Chapter 5

Biomechanics of Human Skeletal Articulations

Joint Classifications

- **Synarthroses** – immovable
- **Amphiarthroses** – slightly movable
- **Diarthroses (synovial)** – freely movable

**Synarthroses**

- Immovable joints such as:
  - Sutures
    - skull
  - Syndesmoses
    - Tibiofibular

**Amphiarthroses**

- Slightly movable joints such as:
  - Synchondroses
    - 1st sternocostal
  - Symphyses
    - Intervertebral body

**Diarthroses (synovial)**

- Freely movable joints such as:
  - Knee
  - Elbow

**Synovial Joint Architecture**

- **Articular cartilage** – protective layer of dense white connective tissue covering the articulating bone surfaces
- **Articular capsule** – a double-layered membrane that surrounds the joint
- **Synovial fluid** – clear, slightly yellow liquid that provides lubrication inside the articular capsule
- **Bursae** – small capsules filled with synovial fluid that cushion the structures they separate
Synovial Joint Classifications

- Gliding
- Hinge
- Pivot
- Condyloid
- Saddle
- Ball and socket

Gliding Joint

- Tarsal metatarsal

Hinge Joint

- Humeroulnar Joint

Pivot Joint

- Radioulnar Joint

Condyloid Joint

- Metacarpal phalangeal Joint

Saddle Joint

- 1st carpal metacarpal joint
Ball and Socket Joint

- Hip joint

Articular Cartilage

- Spreads loads over a wide area reducing contact stress
- Provides a protective lubrication that minimizes friction and mechanical wear at the joint

Articular Fibrocartilage

- Soft-tissue discs or menisci that intervene between articulating bones

Articular Fibrocartilage Functions

- Load distribution
- Improving joint fit
- Limiting slip between articulating bones
- Protecting joint periphery
- Joint lubrication
- Shock absorption

Articular Connective Tissues

- Tendons – connect muscles to bones
- Ligaments – connect bones to bones

Joint Stability

Ability of a joint to resist abnormal displacement of the articulating bones
Factors Increasing Joint Stability

- Closely reciprocating match of the articulating bone surfaces
  - Maximal stability is in close-packed position
- Strong array of ligaments and muscle tendons crossing the joint
- Absence of muscle fatigue

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

ROM Measurement

- ROM is measured directionally from anatomical position (0°)

Factors Influencing Joint Flexibility

- Intervening tissues
  - Bone
  - Muscle
  - Fat
- Tightness/laxity in tissues crossing the joint
  - Muscles
  - Collagenous tissue
- Muscle fatigue

Sensory Receptors Influencing Musculotendinous Extensibility

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

GTO

- Aid in slow, controlled stretching
Muscle Spindles

Golgi Tendon Organs (GTOs)
- Location: Within tendons near the muscle-tendon junction in series with muscle fibers
- Stimulus: Increase in muscle tension
- Response: 1) inhibit tension development in stretched muscle, 2) initiate tension development in stretched muscle
- Overall Effect: Promote stretch in muscle being stretched

Muscle Spindles
- Location: Interspersed among muscle fibers in parallel with the fibers
- Stimulus: Increase in muscle length
- Response: 1) initiate rapid contraction of stretched muscle, 2) inhibit tension development in antagonist muscles
- Overall Effect: Inhibit stretch in muscle being stretched

Active vs. 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

Ballistic vs. Static Stretching
- Ballistic stretching – a series of quick bouncing-type stretches
- Static stretch – maintaining a slow controlled, sustained stretch over time-usually about 30 seconds

Proprioceptive Neuromuscular Facilitation (PNF)
- Group of stretching procedures involving alternating contraction and relaxation of the muscles being stretched

Osteoarthritis
- Common degenerative disease of articular cartilage
- Symptoms include pain, swelling, ROM restriction, and stiffness
- Both too little and too much mechanical stress seem to promote development