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; vetebrae & 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 Tissue

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

Compact Bone Tissue

- Comprised of dense hard bone tissue
- Found in the shaft of long bones & outer surface of all 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 Bone Tissue

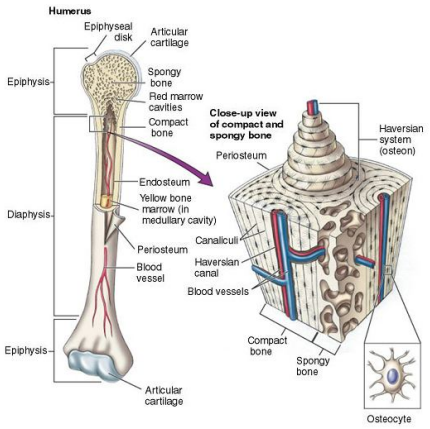
- AKA cancellous bone
- Less dense
- Located at the end of long bones & in the center of other bones
- Do not contain haversian system
- Arranged in plates called **Trabeculae**
- Creates a swiss cheese appearance
- Spaces in bones decrease weight of bone & contain red bone marrow which is the site of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

Bone Tissue of Bone Shapes

- Long Bones:
  - Compact bone tissue in center region & spongy bone tissue at ends
- Short Bones:
  - Spongy bone tissue with outer thin layer of compact bone

Bone Tissue of Bone Shapes

- Flat Bones:
  - Thin bone composed of two parallel plates of compact bone tissue enclosing a layer of spongy bone tissue
- Irregular bones:
  - vary in the amount of compact & spongy bone tissue



Anatomy of Long 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 Long 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 Long 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

Bone Growth

- 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 osteoblast activity
  - Once the epiphyseal disc becomes ossified bone growth ceases
  - Growth hormone & sex hormones influence 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 fontanels & unfused sutures. Discussed in pediatrics

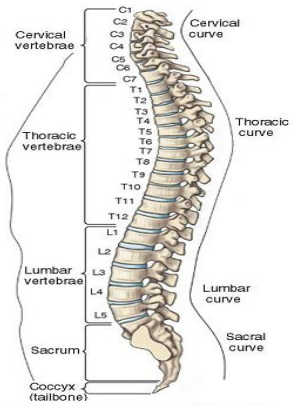
Axial Skeleton

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

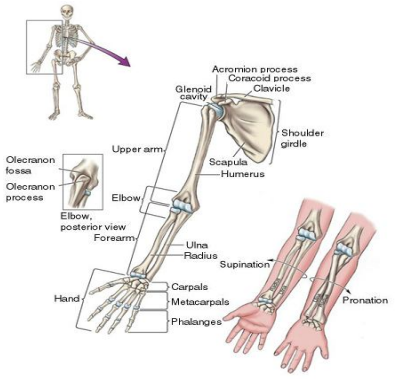
- Appendicular Skeleton: composed of the bones of shoulder girdle, upper limbs, pelvic girdle & lower limbs
- Shoulder girdle:
  - AKA pectoral girdle
  - Supports arms & is place of attachment of muscles
  - Includes clavicle & scapula
  - Flexible allowing varies movements

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

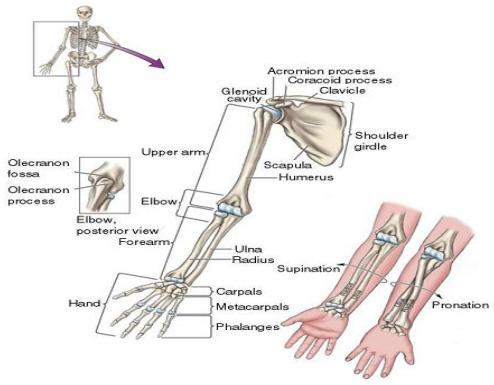
- Radius
  - One of two bones of the forearm
  - Located on the thumbside when palm faces forward
  - Head of radius articulates with both the humerus & ulna
  - Radial tuberosity at the proximal end is site of attachment for the muscle that allows the forearm to bend at the elbow

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

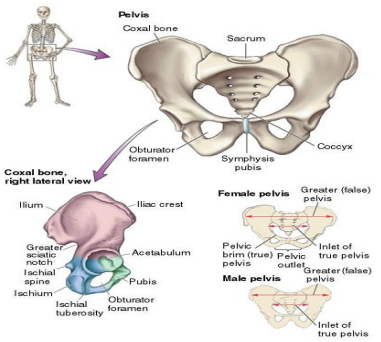
- Coxal Bone: AKA os coxae or hip bone
  - Three parts:
    - ilium—ischium--pubis
  - Ilium:
    - largest part of coxal
    - flared upper bone felt at hip
    - outer edge is iliac crest
    - connects in the back with the sacrum to form sacroiliac joint

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



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

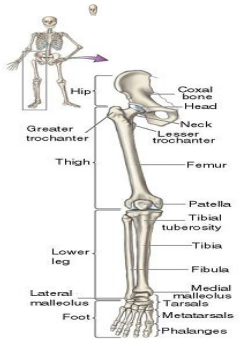
- Patella:
  - AKA kneecap
  - Located within tendon
- Tibia:
  - Shinbone
  - Articulates with femur at knee
  - Weight bearing bone of lower leg
  - Tibial tuberosity is site of attachment muscle & ligament from thigh
  - Distal end has medial malleolus which articulates with the inner ankle bone

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 flexibilty
- 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 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

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 athelets
- 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
- Condyloid:
  - Oval projections
  - Condyle fit into a socket
  - Temporal bone & mandible

Joints

- **Glenohumeral joint**: shoulder joint; head of humerus at the glenoid cavity of the scapula
- **Humeroulnar joint:** Elbow joint; olecranon process of the ulna rest in the olecranon fossa of the humerus
- **Radiocarpal joint:** Wrist joint; distal end of radius & the carpals of the hand
- **Coxal** joint: Hip joint; head of the femur to the acetabulum of coxal
- **Tibiofemoral**: Knee joint; femur meets with the tibia

Joints

- **Proximal tibiiofibular:** tibia meets with the fibula near knee joint
- **Distal tibiofibular**: Ankle joint; the tibia & fibula meet with the tarsals of the foot
- **Humeroulnar:** Elbow joint; the humerus & ulna meet
- **Temporalmandibular:** temporal bone meet the mandible
- **Sternoclavicular :** sternum meets with clavicle
- **Sternomanibrial:** body of sternum meets with the manibrium of sternum

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