Muscular System

Lecture outline

- Structure of a skeletal muscle
 - Connective tissue covering
 - Skeletal muscle fiber
 - Neuromuscular Junction
 - Motor Units
- Skeletal muscle contraction
 - Role of Myosin and Actin
 - Stimulus for Contraction
- Skeletal Anatomy

Function of the Muscle System

- Provides motor movement.
- Maintain posture and body position
- Support soft tissue- abdominal wall
- Helps Maintain body temperature
- Propel body fluids and food, and generates heart beat.

Introduction:

A. All movements require muscle which are organs using chemical energy to contract.

B. The three types of muscle in the body are skeletal, smooth, and cardiac muscle.

Structure of a Skeletal Muscle

A. Each muscle is an organ, comprised of skeletal muscle tissue, connective tissues, nervous tissue, and blood.

B. Each cell in skeletal muscle tissue is a single muscle fiber



B. Connective Tissue Coverings

- 1. Layers of dense connective tissue, called **fascia**, surround and separate each muscle.
- 2. This connective tissue extends beyond the ends of the muscle and gives rise to <u>tendons</u> that are fused to the periosteum of bones.

C. Skeletal Muscle Fibers

Convright©The McGraw-Hill Companies Inc. Pe

- 1. Each muscle <u>fiber</u> is a single, long, cylindrical muscle cell.
- 2. Beneath the <u>sarcolemma</u> (cell membrane) lies <u>sarcoplasm</u> (cytoplasm) with many mitochondria and nuclei; the sarcoplasm contains many **myofibrils**.



Filaments of the MyoFibril

- a. Thick filaments of myofibrils are made up of the protein myosin.
- b. Thin filaments of myofibrils are made up of the protein <u>actin</u>.
- c. The organization of these filaments produces striations.



3. A sarcomere extends from Z line to Z line.

- a. <u>I bands</u> (light bands) made up of actin filaments are anchored to Z lines.
- b. <u>A bands</u> (dark bands) are made up of thick filaments and the overlapping thick and thin filaments.

Copyright®The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

4. Beneath the sarcolemma of a muscle fiber lies the <u>sarcoplasmic reticulum</u> (endoplasmic reticulum), which is associated with <u>transverse (T) tubules</u> (invaginations of the sarcolemma).



D. Neuromuscular Junction

- 1. The site where the motor neuron and muscle fiber meet is the neuromuscular junction.
 - a. The muscle fiber membrane forms a <u>motor end plate</u> in which the sarcolemma is tightly folded and where nuclei and mitochondria are abundant.
 - b. The cytoplasm of the motor neuron contains numerous mitochondria and <u>synaptic</u> <u>vesicles</u> storing neurotransmitters.





E. Motor Units 1. A motor neuron and the muscle fibers it controls make up a motor unit; when stimulated to do so, the muscle fibers of the motor unit contract all at once.















(a) Resting muscle: Fatty acids are catabolized; the ATP product is used to build energy reserves of ATP, CP, and glycogen.





(c) Peak activity: Most ATP is produced through glycolysis, with lactic acid as a by-product. Mitochondrial activity (not shown) now provides only about one-third of the ATP consumed.



Copyright The McGraw-Hill Companies, Inc. Permission required for reproduction or display

2. <u>Multiunit smooth muscle</u> and <u>visceral muscle</u> are two types of smooth muscles.

a. In multiunit smooth muscle, such as in the blood vessels and iris of the eye, fibers occur separately rather than as sheets.

Copyright©The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

b. Visceral smooth muscle occurs in sheets and is found in the walls of hollow organs; these fibers can stimulate one another and display rhythmicity, and are thus responsible for peristalsis in hollow organs and tubes.

B. Smooth Muscle Contraction

- 1. The myosin-binding-to-actin mechanism is the mostly same for smooth muscles and skeletal muscles.
- 2. Both acetylcholine and norepinephrine stimulate and inhibit smooth muscle contraction, depending on the target muscle.

3. Hormones can also stimulate or inhibit contraction.

4. Smooth muscle is slower to contract and relax than is skeletal muscle, but can contract longer using the same amount of ATP.

♦Cardiac Muscle

- A. The mechanism of contraction in cardiac muscle is essentially the same as that for skeletal and smooth muscle, but with some differences.
- B. Cardiac muscle has transverse tubules that supply extra calcium, and can thus contract for longer periods.

- C. Complex membrane junctions, called intercalated disks, join cells and transmit the force of contraction from one cell to the next, as well as aid in the rapid transmission of impulses throughout the heart.
- D. Cardiac muscle is self-exciting and rhythmic, and the whole structure contracts as a unit.

♦ Skeletal Muscle Actions

A. Origin and Insertion

- The immovable end of a muscle is the origin, while the movable end is the insertion; contraction pulls the insertion toward the origin.
- 2. Some muscles have more than one insertion or origin.

B. Interaction of Skeletal Muscles

- Of a group of muscles, the one 1. doing the majority of the work is the prime mover.
- Helper muscles are called 2. synergists; opposing muscles are called antagonists.

♦ Major Skeletal Muscles

A. Muscles are named according to an of the following criteria: size, shape, location, action, number of attachments, or direction of its fibers.





B. Muscles of Facial Expression

- 1. Muscles of facial expression attach to underlying bones and overlying connective tissue of skin, and are responsible for the variety of facial expressions possible in the human face.
- 2. Major muscles include epicranius, orbicularis oculi, orbicularis oris, buccinator, zygomatigus,









D. Muscles that Move the Head

- 1. Paired muscles in the neck and back flex, extend, and turn the head.
- 2. Major muscles include sternocleidomastoid, splenius capitis, and semispinalis capitis.





E. <u>Muscles that Move the Pectoral</u> <u>Girdle</u>

- 1. The chest and shoulder muscles move the scapula.
- 2. Major muscles include trapezius, rhomboideus major, levator scapulae, serratus anterior, and pectoralis minor.





Copyright©The McGraw-Hill Cor



F. <u>Muscles that Move the Arm</u> 1. Muscles connect the arm to the pectoral girdle, ribs, and vertebral column, making the arm freely movable. 2. Flexors include the coracobrachialis and pectoralis major.

duction or display.





CopyrightSThe McGraw-Hill Companies, Inc. Permission required for reproduction or display.

- 3. <u>Extensors</u> include the teres major and latissimus dorsi.
- 4. <u>Abductors</u> include the supraspinatus and the deltoid.
- 5. <u>Rotators</u> are the subscapularis, infraspinatus, and teres minor.









H. <u>Muscles that Move the Wrist, Hand, and</u> <u>Fingers</u>

- 1. Movements of the hand are caused by muscles originating from the distal humerus, and the radius and ulna.
- 2. Flexors include the flexor carpi radialis, flexor carpi ulnaris, palmaris longus, and flexor digitorum profundus.

3. Extensors include the extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris, and extensor digitorum.



I. Muscles of the Abdominal Wall

- 1. This group of muscles connects the rib cage and vertebral column to the pelvic girdle.
 - a. A band of tough connective tissue, the linea alba, extending from the xiphoid process to the symphysis pubis, serves as an attachment for certain abdominal wall muscles.

Copyright@The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

2. These four muscles include: external oblique, internal oblique, transverse abdominis, and rectus abdominis.

K. Muscles that Move the Thigh

- 1. The muscles that move the thigh are attached to the femur and to the pelvic girdle.
- 2. Anterior group includes the psoas major and iliacus.



Copyright 6The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

- 3. Posterior group is made up of the gluteus maximus, gluteus medius, gluteus minimus, and tensor fasciae latae.
- 4. Thigh adductors include the adductor longus, adductor magnus, and gracilis.

Copyright©The McGraw-Hill Companies, Inc. Permission required for reproduction or displa

- L. Muscles that Move the Leg
 - 1. This group connects the tibia or fibula to the femur or pelvic girdle.
 - 2. Flexors are the biceps femoris, semitendinosus, semimembranosus, and sartorius.
 - 3. An extensor is the quadruceps femoris group made up of four parts: rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius.



M.<u>Muscles that Move the Ankle, Foot, and</u> Toes

- 1. Muscles that move the foot are attached to the femur, fibula, or tibia, and move the foot upward, downward, or in a turning motion.
- 2. Dorsal flexors include the tibialis anterior, peroneus tertius, and extensor digitorum longus.



