THE SKELETAL & ARTICULAR SYSTEMS

“The Bones & Joints”
THE SKELETAL SYSTEM

- 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
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
BONE TISSUE:
- Bone is made of up 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
  - Redistributions 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
THE SKELETAL SYSTEM

- **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

Lippert, p15
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
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.
THE ARTICULAR SYSTEM

JOINT CLASSIFICATION:

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

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 refereed to as a peg-in-socket

Lippert, p21-22
**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)

Lippert, p22
## SYNNOVIAL 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 (proprioception)</td>
</tr>
</tbody>
</table>
# Plane Joints

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Slide &amp;/or rotation</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Book sliding or spinning on a table</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>Intercarpal joints</td>
</tr>
</tbody>
</table>
# 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><strong>Primary Motions</strong></td>
<td>Spinning one member on an axis</td>
</tr>
<tr>
<td><strong>Mechanical Analogy</strong></td>
<td>Door knob</td>
</tr>
<tr>
<td><strong>Anatomic Examples</strong></td>
<td>Proximal radioulnar joint</td>
</tr>
</tbody>
</table>
## Elipsoid Joint

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of Freedom</td>
<td>2</td>
</tr>
<tr>
<td>Primary Motions</td>
<td>Flex &amp; Ext, ABD &amp; ADD</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Flattened convex with concave trough</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>Radiocarpal joint</td>
</tr>
</tbody>
</table>
## Saddle Joints

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Bilpanar, excluding spin</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Horseback rider on a saddle</td>
</tr>
</tbody>
</table>
| Anatomic Examples  | CMC joint of the thumb  
Sternoclavicular joint |
## Condyloid Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Biplanar Motion</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Spherical convex surface &amp; concave cup</td>
</tr>
<tr>
<td>Anatomic Example</td>
<td>Tibiofemoral joint, MCP 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

- 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

Lippert, p25
THE ARTICULAR SYSTEM

- **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
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