6.1 Primary Functions of Skeleton

Components of Skeletal System:
- Include all bones in the body
- Cartilage, joints, ligaments, connective tissue (stabilize or connect bone)

Functions:
1. Support - structural support for the entire body.
Soft tissue attachment and organs.
2. Storage - *Yellow bone marrow* stores lipids for energy reserves and mineral reserves for calcium and phosphorus ions held in calcium salts found in bone.
3. Blood Cell Production - red cells, white cells and other blood products are produced in the *red bone marrow*.
4. Protection - Protects tissues and soft organs by surrounding them with the skeleton. (ex. ribs protect heart/lungs, skull protects brain)
5. Leverage - Bones function as levers to move the body with directional force.

6.2 Features of a Long Bone

Features:
-The **diaphysis** is the central shaft that surrounds the **marrow cavity** (or *medullary cavity*) which is the center filled with **bone marrow**
- The **epiphysis** covered with articular cartilage. Articulate with an adjacent bone at a joint.
- **Spongy Bone** Network of bony rods or struts separated by space. Only located in the *Epiphysis* (The interlaced rods are known as trabecular). Red Bone marrow fills the holes between trabeculae. Red marrow is in this section.
- **Compact** Densely packed. Forms wall of the diaphysis, is composed of osteons.
-**Marrow Cavity** Soft fatty tissue. stores lipids and produces blood cell products. Yellow marrow and red marrow are located in the marrow cavity and Red marrow is found here.

6.2 Features of a Long Bone (cont)

Coverings:
- Outer surface is covered by **periosteum**
> Inner cellular layer
> Outer firbous layer - osolates bone from the surrounding tissue and forms attachments with fibers of *tendons* and *ligaments*
- Inner surfaces and spongy bone of marrow cavity covered by **endosteum**
> functions during bone growth and repair

6.3 Bone Formation

- Embryonic development of bone:
> begins at week six of cartilaginous formation and replaced with bone (process called **ossification**)
- Two types:
1. **Intramembranous Ossification**
2. **Endochondral Ossification**

Calcification occurs during ossification and can also occur in other tissues besides bone.
Osteogenesis: (*ossification* - bone tissue formation)
Stages:
>Bone formation - begins in 2nd month of development
> Postnatal bone growth - until early adulthood
> Bone remodeling and repair - lifelong

pg 150-151 classify bone fracture

Open vs. Closed Open projects through the skin. More risk of infection
Closed internal. Only seen in x-rays
Transverse break at right angle. Fracture of ulna- break a bone shaft across its long axis
Displaced vs. non-displaced
Displace-produce new bone and abnormal bone arrangements-
snaps in 2 or more places,

pg 150-151 classify bone fracture (cont)

Non-displace- retain normal alignments of the bone fragments- breaks all the way through, but does not move
*Compression** vertebra under extreme pressure. Often caused by osteoporosis
Spiral twisting stresses that spreads along the bone
Epiphyseal along the growth plate
Comminutedshattered the affected into a multitude of bony fragments
Greenstickonly 1 side of the shaft is broken. Normally happens in children

7.1 Distinguish the functions of muscle tissue

Movement- pull on tendons that move the bones.
Posture- continuous muscle contraction maintains body posture. Helps one sit up without falling over
Support – Abdominal wall and pelvic cavity floor composed of skeletal muscle. Support the weight of our visceral organs and shield our internal tissues from injury
Protection encircle opening of digestive and urinary tracts. Volunteering control over swallowing, defecating and urinating
Thermoregulation- muscles contractions uses energy which generate heat

7.2 anatomical organization of skeletal muscle

Connective tissues- *Epimysium* layer of collagen fiber that covers the entire muscle, separates the muscle from the surrounding tissues and organs. *Perimysium* divides the muscle into compartments aka fascicles. Contain bld vessel and nerve supply fascicles.*Endomysium* covers each muscle fibers and ties fibers together. Contains capillaries and nerve fibers.
-Collagen fibers from all 3 layers come together to form
Tendon- bundle of fibers. Attaches muscle to bones

Aponeurosis Broad sheet of fibers. Connects muscles to each other.
Organ, fascicle, fibers
Fascicles or bundles of muscles fibers
Fibers each cell in the skeletal muscle tissue is a single fiber
A-band, I-band, H-band, Z-line, M-line
Z- marks the boundary at the end of each sarcomere (basic factional unit of muscle fiber-array of thick and thin filaments) . Strands of protein connect the z lines to the thick filament to maintain alignment
M- located in the center of each sarcomere. Made of protein that connect central portions of the thick filaments
A- darker region running length of filaments. Includes zone of overlap containing both thin and thick filaments
I- light region containing the thin filaments. Includes the z line
H- when fibers is relaxed only contains thick filaments. Includes m line and light regions on either side
Thick vs. thin filament
Actin molecules are found in thin filaments. Extend inward towards the center of the sarcomere, they overlap thick
Myosis molecules are found in thick filaments

7.6 ways muscles obtain energy

-**Anaerobic ATP production**(Does not require Oxygen)- Breaks glucose down to pyruvate. Occurs in the cytoplasm of the cell. Can still provide ATP when mitochondria are limited by low oxygen levels. Yields 2 ATP per glucose. This is where you get lactic acid in your muscles.

7.6 ways muscles obtain energy (cont)

_ **Aerobic ATP Production**(Needs Oxygen)- 95% of resting muscle cells use this type of ATP. This occurs in the Mitochondria. Breaks down organic substrates through a series of chemical reactions. The end product of breaking down organic substances are ATP, water and carbon dioxide. (you get 15 ATP produced per pyruvate to enter the citric acid cycle.)

Muscle Contraction

1. Nervous System Signal:
> Sends an action potential down an axon of a neuron (nerve cell).
> At axons end or terminal switch to a chemical messenger.
> Acetylcholine Release ---> crosses synaptic cleft.
2. Muscle Release Calcium:
> motor end fo the muscle cell has received the acetylcholine signal.
> Muscle cell sends an action potential down muscle cell.
> This shock releases calcium from the sacroplasmic reticulum (sarcolemma, t tubules, transverse tubules)
**3. Contraction (Sliding Filament Theory):
> Calcium Binds troponin
>Troponin changes shape and moves tropomyosine out of the way to open the actin myosine (active) binding sites
> myosine heads do a powerstroke mostion by grabbing onto the exposed actin sites and pulling.
4. Relase:
>ATP gets hydrolized into a ADP + P
> the hydrolization releases energy
> calcium is stored back into the sacroplasmic reticulum

Muscle Contraction (cont)

> Acetylcholine is broken down with acetylcholinestrase (if this is turned off you become paralyzed).

7.5 Isotonic and Isometric

-**Isotonic Contraction**- Tension rises and the skeletal muscle's length changes. Tension remains constant until relaxing **Example** Push-ups. Movement/shortening of the muscle.
-**Isometric**- Muscle Length stats the same. Tension produced does not exceed the load. There is no movement required. **Example** holding yourself in a plank or pushing against a wall.
-**Incomplete Tetanus** Producing almost peak tension during rapid cycles of contraction and relaxation. **Example** Charlie horse.
-**Summation**- Addition of one muscle twitch to another. Causes a more powerful contraction. Causes a second stimulus to arrive before the relaxation phase has ended. **Example** working out.
-**Complete Tetanus**- Occurs when rate of stimulation increased until relaxation phase is eliminated. Produces maximum tension and continuous contraction. Results in high calcium ion concentration in the cytosol. **Example** Fight or Flight response adrenaline rush.
-**Small Motor unit**- sustained muscular contraction. Lower threshold for activation. **Example** upright posture
-**Large Motor unit**- Generate more force, but have sparce mitochondria there for easily fatigued. **Example** Jumping.

6.2 Bone Charateristics & Classifications

Characteristics:
-Supports connective tissue containing cells in a matrix
-Cells are called **osteocytes**

6.2 Bone Charateristics & Classifications (cont)

- The matrix contains: **Calcium Salts** in the form of calcium phosphate (which makes up 2/3 the weight of bone) & **Extracellular Protein Fibers** (about 1/3 the weight of the bone).

Bone Categories:

1. Long Bone - Longer than they are wide (ex. femur and humerus)

2. Short Bone - wide as they are short (ex. wrist and ankle)

3. Flat Bones - Thin, broad, and light (ex. parietal bones in skull, ribs and shoulder blades)

4. Irregular Bones - Don't fit in any other category (ex. vertebrae, sacrum)

Bone Characteristics

5. Compact Bones - Densely packed (ex. form the diaphysis)

6. Spongy Bone - Projection of bones separated by space (ex. on all bones)

6.2 Types of Bone Cells

Osteoblasts	Osteocytes	Osteoclasts
- Produce new bone through a process called **ossification**	- Most abundant cells in bone.	- secrete acid and enzymes that dissolve the matrix
	mature cells that maintain bone structure by recycling calcium salts	- process releases minerals through *osteolysis* or *resorption*

6.3 Intramembanous Ossification

Membrane bone develops from fibrous membrane (forms flat bone like clavicles, cranial bones, and mandible)

6.3 Intramembanous Ossification (cont)

-Occurs during fetal development where bone develops within sheets of connective tissue.

- Starts in a **ossification center**
- Osteoblasts differentiate from connective tissue stem cells and form new calcified bone matrix.
- Bone matrix formation extends outward
- Osteoblasts surrounded by the matrix change into osteocytes
- Blood vessels grow into area and are trapped within the developing bone.
- Bone remodeling produces osteons of compact bone

>Results are flat bones like the cranial bone and clavicles.

6.4 Bone remodeling and associated hormones

Bone resorption and deposit- Osteoclast is the erode the bone from the inside that gets absorbed by the body. Osteoblast is deposit from the outer bone-injury

Osteoclasts and Osteoblast- clast most abundant cell in body. Maintain bone structure by recycling calcium salts. Continually remove matrix. BLAST- continually build matrix

Vitamin D- Released by the skin. Increases blood calcium levels. It allows the intestines to absorb calcium. Without Vitamin D we can not absorb calcium

Calcitrol- Released by the kidneys. increases calcium levels in the blood. Stimulates osteoclasts. (Hollowing out the bone)

Parathyroid Hormone- Parathyroid Increased blood calcium. Stimulate Osteoclasts.

Calcitonin-released by the thyroid. Lowers calcium levels in the body fluids. Released by osteoblasts. (Bricks building a wall.)

6.5 Homeostatic imbalances of Integumentary system

-**Osteopenia**- Bones become thinner and more weaker as a normal part of aging. (Everyone becomes slightly ostepenic as we age). People start to lose the mass of their bones between the ages of 30 and 40. Once it begins women lose roughly 8% of their bone mass while men lose about 3% per decade. "Not all parts of the skeleton are equally affected"

-**Osteoporosis**- That reduces bone mass so much that normal function is compromised. The difference between the normal oseopenia of aging and osteoporosis is a matter of degree "Sex Hormones". Over the age of 45, an estimated 29% of women and 18% of men have osteoporosis. Women get it early because of menopause. Men get it at a much later age because they still produce sex hormones

-**Osteomalacia**- Softening of bones dues to demineraliztion. (low levels of calcium, phosphate or vitamin D. Could also be increase in calcium resorption out of bone.) This would just be a Calcium deficiency.

-**Arthritis**- Damage to synovial lining of joints. It causes grinding and further damage during articulation. Cortisone shots can decrease the inflammation.

-**Rheumatoid Arthritis**- It is an auto-immune disorder. This is where your immune system improperly attacks the body's own tissue. It is treatable with immunosuppressants, in addition to cortlicosteriods.

-**Rickets**- Disease where lack of calcium,phosphate or vitamin D prevents proper bone **development**, leaving bones weak and deformed. Usually in children.

6.10 Structures and functions of synovial joints

Plane Joints-	Plane joints have flattened or slightly curved surfaces that slide across on another. The amount of movement in this joint is very slight. Ex: The hip bone and the joints at the end of the clavicles.
Hinge Joint-	Hinge joint permits the angular motion in a single plane. Ex: Joints at the elbow, knee, and ankle.
Condylar Joint-	Condylar joint has an oval articular face that nestles within a depression on the opposing surface. Ex: The joints between the phalanges of the fingers within the metacarpal bones.
Saddle Joint-	Saddle joint have articular faces that fit together like a rider in a saddle. Ex: The carpometacarpal joint at the base of the thumb.
Pivot Joint-	Pivot joint only permits rotation. Ex: The joint between the atlas and axis.

6.10 Structures and functions of synovial joints (cont)

Ball-and-s-ocket Joint-	Ball-and-socket joint has a round head of one bone rests within a cup-shaped depression in another. Ex: The joints at the shoulder and hips.

Synovial joints are free movement joints. The structure of these joints is complex and is bound by a joint capsule and they contain synovial fluid. Since the structure of these joints allow them to move more freely there are many motions these joints can make such as plane (gliding), hinge, condylar, saddle, pivot, or ball-and-socket.

6.9 Movements allowed by joints

-**Synarthrosis**- Immovable joints. Joints are fused together. "Syn-" Together, "Art-hr-" Joint, "-osis" Condition.
Classification of Synarthrosis joints
Suture- Connects skull bones with dense connective tissue
Gomphosis- A Ligament binding each tooth in the socket.
Synchondrosis- A hyaline carilaginous connection between the first pair of ribs anad the sternum (all other rib-sternum joins are synovial)
-**Amphiarthroses**- Limited Movement. condition where a joint is a both movable and immovable. (A joint that is slightly movable) "Amphi-" both, "Arthr-" Joint, "-os-is" Condition.
Classification of Amphiarthroses joints
Syndesmosis- Fibrous joint connected by a ligament, attaches tibia to fibula and radius to ulna.
Symphysis- bones separated by fibrocart-ilage pad, between the pubic areas of coxal bones as well as intervertebral discs.

6.9 Movements allowed by joints (cont)

-**Diarthroses (Synovial Joints)**- Freely movable joints. Joints can move two ways (back and forth). These are movable joints. Most common joints. Covered in Synovial Fluid.
-**Flexion**- The movement in the anterior--posterior or sagittal. plane that decreases the angle between articulating bones.
-**Extension**- Occurs in the same plane as flexion, but it increeases the angle between articulating bones.
-**Abduction**-Movement *away* from the from the body in the frontal plane. **Example** swinging the upper lib to the side is abduction of the limb.
-**Adduction**- Moving the swinging body part back to the anatomical position. **Example** Throwing a ball and bringing your arm back to your side.
-**Circumduction**- Moving your limb in a 360 degree circle. **Example** drawing a circle with your leg or arm.
- **Rotation**- involes turing around the longit-udinal axis of the body or limb. **Example** turning your head left and right.
-**Pronation**- Moving your palm from facing the front to facing the back.
-**Supination**- Moves palm from facing the back to facing the front.
Example you use pronation and supination when you turn a doorknob.
-**Inversion**- Twisting motion of the foot that turns the sole inward, elevating the medial edge of the sole.
-**Eversion**- Twisting motion of the foot that turn the sole outward, lowering the medial edge of the sole.
-**Plantar flexion**- Extension at the ankle. **Example** Pointing the foot downward.
-**Dorsifelxion**- *flexing* of the foot. **Example** point the toes up to your face.

6.2 Structure & Function of Compact/Spongy Bone

Compact (*Dense Bone*)	**Spongy** (*Cancellous Bone*)
Structure- covers all bones surface except the articular surface or joint capsules.	**Sturcture** - No osteons (osteons - contain the cell matrix), also lighter than compact bone which reduces muscle effort to move bone. Interlacing network of bony rods (**trabeculae**) seperated by spaces. Contain osteocytes, lacunae, and canaluculi. Also has red bone marrow between trabeculae.
Function - can tolerate a lot of stress due to being more dense and solid. Tolerates more on the ends vs. the center. Forms the wall of the diaphysis	**Function** - found in the epiphysis where stress is handled by the joints. Lines the marrow cavity.

6.2 Structure & Function of Compact/Spongy Bone

Osteons:
- Unit that makes up compact bone (*Haversian System*)
- **Lamillae** (*Haversian Canal*) hollow tubes of the bone matrix ,which are calcified, are placed outside but next to each other to form rings similar to those of a trees growth rings.
- **Lacuna** are holes between the lamillae
- **Osteocytes**(*bone cells*) are the red blood cells located in the lacuna

6.2 Structure & Function of Compact/Spongy Bone (cont)

- **Perforating Canals** are the pathways for blood to be linked to other vessels in the periosteum and marrow cavity.
- **Canalculi** are hair like fiber channels connecting lacuna to each other and the central canal blood vessels for nutrient/-waste exhange. The contain cytoplasmic extensions of the osteocytes and radiate through the matrix.
- **Trabeculae** are rods formed by the lamellae that create the support network of bones.

6.3 Endochondrial Ossification

Endochondrial Ossification - process of formation for most bones, begins with hyaline cartilage models, and completed in five steps.

Step 1: *Chondrocytes enlarge and surrounding matrix begins to calcify.* This is because chondrocytes are cut off from nutrients and begin to die whichs slows diffusion.

Step 2: - *Bone formation starts at the shaft surface.* Blood vessels grow around edges, invade the perichondrium where perichondrium cells differentiate into osteoblasts and then new osteoblasts produce bone matrix.

Step 3: *blood vessels invade inner region of cartilage.* Migrating fibroblasts differentiate into osteoblasts, new osteoblasts form spongy bone at primary ossification center, bone then develops toward each end filling the shaft with spongy bone.

Step 4: *Osetoclasts begin to break down spongy bone in center of bone.* To form the marrow cavity **epiphyseal catilages** or **epiphyseal plates** on the ends of bone enlarge which increase length of bone.

6.3 Endochondrial Ossification (cont)

Step 5: *centers of the epiphysis begin to calcify.* Secondary ossification centers form as blood vessels and osetoblasts enter, epiphysis fill with spongy bone, bone grows in length from the epiphyseal cartialges forming **articular cartilage**, bone of shaft and epihysis seperated by epiphyseal cartilage.

6.9 Classify Major Categories of Joints (FIX)

Three major types of joints:

Fibrous:

> usually connected by dense connective tissue and this connective tissue is rich in collagen fibers.

> immovable and typically interlocks with irregular edges.

> divided into three subcategories called suture, syndesmoses and gomphosis.

- **Suture** - Fibrous connection plus interlocked surfaces. (Between the bones of the skull)

-**Synchrondrosis** - Inter postion of cartilage bridge or place (between first of ribs and the sternum).

-**Gomphosis**- found at the articulation between the sockets of the maxilla and the teeth. This fibrous tissue connects the socket and tooth with the periodontal ligament.

Cartilagenous:

> connected fibrocartilage or hyaline cartilage. This type of fibrous joint allows more movement but still less than the synovial joint.

- **Primary** - example of the primary or synchondroses joint is a epiphysial growth platers.
- **Secondary** - an example of the secondary or symphyses is intervertebral discs and pubic symphysis.

Synovial:

> the most common of joints and allows the most movement

> This type has a synovial cavity and is connected by dense irregular connective tissue that forms an articular capsule surrounding the bones articulating surfaces.
> connects bones with a fibrous joints capsule that is continuous with the periosteum. The joint capsule constitutes the boundary of the synovial cavity and surrounds the bones articulating surface. These cavities are filled with synovial fluid and examples of these are knees or elbows.

6.11 Factors that influence joint stability

There are many factors that affect joints stability; those factors are if the bones of the joints interlock, how deep the joint sits, if there are ligaments or smaller bones supporting that joint, and the amount of mobility available in the joint.
An example of the mobility factor: The shoulder has a wide range of mobility and is more likely to be dislocated then other joints.
An example of ligaments and smaller bones supporting factor: The kneecap
An example of how deep a joint sits factor: The hip
An example of interlocking bones factor: The elbow

Sliding Filament Theory

Role Calcium:
- contractions starts with the arrival of calcium ions within the zone of overlap, they then bind to troponin.

Troponin:
- when calcium binds to troponin to weakening the bond between actin and the troponin-tropomyosine complex.

Tropomyosine:
-Tropomyosine is moved out of the way exposing the actin sites.

Sliding Filament Theory (cont)

Actin:
- Actin is exposed during the weakening of the bond between troponin and tropomyosine. Then myosine heads are able to grab onto the exposed actin forming a cross bridge.

Myosine:
- Myosine heads are able to grab onto the actin sites (this is called a cross bridge because stored energy is pulling the myosine head toward the m line) and pull along them to conract the muscles. This is called a powerstroke motion and as a result the bound ADP and phosphate groups are released.

ATP:
- when another ATP binds to the myosine head the link between myosine and the active site on the actin molecule is broken. This exposes the active site allowing the next myosine head to form another cross bridge.

Myosine Reactivation:
- occurs when the free myosine head splits the ATP into ADP + P. The energy released is used to recock the myosine head.

SLO 8.7 Differentiate the types of muscle fibers.

There are three different types of muscle fibers. They are categorized by how fast some fibers contract relative to others and how fibers produce ATP. The three main types of skeletal muscle fibers are slow oxidative (SO), fast oxidative (FO), and fast glycolytic (FG).

Slow oxidative (SO)-	These fibers contract relatively slowly and use aerobic respiration.

SLO 8.7 Differentiate the types of muscle fibers. (cont)

Fast oxidative (FO)-	These fibers have fast contractions and primarily use aerobic respiration. They may switch to anaerobic respiration (glycolysis) and fatigue more quickly then SO fibers.
Fast glycolytic (FG)-	These fibers have fast contractions and primarily use anaerobic glycolysis. These fibers fatigue more quickly than others.

SLO 8.8 homeostatic imbalances of muscular system.

In the muscular system, when homeostasis is not maintained, diseases and disorders start to develop. The four most common examples of homeostatic imbalances of the muscular system are botulism, tetanus, hernias, and myasthenia gravis.

Botulism-	This is a disease that happens when foods contaminated with a bacterial toxin are consumed. This toxin prevents the release of Ach at the axon terminals, which leads to a potentially fatal muscular paralysis.

Tetanus-	This is a disease that happens when body tissues are exposed to a bacteria called Clostridium tetani. This is usually done by being punctured or scraped by rusty metal where this bacteria flourishes. This bacteria releases a powerful toxin that affects the central nervous system. The result is a sustained and powerful contraction of skeletal muscles throughout the body.
Hernias-	This is a disease that happens when an organ pushes through a muscle that holds it in place. The result is the appearance of a bulge because of a area of weakened muscle.
Myasthenia gravis-	This is an autoimmune disease that causes progressive muscular paralysis. This disease results in the loss of Ach receptors at the motor end plate.

Powerpoint : Homeostatic Imbalances of Joints	
Sprain	stretched or torn ligaments
Strain	stretched or torn muscles or tendons
Rheumatism	any disease marked by inflammation and pain in the joints, muscles, or firbouse tissue, especially rheumatoid arthritis

Powerpoint : Homeostatic Imbalances of Joints (cont)	
Rheumatoid Arthritis	relatively uncommon and is an auto-immune disease
Osteoarthritis	far more common and results from wear/tear on the joints, as well as another other damage to the articular cartilage