Chapter 9/10: Muscles and Joints

34. Describe the following regarding spinal column: cervical curvature, thoracic curvature, lumbar curvature and sacral curvature.

35. Discuss the structures of a synovial joint including joint cavity, articular cartilage, synovial fluid, ligaments and joint capsule.

41. Compare and contrast the following types of muscle contractions: isotonic, isometric, and tetanic.

42. List the names and functions of major chemical compounds found in muscle tissue.

43. Explain the roles of agonists, antagonists, synergists, and fixation muscles in body movement.

The following objectives will be discussed to prep those students taking the HESI exam. Objectives 44-46 will NOT be on Unit Exam 1.

44. List the types of arthroses (structural and functional) and give an example of each.

45. Discuss the structures that characterize diarthrotic joints and identify six types, based upon the relative strength and range of motion in each joint type.

46. Describe each of the following movements: flexion, extension, dorsiflexion, plantarflexion, supination, pronation, abduction, and adduction.
Muscle Fatigue

The inability to maintain force of contraction after prolonged activity.

Due to:

- Inadequate release of Ca\(^{2+}\) from SR
- Depletion of CP, oxygen, and nutrients.
- Build up of lactic acid and ADP.
- Insufficient release of ACh at NMJ.
Oxygen Consumption After Exercise

Why do you continue to breathe heavily for a period of time after stopping exercise?

Oxygen debt:
- Replenish CP stores
- Convert lactate into pyruvate
- Reload $O_2$ onto myoglobin

The two major components of oxygen recovery are:

*Alactacid oxygen debit (fast component)*
- the portion of oxygen required to synthesize and restore muscle phosphate stores (ATP and PC)

*Lactacid oxygen debit (slow component)*
- the portion of oxygen required to remove lactic acid from the muscle cells and blood

The replenishment of muscle myoglobin with oxygen is normally completed within the time required to recover the Alactacid oxygen debit component.
Muscle Tone

Even when at rest, a skeletal muscle exhibits a small amount of tension, called tone.

- Due to weak, involuntary contraction of motor units
- When you pass out/faint muscle tone is lost
- Muscles with LESS tone are flaccid
- Muscles with MORE tone are spastic
- Tone is maintained by a negative feedback mechanism centered in the nervous system (spinal cord)
Isotonic vs. Isometric Contractions

Isotonic – tension is constant while muscle length changes

- **Concentric**: type of muscle contraction in which the muscles shorten while generating force.

- **Eccentric**: type of muscle activation that increases tension on a muscle as it lengthens

Isometric – muscle contracts but does not change length
Tetanic Contraction

- Also called tetanized state or tetanus
- Sustained muscle contraction evoked when the motor nerve that innervates a skeletal muscle emits action potentials at a very high rate.
- Motor unit is stimulated by multiple impulses at a sufficiently high frequency.
- Each stimulus causes a twitch.
- Tetanus is a serious bacterial disease that affects your nervous system
  - leads to painful muscle contractions, particularly of your jaw and neck muscles.
Names and functions of major chemical compounds found in muscle tissue.

- 75% water-hydrates tissue, forms the solution for biochemical reactions in muscle tissue (ex. hydrolysis).
- 20% protein
  - **Myosin** - a protein that converts chemical energy in the form of ATP to mechanical energy, thus generating force and movement.
  - **Actin** - a protein that functions in the contractile system of skeletal muscle, where it is found in the thin filaments.
  - **Tropomyosin** - a muscle protein of the I band that inhibits contraction by blocking the interaction of actin and myosin, except when influenced by troponin.
  - **Troponin** - a protein of muscle that together with tropomyosin forms a regulatory protein complex controlling the interaction of actin and myosin.
- **Myoglobin** - an iron- and oxygen-binding protein found in the muscle tissue.
- 5% salts, phosphates, ions, and macronutrients
  - Proper nerve stimulation and conduction in regards to skeletal muscle contraction. Ions like Ca+2 required for muscle contraction.
Agonists “prime movers”: a muscle or group of muscles that causes the motion

- Without agonist muscle (or group) the motion is no longer considered functional
- Isotonic contraction to produce a motion or isometric contraction to maintain a position
- The isotonic contraction is concentric
- Motion results from the shortening of the muscle

Example: The biceps brachii
Antagonists

• Performs the opposite motion of the prime mover

• It contracts eccentrically or "relaxes" and lengthens to prevent, slow or control a motion

Example: With elbow extension, the triceps would be the agonist and the biceps would be the antagonist.

With elbow flexion, the biceps would be the agonist and the triceps would be the antagonist
Synergists

- **Synergist** muscles performs, or helps perform, the same set of joint motion as the agonists.

- **Synergists** muscles act on movable joints.

Example: Brachioradialis muscle
Fixator Muscles

• The muscle may contract to hold a body part immobile while another body part is moving.

• Stabilizes the origin of the prime mover.

• Contraction does not produce movement, stabilizing contraction is frequently isometric.

Example: Muscles attaching the shoulder girdle to the trunk contract to fix shoulder girdle, allowing the deltoid muscle to move holder joint (humerus)
What is a joint?

A joint is a point of contact between:

- Two or more bones
- Cartilage and bone
- Teeth and bone

Joints can be classified

- Structurally
  - Is there a joint cavity?
  - What type of connective tissue is involved?
- Functionally
  - What degree of movement is permitted?
Joints can also be classified functionally according to the type and degree of movement they allow:

- **Synarthrosis** – permits little or no mobility. Most synarthrosis joints are fibrous joints (e.g., skull sutures).

- **Amphiarthrosis** – permits slight mobility. Most amphiarthrosis joints are cartilaginous joints (e.g., intervertebral discs).

- **Diarthrosis** – freely movable. All diarthrosis joints are synovial joints (e.g., shoulder, hip, elbow, knee, etc.), and the terms "diarthrosis" and "synovial joint" are considered equivalent.
Structural Classification

Structural classification names and divides joints according to the type of binding tissue that connects the bones to each other.

- Fibrous joint – joined by dense regular connective tissue that is rich in collagen fibers
- Cartilaginous joint – joined by cartilage
- Synovial joint* – not directly joined – the bones have a synovial cavity and are united by the dense irregular connective tissue that forms the articular capsule that is normally associated with accessory ligaments.

*Only type of joint on Unit 1 Lecture Exam
Synovial Joints

Have 5 distinguishing features


2. Joint cavity – space that is filled with Synovial fluid. Synovial membrane – covers all the surface within the joint capsule and secretes synovial fluid.

3. Articular capsule – the joint cavity is enclosed by a double-layered articular capsule.

4. Synovial fluid – a slippery fluid that occupies all free spaces within the joint capsule.

5. Reinforcing ligaments – are reinforced by a number of ligaments.
• Some synovial joints such as hip and knee have fatty pads between the fibrous capsule and the bone.
• Some have discs or wedges of fibrocartilage separating the articular surface of bones (e.g. menisci of knee).
• Some synovial joints have bursa which is a fluid filled sac containing the synovial fluid.
• Ligament: a sheet of strong fibrous connective tissue connecting the articular ends of bones, binding them together and facilitating or limiting motion.
• Tendon: Fibrous connective tissue that attaches muscle to bone.
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<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Movements Allowed</th>
<th>Examples</th>
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<tr>
<td>Hinge</td>
<td>Convex surface fits into a concave surface</td>
<td>Flexion, extension</td>
<td>Knee, elbow, interphalangeal joints</td>
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<tr>
<td>Condyloid</td>
<td>Oval shaped projection fits into oval shaped depression</td>
<td>Flexion, extension, abduction, adduction, circumduction</td>
<td>Metacarpophalangeal joints of fingers, radiocarpal joint of wrist</td>
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<td><img src="http://1biology.50megs.com/Biol%202710%20Course%20Objectives/Articulations.pdf" alt="Condyloid joint" /></td>
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<tr>
<td>Saddle</td>
<td>Articular surface of one bone is saddle-shaped; articular surface of other bone “sits” in saddle</td>
<td>Flexion, extension, abduction, adduction, circumduction</td>
<td>First carpometacarpal joint of thumb</td>
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<tr>
<td>Plane</td>
<td>Articulating surfaces flat or slightly curved</td>
<td>Flexion, extension, inversion, eversion</td>
<td>Superior-inferior articular process articulations between vertebrae</td>
</tr>
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<td>Pivot</td>
<td>Round or pointed surface fits into ring formed partly by bone and partly by ligament</td>
<td>Rotation</td>
<td>Atlanto-axial joint and radioulnar joint</td>
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<tr>
<td>Ball and Socket</td>
<td>Ball like surface fits into cuplike depression</td>
<td>Flexion, extension, abduction, adduction, circumduction, medial and lateral rotation</td>
<td>Shoulder and hip joints</td>
</tr>
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Articulations and Movement: HESI Exam (Not on BIOL2719 Unit One Exam)

http://1biology.50megs.com/Biol%202710%20Course%20Objectives/Articulations.pdf
The cervical curvature, thoracic curvature, lumbar curvature and sacral curvature.

- Lordosis refers to the normal inward *lordotic* curvature of the lumbar and cervical regions of the spine.
- Kyphosis refers to the rounding (convex) curvature of the back.