Skeletal System

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Skeletal System

- Skeletal System consists of :
  - Bones
  - Joints
  - Cartilage
  - Ligaments
- It is living & metabolically active tissue although it contains non-living material such as calcium & phosphorus creating a dried up or dead appearance

Skeletal System

- Function of the skeletal system:
  - **Support** the weight of the body
  - **Protection** of soft organs i.e. heart, brain
  - **Movement** of body
  - **Storage** of minerals such as calcium & phosphorus
  - **Hemopoiesis**

Skeletal System

- Shapes of bones:
  - Long bones: longer than wider; femur & humerus
  - Short bones: cubed shaped; carpals & tarsals
  - Flat bones: thin, flat & curved; skull & breatbone
  - Irregular bones: differently shaped: vetebrae & hip

Skeletal System

- Bone Tissue & Formation
  - Bone is osseous tissue which is the hardest connective tissue
  - Bone cells are osteocytes
  - Osteocytes secrete an intracellular matrix containing calcium & other minerals which are deposited around protein fibers
  - Minerals make the bone hard & strong

Skeletal System

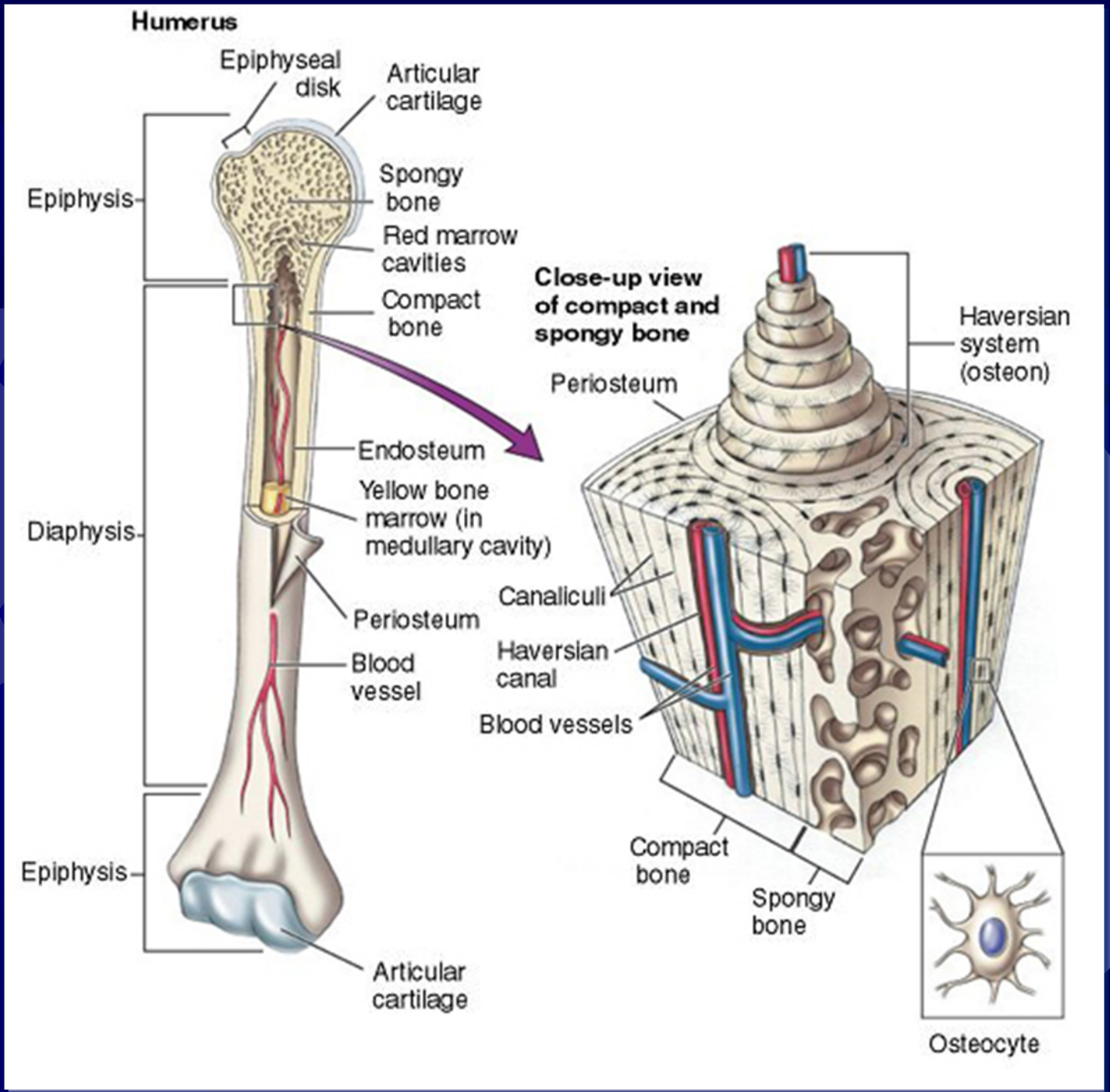
- There are two types of bones:
  - Compact bone
  - Spongy bone

Skeletal System

- Compact Bones
  - Dense hard bone tissue
  - Found in the shafts of long bones & outer surface of other bones
  - Tightly packed so dense & strong
  - Structural unit is the osteon or haversian system
  - Composed of osteocytes in concentric circles surrounding blood vessels.
  - Area around osteocyte is filled with protein fibers, calcium & minerals
  - Covered with periosteum

Skeletal System

- Spongy Bones
  - AKA cancellous bone
  - Less dense
  - Located at the end of long bones & in the center of other bones
  - Do not contain haversian system
  - Arranged in plates called **Trabeculae**
  - Creates a swiss cheese appearance
  - Spaces in bones decrease weight of bone & contain red bone marrow for blood cell production


Humerus
Epiphyseal disk
Articular cartilage
Epiphysis
Spongy bone
Red marrow cavities
Compact bone
Endosteum
Yellow bone marrow (in medullary cavity)
Diaphysis
Periosteum
Blood vessel
Epiphysis
Articular cartilage
Close-up view of compact and spongy bone
Haversian system (osteon)
Periosteum
Canaliculi
Haversian canal
Blood vessels
Compact bone
Spongy bone
Osteocyte

Skeletal System

- Long Bones Anatomy:
  - Diaphysis: long shaft of bone, primarily compact bone therefore strong
  - Epiphysis: enlarged ends of bone, meets with 2nd bone at joint, consists of thin layer of compact bone over spongy bone & covered by cartilage

Skeletal System

- Long Bone Anatomy:
  - Epiphyseal Disc:
    - band of cartilage located at the end of long bones between the epiphysis & diaphysis
    - area where longitudinal bone growth occurs
    - AKA: Growth Plate
  - Medullary:
    - hollow center of the diaphysis
    - lined with connective tissue endosteum
    - in adults, filled with yellow bone marrow
    - storage site for fat

Skeletal System

- Long Bone Anatomy:
  - Periosteum:
    - Tough fibrous connective tissue membrane covering the outside of the diaphysis
    - Protects bone
    - Site for muscle attachment
    - Contains blood vessels that nourish the underlying bone
  - Articular Cartilage:
    - Found on outer surface of the epiphysis
    - Smooth & shiny surface
    - Helps decrease friction within joint

Skeletal System

- Ossification: formation of bone
  - Flat bone ossification: osteoblasts migrate to area of flat bones and secrete calcium & minerals replacing thin membrane with bone
  - Long bone ossification: fetal skeleton is composed mostly of cartilage. Osteoblasts invade cartilage and replace it with bone.

Skeletal System

- Bones grow in two ways:
  - Taller
  - Thicker & Wider
- Taller:
  - longitudinal growth occurs at the epiphyseal disc
  - As long as cartilage continues to form in the epiphyseal disc the bone continues to lengthen
  - Cartilage continues to grow & change to bone by osteoblasts
  - Once the epiphyseal disc becomes ossified bone growth ceases
  - Growth hormone & sex hormones influence bone growth

Skeletal System

- Bone Growth
- Thicker & Wider:
  - Bones are continuously being reshaped or remodeled
  - Accomplished by osteoblast & osteoclasts
  - Osteoblasts deposit bone on outer surface of bone
  - Osteoclasts hollow out the interior of bone
  - Both help create wide hollow bones

Skeletal System

- Bone Surface:
  - Irregular and bumpy
  - Ridges, projections, depressions & grooves called bone markings
  - Projections serve as points of attachment for muscles, tendons, & ligaments
  - Grooves & depressions are areas blood vessels & nerves pass
  - Depressions & projections help to form joints

Skeletal System

- Bone Fractures:
- Different types:
  - Simple: fracture of bone in which skin remains intact
  - Compound: fractured bone pierces the skin
  - Greenstick: incomplete fracture of bone. Seen in children

Skeletal System

- See terminology on page 116 Table 8-1
- Student is responsible to review

Skeletal System

Division of the Skeletal System

- Divided into two: Axial & Appendicular
- Axial: contains 80 bones
  - Skull: 28 bones } cranium , ear , face
  - Spine: 26 bones } vertebrae
  - Thorax: 25 bones } ribs , sternum
- Appendicular: contains 126 bones
  - Upper extremities: 64 bones } arms, hands & pectoral girdle
  - Lower extremities: 62 bones } pelvic girdle, legs, feet

Skeletal System

- Cranial Bones:
  - Frontal (1): forehead, also forms part of floor of cranium & most part of eye sockets
  - Parietal (2): form most of the top of the head & sides of head
  - Temporal (2): form lower sides of head near ears. Contain ear structures:
    - External auditory meatus: opening for ear
    - Zygomatic process: forms part of cheek bone
    - Styloid process: sharp projection for muscle attachment associated with tongue & larynx
    - Mastoid process: forms a point of attachment for muscles of neck

Skeletal System

- Occipital bone (1):
  - forms base of skull
  - contains large hole called foramen magnum where the spinal cord enters
  - occipital condyles are bony projections that sit on the first vertebra

Skeletal System

- Sphenoid bone (1):
  - Butterfly shaped bone that forms part of the floor & sides of the cranium
  - Forms part of orbits
  - Small depression in center called sella turcica (AKA Turk's Saddle) where the pituitary gland sits
- Ethmoid bone (1):
  - Bony structure that helps form nasal cavity

Skeletal System

- Facial Bones:
  - Nasal Bones (2): form upper bridge of nose
  - Mandible (1):
    - lower jaw bone & anterior portion of chin
    - carries lower teeth
    - articulates with temporal bones at temporomandibular joint
    - points of attachment for chewing muscles

Skeletal System

- Maxilla (2):
  - Two maxilla bones fuse together to form upper jaw which holds upper teeth
  - Part of eye orbits & nasal cavities
  - The palatine process, an extension of maxilla, forms the anterior portion of the hard palate
- Palatine (2):
  - Forms the posterior part of hard palate & floor of nasal cavity

Skeletal System

- Zygomatic Bones (2):
  - Cheekbones & forms part of orbit
- Lacrimal Bones:
  - Form medial wall of eye socket & side wall of nasal cavity
- Inferior nasal concha (2):
  - Forms curved wall inside nose
- Vomer Bone (1):
  - Forms lower back part of nasal septum
- Hyoid Bones (1):
  - U-shaped bone in neck anchors tongue

Skeletal System

- Sinuses: air-filled cavities located in bones of skull
- Two functions:
  - Lessen weight of skull & amplify & ↑ voice
- Four sinuses called paranasal sinuses because they connect nasal passages & throat
- Four sinuses:
  - Frontal—ethmoidal—sphenoidal—maxillary

Skeletal System

- Sutures:
  - Joins the bones of the skull together
- Main sutures:
  - Coronal
  - Lambdoidal
  - Squamosal
- Infant skull: has fontanels & unfused sutures. Discussed in pediatrics

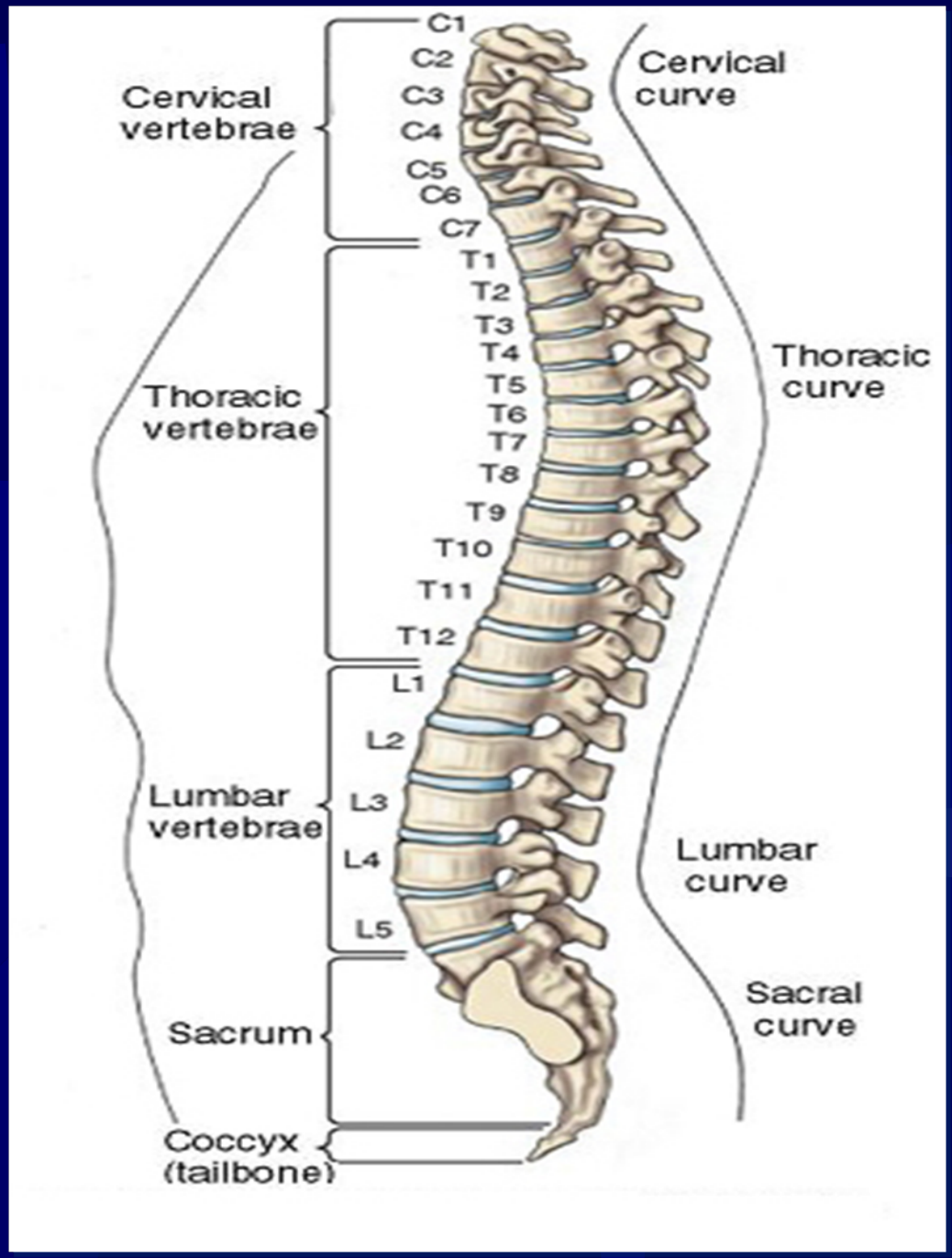
Skeletal System

Vertebral Column:

- AKA: backbone or spine
- Extends from skull to the pelvis
- Consists of series of bones stacked in a column called vertebrae
- Cartilaginous discs are between the vertebrae and act as a cushion
- Vertebral foramen is opening for spinal cord

Skeletal System

- Four Major Functions:
  - Support structures from head & thorax
  - Forms an attachment for pelvic girdle
  - Encases & protects spinal cord
  - Provides flexibility for body
- Vertebrae are named for location
  - 7 cervical—12 thoracic—5 lumbar
    1 sacrum—1coccyx


C1
C2
C3
C4
C5
C6
C7
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
Cervical vertebrae
Thoracic vertebrae
Lumbar vertebrae
Sacrum
Coccyx (tailbone)
Cervical curve
Thoracic curve
Lumbar curve
Sacral curve

Skeletal System

- 7 Cervical: neck region
  - C1:
    - first cervical vertebrae is called atlas
    - contains depressions for which the bony projections of the occipital bone fit
    - Supports skull & allows one to nod for yes
  - C2:
    - second cervical vertebrae called axis
    - Has projection that fits into atlas
    - Acts as swivel for the atlas & allows head to rotate side to side to say no

Skeletal System

- Adult spine contains 26 vertebrae:
  - 12 Thoracic—Chest Area—T1-T12
  - 5 Lumbar—Lower back—L1-L5
  - 1 Sacrum—Fused as 1—forms posterior wall of pelvis
  - 1 Coccyx—tailbone

Skeletal System

- Curvature of the spine
  - 4 Normal Curvatures:
    - cervical curve: bend toward front of body
    - thoracic curve: bend away from front of body
    - lumbar curve: bend toward front of body
    - sacral curve: bend away from front of body
  - Center the head over the body providing balance needed for walking in upright position

Skeletal System

- Abnormal Curvatures of Spine:
  - Scoliosis: lateral curvature, usually involves thoracic vertebrae
  - Kyphosis: exaggerated thoracic curvature

  AKA: hunchback
  - Lordosis: exaggerated lumbar curvature
- Causes may be genetic, disease, or poor posture

Skeletal System

- Thoracic Cage:
  - Bony cone shaped cage that surrounds the lungs, heart, and large blood vessels
  - Consists of thoracic vertebrae, ribs, & sternum
  - Function:
    - Assist in breathing
    - support bones of shoulder
    - Protects lungs, heart, & large blood vessels

Skeletal System

- Sternum:
  - AKA Breastbone
  - dagger shaped bone located on anterior chest
  - Three parts:
    - Manubrium
    - the body
    - xiphoid process: landmark for CPR

Skeletal System

- Ribs (24):
  - 14 true ribs: attached directly to the sternum by costal cartilage
  - 10 false ribs: attached indirectly to sternum
  - Last 4 false ribs AKA floating ribs because of the lack of sternal support
- Intercostal muscles are located between ribs & contract to move thoracic cage during breathing.

Skeletal System

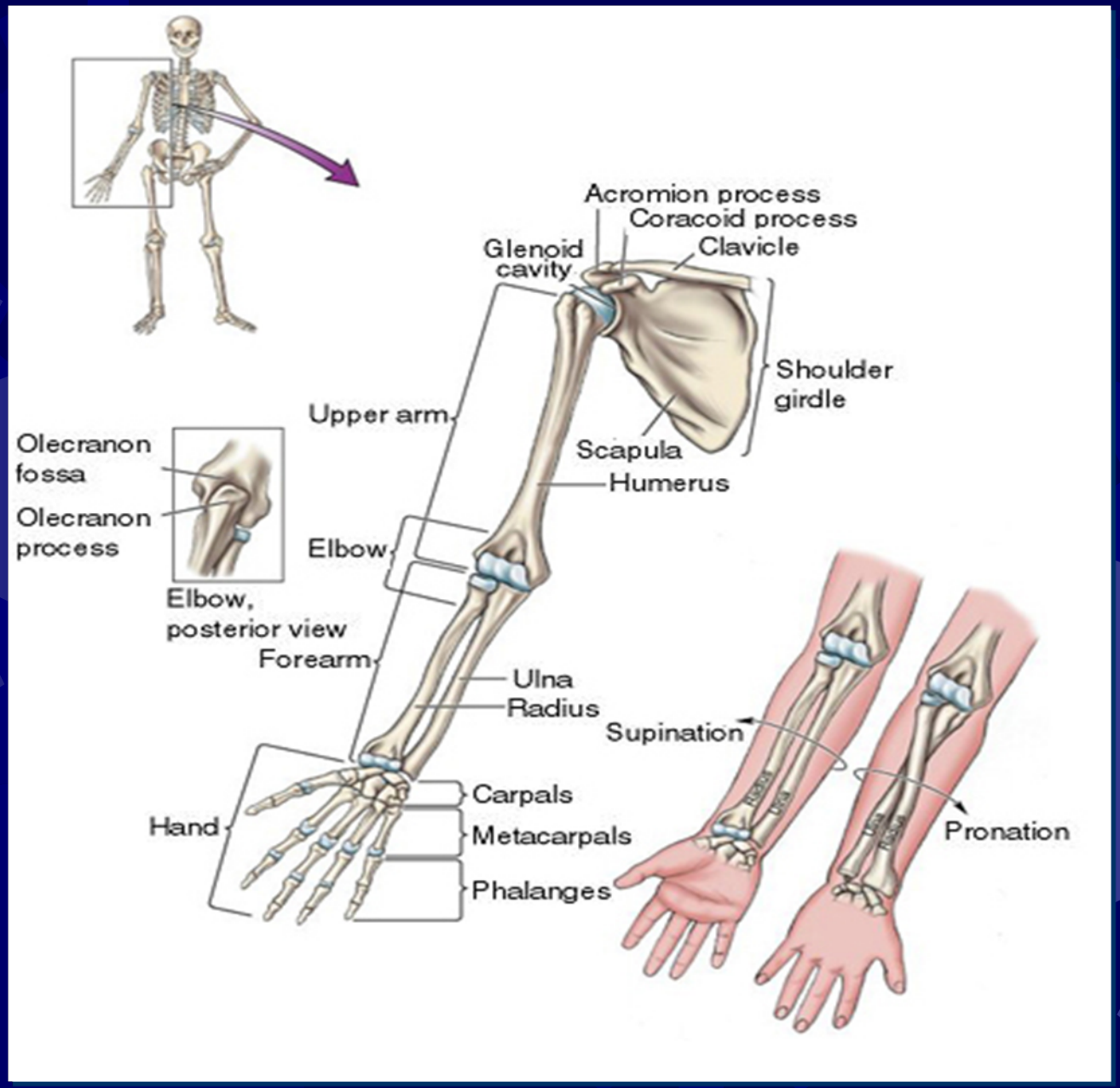
- Appendicular Skeleton: composed of the bones of shoulder girdle, upper limbs, pelvic girdle & lower limbs
- Shoulder girdle:
  - AKA pectoral girdle
  - Supports arms & is place of attachment of muscles
  - Includes clavicle & scapula
  - Flexible allowing varies movements

Skeletal System

- Clavicle:
  - AKA collarbone
  - Long rod shaped bone that articulates with sternum & scapula
  - Helps stabilize shoulder
  - Attachment is weak & easily dislocated
  - Most frequently broken bone

Skeletal System

- Scapula:
  - AKA shoulder blade or wing bone
  - Articulates with clavicle & is points of attachment for arm & chest muscles
  - Glenoid cavity on scapula is site where the head of humerus fits allowing rotation of arm
  - Acromion process & coracoid process serve as points of attachment for ligaments & muscles


Acromion process
Coracoid process
Glenoid cavity
Clavicle
Shoulder girdle
Upper arm
Scapula
Humerus
Olecranon fossa
Olecranon process
Elbow
Elbow, posterior view
Forearm
Ulna
Radius
Supination
Pronation
Carpals
Hand
Metacarpals
Phalanges

Skeletal System

Upper Extremities

- Humerus:
  - Long bone of upper arm
  - Contains head which fits into glenoid cavity & allows upper arm rotation
  - Olecranon fossa is a depression at the distal end that holds the ulna when the elbow is extended

Skeletal System

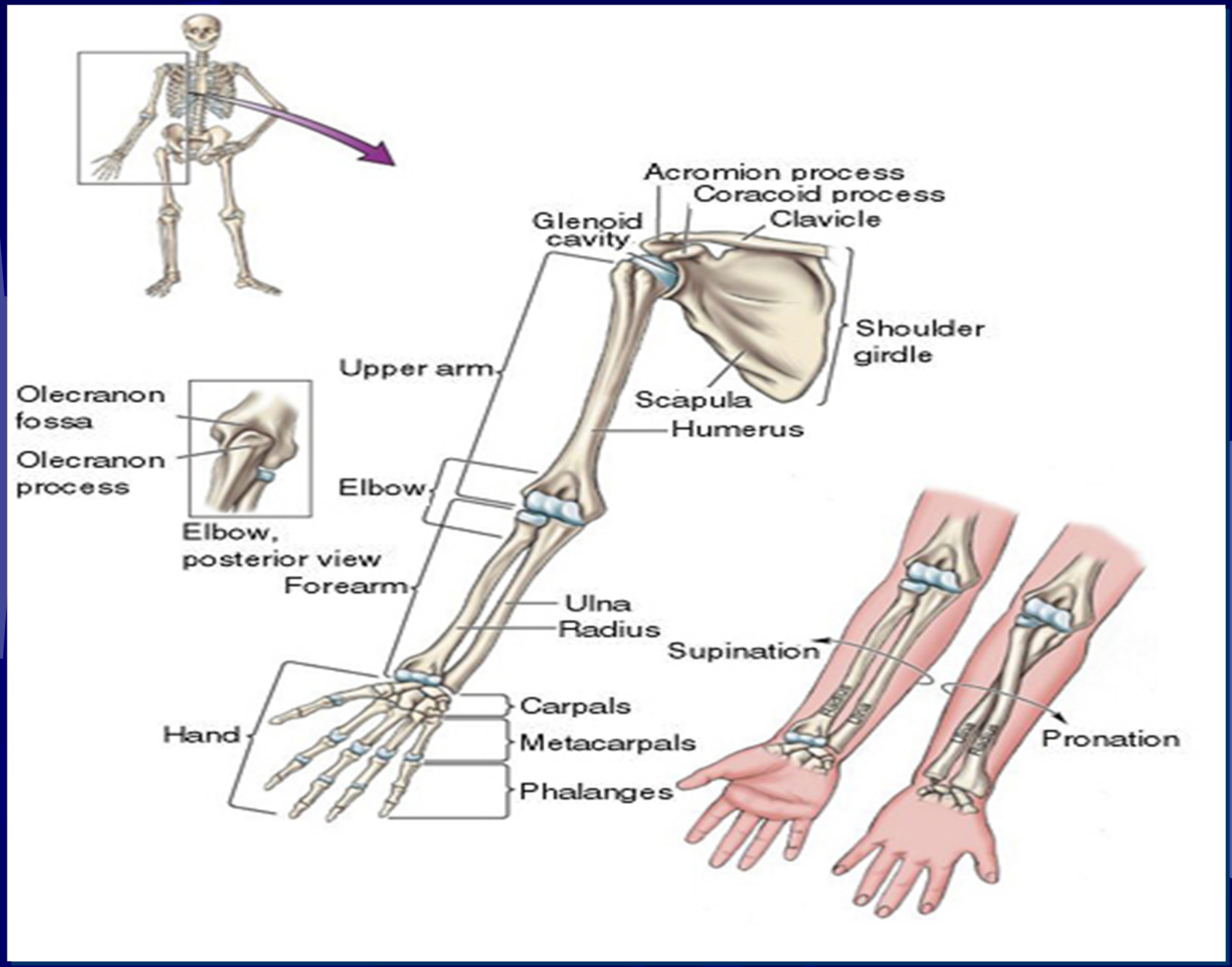
- Radius
  - One of two bones of the forearm
  - Located on the thumbside when palm faces forward
  - Head of radius articulates with both the humerus & ulna
  - Radial tuberosity at the proximal end is site of attachment for the muscle that allows the forearm to bend at the elbow

Skeletal System

- Ulna:
  - Second bone of forearm
  - Longer of two bones located on the little finger side of the forearm
  - Articulates with humerus, radius & carpals
  - Olecranon process is what is felt as the point of the elbow
  - When palms up (supination) radius & ulna are parallel
  - When palms face down (pronation) the bones cross

Skeletal System

- Hand consists of wrist, palm & fingers
- Wrist:
  - consist of 8 bones called carpals
  - tightly bound by ligaments
- Palm:
  - consists of 5 bones called metacarpals
- Fingers:
  - Each finger has three bone except the thumb that has two bones totaling 14 called phalanges
  - Head of the phalanges are prominent creating knuckles


Acromion process
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Elbow, posterior view
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Carpals
Hand
Metacarpals
Phalanges

Skeletal System

- Pelvic girdle:
  - composed of two coxal bones, sacrum & coccyx.
  - the female pelvis is broader & more shallow for child-bearing
  - Functions include:
    - bearing weight of body
    - attachment for legs
    - protection of pelvic organs

Skeletal System

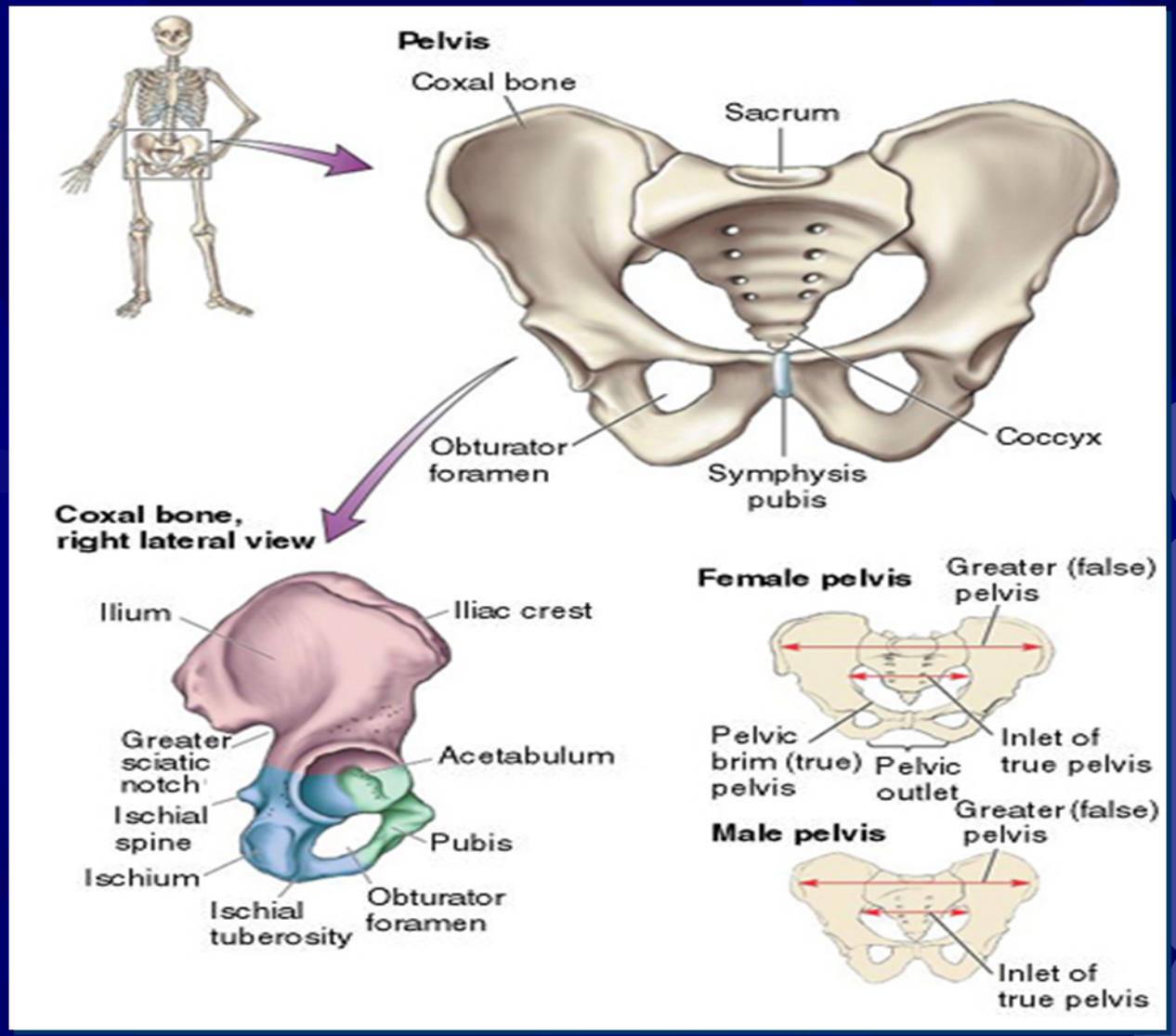
- Coxal Bone: AKA os coxae or hip bone
  - Three parts:
    - ilium—ischium--pubis
  - Ilium:
    - largest part of coxal
    - flared upper bone felt at hip
    - outer edge is iliac crest
    - connects in the back with the sacrum to form sacroiliac joint

Skeletal System

- Ischium:
  - Inferior part of coxal bone
  - Three parts:
    - ischial tuberosity: part of coxal on which we sit
    - ischial spine: projects into pelvic cavity narrowing pelvis
    - greater sciatic notch: site where blood vessels & sciatic nerves pass from pelvic cavity into the posterior thigh

Skeletal System

- Pubis:
  - Most anterior portion of coxal
  - Two bones join in front as symphysis pubis & are separated by a disc of cartilage
  - Obturator foramen large hole formed when pubic bone fuses with a part of the ischium allowing blood vessels & nerves to pass to anterior thigh
  - False pelvis: area surrounded by the flaring part of 2 iliac bones
  - True pelvis: ring formed by fusion of pelvic bones


Pelvis
Coxal bone
Sacrum
Coccyx
Obturator foramen
Symphysis pubis
Coxal bone, right lateral view
Ilium
Iliac crest
Greater sciatic notch
Acetabulum
Ischial spine
Pubis
Ischium
Obturator foramen
Ischial tuberosity
Female pelvis
Greater (false) pelvis
Pelvic brim (true) pelvis
Pelvic outlet
Inlet of true pelvis
Male pelvis
Greater (false) pelvis
Inlet of true pelvis

Skeletal System

Lower Extremities

- Femur:
  - AKA thighbone
  - Longest & strongest bone in body
  - Articulates with coxal bone to form hip & bones of lower leg to form knee
  - Head of femur continues as the neck
  - The bony processes greater & lesser trochanter are the most important providing sites for muscle attachment

Skeletal System

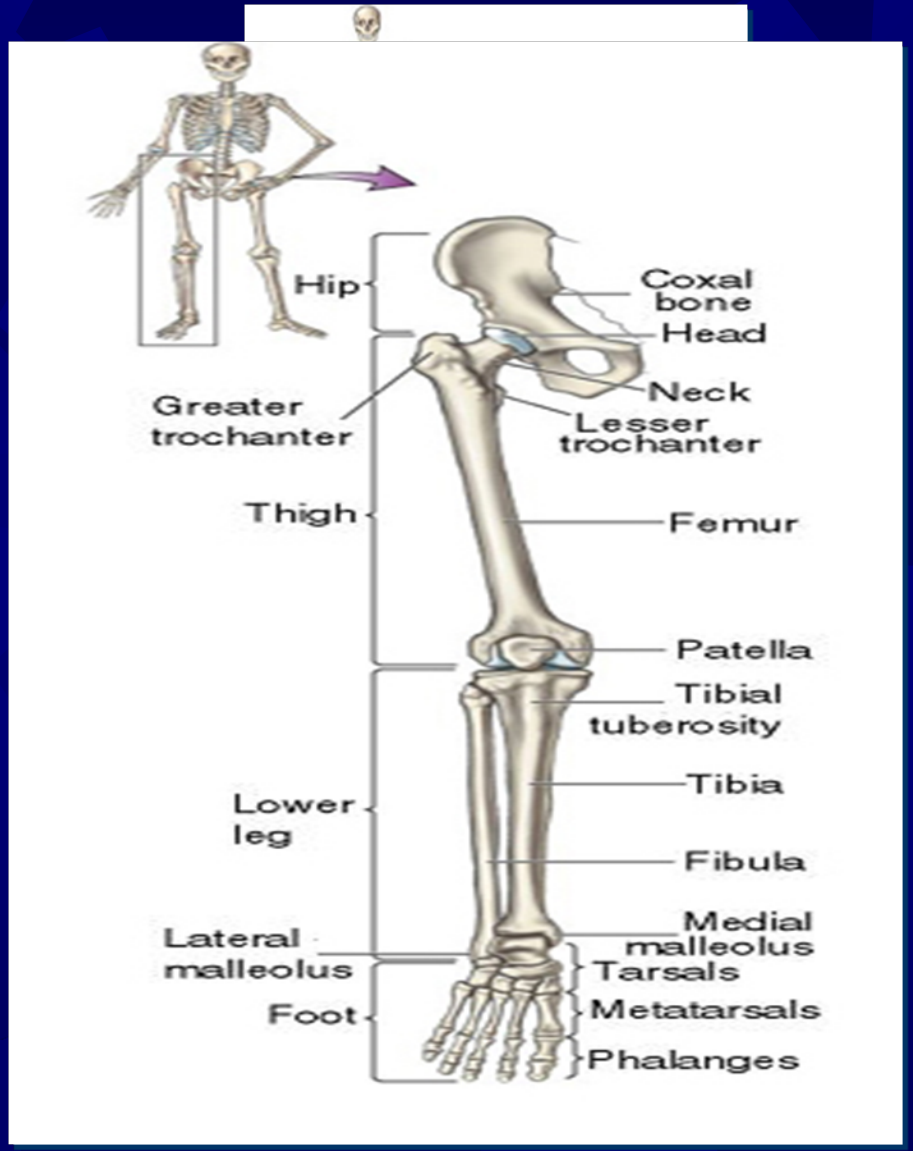
- Patella:
  - AKA kneecap
  - Located within tendon
- Tibia:
  - Shinbone
  - Articulates with femur at knee
  - Weight bearing bone of lower leg
  - Tibial tuberosity is site of attachment muscle & ligament from thigh
  - Distal end has medial malleolus which articulates with the inner ankle bone

Skeletal System

- Fibula:
  - Thinner bone alongside tibia
  - Proximal end articulates with tibia
  - Lower end forms lateral malleolus & articulates with outer ankle bones
- Foot:
  - Ankle—instep—toes

Skeletal System

- Ankle:
  - 7 tarsal bones form the ankle
  - Most proximal tarsal bone is talus which articulates the tibia & fibula
  - Calcaneus (heelbone) bears most weight of body
- Instep:
  - Formed by 5 metatarsal bones
  - Ball of foot is formed from the distal ends of metatarsal
  - Arch is formed from metatarsals, tarsal, tendons & ligaments
- Toes contain 14 phalanges


Hip
Coxal bone
Head
Neck
Greater trochanter
Lesser trochanter
Thigh
Femur
Patella
Tibial tuberosity
Tibia
Lower leg
Fibula
Medial malleolus
Lateral malleolus
Tarsals
Foot
Metatarsals
Phalanges

Skeletal System

- Joints:
  - AKA: Articulations are sites where two bones meet
  - Two functions:
    - Hold bones together
    - Provide flexibilty
- Three groups:

  immovable—slightly movable—freely movable

Skeletal System

- Immovable Joints:
  - Synarthroses
  - Sutures of skull are immovable joints
- Slightly Movable Joints:
  - Amphiarthroses
  - Limited movement
  - Connected by cartilaginous disc
  - Spinal column & symphysis pubis

Skeletal System

- Freely Movable Joints:
  - Diarthroses
  - Much flexibilty & movement
  - Most joints of skeletal system
  - Considered synovial joints
- Synovial Joints include:
  - Articular cartilage: smooth surface within joint
  - Joint capsule: made of fibrous connective tissue covering joint

Skeletal System

- Synovial membrane: lining of the joint that secretes synovial fluid
- Synovial fluid: lubricates bone joints & decreases friction
- Bursae: small sacs of synovial fluid between the joint & tendons that cross the joint. Helps tendon slide as bone moves.
- Supporting ligaments: surround joint helping stabilize the joint & join bones

Skeletal System

- Knee is an example of synovial joint but has added pads of cartilage to absorb shock
- Two crescent shaped pads of cartilage that rest on tibia:
  - Medial meniscus & lateral meniscus
  - Frequently torn or injured by athelets
- Reinforced with supporting ligament called cruciate ligament

Skeletal System

- Types of Freely Movable Joints:
  - Hinge joint:
    - Similar to hinge on door
    - Allows movement in one direction
    - Elbows, knees, fingers
  - Ball-and-socket joint:
    - Formed when ball shaped end of bone fits into cup shaped socket of another bone
    - Moves in many directions & permits wide ROM
    - Shoulders & hips

Skeletal System

- Pivot joints:
  - Small projection of one bone pivots in an arch of another bone
  - Allows only rotation
  - Rotation occurs as atlas swivels or pivots on the axis
  - First & second vertebrae
- Saddle joints:
  - One pair between metacarpal of each thumb & carpal of wrist
  - Allows flex, extend, adduction, abduction & circumduction

Skeletal Systems

- Gliding:
  - Least movable
  - Located between successive vertebrae
  - Limited sliding
- Condyloid:
  - Oval projections
  - Condyle fit into a socket
  - Temporal bone & mandible

Skeletal System

- Joints:
  - Shoulder joint: head of humerus at the glenoid cavity of the scapula
  - Elbow joint: olecranon process of the ulna rest in the olecranon fossa of the humerus
  - Wrist joint: distal end of radius & the carpals of the hand
  - Hip joint: head of the femur to the acetabulum of coxal
  - Knee joint: femur meets with the tibia
  - Ankle joint: the tibia & fibula meet with the tarsals of the foot

Skeletal System

- Diseases & Disorders of the Joints include:
- Arthritis: inflammation of a joint
- Gout: accumulation of uric acid crystals in a joint
- These disease process are discussed later in pathophysiology courses

Skeletal System

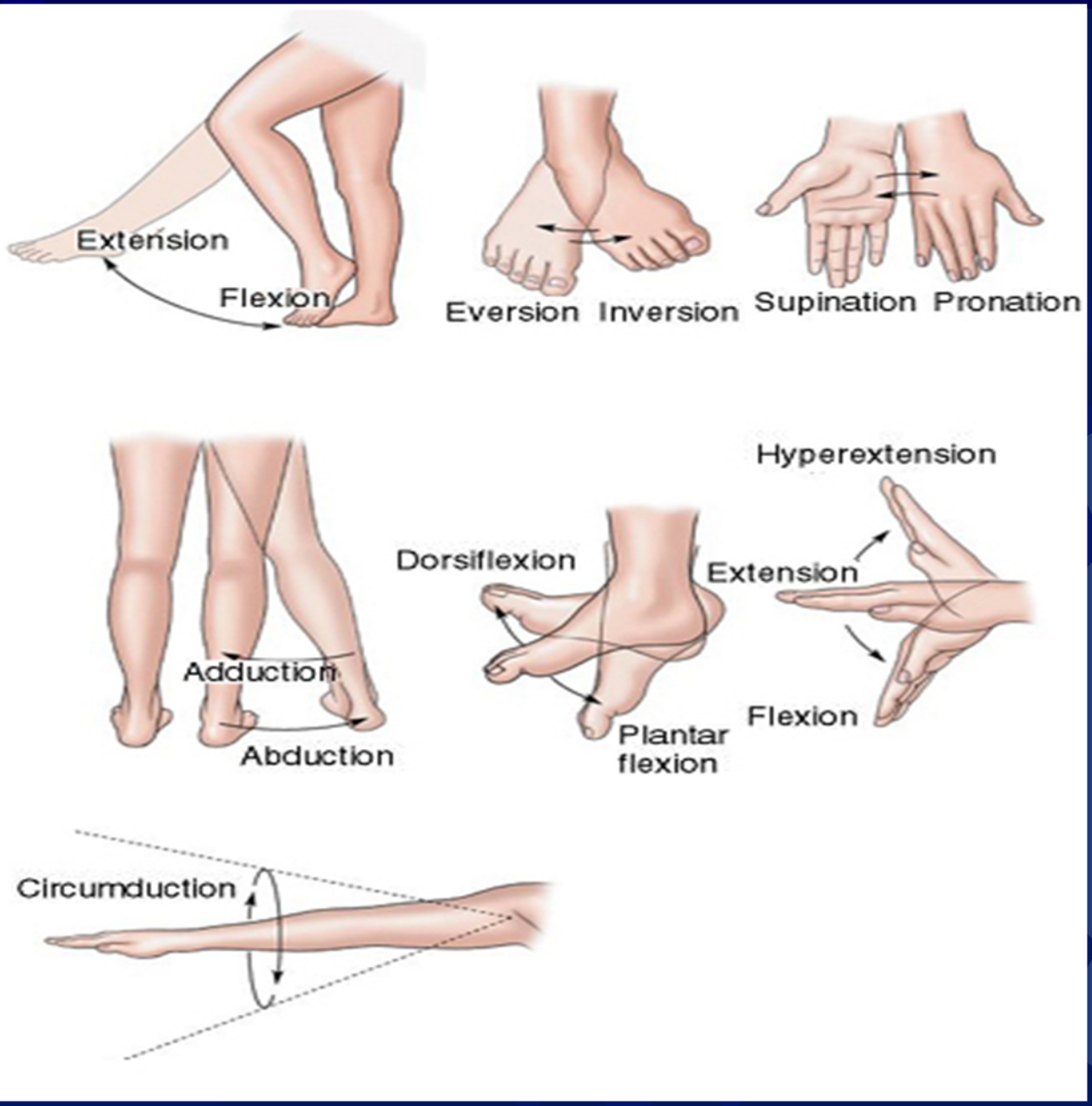
- Types of Joint Movement:
  - Flexion: bending that decreases angle
  - Extension: straightening of joint that increases angle
  - Plantar flexion: bending foot down
  - Dorsiflexion: bending foot up
  - Hyperextension: overextending joint beyond normally straightened position

Skeletal System

- Abduction: movement away from the midline of the body
- Adduction: movement toward the midline of the body
- Inversion: turning the sole of foot inward facing the opposite foot
- Eversion: turning the sole of the foot outward

Skeletal System

- Supination: turning the hand so that the palm faces up
- Pronation: turning the hand so that the palm faces downward
- Circumduction: combination of movements, circular movement


Extension
Flexion
Eversion
Inversion
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Pronation
Adduction
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Dorsiflexion
Plantar flexion
Hyperextension
Extension
Flexion
Circumduction