JOINTS

**STRUCTURE AND FUNCTION:**

*JOINTS*

A "connection" between 2 or more bones

A pivot point for bony motion

The "features" of the joint help determine
  - The ROM
  - Degrees of freedom
  - Functional potential of the joint

**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
Appendicular Skeleton

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

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
Cancellous bone

Hip bone

Diaphysis

Epiphysis (2)
- Proximal
- Distal

Articular cartilage – hyaline cartilage

Periosteum

Medullary canal

Endosteum
Primary Types of Bones

- Five categories
  - Long
  - Sesamoid
  - Irregular
  - Flat
  - Short

Joints

- A "connection" between 2 or more bones
- A pivot point for bony motion
- The "features" of the joint help determine
  - The ROM
  - Degrees of freedom
  - Functional potential of the joint
Joint Classifications

- **Synarthrosis (Fibrous)**
  - Allows little to no movement
  - Sutures in the skull
  - Distal tibiofibular joint

Joint Classifications

- **Amphiarthrosis**
  - Formed by fibro and hyaline cartilage
  - Shock absorbers
  - Allows limited motion

Joint Classifications

- **Diarthrosis**
  - No direct union between the bone ends
  - Synovial fluid contained within a capsule
Joint Classifications

- Diarthrosis (Synovial Joints)
  - Contains fluid-filled cavity between 2 or more bones
  - All synovial joints have 7 common elements

<table>
<thead>
<tr>
<th>What</th>
<th>Why</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 contain 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>

Synovial Joint Classifications

The structure of the joint determines the functional potential for the joint. Most of the names intentionally resemble functional structures!

- Hinge
- Condyloid
- Pivot
- Saddle
- Ellipsoid
- Plane
- Ball-and-Socket

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; Rotation</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>

### Ellipsoid Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>2</th>
</tr>
</thead>
<tbody>
<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>

### 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>
Saddle Joints

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Motions</td>
<td>Biplanar, excluding spin</td>
</tr>
<tr>
<td>Mechanical Analogy</td>
<td>Horseback rider on a saddle</td>
</tr>
<tr>
<td>Anatomic Examples</td>
<td>CMC joint of the thumb, Sternoclavicular joint</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, intertarsal joints</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>Glenohumeral joint and hip</td>
</tr>
</tbody>
</table>
Joint Positions

- Close-packed
  - Surfaces of joint matches perfectly
  - Joint stability is greatest
  - Usually at one extreme end range

- Open-packed
  - All other positions than close-packed
  - Usually in the middle of range of motion

Connective Tissue

- All connective tissues that support the joints of the body are composed of:
  - Fibers
    - Type I: thick, resist elongation
    - Primarily compose ligaments
    - Type II: thinner, less stiff
    - Primarily compose hyaline cartilage
    - Elastic: elastic in nature
    - Have more "give"
  - Ground substance
    - Viscous fluid in which the fibers and cells are embedded
    - Occupies the space between the cells and fibers of connective tissues
  - Cells
    - Responsible for maintenance & repair
Types of Connective Tissue in Joints

- Dense Irregular Connective Tissue
  - Binds bones together
  - Makes up ligaments & external joint capsule
  - Type I collagen
  - Injuries
    - Ankle sprain

- Articular Cartilage
  - Resists compressive and shear forces in articular surfaces
  - Covers the ends of articulating surfaces of bones in synovial joints
  - High % type II collagen content which helps to anchor the cartilage to the bone
  - Injuries
    - Wear & tear decreases its effectiveness in reducing compression leading to OA and joint pain & inflammation.

- Fibrocartilage
  - Provides support & stabilization to joints, resists compression & shear forces
  - Makes up the intervertebral discs and menisci of the knees
  - Multidirectional bundles of type I collagen
  - Injuries
    - Tearing can cause disruption of the integrity of the structure and pain with loss of function
Types of Connective Tissue in Joints

- **Bone**
  - Forms primary supporting structure of the body & a rigid level to transmit the force of muscle to move & stabilize the body
  - Forms internal levers of musculoskeletal system
  - Specialized arrangement of Type I collagen & framework for hard mineral salts
- **Injuries**
  - osteoporosis

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Types of Connective Tissue

1. **Dense irregular** (attachment points)
   - Ligaments
   - Joint capsule
2. **Articular cartilage** (ease of movement)
   - Covering at the end of bones of synovial joints
3. **Fibrocartilage** (the shock absorbers)
   - Menisci pleural of “meniscus”
   - Intervertebral discs
4. **Bone** – (the levers in the musculoskeletal system)

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<table>
<thead>
<tr>
<th>Types of Connective Tissue that form the Structure of Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Function</td>
</tr>
<tr>
<td>Dense irregular</td>
</tr>
<tr>
<td>Articular cartilage</td>
</tr>
<tr>
<td>Fibrocartilage</td>
</tr>
<tr>
<td>Bone</td>
</tr>
</tbody>
</table>

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Table 2-1: Types of Connective Tissue that Form the Structure of Joints (Modified from Neumann DA. Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation. 4th ed. Lippincott, 2002. Miller, Table 2-1. Kinesics [currently published}).
Tendons versus Ligaments

- **Tendon**: attaches muscle to bone
  - Collagen fibers are aligned parallel to one another

- **Ligament**: attaches bone to bone
  - Collagen fibers are aligned in irregular crossing patterns