THE SKELETAL & ARTICULAR SYSTEMS
Think-Pair-Share:

Why do we need bones? Try to think of 3 reasons.
Is made up of numerous bones and is the rigid framework of the human body

It gives support and shape to the body

It protects vital organs such as the brain, spinal cord, and heart

It assists in movement by providing a rigid structure for muscle attachment and leverage

It manufactures blood cells in the ilium, vertebra, sternum and ribs

Calcium and other mineral salts are stored throughout osseous tissue

Lippert, p13
Skeletal Structures

• necessary for stability, support, protection, locomotion, production of nutrients

Without

With
TYPES OF SKELETONS:
- The bones of the body are grouped into 2 main categories:
  - Axial skeleton
  - Appendicular skeleton
Axial Skeleton

- The Axial Skeleton makes up the central bony axis of the body and is composed of:
  - the skull
  - hyoid bone
  - sternum
  - ribs
  - vertebral column
  - sacrum
  - coccyx

Mansfield, p21-22
Appendicular Skeleton

- Just as the name suggests, the appendicular skeleton is composed of the appendages or extremities:
  - This includes the supporting structures

Mansfield, p22
**Bone Tissue:**
- Bone is made up of 1/3 organic (living) material, which gives the bone its elasticity and 2/3 inorganic (non-living) material, which provides hardness and strength.

**Cortical (Compact) Bone**
- The hard, dense, outer shell
- Thick along the shaft and thin at the ends of long bones
- Is strong and absorbs compressive forces through the long axis

**Cancellous Bone**
- The porous and spongy inside portion called trabeculae ("little beams")
- Resists local stresses and strains
- Trabeculae are filled with bone marrow and make the bone lighter
- Makes up most of the articular ends of bones

Lippert, p14 & Mansfield, p22
Primary Types of Tissue

- **Cortical (compact)** — outmost portions of bone
  - Strong
  - Dense
  - Absorptive (forces)

- **Cancellous (spongy)** — inner portions of bone
  - Porous
  - Lightens the bone
  - Redistributes forces & is covered by articular cartilage

Mansfield, p22
**BONE STRUCTURE (PARTS):**

- When we look at a long bone, we see the diaphysis, metaphysis and epiphysis.
- **Diaphysis:**
  - The main shaft of bone
  - Made up mostly of compact bone
- **Metaphysis:**
  - The flared part of each end
  - Made up mostly of cancellous bone
  - Functions to support the epiphysis
- **Epiphysis:**
  - The area at each end of the long bone
  - Tends to be wider than the shaft (diaphysis)
  - In adult bone, it is osseous
  - In growing bone, it is cartilagenous
BONE STRUCTURE CONTINUED:

GROWING BONES

- In growing bone, the epiphysis is cartilagenous, and it is called the epiphyseal plate.
- Longitudinal growth occurs at the epiphyseal plate.
- On an X-ray, a growing bone will show a distinct line between the epiphyseal plate and the rest of the bone.
- Once bone stops growing, the line can no longer be seen.

Lippert, p14-15
**BONE STRUCTURE (INTERNAL):**

- **Medullary Canal**
  - In the center of the diaphysis
  - Hollow canal which decreases the weight of the bone
  - Contains marrow and provides passage for arteries

- **Endosteum**
  - The membrane that lines the medullary canal
  - Contains bone-resorbing osteoclasts
BONE STRUCTURE (EXTERNAL):

- **Periosteum**
  - Thin membrane covering all of the bone except the articular surfaces
  - Contains nerve and blood vessels
  - Serves as attachment point for tendons and ligaments

- **Hyaline (articular) cartilage**
  - Covers the articular surfaces of bone
  - Acts as a shock absorber between joints

Lippert, p15 & Mansfield, p23
The Skeletal System

Types of Bones:

- Long Bones (femur, humerus)
  - Length is greater than width
  - Largest bones in body
  - Make up most of appendicular skeleton

- Short Bones (carpals and tarsals)
  - More equal dimensions of height, length, and width
  - Lots of articular surface and usually articulate with > 1 bone

- Flat Bones (ilium and scapula)
  - Broad surface and not very thick
  - Tend to have curved surfaces rather than flat

- Irregular Bones (vertebrae, sacrum)
  - Variety of mixed shapes

- Sesamoid Bones (patella, near head of 1st metatarsal)
  - Small bones located where tendons cross the ends of long bones
  - They develop within the tendon and protect it from excessive wear
Primary Types of Bones

- **Axial Skeleton**
  - Has no long or short bones

- **Appendicular Skeleton**
  - Has no irregular bones
THE ARTICULAR SYSTEM

- **JOINT DEFINITION:**
  - A connection between two bones

- **JOINT FUNCTION:**
  - To allow motion
  - Help bear the body’s weight
  - To provide stability
  - Lubricate the joint and nourish the cartilage (via synovial fluid)

Lippert, p21
**RELATIONSHIP BETWEEN STABILITY & MOBILITY:**

- There exists an inverse relationship between stability and mobility.
- There is a tradeoff between the stability and the mobility of a joint.
- For example, the humeroulnar joint is highly stable, but it comes at the cost of mobility (because motion is limited to only 1 plane).
- In contrast, consider the glenohumeral joint. The structure of this joint allows for a tremendous amount of mobility (motion in all 3 planes) and is therefore one of the most unstable joints of the body.
- Every joint must find balance between mobility and stability to properly function.

Mansfield, p33
#1. THINK (on your own): of a real life example that demonstrates the relationship between mobility & stability. It doesn’t have to be exercise or rehab related!
The relationship between structure and function is much like the question: “which came first, the chicken or the egg?”

- Structure and function depend on one another
- Function is available and dependent on the structure
JOINT CLASSIFICATION:

- Joints
  - Fibrous
    - Synarthrosis
    - Syndesmosis
    - Gomphosis
  - Cartilagenous
  - Synovial
    - Nonaxial
      - Plane
    - Uniaxial
      - Hinge
    - Biaxial
      - Ellipsoidal
    - Triaxial
      - Ball & Socket
    - Uniaxial
      - Pivot
    - Biaxial
      - Saddle
      - Condylloid

Lippert, p23 & Mansfield, p25
**Fibrous Joints:**

- Have a thin layer of fibrous periosteum between the 2 bones.
- There are 3 types of fibrous joints:
  - **Synarthrosis:**
    - Suture joint
    - Ends of the bones allow them to interlock
    - Essentially no movement
    - Purpose: provide strength and shape
    - Example: skull
  - **Syndesmosis:**
    - Ligamentous joint
    - There is a great deal of fibrous tissue (ligaments and interosseous membranes) holding the joint together
    - A small amount of twisting or stretching can occur
    - Example: distal tibiofibular joint and distal radioulnar joint
  - **Gomphosis:**
    - Occurs between a tooth and the wall of its dental socket in the mandible and maxilla
    - Its structure is referred to as a peg-in-socket
CARTILAGENOUS JOINTS:

- Aka amphiarthrosis
- Has either fibrocartilage or hyaline (articular) cartilage between the 2 bones
- Plays important role in shock absorption
- Allows limited amounts of movement
- Example: intervertebral joints (have disks of fibrocartilage directly connecting the bones)
SYNOVIAL JOINTS:
- All categories of synovial joints contain these 7 common elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synovial fluid</td>
<td>for joint lubrication &amp; nutrition</td>
</tr>
<tr>
<td>Articular cartilage</td>
<td>to spread out and absorb forces</td>
</tr>
<tr>
<td>Articular capsule</td>
<td>to surround and protect the joint</td>
</tr>
<tr>
<td>Synovial membrane</td>
<td>To produce the fluid for the joint</td>
</tr>
<tr>
<td>Capsular ligaments</td>
<td>to limit excessive joint motion</td>
</tr>
<tr>
<td>Blood vessels</td>
<td>to provide nutrients, permit healing to occur!</td>
</tr>
<tr>
<td>Sensory nerves</td>
<td>transmit pain and awareness of position</td>
</tr>
<tr>
<td></td>
<td>(proprioception)</td>
</tr>
</tbody>
</table>
SYNOVIAL JOINTS CONTINUED:

- There are many types of synovial joints (see joint classification table on previous slide)
- Joints are built (or structured) differently. The type of structure is categorized.
- The structure of the joint determines
  - The degrees of freedom for that joint
  - Which plane(s) the joint can move through
- We will review 3 types to showcase the difference, and further detail can be found in your textbook.
Hinge Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Flexion and extension</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Door hinge</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>Humero-ulnar joint, interphalangeal joints</td>
</tr>
</tbody>
</table>
# Pivot Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Spinning one member on an axis</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Door knob</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>Proximal radioulnar joint</td>
</tr>
</tbody>
</table>
### Ball & Socket Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Flex &amp; Ext, ABD &amp; ADD, IR &amp; ER</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Spherical convex surface &amp; concave cup</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>Glenohumoral joint and hip</td>
</tr>
</tbody>
</table>
JOINT STRUCTURE:

- **Ligaments:**
  - Bands of fibrous connective tissue that connect 2 bones
  - Provide attachment for cartilage, fascia, and muscle
  - Flexible, but not elastic
  - Prevent excessive joint movement
  - When they surround a joint, they are called capsular ligaments

Lippert, p25
**JOINT STRUCTURE:**

- **Joint Capsule:**
  - Every synovial joint has one
  - It encases the joint and protects the bones
  - It has 2 layers: an outer layer and an inner layer
  - The outer layer is fibrous tissue and is reinforced by ligaments
  - The inner layer is lined with a synovial membrane, a thick, vascular connective tissue that secretes synovial fluid
  - **Synovial fluid** = a thick, clear fluid (similar to egg white) that lubricate articular cartilage, reducing friction, providing shock absorption and providing a major source of nutrition for the articular cartilage
JOINT STRUCTURE:

- **Tendons:**
  - Connects a muscle to bone

- **Tendon Sheaths:**
  - Occasionally encases tendons
  - It is a fibrous sleeve that surrounds a tendon when it is subject to pressure or friction
  - Sheaths are lubricated by fluid secreted from their linings

- **Aponeurosis:**
  - A broad, flat tendinous sheet
  - In the anterior abdominal wall, aponeuroses provide a base of muscular attachment where no bone is present but where great strength is needed

Lippert, p26
THE ARTICULAR SYSTEM

**JOINT STRUCTURE:**

- **Articular (Hyaline) Cartilage:**
  - Dense, fibrous connective tissue that can withstand great amounts of pressure and tension
  - Covers the end of opposing bones
  - With the help of synovial fluid, it provides a smooth articulating surface in all synovial joints
  - It lacks its own blood and nerve supply, gets its nutrition from synovial fluid, and cannot repair itself if damaged

- **Fibrocartilage:**
  - Dense, fibrous connective tissue that acts as a shock absorber
  - Especially important in weight bearing joints
    - Meniscus in knee
    - Intervertebral disks
    - Labrum in shoulder

Lippert, p25-26
JOINT STRUCTURE:

- Bursae
  - Small, padlike sacs found around joints
  - Located in areas of excessive friction, such as under tendons and over bony prominences
  - Reduces friction between moving parts

Lippert, p26
REFERENCES