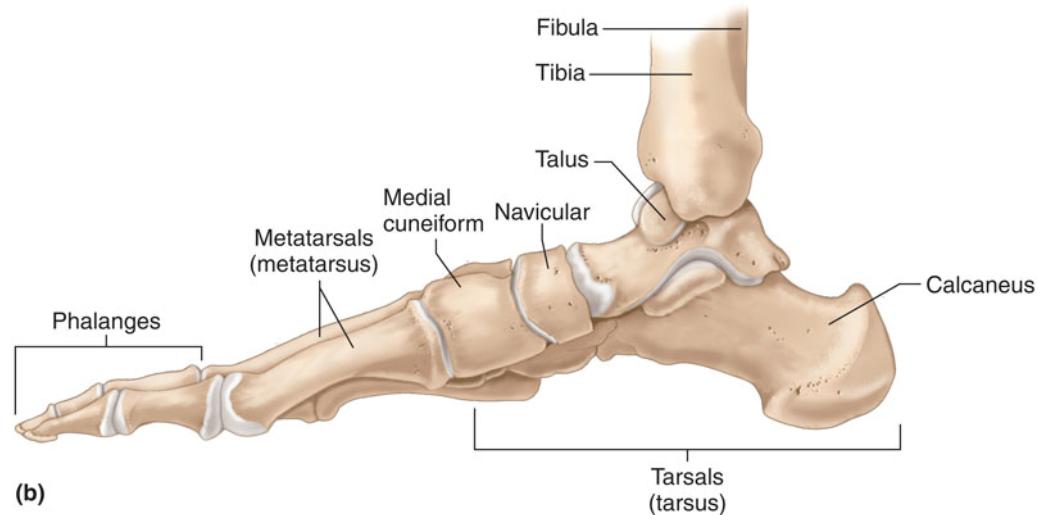
- **Tarsals (14)**

- calcaneus
- talus
- navicular
- cuboid
- lateral cuneiform
- intermediate cuneiform
- medial cuneiform

- **Metatarsals (10)**

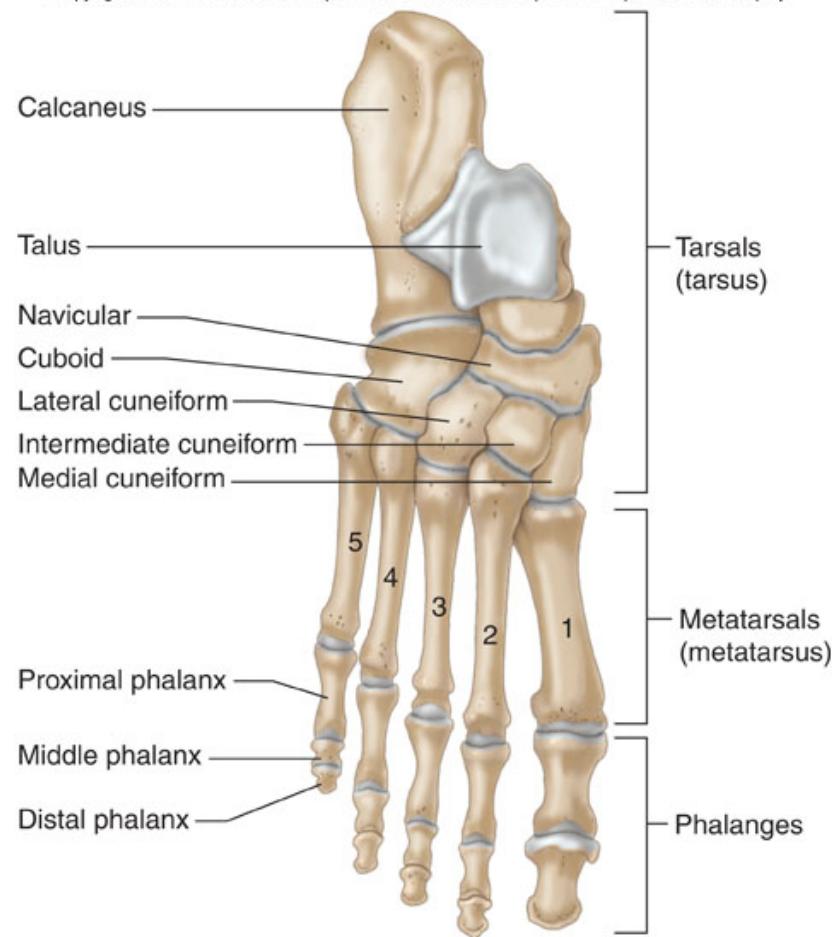
- **Phalanges (28)**
 - proximal
 - middle
 - distal

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Ankle and Foot

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Life-Span Changes

- decrease in height at about age 30
- calcium levels fall
- bones become brittle
- osteoclasts outnumber osteoblasts
- spongy bone weakens before compact bone
- bone loss rapid in menopausal women
- hip fractures common
- vertebral compression fractures common

Clinical Application

Types of Fractures

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- green stick
- fissured
- comminuted
- transverse
- oblique
- spiral

A *greenstick* fracture is incomplete, and the break occurs on the convex surface of the bend in the bone.



A *comminuted* fracture is complete and fragments the bone.



A *fissured* fracture involves an incomplete longitudinal break.



A *transverse* fracture is complete, and the break occurs at a right angle to the axis of the bone.



A *spiral* fracture is caused by twisting a bone excessively.



An *oblique* fracture occurs at an angle other than a right angle to the axis of the bone.

