Bony components of the skeletal system

What are the functions of the skeletal system?

> Support, movement, protection, mineral storage, electrolyte/pH balance, detox (absorb metals and foreign elements), and blood cell formation

What is osseous tissue and how is it formed/maintained?

> Osseous tissue is connective tissue with a hard extracellular matrix. It is formed through ossification (**endochondral** [cartilage model is replaced by bone] and **intramembranous** [bone develops from mesenchymal sheet])

What are the different bone classifications? (Think shape)

> Irregular, flat, short, long, and sesamoid

What are the connective tissue membranes of bones?

> Periosteum, perforating fibers, nutrient foramina, endosteum and articular cartilage

Bony components of the skeletal system (cont)

What are the microanatomical structures of compact bone?

> Osteons are the structural unit of compact bone, lamella are the rings of the calcified matrix (circumferential are the external and internal surface of compact bone and interstitial lamellae are found in between osteons), the central canal is at the core of the osteon and has the nerve and blood supply, perforating canals extend from the marrow cavity to the periosteum providing blood supply, canaliculi connect neighboring osteocytes and capillaries

What are the microanatomical structures of spongy bone?

> Trabeculae are the structural component of spongy bone (porous), it has layers of lamellae but NO osteons, often has bone marrow (yellow is fat and red is blood)

Bony components of the skeletal system (cont)

What characteristics of bone prevent breakage?

> Trabecular organization is meant to form along stress lines and resist stress with low mass. The structure of lamellae resist breakage because of their spiraling layers of calcified rings

Define bone appositional growth

> Bones widen and thicken (circumferential lamellae are added)

Define bone elongation

> growth at the epiphyseal plate

How does bone elongation occur?

> Starts at the zone of reserve: matrix production. Second stage is the proliferative zone: mitosis takes place. Third is the zone of hypertrophy: lipids, glycogen and alkaline phosphatase accumulate; the matrix calcifies. Fourth is the zone of calcification: chondrocyte cell death. Last is the zone of ossification: where the new bone is.

Bony components of the skeletal system (cont)

What is bone marrow? Where are the different marrows found?

> It is soft, spongy tissue present in bone. Red marrow is typically found in the epiphysis of bone and yellow marrow is found in the medullary cavity of long bones.

What bones develop through endochondral ossifcation?

> All bones from the base of the skull down (aside from the clavicles)

What bones develop through intramembranous ossification?

> Flat bones of the skull, the clavicles, and some of the facial bones

What are the functions of bone remodeling?

> Functions to respond to mechanical stress/injury (maintain blood calcium and $PO4^{3-}$

What are the processes involved in bone remodeling?

> Resorption- osteoclast activity
> Deposition- osteoblast activity

What are bone fractures?

> A broken bone due to trauma (high stress)

Bony components of the skeletal system (cont)

What are the processes involved in bone repair?

> 1. Hematoma formation (fracture hematoma) 2. Soft callus formation 3. Hard callus formation 4. Remodeling

Cartilaginous Components of the Skeletal System

Hyaline Cartilage Characteristics	Most common cartilage with lots of tissue fluid
Elastic Cartilage Characteristics	Contains elastic and collagen fibers
Fibrocartilage Characteristcs	Contains thick collagen fibers
Hyaline Cartilage Functions	Support, cushions, eases movement and is the template for bone growth
Elastic Cartilage Function	Provide flexible support (recoil)
Fibrocartilage Functions	Resist compression and absorb shock

Bones of the Body

What are cranial bones? What are facial bones?

> Cranial bones are the flat bones of the skull. Facial bones are any of the bones surrounding the mouth and nose and contributing to the eye socket

What is the vertebral column? What are the different types of vertebrae?

> The vertebral column is the central axis of the skeleton, it provides muscle attachments, protects the spinal cord, and supports the trunk. The different types of vertebrae include cervical vertebrae (7), thoracic vertebrae (12), and lumbar vertebrae (5), included is the sacrum and the coccyx.

What are the curves of the spine?

> Kyphosis- concave anteriorly Lordosis- concave posteriorly

What bones make up the thoracic cage?

> The sternum (manubrium, body, and xiphoid) and 12 pairs of ribs (true are 1-7, false are 8-12, floating are 11-12)

Bones of the Body (cont)

What bones make up the brachium, antebrachium, and the hand?

> Brachium: humerus. Antebrachium: ulna and radius. Hand: carpals (8), metacarpals (5), and phalanges (14)

What bones make up the pelvic girdle?

> The hip bones (coxal, ossa coxae, pelvic, innominate), the pelvis and articulates (ilium and ischium)

What bones make up the thigh, crura (leg), and feet?

> Thigh: femur. Crura: tibia and fibula. Foot: tarsals (7), metatarsals (5), and phalanges (14)

Functional Joint Classification

Synarthroses	immobile (short fibers)
Amphiarthroses	limited mobility (long fibers)
Diarthroses	Freely movable

Structural Joint Classification

Bony (synarthrotic) joints	The space between two bones ossifies (hip, epiphyseal line, frontal bone)

Structural Joint Classification (cont)

Fibrous (synarthrotic) joints	Elements are connected by fibrous connective tissue (3 types: sutures [bind bones of the skull], gomphosis [anchors tooth root in socket], and syndesmosis [bones attached via ligaments])
Cartilaginous (amphiarthrotic) joints	Bones are attached via cartilage (synchondroses [hyaline cartilage unites bone] and symphyses [fibrocartilage connects bone])
Synovial (diarthrotic) joints	Bones are structurally complex

Synovial Joints

What are the characteristics/structures associated with synovial joints?

1. **Joint (articular) capsule**- encloses the joint cavity and has a fibrous capsule and synovial membrane. 2. **Synovial Fluid** 3. **Articular cartilage** Accessory structures include **tendons** (joint stabilization), **ligaments** (reinforcing the capsule), and **bursae** (fluid filled fibrous sacs that ease friction in the joint)

What are the full structural classifications of synovial joints?

Uniaxial diarthrotic joints, biaxial diarthrotic joints, multiaxial diarthrotic joints, and sometimes nonaxial diarthrotic joints

What are the full functional classifications of synovial joints?

Pivot- uniaxial **Hinge**-uniaxial **Condylar**-biaxial **Saddle**- biaxial **Plane**-biaxial/nonaxial **Ball and Socket**- multiaxial

Muscle Function and Properties

Muscle Functions	Movement, posture/joint stabilization, open & close passages, heat production
Properties of muscle tissue	Excitation, conductivity, contractility, elasticity, and extensibility
Skeletal muscle	Striated, voluntary
Cardiac muscle	Striated, involuntary
Smooth muscle	involuntary

Histology of Muscles

What are the structures of skeletal muscle fibers?

Sarcolemma, sarcoplasma, myofibrils, t-tubules, sarcoplasmic reticulum, glycogen, and myoglobin

What is the sarcolemma?

plasma membrane of muscle cells (excitable)

What is the sarcoplasm?

the cytoplasm of muscle cells

What is the T-Tubule?

invaginations of sarcolemma

Histology of Muscles (cont)

What is the function of a t-tubule?

Conduct nerve impulses throughout muscle

What is the sarcoplasmic reticulum?

Elaborate smooth ER surrounding myofibrils

What is the function of the sarcoplasmic reticulum?

store and release calcium

Structure of Myofibrils

What are myofibrils?

the contractile organelles of skeletal and cardiac muscle

What are the structures of myofibrils?

Actin (thin filaments) and myosin (thick filaments)

What are sarcomeres?

the functional unit of muscle

What proteins/structures make up a sarcomere?

Myofilaments, z disks, m line, titin, a band, h band, and I band

Muscle Contraction

1. Cross-bridge forms: myosin heads binds to actin

2. Myosin "flexes" and pulls on actin

Muscle Contraction (cont)

3. Actin pulls Z disk towards each other

Muscle Relaxation

Nervous stimulation stops

SR absorbs calcium

Cross-bridges no longer form

Muscle returns to resting length

Muscle Contraction Questions

What is excitation-contraction coupling?

The nerve sends the impulse, the impulse excites the muscle, so the muscle contracts

What is the sliding filament model?

thin filaments pulled past thick (filaments do not shorten

What happens to each element of a sarcomere during contraction?

I Band- narrows, **H Zone-** narrows **A Band-** unaffected **Z Disk-** unaffected

What are the roles of Ca+ and ATP during contraction?

Calcium binds the myosin heads to actin and ATP breaks the binding apart

Muscle Contraction Questions (cont)

What happens during relaxation?

- Cross-bridges are no longer forming and the muscle returns to its resting length

What are the different types of muscle contraction?

- **Concentric-** muscle shortens (movement upwards) **Eccentric-** muscle is trying to contact but the load is too heavy (movement downwards) **Isometric-** muscle remains contracted (0 movement)

Fascicle Arrangement

Parallel	fascicles are parallel to each other (sartorius)
Fusiform	a bulging parallel muscle (biceps brachii)
Circular	go in a circle around something (orbicularis oris)
Convergent	broad base to a narrow end, kinda like a triangle (pectoralis major)
Pennate	attach to CT at an oblique angle; feather like

Muscle Growth & Atrophy

What is hypertrophy and how does it occur?

- muscle fibers get bigger, connective tissue development increases

What is atrophy and how does it occur?

- number of myofibrils and sarcomeres decrease, reduced use

Muscle Attachment

What is the origin?

- Where the muscle is less mobile

What is the insertion?

- Where the muscle is more mobile

During normal movement what attachment moves toward the other?

- Insertion moves toward the origin

What is a direct attachment?

- It looks fleshy, kinda like muscle to muscle

What is an indirect attachment?

- Aponeurosis and tendon

How do muscles attach?

- CT sheaths fuse/fused sheaths attach to bone (at periosteum)

Muscle Actions

Linear	Protraction, retraction, elevation, depression, and compression
Angular	Flexion, extension, adduction, abduction, dorsiflexion, plantar flexion, and lateral flexion
Rotational	Rotation, medial/lateral rotation
Pronation	
Supination	
Eversion	
Inversion	

Muscle Interactions

What is the agonist?

- the prime mover, it is the muscle doing the action

What is the synergist?

- the helper to the prime mover (produces the same action as the agonist)

What is the antagonist?

- muscle with the opposite action of the agonist

What is the fixator?

- the muscles that stabilize the joint

Levers

What is the lever?

- the "bar" (bone)

What is the fulcrum?

- the point of movement (joint)

What is the effort?

- the force exerted (muscle)

What is the load?

- what is being moved

What are the benefits of lever systems?

- moving a heavy load with less effort and moving a load farther/faster

Describe mechanical advantages

- the further the effort arm is from the joint, the better the mechanical advantage

How do you find the mechanical advantage?

- effort arm/load arm **Higher the number, the higher the advantage**

Lever System