**MUSCULAR SYSTEM**

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| **Topic from**  **HAPS Guidelines** | **Learning Outcome** | **Tortora** | **HTHS 1110 Objectives** |
| General functions of muscle tissue | 1. List and explain the functions of muscle tissue. | 10.1 | Module 9 Objective 1. List the various functions of skeletal, cardiac, and smooth muscles. Understand the meaning of the terms excitability, contractility, extensibility, and elasticity as properties of muscle tissues. |
| Identification, general location, & comparative characteristics of skeletal, smooth, & cardiac muscle tissue | 1. Identify skeletal, cardiac and smooth muscle. | 10.1  10.8  10.9 | Module 9 Objective 2. Describe the structure, location in the body, and function of skeletal, cardiac and smooth muscle. Compare and contrast the characteristics of skeletal, cardiac and smooth muscle. |
| 1. Describe the structure, location in the body and function of skeletal, cardiac and smooth muscle. | 10.1  10.8  10.9 |
| 1. Compare and contrast the characteristics of skeletal, cardiac and smooth muscle. | 10.1  10.8  10.9 |
| Detailed gross & microscopic anatomy of skeletal muscle | 1. Describe the organization of muscle tissue from cell to whole muscle to groups of muscles. | 10.2 | Module 9 Objective 3. Describe the organization of muscle tissue from cell to whole muscle to groups of muscles. |
| 1. Name the connective tissue layers that surround each cell, fascicle, muscle, and group of muscles and indicate the specific type of connective tissue that composes all of these layers. | 10.2 | Module 9 Objective 4. Name the connective tissue layers that surround each cell, fascicle, muscle, and group of muscles, and indicate the specific type of connective tissue that composes all of these layers. Understand how connective tissues attach muscles to bone. |
| 1. Describe a skeletal muscle fiber including the transverse (T) tubules, sarcoplasmic reticulum and myofibrils. | 10.2 | Module 9 Objective 6. Describe the microscopic anatomy of a skeletal muscle fiber including the sarcolemma, transverse (T) tubules, sarcoplasm, sarcoplasmic reticulum and myofibrils. |
| 1. Explain the organization of a myofibril. | 10.2 | Module 9 Objective 7. Explain the organization of a myofibril. |
| 1. Name, and describe the function of, each of the contractile, regulatory, and structural protein components of a sarcomere. | 10.2 | Module 9 Objective 8. Recognize the elements of a sarcomere, and understand the sarcomere’s importance in the organization of a myofibril.  Module 9 Objective 9. Name and describe the function of each of the contractile, regulatory, and structural protein components of a sarcomere. Learn the names of the proteins which compose the thick and thin myofilaments. |
| 1. Describe the anatomy of the neuromuscular junction. | 10.3 | Module 9 Objective 14. Describe the anatomy of the neuromuscular junction and the role of acetylcholine (ACh), acetylcholinesterase (AChE) and each of the following structures: the neuromuscular junction, synaptic cleft, motor endplate, and motor unit. |
| 1. List the anatomical and metabolic characteristics of fast, slow, and intermediate muscle fibers. | 10.6 | Module 9 Objective 21. List the anatomical and metabolic characteristics of fast, slow, and intermediate muscle fibers. |

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| Physiology of skeletal muscle contraction | 1. Explain the sliding filament theory of muscle contraction. | 10.3 | Module 9 Objective 10. Explain the sliding-filament mechanism of muscle contraction. |
| 1. Describe the sequence of events involved in the contraction cycle of skeletal muscle. | 10.3 | Module 9 Objective 11. Describe the sequence of events involved in the contraction cycle of muscle. Recite the specific roles played by ATP, myosin, actin, troponin, tropomyosin, and calcium. |
| 1. Explain how an electrical signal from the nervous system arrives at the neuromuscular junction. | 10.3 | Module 9 Objective 13. Explain how an electrical signal from the nervous system arrives at the neuromuscular junction. |
| 1. Describe, in order, the events that occur at the neuromuscular junction that elicit an action potential in the muscle fiber. | 10.3  12.5 | Module 9 Objective 15. Describe, in order, the events that occur at the neuromuscular junction to elicit an action potential in the muscle fiber. |
| 1. Explain what is meant by the expression "excitation-contraction coupling". | 10.3 | Module 9 Objective 16. Explain what is meant by the expression “excitation-contraction coupling”. Describe, in order (starting with a motor neuron and the neuromuscular junction), the sequence of events involved in the contraction cycle of skeletal muscle. |
| Skeletal muscle metabolism | 1. List the sources of energy stored in a typical muscle fiber. | 10.4 | Module 9 Objective 17. List the sources of energy stored in a typical muscle fiber. Describe the reactions by which muscle fibers produce ATP, both aerobically and anaerobically. Understand the specific role of creatine phosphate in muscle tissues. |
| 1. Describe the mechanisms that muscle fibers use to obtain ATP for muscle contraction. | 10.4 |
| 1. Explain the factors that contribute to muscle fatigue. | 10.4 | Module 9 Objective 18. Explain the factors that contribute to muscle fatigue. Why is excess post-exercise oxygen consumption important? |
| 1. Summarize the events that occur during the recovery period of muscle contraction. | 10.4 |
| 1. Compare and contrast the metabolism of skeletal, cardiac and smooth muscle. |  | Module 9 Objective 19. Compare and contrast the metabolism of skeletal, cardiac, and smooth muscle. |
| Principles & types of whole muscle contraction | 1. Interpret a myogram of a twitch contraction with respect to the duration of the latent, contraction and relaxation periods and describe the events that occur in each period. | 10.5 | Module 9 Objective 22. Interpret a myogram of a twitch contraction with respect to the duration of the latent period, contraction period, relaxation period, and refractory period. Describe the events that occur in each period. |
| 1. Define the terms tension and contraction, with respect to muscles. | 10.5 | Module 9 Objective 12. With respect to muscles, define the terms tension and contraction. Explain how variations in stretching or constricting sarcomere length affects the ability of the muscle to produce tension, and therefore contract. |
| 1. Define the term motor unit. | 10.5 | Module 9 Objective 20. Define the term “motor unit.” Identify the relationship between muscular precision and the number of muscle fibers per motor unit. |
| 1. With respect to the mechanisms by which musclesgenerate variable amounts of tension: |  | Module 9 Objective 23. Understand how the frequency of stimulation affects muscle tension and how muscle tone is produced. Discuss the anatomical basis for these relationships. |
| 1. Interpret a myogram or graph of tension vs. stimulus frequency and explain the physiological basis for the phenomena of treppe, summation and tetanus. |  |
| 1. Interpret a myogram or graph of tension vs. stimulus intensity and explain the physiological basis for the phenomenon of recruitment. |  |
| 1. Interpret a graph of the length-tension relationship and discuss the anatomical basis for that relationship. |  |
| 1. Demonstrate isotonic and isometric contraction and interpret graphs of tension vs. time and muscle length vs. time for each type of contraction. |  | Module 9 Objective 24. Compare isotonic (both concentric and eccentric) and isometric contraction and interpret graphs of tension vs. time and muscle length vs. time for each type of contraction. |
| 1. Demonstrate concentric and eccentric contraction and contrast the relative tension and resistance that exists, as well as the change in muscle length that occurs, in each type of contraction. |  |
| Nomenclature of skeletal muscles | 1. Explain how the name of a muscle can help identify its action, appearance, or location. | 11.2 | Module 9 Objective 25. Explain how the name of a muscle can help identify its action, appearance, or location. |
| Location & function of the major skeletal muscles | 1. Identify the origin, insertion and action of the major skeletal muscles and demonstrate these muscle actions. | 11.1  Exhibits 11.1 to 11.20 | Module 9 Objective 26. Identify what is meant by the origin and the insertion of a skeletal muscle.  Module 9 Objective 29. Identify the origin, insertion, and action of the major skeletal muscles of the body. |
| Group actions of skeletal muscles | 1. Define the terms prime mover (or agonist), antagonist, synergist and fixator. | 11.1 | Module 9 Objective 28. Coordination among muscles: Define the terms prime mover (or agonist), antagonist, synergist, and fixator. For a given movement, differentiate specific muscles that function as prime mover, antagonist, synergist, or fixator. |
| 1. For a given movement, differentiate specific muscles that function as prime mover, antagonist, synergist or fixator. | 11.1 |
| Lever systems | 1. Differentiate among the three classes of levers in terms of the relative position of fulcrum, effort and load, as well as in terms of the relative power and range of motion. | 11.1 | Module 9 Objective 27. Define or identify on a diagram: 1st, 2nd, and 3rd class levers. Differentiate among the three classes of levers in terms of the relative position of fulcrum, effort, and load, as well as in terms of the relative power and range of motion. Give examples of each kind of lever in the muscular system of the body. |
| 1. Give examples in the human body of muscles and their associated joints to illustrate each type of lever system. | 11.1 |
| Application of homeostatic mechanisms | 1. Provide specific examples to demonstrate how the muscular system responds to maintain homeostasis in the body |  |  |
| 1. Explain how the muscular system relates to other body systems to maintain homeostasis |  | Module 9 Objective 30. Learn the specific examples below (from Tortora ) on how the muscular system relates to other body systems to maintain homeostasis. |
| Predictions related to homeostatic imbalance, including disease  states & disorders | 1. Predict factors or situations affecting the muscular system that could disrupt homeostasis. |  | Module 9 Objective 31. Predict factors or situations affecting the muscular system that could disrupt homeostasis. Predict the types of problems that would occur in the body if the muscular system could not maintain homeostasis. |
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