

Skeletal System

Rita Carey-Nita

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

Function of 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
- **Hematopoiesis** (production of blood cells) occurs in red bone marrow

Shapes of Bones

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

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

Bone Types

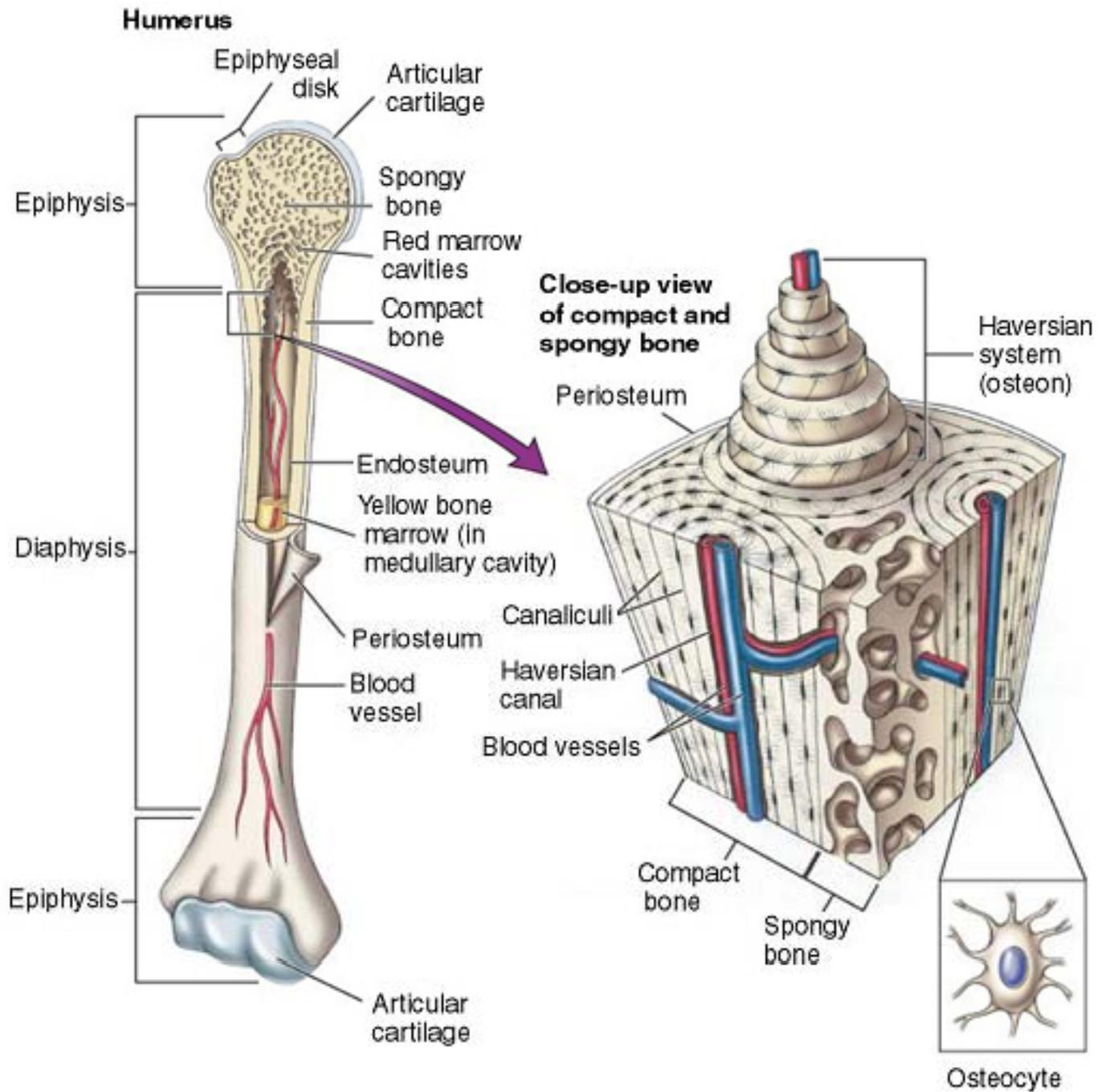
- There are two types of bones:
 - Compact bone
 - Spongy bone

Compact Bones

- Dense hard bone tissue
- Found in the shafts of long bones & outer surface of other bones
- Tightly packed making them 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
- Cylinder appearance running parallel to each other
- Covered with periosteum

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



Anatomy of Bones

- 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

Anatomy of Bones

- 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

Anatomy of Bones

- 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

Ossification of Bones

- 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.

Bone Growth

- 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

Bone Growth

- 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
 - Strong but not heavy

Bone Surface

- May be irregular and bumpy
- Contain ridges, projections, depressions & grooves called bone markings
- Have projections that serve as points of attachment for muscles, tendons, & ligaments
- Contain grooves & depressions which are areas blood vessels & nerves pass
- Depressions & projections help to form joints

Bone Markings

- Projections/Processes:
 - Condyle: large rounded knob that articulates with another bone
 - Epicondyle: an enlargement near or above a condyle
 - Head: enlarged, rounded end of bone
 - Facet: small flattened surface
 - Crest: a ridge on a bone

Bone Markings

- Projections/Processes:
 - Process: a prominent projection on a bone
 - Spine: a sharp projection
 - Tubercule/ Tuberosity: a knoblike projection
 - Trochanter: a large tubercle found only on femur

Bone Markings

- Depressions/Openings:
 - Foramen: an opening through a bone; serves as passageway
 - Fossa: deep depression or groove
 - Meatus: a tunnel or tubelike passage
 - Sinus: a cavity or hollow space

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

Division of 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

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

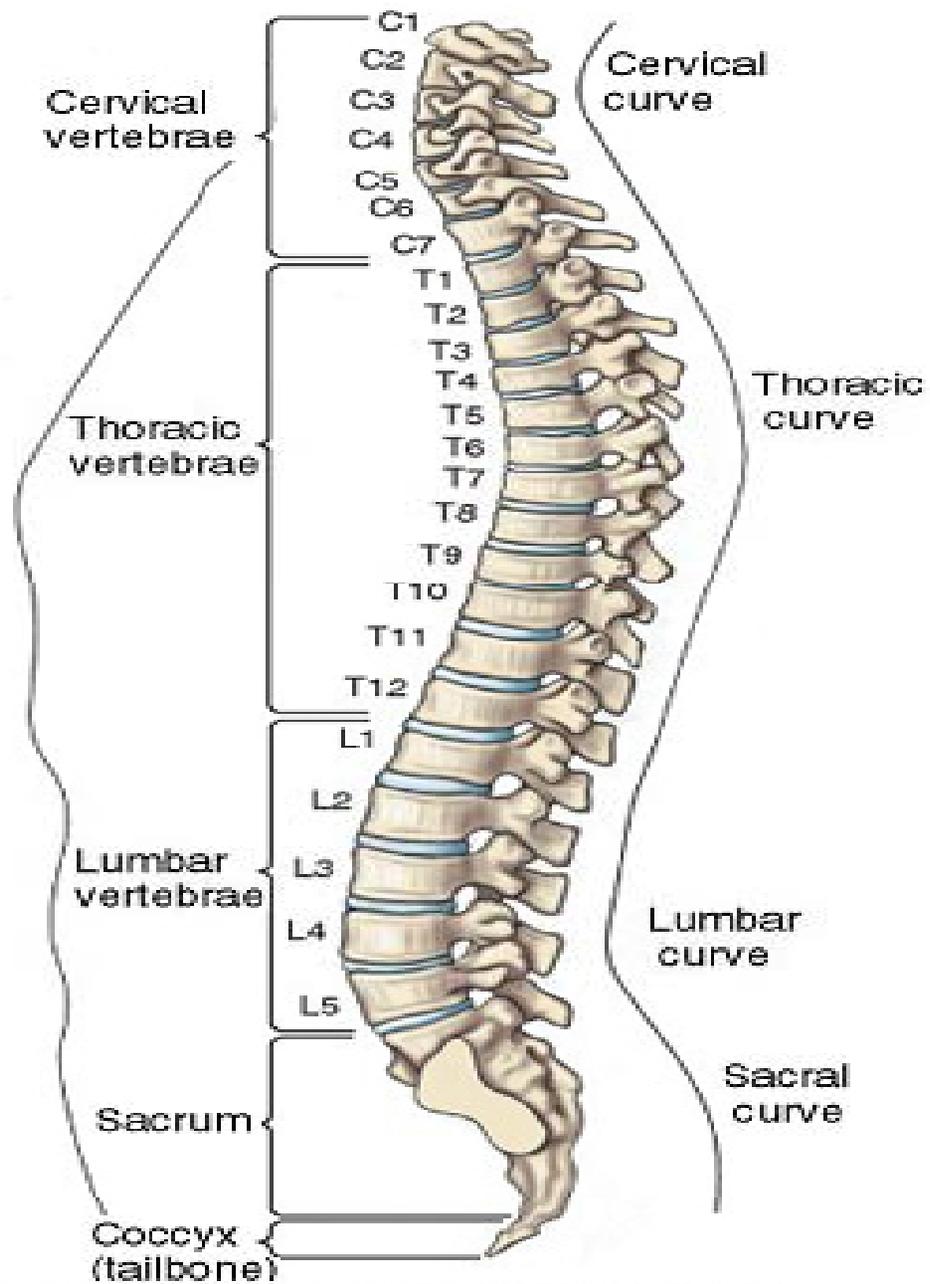
Axial Skeleton

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

Axial Skeleton

- 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



Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- Anatomy of an individual vertebra:
 - Vertebral foramen
 - Spinous process
 - Lamina
 - Body

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

- 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

Axial Skeleton

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

Axial Skeleton

- 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.

Appendicular Skeleton

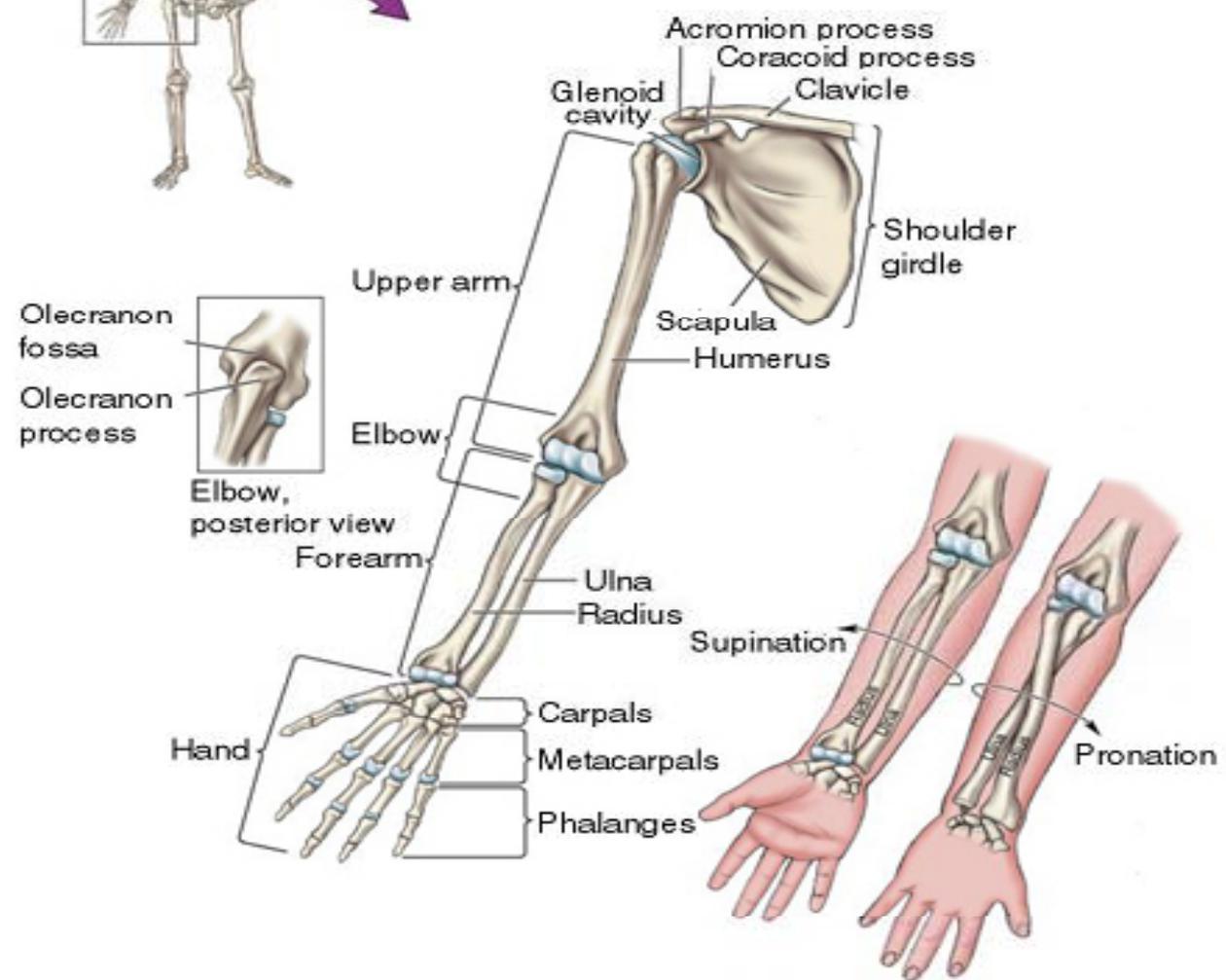
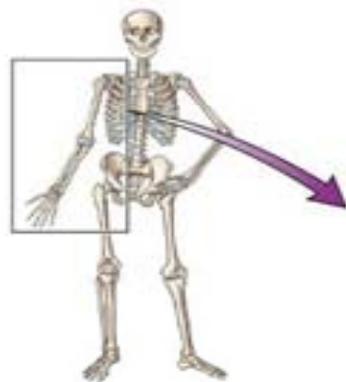
- Appendicular Skeleton: composed of the bones of shoulder girdle, upper limbs, pelvic girdle & lower limbs
- Shoulder girdle:
 - AKA pectoral girdle
 - Supports arms & is place of attachment of muscles
 - Includes clavicle & scapula
 - Flexible allowing varies movements

Appendicular Skeleton

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

Appendicular Skeleton

- 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



Appendicular Skeleton

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

Appendicular Skeleton

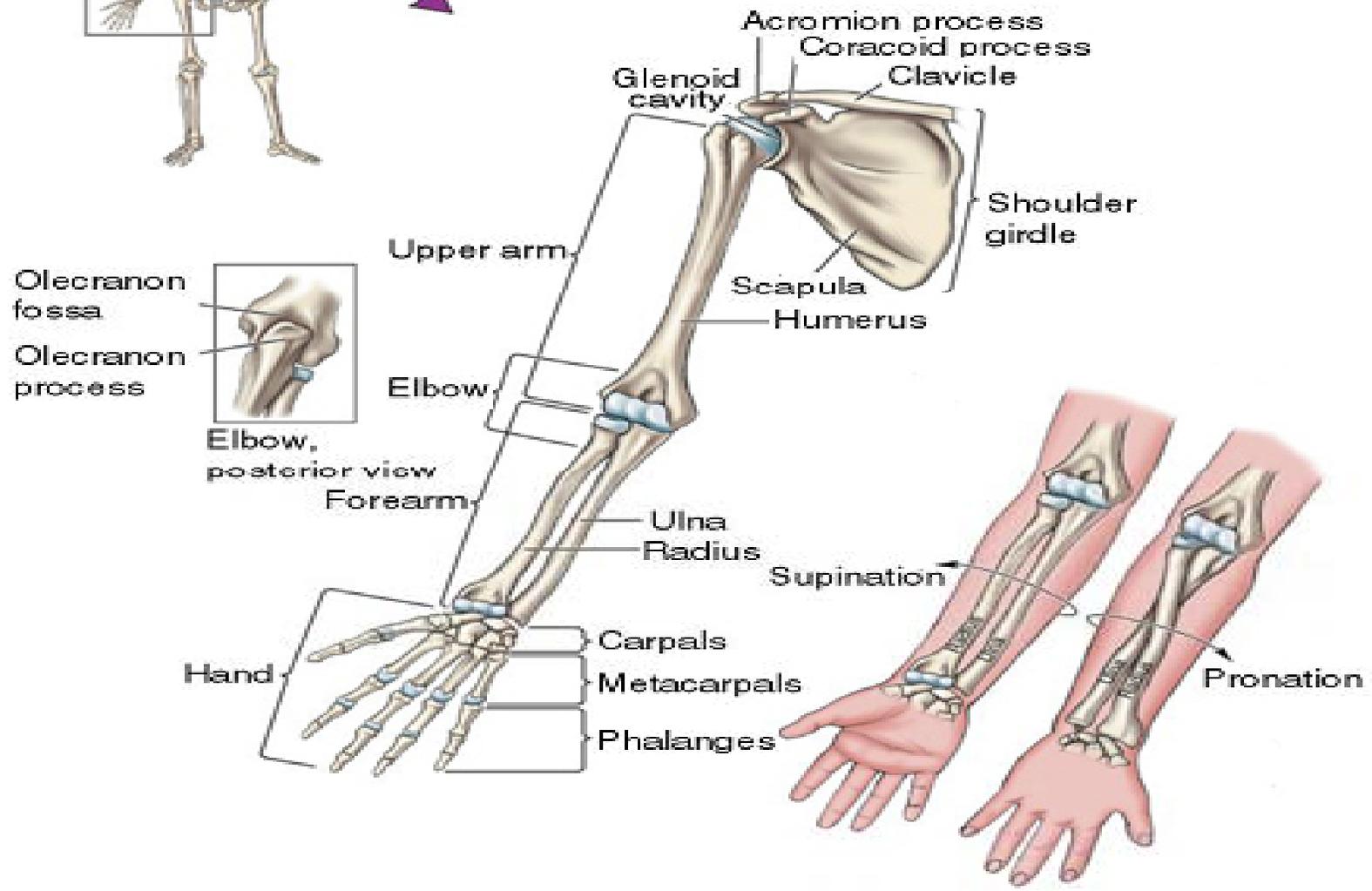
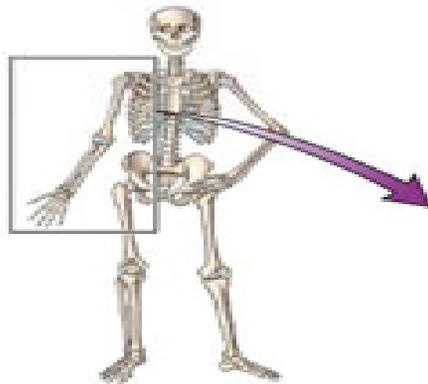
- Radius
 - One of two bones of the forearm
 - Located on the thumbside when palm faces forward
 - Head of radius articulates with both the humerus & ulna
 - Radial tuberosity at the proximal end is site of attachment for the muscle that allows the forearm to bend at the elbow

Appendicular Skeleton

- 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

Appendicular Skeleton

- 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



Appendicular Skeleton

- 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

Appendicular Skeleton

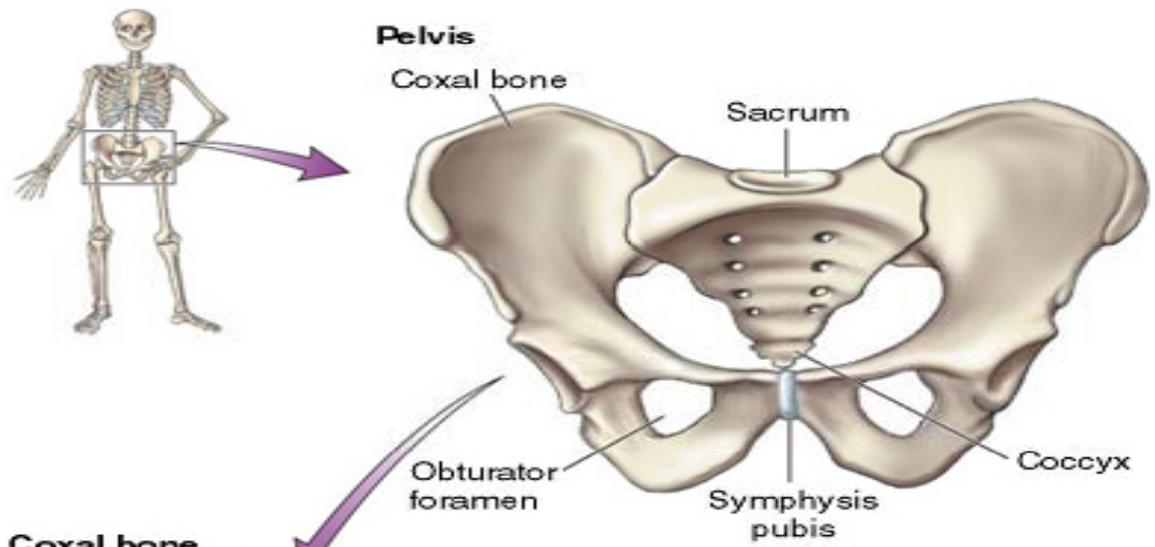
- Coxal Bone: AKA os coxae or hip bone
 - Three parts:
 - ilium—ischium--pubis
 - Ilium:
 - largest part of coxal
 - flared upper bone felt at hip
 - outer edge is iliac crest
 - connects in the back with the sacrum to form sacroiliac joint

Appendicular Skeleton

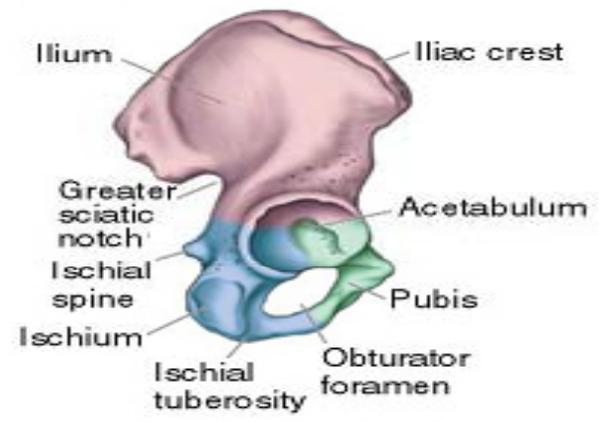
- Ischium:
 - Inferior part of coxal bone
 - Three parts:
 - ischial tuberosity: part of coxal on which we sit
 - ischial spine: projects into pelvic cavity narrowing pelvis
 - greater sciatic notch: site where blood vessels & sciatic nerves pass from pelvic cavity into the posterior thigh

Appendicular Skeleton

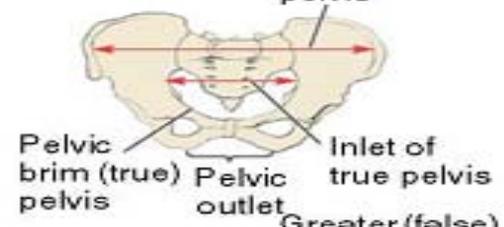
- Pubis:
 - Most anterior portion of coxal
 - Two bones join in front as symphysis pubis & are separated by a disc of cartilage
 - Obturator foramen large hole formed when pubic bone fuses with a part of the ischium allowing blood vessels & nerves to pass to anterior thigh
 - False pelvis: area surrounded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



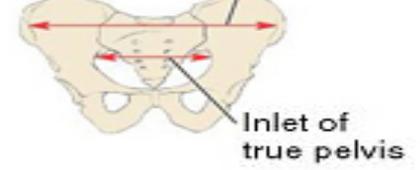
Coxal bone, right lateral view



Female pelvis



Male pelvis



Appendicular Skeleton

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

Appendicular Skeleton

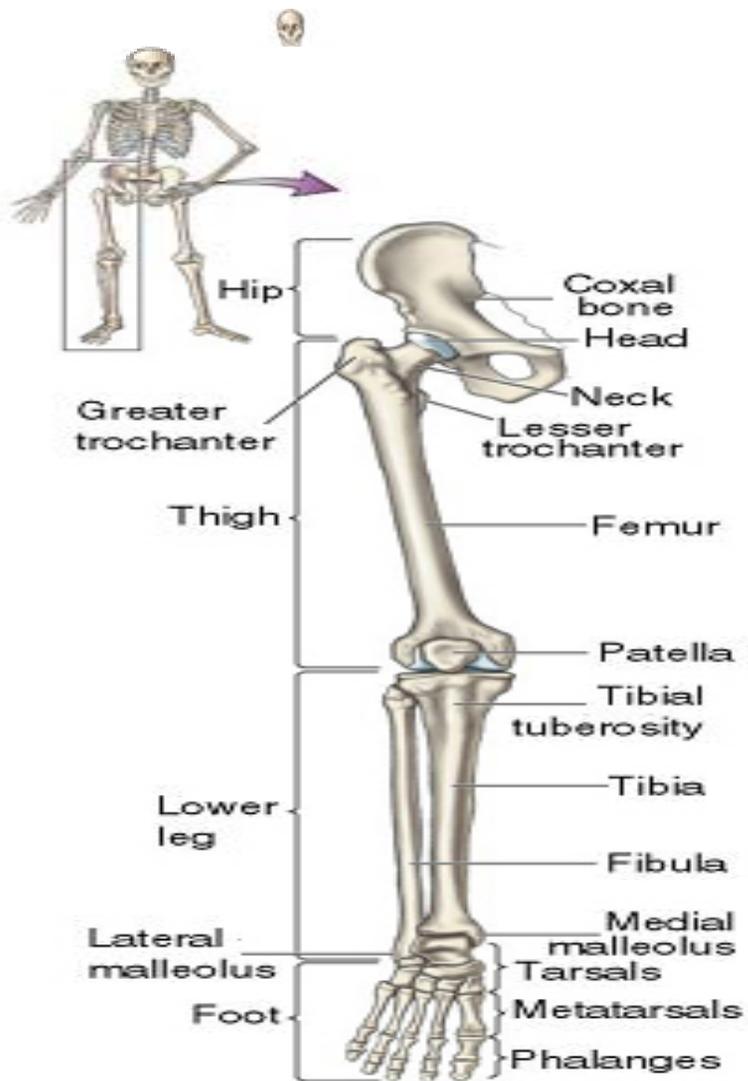
- Patella:
 - AKA kneecap
 - Located within tendon
- Tibia:
 - Shinbone
 - Articulates with femur at knee
 - Weight bearing bone of lower leg
 - Tibial tuberosity is site of attachment muscle & ligament from thigh
 - Distal end has medial malleolus which articulates with the inner ankle bone

Appendicular Skeleton

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

Appendicular Skeleton

- 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



Joints

- Joints:
 - AKA: Articulations are sites where two bones meet
 - Two functions:
 - Hold bones together
 - Provide flexibility
- Three groups:
 - immovable—slightly movable—freely movable

Joints

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

Synovial Joints

- Freely Movable Joints:
 - Diarthroses
 - Much flexibility & 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

Synovial Joints

- 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

Knee Joint

- 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 athletes
- Reinforced with supporting ligament called cruciate ligament

Joints

- 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

Joints

- 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

Joints

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

Joints

- 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

Diseases & Disorders

- 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

Joint Movement

- 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

Joint Movement

- 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

Joint Movement

- 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

