STRUCTURE AND FUNCTION:

JOINTS
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
Structural Features of Bone

- Diaphysis
- Epiphyses (2)
  - Proximal
  - Distal
- Articular cartilage – hyaline cartilage
- Periosteum
- Medullary canal
- Endosteum
Primary Types of Bones

• Five categories
  • Long
  • Sesamoid
  • Irregular
  • Flat
  • Short
Joint Classifications

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

Suture lines
Joint Classifications

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

- **Diarthrosis (Synovial Joints)**
  - Contains fluid-filled cavity between 2 or more bones
  - There are 7 categories with 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-to</td>
<td>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
- Pivot
- Ellipsoid
- Ball-and-Socket
- Condyloid
- Saddle
- Plane
# 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>
### Elipsoid 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>
# Ball & Socket Joint

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Motions</strong></td>
<td>Flex &amp; Ext, ABD &amp; ADD, IR &amp; ER</td>
</tr>
<tr>
<td><strong>Mechanical Analogy</strong></td>
<td>Spherical convex surface &amp; concave cup</td>
</tr>
<tr>
<td><strong>Anatomic Examples</strong></td>
<td>Glenohumoral joint and hip</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>
# 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>
<tr>
<td>Anatomic Examples</td>
<td>CMC joint of the thumb, Sternoclavicular joint</td>
</tr>
</tbody>
</table>
**Condyloid Joint**

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Motions</strong></td>
<td>Biplanar Motion</td>
</tr>
<tr>
<td><strong>Mechanical Analogy</strong></td>
<td>Spherical convex surface &amp; concave cup</td>
</tr>
<tr>
<td><strong>Anatomic Example</strong></td>
<td>Tibiofemoral joint, MCP joint</td>
</tr>
<tr>
<td>Joint</td>
<td>Degrees of Freedom</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Hinge</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Pivot</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Ellipsoid</td>
<td>2</td>
</tr>
<tr>
<td>Ball-and-socket</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Plane</td>
<td>Variable</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Saddle</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Condyloid</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*TABLE 2-1 TYPES OF SYNOVIAL JOINTS.*

(Modified from Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, St Louis, 2002, Mosby, Table 2-3. Some items previously published.)
Connective Tissue

- All connective tissues that support the joints of the body are composed of:
  - Fibers
    - There are 3 types of fibers
      - Type I collagen
        - Thick and resist stretching
        - Ligaments, tendons & fibrous capsules
      - Type II collagen
        - Thinner and less stiff
        - Provide a flexible framework to maintain the shape & consistency of the structures such as hyaline cartilage
      - Elastin
        - Elastic and help prevent injury due to ability to “give” and not break
Connective Tissue

- All connective tissues that support the joints of the body are composed of:
  - Ground substance
    - Collagen & elastin within a water saturated matrix
  - Cells
    - Responsible for maintenance & repair
Connective Tissue: Joint “support”

Ground substance
Disperses repetitive forces
- Water
- Glycosaminoglycans
- Solutes

Cells – “cytes”
Cells for maintenance and repair.
- Blastocyes,
- phagocytes

Why do bones need 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**
  - Ruptured Lateral Collateral ligaments in the ankle, instability in the talocrural ligament
Types of Connective Tissue in Joints

- **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.
Types of Connective Tissue in Joints

- **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
Types of Connective tissue

1. **Dense irregular** (attachment points)
   a. Ligaments
   b. Joint capsule

2. **Articular cartilage** (ease of movement)
   a. Covering at the end of bones of synovial joints

3. **Fibrocartilage** (the shock absorbers)
   a. Menisci *pleural of “meniscus”*
   b. Intervertebral discs

4. **Bone** – (the levers in the musculoskeletal system)
Dancing Bones
http://www.youtube.com/watch?v=GJMwq_BZ53k

Skully
http://www.youtube.com/watch?v=gpmnxvA2Zf8

Sleight of Hand
http://www.youtube.com/watch?v=NNrqedPg6_Q
<table>
<thead>
<tr>
<th>Mechanical Specialization</th>
<th>Anatomic Location</th>
<th>Fiber Types</th>
<th>Clinical Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense irregular connective tissue</td>
<td>Binds bones together and restrains unwanted movement of joints</td>
<td>Composes ligaments and the tough external layer of joint capsules</td>
<td>Primarily type I collagen fibers; low elastin fiber content</td>
</tr>
<tr>
<td>Articular cartilage</td>
<td>Resists and distributes compressive and shear forces transferred through articular surfaces</td>
<td>Covers the ends of articulating bones in synovial joints</td>
<td>High type II collagen fiber content; fibers help anchor the cartilage to bone</td>
</tr>
<tr>
<td>Fibrocartilage</td>
<td>Provides support and stabilization to joints; primarily functions to provide shock absorption by resisting and dispersing compressive and shear forces</td>
<td>Composes the intervertebral discs of the spine, and the menisci of the knee</td>
<td>Multidirectional bundles of type I collagen</td>
</tr>
<tr>
<td>Bone</td>
<td>Forms the primary supporting structure of the body and provides a rigid lever to transmit muscle force to move and stabilize the body</td>
<td>Forms the internal levers of the musculoskeletal system</td>
<td>Specialized arrangement of type I collagen that provides a framework for hard mineral salts</td>
</tr>
</tbody>
</table>

(Modified from Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, St Louis, 2002, Mosby, Table 2-2. Some items previously published.)