Chapter 5

The Biomechanics of Human Skeletal Articulations
Joint Architecture

Classification of Joints:

*Synarthroses*: (immovable)

*Sutures*

Sutures of the skull.

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Joint Architecture

Classification of Joints:

\[
\begin{align*}
\text{Synarthroses:} & \quad \text{(immovable)} \\
\text{Syndesmoses} & \\
\end{align*}
\]

The mid-radioulnar joint is an example of a syndesmosis, where fibrous tissue binds the bones together.
Joint Architecture

Classification of Joints:

- Amphiarthroses: (slightly moveable)
- Synchondroses

The sternocostal joints are examples of synchondroses, wherein the articulating bones are joined by a thin layer of hyaline cartilage.

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Joint Architecture

Classification of Joints:

- Amphiarthroses: (slightly moveable)
- Symphyses

Note the hyaline cartilage disc separating the bones of the pubic symphysis, typical of a symphysis joint.
Joint Architecture

Classification of Joints:

**Diarthroses** or **synovial**: (freely movable) characterized by:

**Articular cartilage** - a protective layer of dense white connective tissue covering the articulating bone surfaces

**Articular capsule** - a double-layered membrane that surrounds the joint

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Joint Architecture

Classification of Joints:

**Diarthroses** or **synovial**: (freely movable) characterized by:

- **Synovial fluid** - a clear, slightly yellow liquid that provides lubrication inside the articular capsule
- **Associated bursae** - small capsules filled with synovial fluid that cushion the structures they separate

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The knee is an example of a synovial joint, with a ligamentous capsule, an articular cavity, and articular cartilage.

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Joint Architecture

Classification of Joints:

**Diarthroses or synovial:** (freely movable)
- Gliding
- Hinge
- Pivot
- Condyloid
- Saddle
- Ball and socket
Joint Architecture

A Ball-and-socket joint
B Condyloid joint
C Gliding joint
D Hinge joint
E Pivot joint
F Saddle joint
Joint Architecture

What are the functions of articular cartilage?

- It spreads loads over a wide area, thereby reducing contact stress.
- It provides a protective lubrication that minimizes friction and mechanical wear at the joint.

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What is articular fibrocartilage?

(soft-tissue discs or menisci that intervene between articulating bones, as exemplified by the menisci of the knee above)

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Joint Architecture

What are the possible functions of articular fibrocartilage?

- Distributing loads over joint surfaces
- Improving the fit of articulations
- Limiting slip between articulating bones
- Protecting the joint periphery
- Lubricating the joint
- Absorbing shock at the joint
Joint Architecture

What are articular connective tissues?

- Tendons - connect muscles to bones
- Ligaments - connect bones to other bones
Joint Stability

What is joint stability?

(ability of a joint to resist abnormal displacement of the articulating bones)
Joint Stability

What factors increase joint stability?

- A closely reciprocating match of the articulating bone surfaces (stability is maximal when joints are in the close-packed position)
- A strong array of ligaments and muscle tendons crossing the joint
- Absence of muscle fatigue
Joint Flexibility

What is joint flexibility?
(a description of the relative ranges of motion allowed at a joint in different directions)

Range of motion (ROM): the angle through which a joint moves from anatomical position to the extreme limit of segment motion in a particular direction

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Range of motion is measured directionally from anatomical position (zero).
Techniques for Increasing Joint Flexibility

What sensory receptors influence the extensibility of the musculotendinous unit?

- **Golgi tendon organs** - inhibit tension in muscle & initiate tension development in antagonists
- **muscle spindles** - provoke reflex contraction in stretched muscle & inhibit tension in antagonists

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# Golgi Tendon Organs and Muscle Spindles: How do they Compare?

<table>
<thead>
<tr>
<th></th>
<th>Golgi Tendon Organs</th>
<th>Muscle Spindles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Within tendons near the muscle-tendon junction in series with muscle fibers</td>
<td>Interspersed among muscle fibers in parallel with the fibers</td>
</tr>
<tr>
<td><strong>Stimulus</strong></td>
<td>Increase in muscle tension</td>
<td>Increase in muscle length</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>1) inhibit tension development in stretched muscle, 2) initiate tension development</td>
<td>1) initiate rapid contraction of stretched muscle, 2) inhibit tension development</td>
</tr>
<tr>
<td></td>
<td>in stretched muscle</td>
<td>in antagonist muscles</td>
</tr>
<tr>
<td><strong>Overall Effect</strong></td>
<td>Promote stretch in muscle being stretched</td>
<td>Inhibit stretch in muscle being stretched</td>
</tr>
</tbody>
</table>

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Techniques for Increasing Joint Flexibility

What are active and passive stretching?

**Active stretching** - produced by active development of tension in the antagonist muscles

**Passive stretching** - produced by a force other than tension in the antagonist muscles

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What are ballistic and static stretching?

**Ballistic stretching** - a series of quick, bouncing-type stretches

**Static stretching** - maintaining a slow, controlled, sustained stretch over time (usually about 30 seconds)

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Active static stretching involves holding a position near the extreme of joint range of motion, usually for about 30 seconds.

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What is PNF?

(Proprioceptive neuromuscular facilitation is a group of stretching procedures involving alternating contraction and relaxation of the muscles being stretched)
PNF techniques require the assistance of a partner.

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Osteoarthritis

What is osteoarthritis?
- A common, degenerative disease of articular cartilage
- Symptoms include pain, swelling, ROM restriction, and stiffness
- Cause is unknown
- Both too little and too much mechanical stress seem to promote development

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