
The SKELETAL System
The framework of bones and cartilage which protect organs, and provides a lever system that allows locomotion.

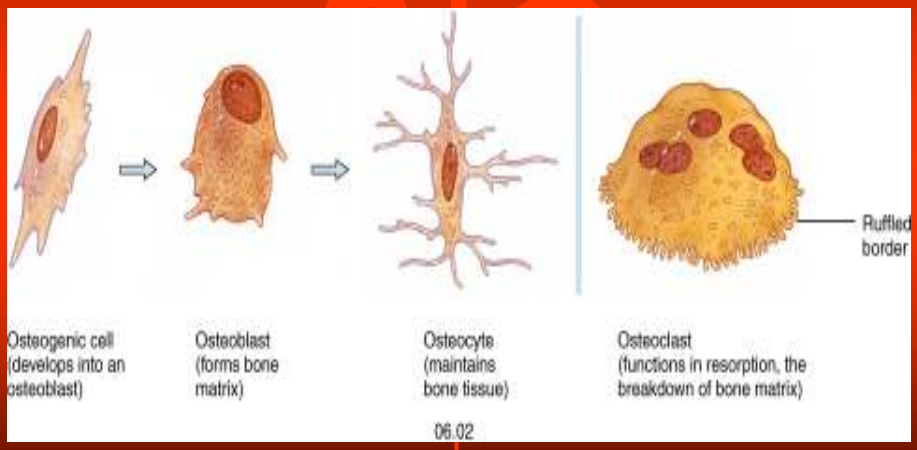
Functions of the Skeletal System

- Support
- Protection
- Movement Facilitation
- Mineral Storage and Homeostasis
- Hematopoiesis
- Storage of Energy

Types of Bone Cells

- Osteoblasts deposit mineral salts and collagen fibers
- Osteocytes maintain bone tissue
- Osteoclasts break down bone tissue

Bone Cells


Ruffled border
Osteogenic cell (develops into an osteoblast)
Osteoblast (forms bone matrix)
Osteocyte (maintains bone tissue)
Osteoclast (functions in resorption, the breakdown of bone matrix)
06.02

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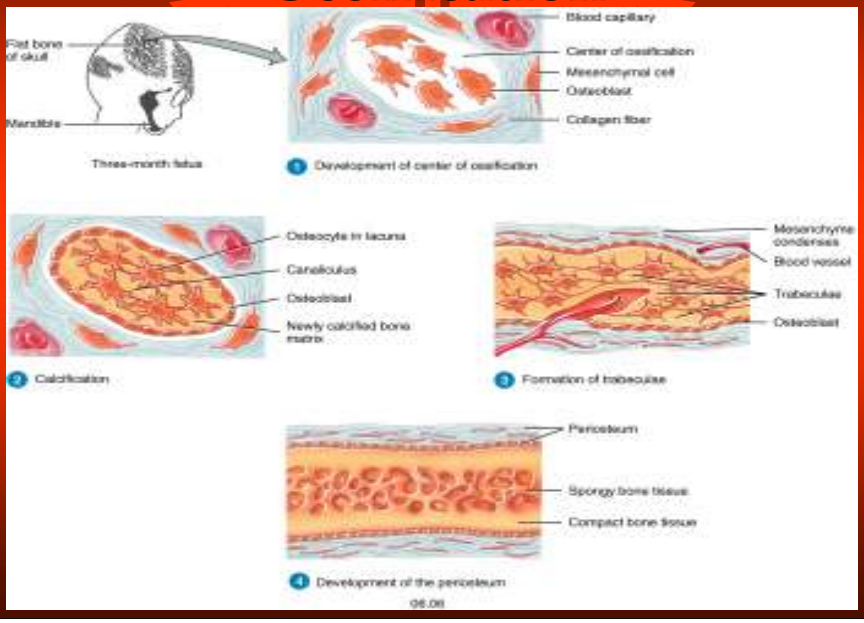
Ossification

- the process by which bones form in the body (Osteogenesis)
- the replacement of pre-existing connective tissue with bone
- Intramembranous Ossification
  - Membranes ----> Bone
  - (Periosteum - Width-wise Growth)
- Endochondral Ossification
  - Cartilage ----> Bone
  - (Epiphyseal Plate - Length-wise Growth)

Intramembranous Ossification



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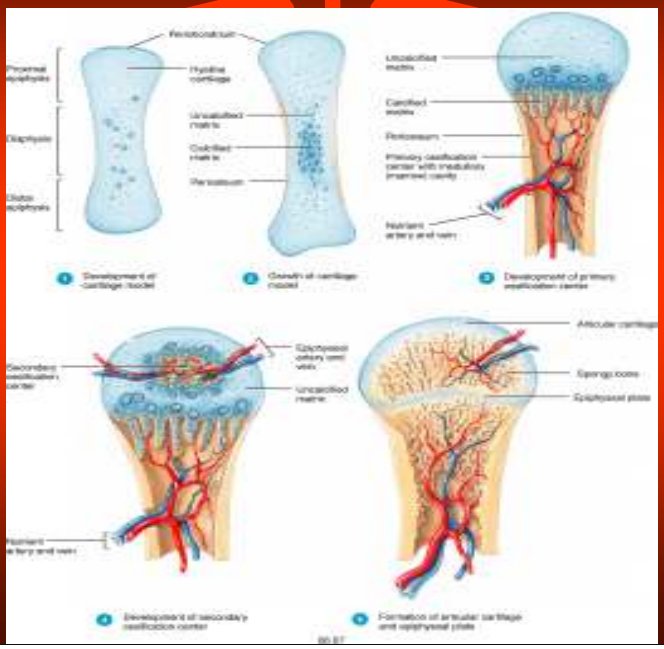
Endochondral Ossification



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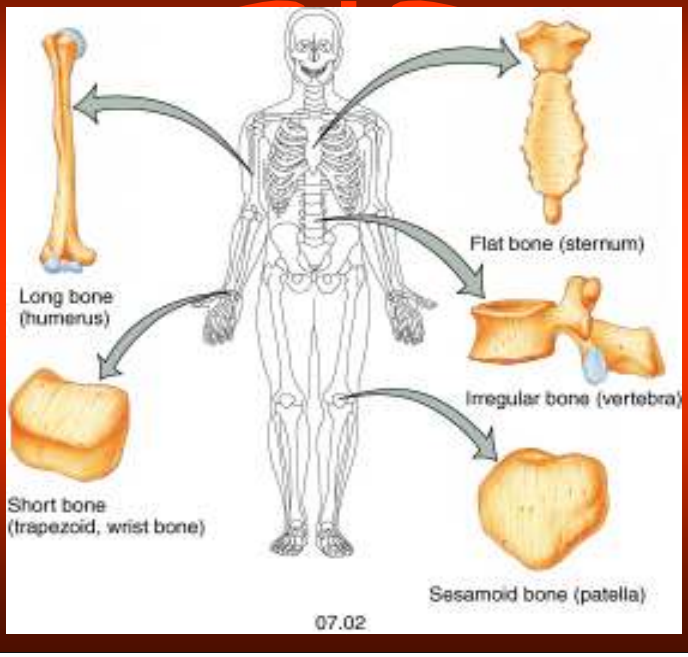
Homeostasis and Bone Remodeling

- Bones are constantly undergoing ossification and remodeling
- Replacing old bone matrix with new bone matrix
  - bone reabsorption (osteoclasts)
  - bone deposition (osteoblasts)
- Allows injured or worn out bone to be replaced
- Compact bone tissue is formed by the reorganization of spongy bone tissue

Types of Bones

- Long Bones
- Short Bones
- Flat Bones
- Irregular Bones
- Sesamoid Bones (not a classification used by all anatomists)

Types of Bones



Long Bones

- Greater length than width
- Have a distinct diaphysis and a variable number of epiphysis
- Slightly curved for strength
- Examples: humerus, ulna, radius, femur, tibia, fibula, metacarpals, metatarsals, phalanges

Short Bones

- Cube-shaped bones
- Nearly equal in length and width
- Spongy texture on inside of the bone
- Examples: carpal and tarsal bones

Flat Bones

- Generally thin and flat
- Compact bone on anterior and posterior surfaces with spongy bone in the middle
- Provides protection to organs
- Large surface area for muscle attachment
- Examples: cranial bones, sternum, scapula, ribs

Irregular Bones

- Complex shaped bones
- Cannot be classified into other categories
- Vary in the amount of spongy and compact bone
- Examples: vertebrae, facial bones, patella

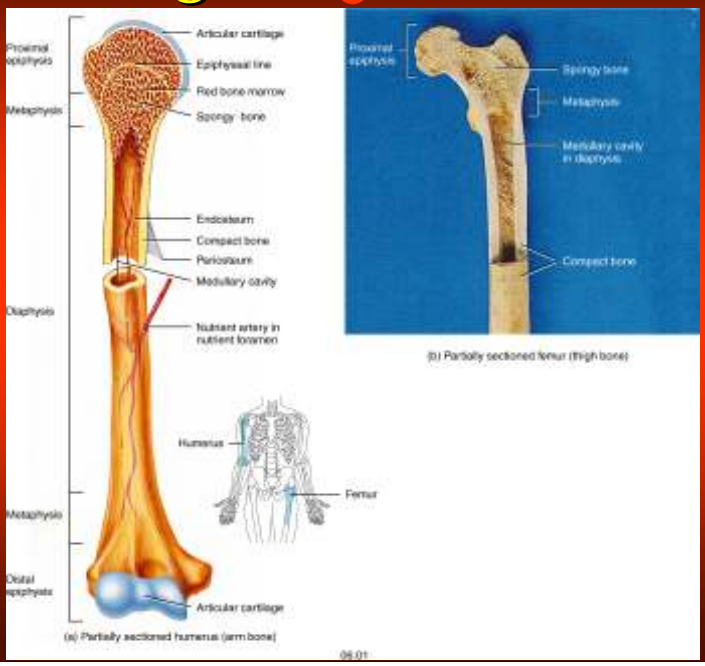
Long Bone Structure

- Periosteum – the outer covering
- Diaphysis - shaft of a long bone
- Epiphysis - ends of a long bone
- Medullary Cavity – contains marrow
- Red Marrow – where blood cells are produced.
- Yellow Marrow – where fat is stored

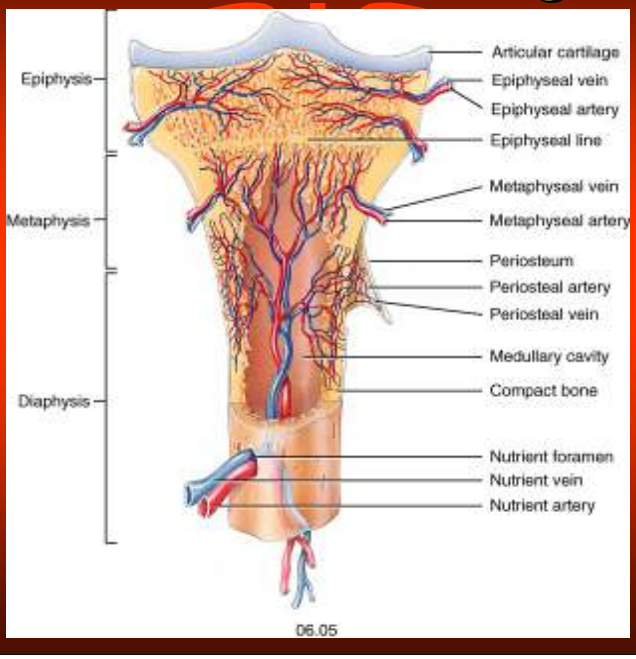
- Articular Cartilage – hyaline cartilage found at the ends of long bones to reduce friction during movement.
- Endosteum – the lining of the medullary cavity.
- Compact Bone – densely packed osteocytes to provide strength to the bone.

- Spongy bone – loosely packed osteocytes which help to reduce the weight of the bone and form the red marrow.

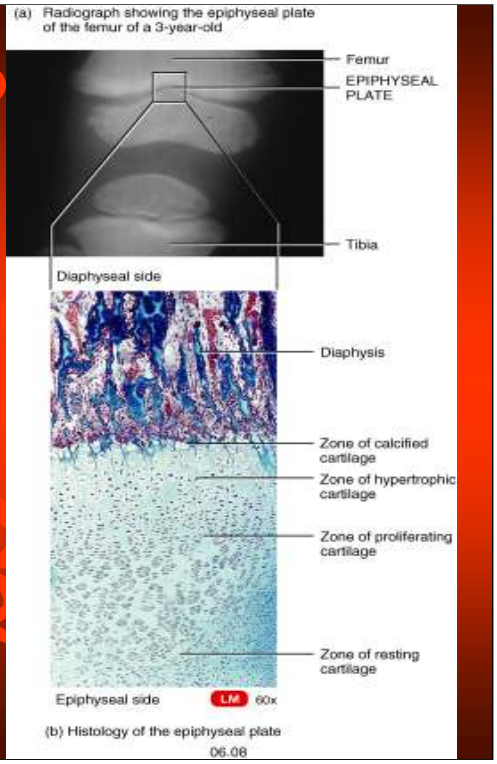
Long Bone Structure



Proximal End of a Long Bone



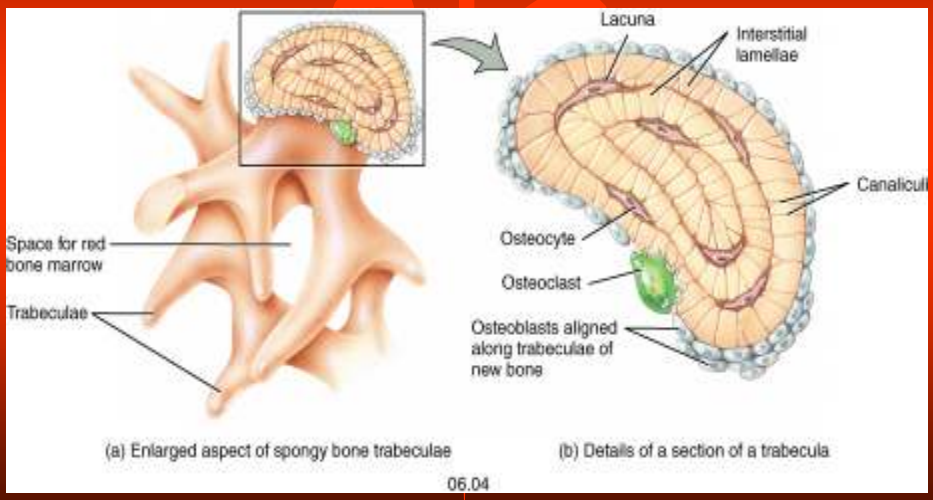
Epiphyseal Plate



Classification of Bones

- Compact Bone (Dense Bone)
  - little space between the solid components of bone
- Spongy Bone (Trabecular Bone)
  - made up of an irregular network of thin plates of bone with many intercellular spaces called trabeculae (spicules)
    - spaces between trabeculae filled with red bone marrow
    - responsible for hematopoiesis

Spongy Bone Structure



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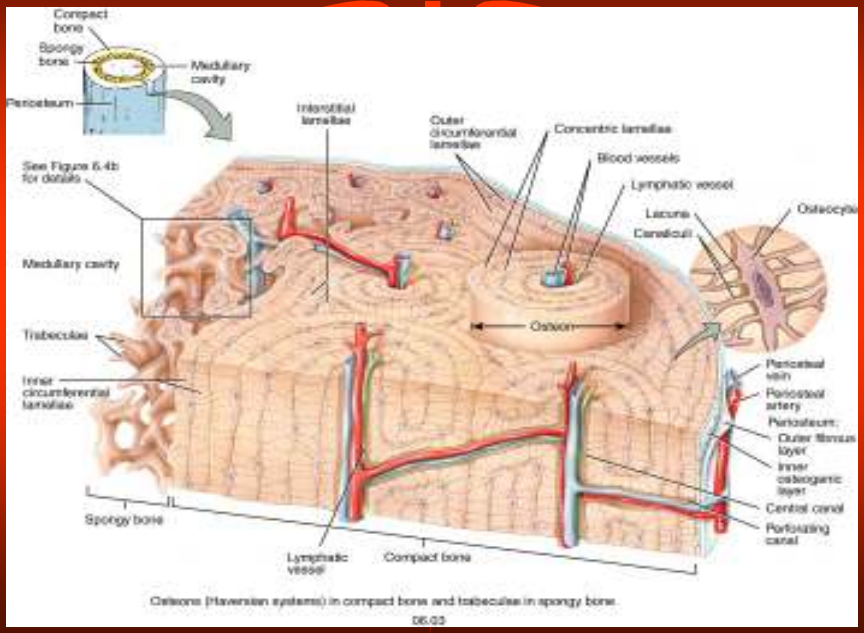
Compact Bone



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Bone Markings

- Foramen - an opening or hole in a bone
- Meatus - a tube-like passageway within a bone
- Sinus - a space within a bone lined with mucus membrane that reduces the weight of a bone
- Fossa - a depression or groove on a bone

Bone Markings

- Condyle - "Knuckle" - a large rounded prominence on a bone
- Tuberosity - an elevated, rounded, usually roughened area of a bone
- Trochanter - a large blunt process found only on the femur
- Tubercle - a small rounded process

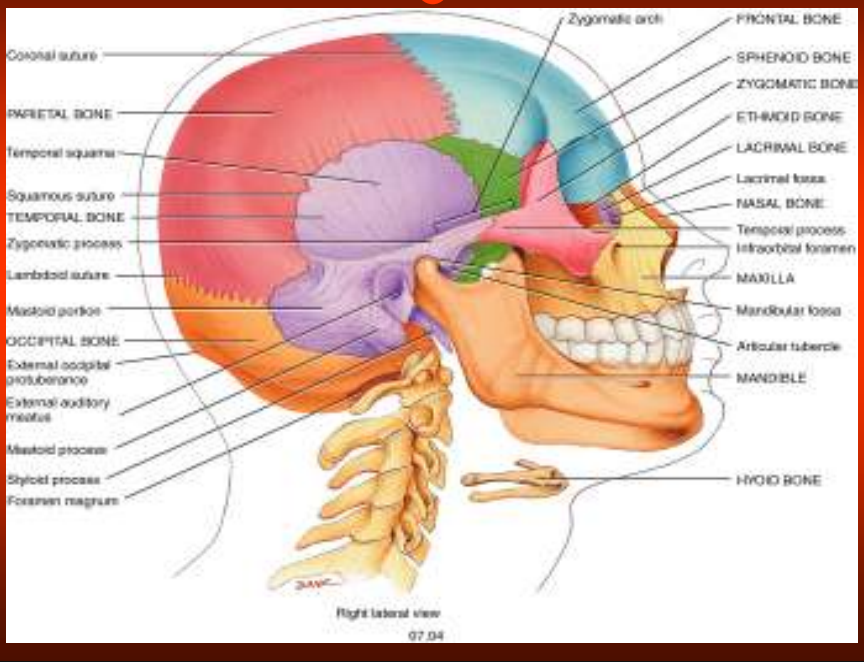
Bone Markings

- Process - any projection from the surface of a bone

Suture and Fontanel

- Sutures are the joints between the skull bones. They fuse together between the ages of 18 months old and 3 years.
- Fontanels are the soft, membranous spots of a baby's skull that allows for brain growth and the delivery of the fetus through the birth canal.

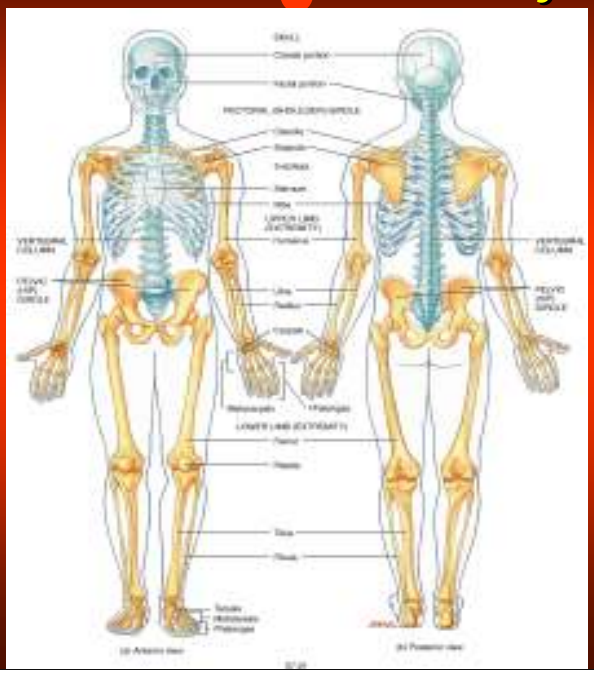
Skull – Lateral View



Divisions of the Skeleton

- Axial Skeleton - bones that lie along the long axis of the body. Includes the skull, hyoid bone, sternum, ribs, and vertebrae.
- Appendicular Skeleton - bones of the extremities.

Bones of the Skeletal System




The Axial Skeleton

Axial Skeleton
80 Bones

- Skull
- Hyoid Bone
- Vertebral Column
- Sternum
- Ribs

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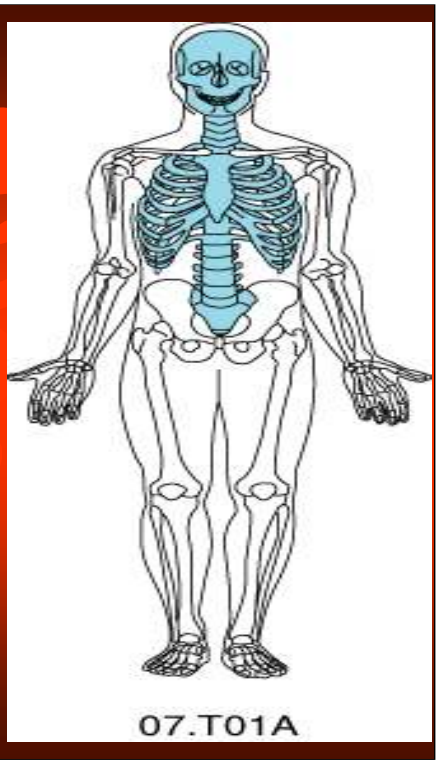
Axial Skeleton



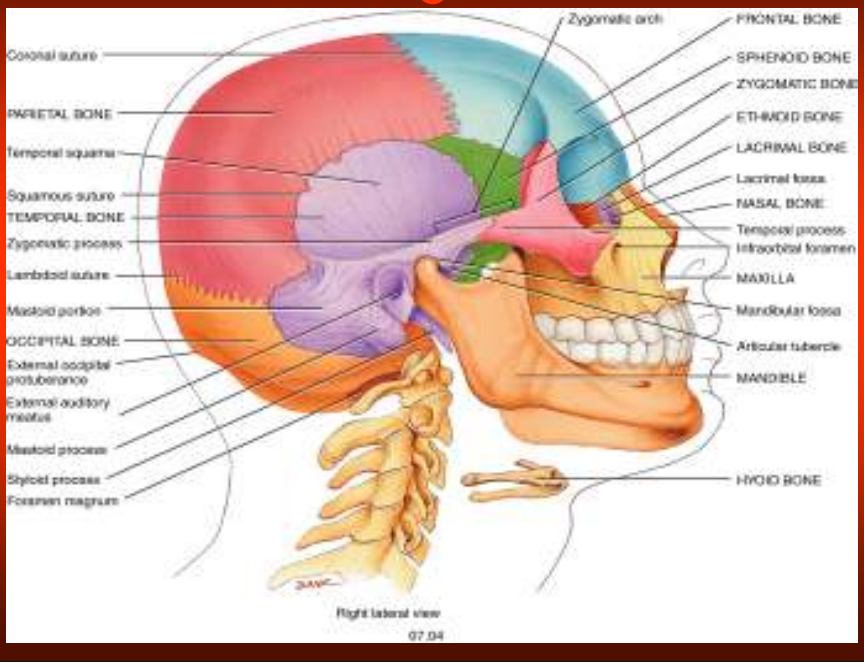
Location of Basic Skull Bones

- Mandible
- Maxilla
- Zygomatic
- Frontal
- Parietal
- Occipital
- Sphenoid

Location of Basic Skull Bones

- Ethmoid
- Hyoid
- Temporal
- Mastoid Process

Skull – Lateral View



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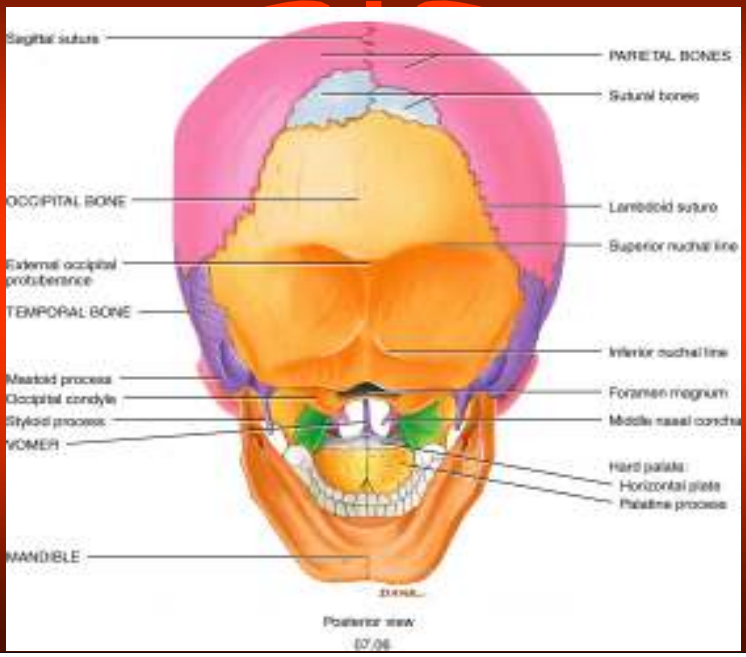
Skull – Posterior Vier



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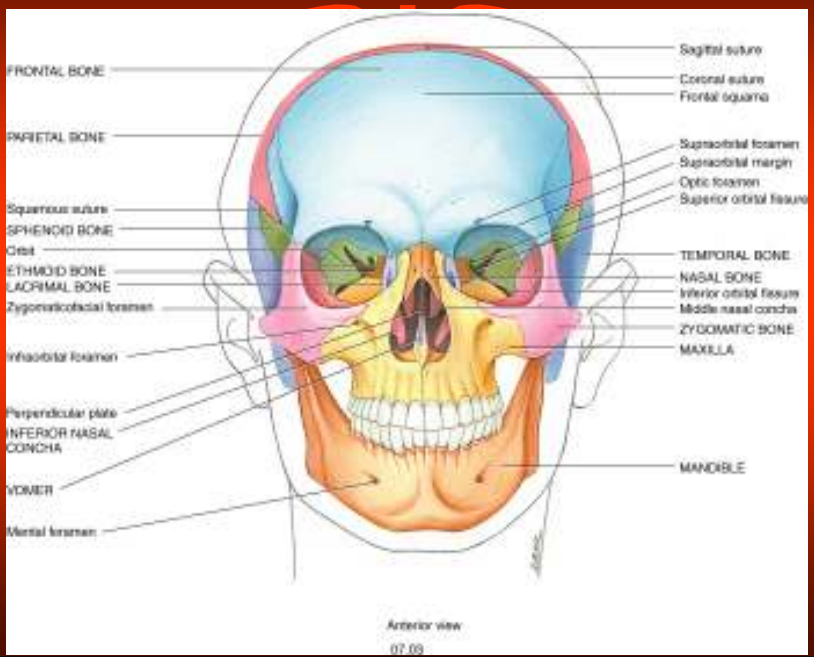
Cranial Bones (8)

- Frontal Bone
- Parietal Bones (2)
- Temporal Bones (2)
- Occipital Bone
- Sphenoid Bone
- Ethmoid Bone

Skull – Anterior View



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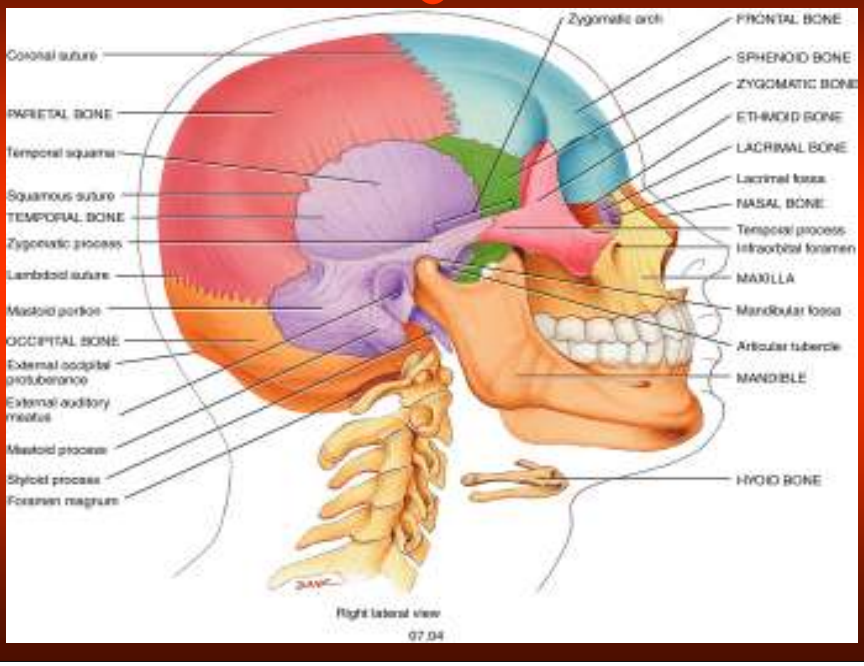
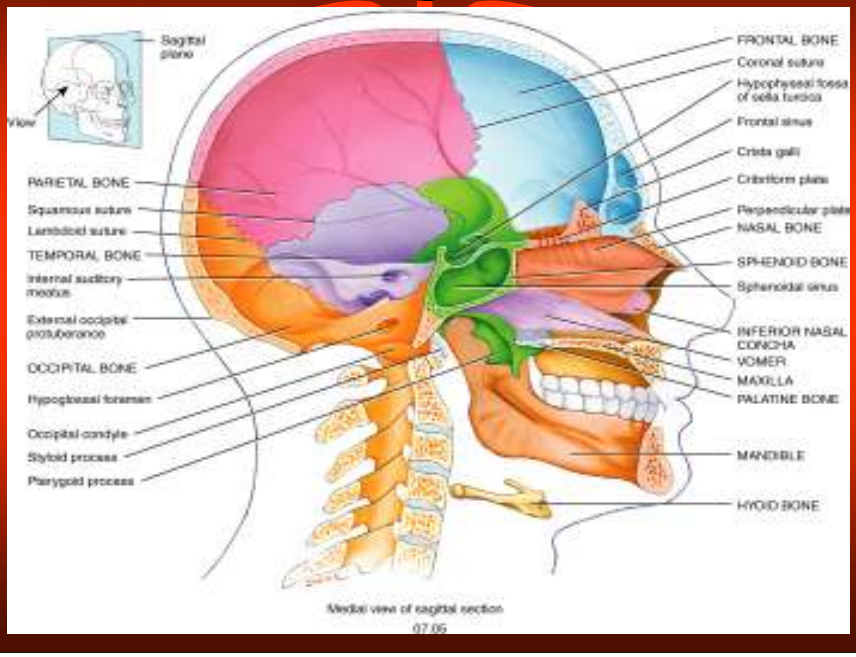
Skull – Lateral View



Skull – Sagittal View



Medial view of sagittal section

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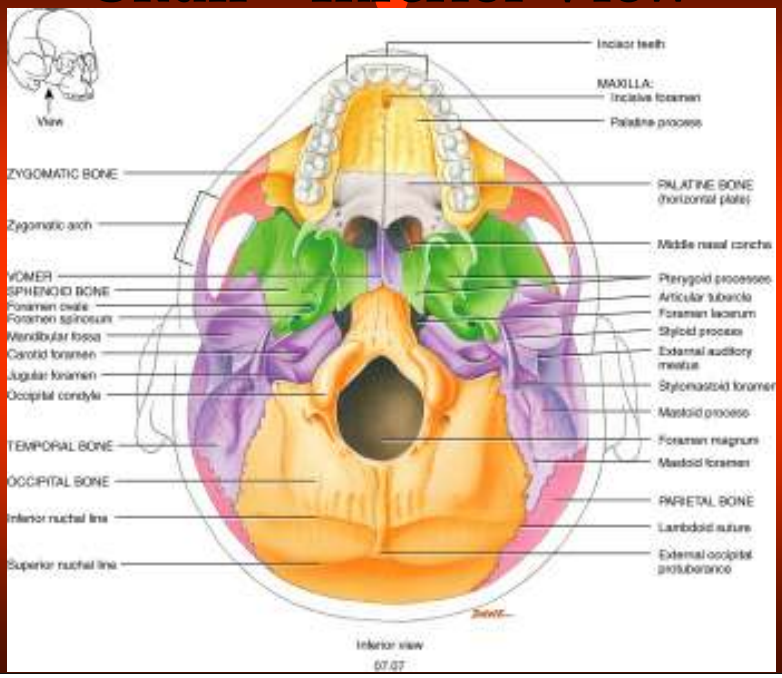
Skull – Inferior View



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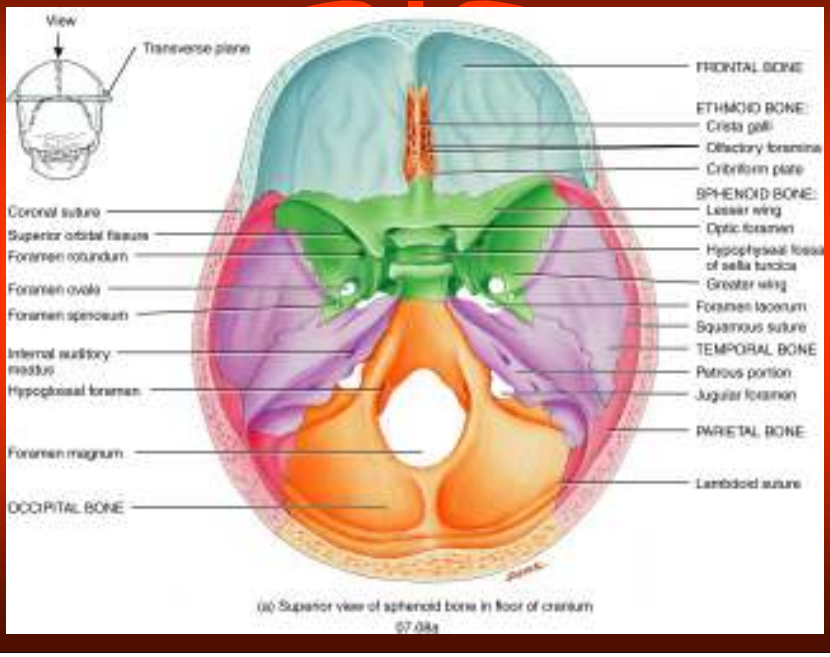
Skull – Transverse Section



(a) Superior view of sphenoid bone in floor of cranium

07.08a

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Frontal Bone

- Forms the forehead
- Forms the roof of the orbits (eye sockets)
- Forms most of the anterior portion of the cranial floor

Parietal Bones (2)

- Form the greater portion of the sides and roof of the cranial cavity

Temporal Bones (2)

- Form the inferior sides of the cranium and part of the cranial floor
- Temporal bone landmarks:
  - Zygomatic Process
  - Mandibular Fossa
  - External Auditory Meatus
  - Mastoid Process
  - Styloid Process

Occipital Bone

- The posterior part and prominent portion of the base of the cranium
- Occipital bone landmarks:
  - Foramen Magnum
  - Occipital Condyles
  - External Occipital Protuberance

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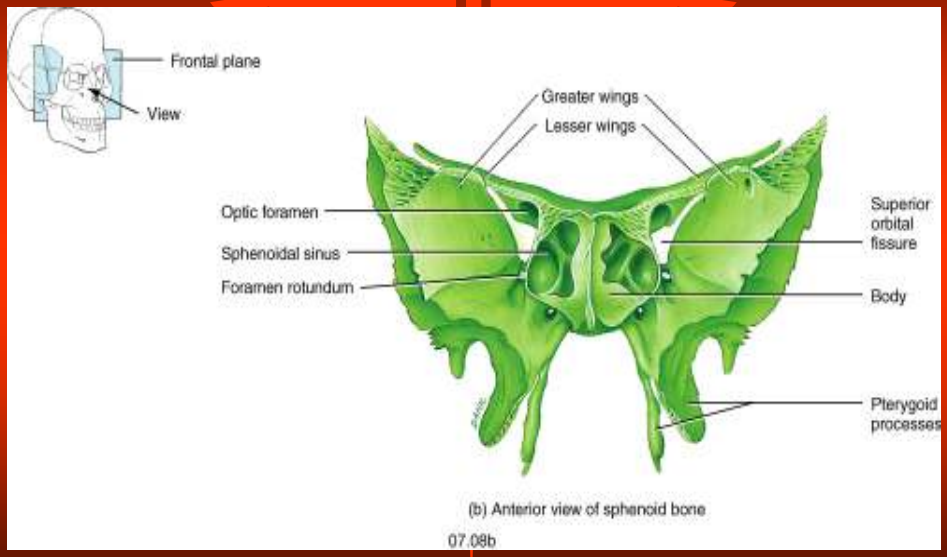
Sphenoid Bone

- Bone situated in the middle part of the base of the skull
- Shaped like a bat
- Only bone that connects to all other cranial bones
- Sphenoid bone landmarks:
  - Body - Sella Turcica
  - Greater Wings -Sphenoid Sinuses

Sphenoid Bone



(b) Anterior view of sphenoid bone

07.08b

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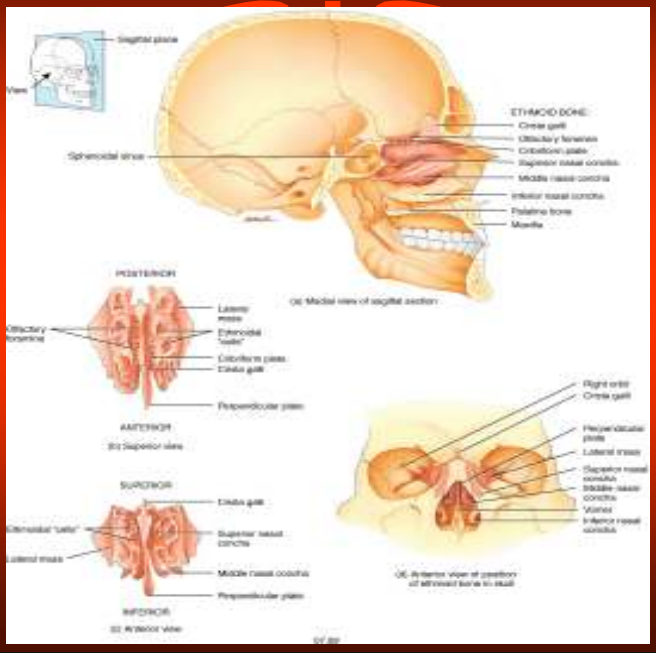
Ethmoid Bone

- Light, spongy bone located in the anterior floor of the cranium between the orbits
- Makes up much of the structure of the nasal cavity
- Ethmoid bone landmarks:
  - Lateral Masses (Labyrinths)
  - Ethmoid Sinuses - Crista Galli
  - Perpendicular Plate -Cribriform Plate
  - Superior Nasal Conchae
  - Middle Nasal Conchae

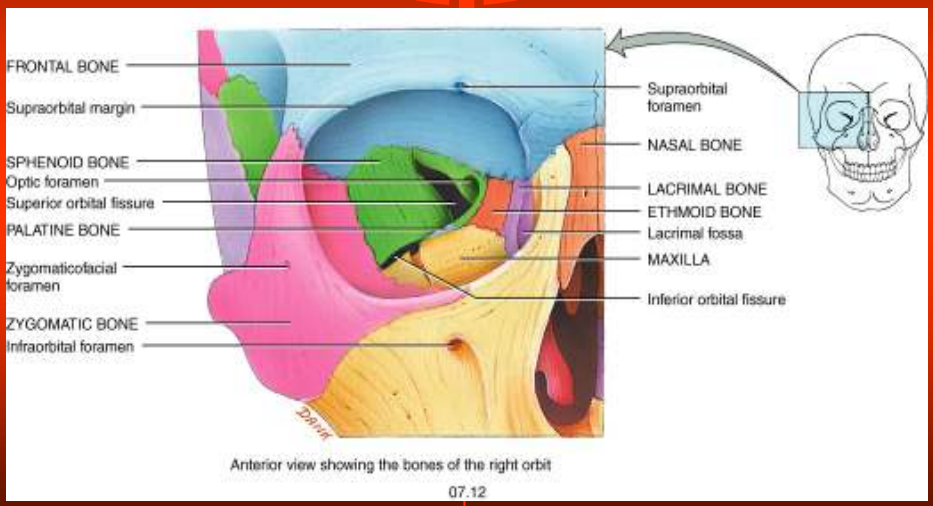
Ethmoid Bone



Facial Bones (14)

- Nasal Bones (2)
- Maxillae (2)
- Zygomatic Bones (2)
- Lacrimal Bones (2)
- Palatine Bones (2)
- Inferior Nasal Conchae (2)
- Vomer
- Mandible

Facial Bones



Anterior view showing the bones of the right orbit

07.12

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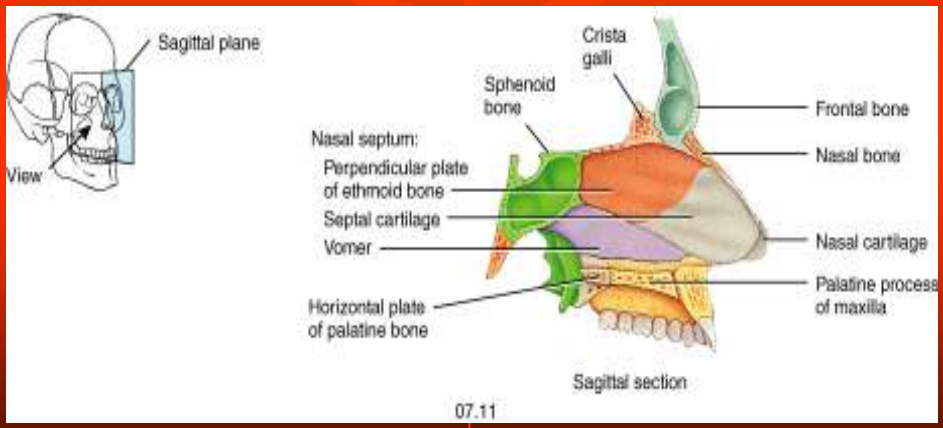
Zygomatic Bones (2)

- cheek bones
- form the prominences of the cheeks and the floor and outer walls of the orbits
- Zygomatic bone landmarks:
  - temporal processes
  - zygomatic arches

Maxillary Bones (2)

- Pair of bones that unite to form the upper jaw
- Articulate with every bone of the face except the mandible
- Maxillary bone landmarks:
  - Alveolar Processes
  - Alveoli
  - Palatine Processes - horizontal projection from the maxillae that forms the anterior three fourths of the hard palate
  - Cleft Palate - Cleft Lip

Facial Bones
Sagittal Section



07.11

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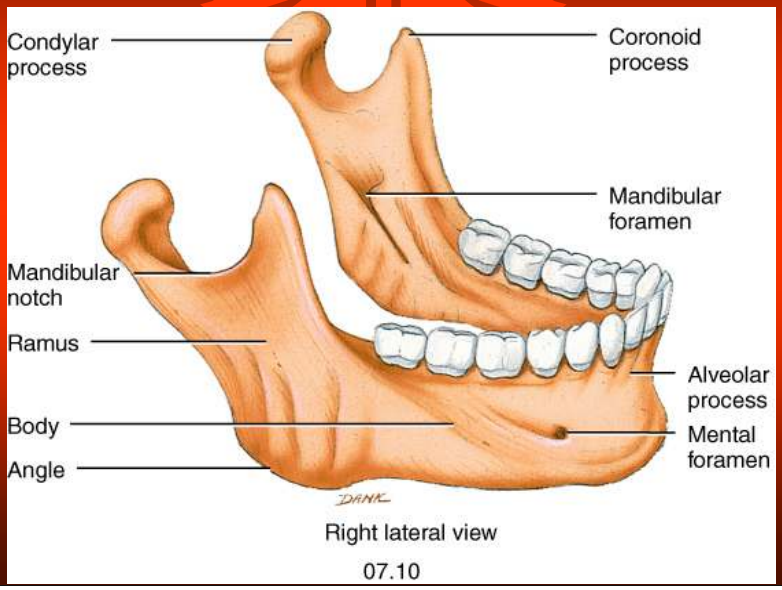
Mandible (Lower Jaw) Bone

- Largest and strongest bone in the face
- The only moveable skull bone
- Articulates with the temporal bone to form the Temporal Mandibular Joint (TMJ)

Mandibular Landmarks

- Body - front and sides of the bone
- Rami - perpendicular portions of bone
- Angle
- Condylar Processes - joint
- Coronoid Processes - muscles
- Mandibular Notch
- Alveolar Processes and Alveoli
- Mental Foramen - front/body
- Mandibular Foramen - posterior ramus
- Mandibular Canal

Mandible



Right lateral view

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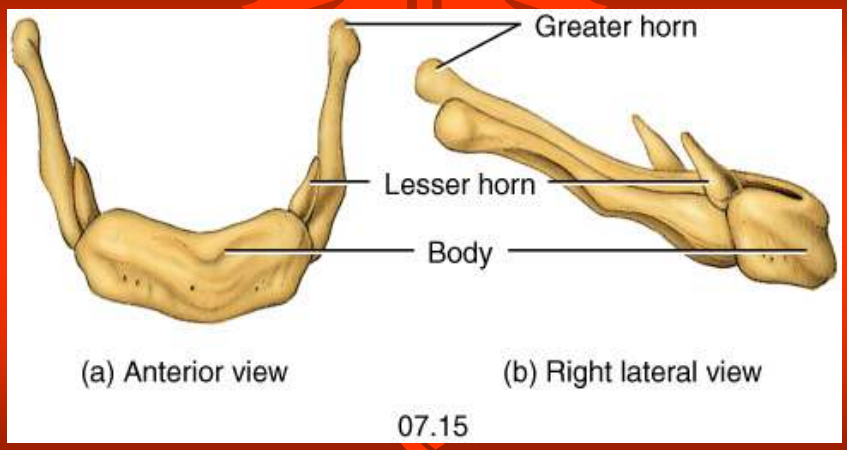
Hyoid Bone

- U-shaped bone suspended from the styloid processes by ligaments
- Only bone in the body that doesn't directly articulate with another bone
- Located between mandible and larynx
- Supports the tongue and provides point of attachment for some tongue and neck muscles

Hyoid Bone


Greater horn
Lesser horn
Body
(a) Anterior view
(b) Right lateral view
07.15

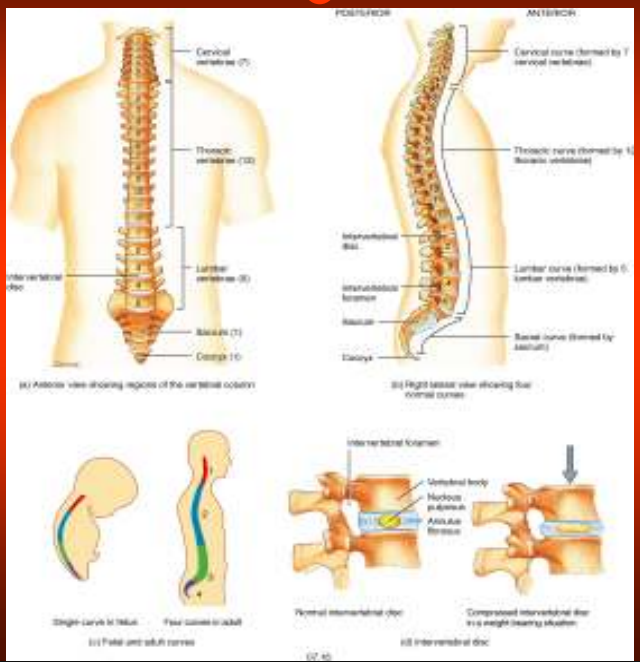
The Vertebral Column (Spine)

- Together with ribs and sternum provide about two-fifths (40%) of the height of the body
- Composed of 33 (26) different bones
- Encloses and protects the spinal cord
- Supports the head
- Lower vertebrae supports the weight of the entire upper body

Vertebrae

- Bones of the vertebral column
- Cervical vertebrae (7) - neck
- Thoracic vertebrae (12) - ribs
- Lumbar vertebrae (5) - lower back
- Sacral vertebrae (5) - pelvic bones
- Coccygeal vertebrae (4) - tail bone
- Intervertebral Foramina - openings between the vertebrae for nerve exit

Vertebral Column



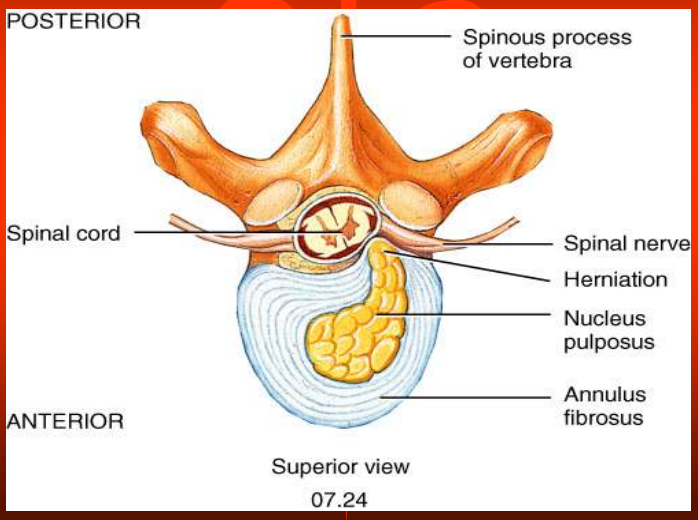
Intervertebral Discs

- Discs of fibrocartilage found between the vertebrae from C1 to the sacrum
- Functions to absorb shock
- Allows for the multi-directional motion between each vertebrae
  - Annulus Fibrosis - outer fibrous ring
  - Nucleus Pulposus - inner, soft pulpy portion of the intervertebral discs

Herniated Discs (Slipped Discs)

- Rupture of the fibrocartilage discs
- Usually caused by compression forces
- Usually occurs between L4 and L5 or L5 and the 1st Sacral Vertebrae
- Disc protrudes and exerts pressure on spinal nerves
- To decrease risk of herniated discs:
  - 1. maintain optimal body weight
  - 2. strengthen abdominal muscles
  - 3. increase lower back flexibility

Herniated Disc



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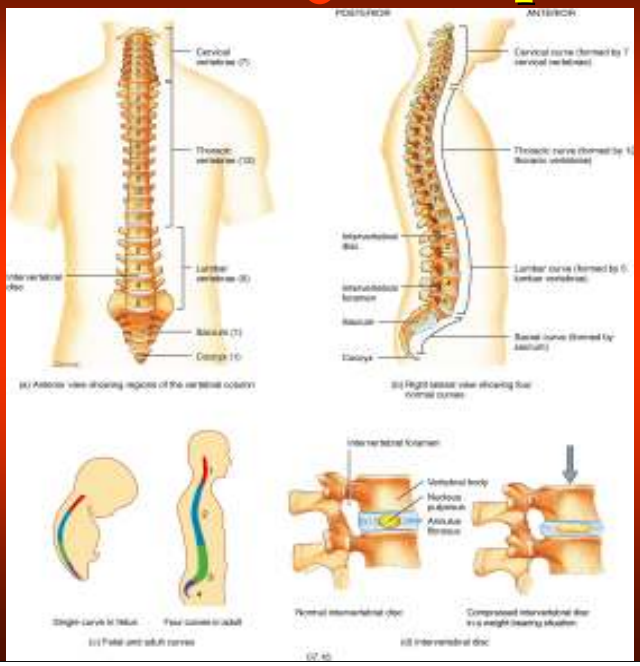
Spina Bifida

- congenital defect where the neural arch fails to unit
- usually involves the lumbar vertebrae
- symptoms may be mild to severe
  - usually results in paralysis
  - partial or complete loss of bladder control
  - absence of reflexes
- can be diagnosed during pregnancy by sonography, amniocentesis, blood tests

Curvature of the Spine

- Increases strength of the spine
- Helps maintain balance
- Dissipates vertical shock
- Protects spinal column from fracture
- Anterior Curves (Secondary Curves)
  - Cervical Vertebrae -Lumbar Vertebrae
- Posterior Curves (Primary Curves)
  - Thoracic Vertebrae -Sacral Vertebrae

Curvature of the Spine



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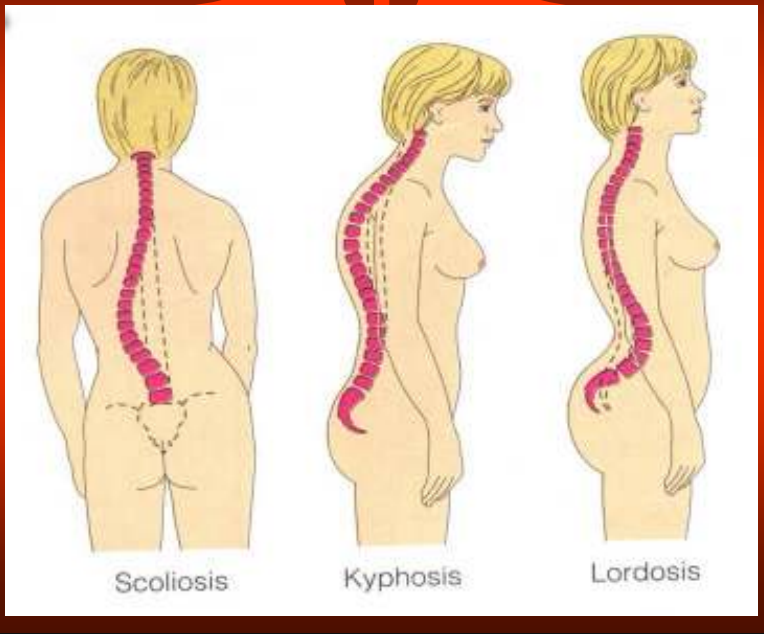
Abnormal Curvatures of the Spine

- Scoliosis - lateral curvature of the spine
  - usually in thoracic and lumbar region
- Kyphosis - hunchback/humpback
  - exaggeration of thoracic curvature
- Lordosis - swayback (sprinters butt)
  - exaggeration of lumbar curvature

Abnormal Curvatures



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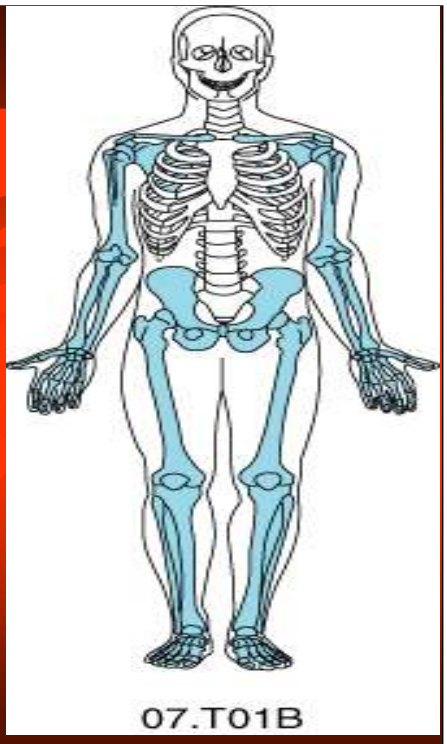
The Appendicular Skeleton

Appendicular Skeleton
126 Bones

- clavicle
- scapula
- humerus
- ulna
- radius
- carpals
- metacarpals
- phalanges
- pelvis
- femur
- patella
- tibia
- fibula
- tarsals
- metatarsals
- phalanges

Appendicular Skeleton



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Joints (Articulations)

The points of contact between bones, between bones and cartilage, or between teeth and bones.

Structural Classification of Joints

- Classification of joints based upon how they are held together
- Fibrous Joints
  - held together by fibrous connective tissue
- Cartilaginous Joints
  - held together by cartilage
- Synovial Joints
  - joint enclosed within a synovial or joint capsule

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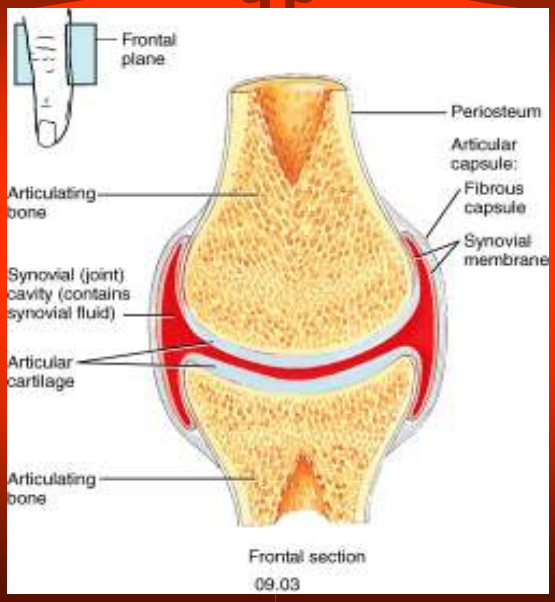
Synovial Joints

- Enclosed within a joint or synovial capsule
  - fibrous capsule - outer layer
    - attaches to periosteum of bone
  - synovial membrane - inner layer
    - secretes synovial fluid
- Space between the ends of articulating bones called a synovial space
- End of articulating bones are covered with hyaline (articular) cartilage

Typical Synovial Joint



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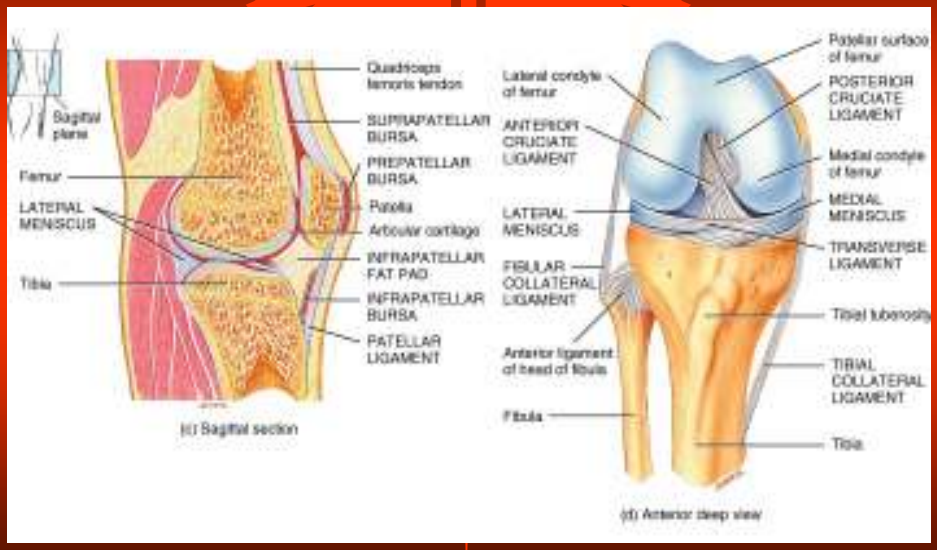
Menisci

- Pads of fibrocartilagenous discs found between bony surfaces in some joints
- Allows the bones to fit together better
- Maintains the stability of the joint
- Absorbs shock
- Directs the flow of synovial fluid to areas of greatest friction

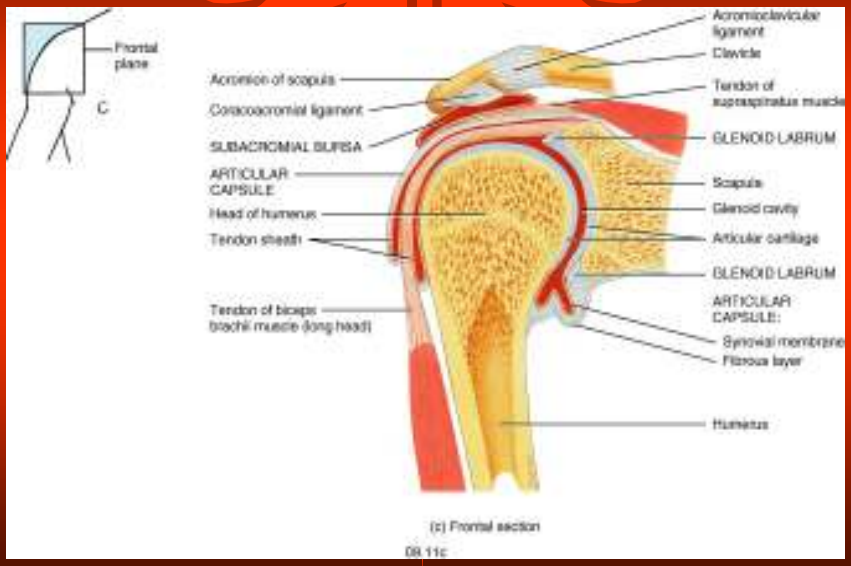
Bursae

- Sac-like structures that resemble joint capsules situated within body tissues
- Function like ball-bearings
- Reduces friction between bones and soft tissues
- Reduces friction between bones and skin

Knee Joint


Sagittal plane
Femur
LATERAL MENISCUS
Tibia
Quadriceps femoris tendon
SUPRAPATELLAR BURSA
PREPATELLAR BURSA
Patella
Articular cartilage
INFRAPATELLAR FAT PAD
INFRAPATELLAR BURSA
PATELLAR LIGAMENT
(c) Sagittal section
Lateral condyle of femur
ANTERIOR CRUCIATE LIGAMENT
LATERAL MENISCUS
FIBULAR COLLATERAL LIGAMENT
Anterior ligament of head of fibula
Fibula
Patellar surface of femur
POSTERIOR CRUCIATE LIGAMENT
Medial condyle of femur
MEDIAL MENISCUS
TRANSVERSE LIGAMENT
Tibial tuberosity
TIBIAL COLLATERAL LIGAMENT
Tibia
(d) Anterior deep view

Shoulder Joint



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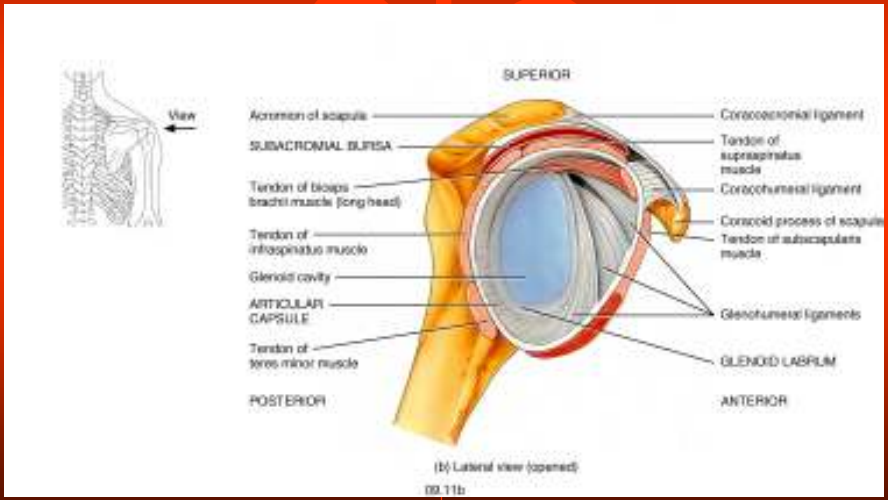
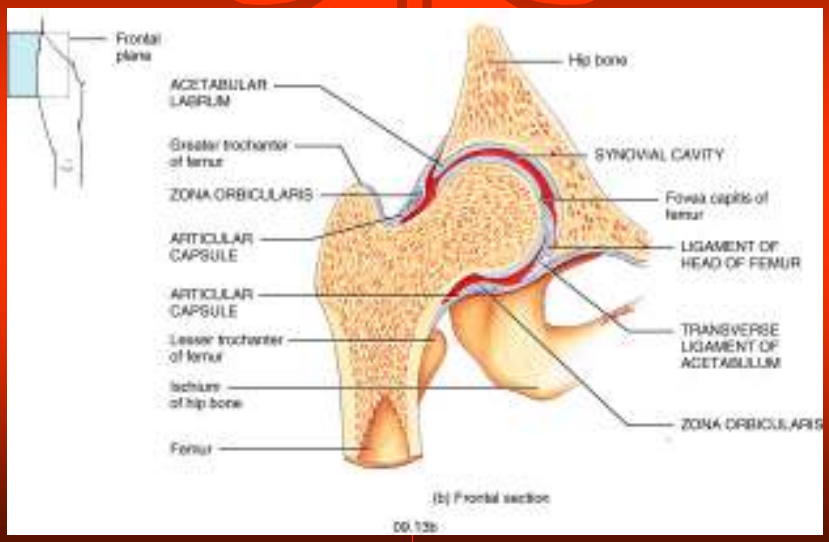
Shoulder Joint



Hip Joint

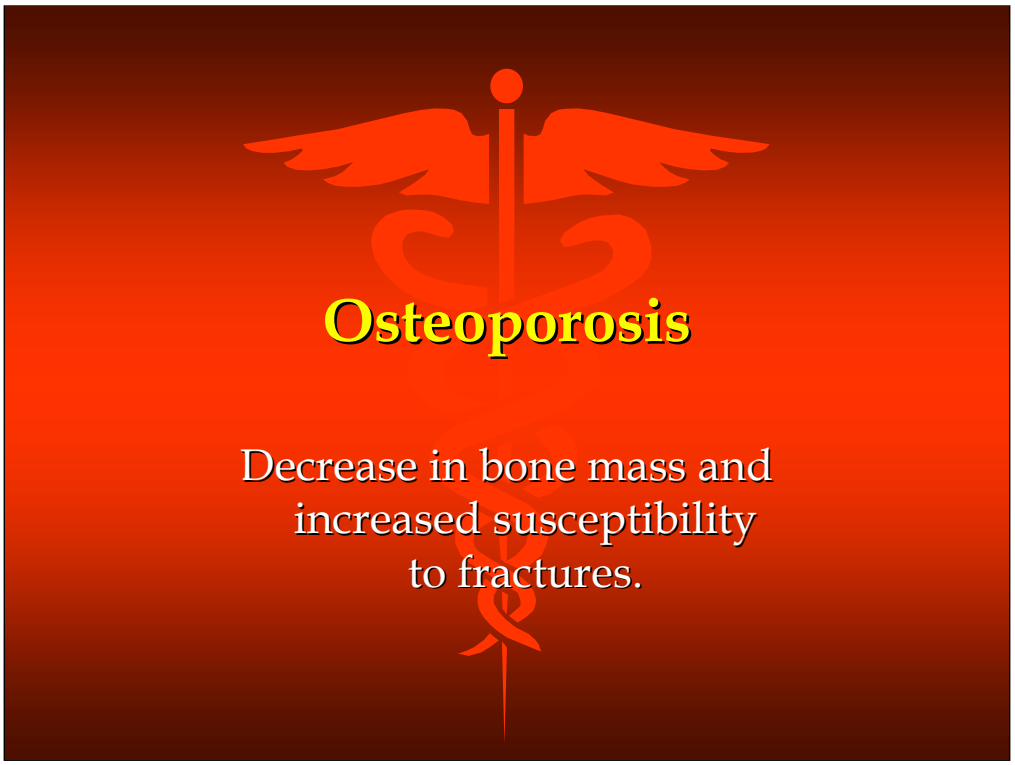

Frontal plane
ACETABULAR LABRUM
Greater trochanter of femur
ZONA ORBICULARIS
ARTICULAR CAPSULE
ARTICULAR CAPSULE
Lesser trochanter of femur
Ischium of hip bone
Femur
Hip bone
SYNOVIAL CAVITY
Fovea capitis of femur
LIGAMENT OF HEAD OF FEMUR
TRANSVERSE LIGAMENT OF ACETABULUM
ZONA ORBICULARIS
(b) Frontal section
09.13b

Tendons and Ligaments

- Tendons - connect muscle to bone
  - A band or cord of dense fibrous connective tissue extending from a muscle to a bone for attachment
- Ligaments - connect bone to bone
  - A band or cord of dense fibrous connective tissue extending from one bone to another bone to provide a joint with structural stability

Osteoarthritis

- Degenerative joint disease associated with aging
- Usually preceded by traumatic joint injury
- Characteristics:
  - degeneration of articular cartilage
  - development of bone spurs
  - usually effects large joints (knees, hips, etc)
- Treatment:
  - rest - removal of bone spurs
  - joint replacement


Osteoporosis
Decrease in bone mass and
increased susceptibility
to fractures.

Osteoporosis
Contributing Factors

- Decreased estrogen production
- Poor nutritional status
- Low activity levels
- Weight
- Smoking
- Drugs and alcohol consumption
- Gender/race/hereditary factors

Osteoporosis - Treatment

- Calcium supplementation
- Estrogen Replacement Therapy
- Weight-bearing exercise
- Steroid treatment therapy